

BOUND

- ✓ 1. IV. Crustacea. *of Lake Titicaca*  
Bull. Mus. Comp. Zool., 1876, pp. 361-375,  
figs. 1-37.
- ✓ 2. Description of Lucifer Typus, M.-Edw.?  
Johns Hopkins Biol. Lab. Stud, Vol. 1,  
1878, pp. 113-119, pl. 7.
- ✓ 3. On some young stages in the development of  
Hippra, Porcellana, and Pinnixa.  
Bull. Mus. Comp. Zool., Vol. V, No. 11,  
1879, pp. 253-268, pls. I-V.
- ✓ 4. On the Development of Palaemonetes vulgaris.  
Bull. Mus. Comp. Zool., Vol. V, No. 15,  
1879, pp. 303-330, pls. I-IV.
- ✓ 5. On some points in the structure of the embryonic  
Zoea.  
Bull. Mus. Comp. Zool., Vol. VI, No. 10,  
1880, pp. 159-166, pls. I & II.
- ✓ 6. On some Crustacean deformities.  
Bull. Mus. Comp. Zool., Vol. VIII, No. 13,  
1881, pp. 257-274, pls. I & II.
- 7. *Selections from Embryological monographs.*  
I. Crustacea.  
Bull. Mus. Comp. Zool., Vol. IX, No. 6,  
1882, pp. 197-250.
- 8. Chromatophores in Crustaceans.  
Amer. Nat., May, 1883, pp. 553-556.
- ✓ 9. Art. VIII. On the so-called Dimorphism in  
the Genus Cambarus.  
Amer. Jour. Sci., Vol. XXVIII, Jan., 1884,  
pp. 42-44.
- ✓ 10. Descriptions of new species of Cambarus; to which  
is added a synonymical list of the known species  
of Cambarus and Astacus.  
Contrib. from the Zool. Lab. of the Mus.  
Comp. Zool., [Reprinted from Proc. Amer. Acad.  
Arts & Sci., Vol. XX, pp. 107-158. 1884.



- ✓11. A list of the Astacidae in the U. S. National Museum.  
Proc. U. S. Nat. Mus., 1885, pp. 355-362.
- ✓12. Notes on North American Crayfishes, Family Astacidae.  
Proc. U. S. Nat. Mus., Vol. XII, No. 785, 1890, pp. 619-634.
- ✓13. VI. Preliminary Descriptions of New Species of Crustacea.  
Bull. Mus. Comp. Zool., Vol. XXIV, No. 7, 1893, pp. 149-220.
- ✓14. XXXVII. Supplementary Notes on the Crustacea.  
Bull. Mus. Comp. Zool., Vol. XXX, No. 3, 1896, pp. 153-166, pls. I & II.
- ✓15. Observations on the Astacidae in the United States National Museum and in the Museum of Comparative Zoology, with descriptions of new species.  
Proc. U. S. Nat. Mus., Vol. XX, No. 1136, pp. 643-694, pls. LXII-LXX. 1898.
- ✓16. Preliminary Catalogue of the Crayfishes of Kansas.  
Bull. Washb. Coll., i, pp. 140-146. 1886?

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Division of Crustacea







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No. 16. — *Exploration of Lake Titicaca* by ALEXANDER AGASSIZ  
and S. W. GARMAN.

1876.

IV. *Crustacea.* By WALTER FAXON.

THE crustacean fauna of Lake Titicaca, as indicated by the dredgings of Mr. Agassiz, carried on with the assistance of Mr. S. W. Garman, in January and February, 1875, is very meagre. Excepting a species of *Cypris*, all the specimens collected belong to one amphipodous genus, *Allorchestes*, which had hitherto afforded but one or two authentic fresh-water species, ranging from Maine to Oregon and the Straits of Magellan. Seven new species are described in this paper from Lake Titicaca. Several of them are remarkable among the *Orchestidæ* for their abnormally developed epimeral and tergal spines. Some are also noteworthy as comparatively deep-water forms of a family commonly regarded as pre-eminently littoral. I believe that no *Orchestidæ* have heretofore been found at a depth so great as sixty-six fathoms,\* unless it be *Orchestia (Talitrus) Brasiliensis* Dana and *Nicea media* (Dana), dredged in the harbor of Rio Janeiro (at what depth is not specified) by the Wilkes Exploring Expedition. The marine species usually inhabit the shore above low-water mark, and the previously described fresh-water species are found in the shallow water of brooks, pools, or edges of lakes. No strictly fresh-water *Orchestidæ* have been reported from the Eastern continent, although a few terrestrial *Orchestiæ* are described as inhabiting moist soil away from the sea.

\* The greatest depth of the lake is 154 fathoms.

## ORDER AMPHIPODA.

## FAMILY ORCHESTIDÆ.

## GENUS ALLORCHESTES.

- Syn. 1849. *Allorchestes* (in part) DANA, Amer. Jour. Sci. [2], VIII. 136.  
 1852. *Allorchestes* (in part) DANA, Proc. Amer. Acad. Sci. Boston, II. 205.  
 1852. *Allorchestes* (in part) DANA, U. S. Explor. Exped. XIII. Crust. Pt. II. 883.  
 1856. *Allorchestes* BATE, Rep. Brit. Assoc. 1855, p. 57 (no descrip.).  
 1857. *Allorchestes* BATE, Ann. Mag. Nat. Hist. [2], XIX. 136.  
 1861. *Allorchestes* BATE and WESTWOOD, Brit. Sessile-eyed Crust. I. 38.  
 1862. *Allorchestes* BATE, Cat. Amphip. Crust. Brit. Mus. p. 34.  
 1866. *Allorchestes* HELLER, Beitr. z. näh. Kennt. d. Amphip. d. adriat. Meeres, p. 4. Denkschr. d. Math.-Natur. Classe d. Akad. d. Wissensch.  
 1874. *Hyaella* SMITH, Rep. U. S. Fish Comm. for 1872 and 1873, p. 645.  
 1874. *Hyaella* SMITH, Rep. U. S. Geolog. Geograph. Survey of Colorado for 1873, p. 608.

First maxillæ with small uniarticulate palpi. Palpus of the maxillipeds composed of four segments, the distal segment usually bearing a movable spine at its apex. First antennæ shorter than the second antennæ, longer than the peduncle of the second antennæ. First and second thoracic legs subcheliform. Propodite of second pair larger than propodite of first pair, and much larger in the male than in the female. Telson short and entire.

\* Differs from *Nicea* Nicolet (as limited by Bate and Heller) in having the telson single instead of double or cleft. The fourth segment of the palpus of the maxillipeds is well developed, as in *Nicea* and *Gammarus*, and, as in these genera, is commonly unguiculiferous. Neither Dana, in describing *Allorchestes*, nor Nicolet, in his description of *Nicea*\* (published in the same year), mentioned the form of the telson. The two names were therefore synonymes. Bate, in a list of British *Amphipoda*, published in 1856 in the Report of the British Association for the Advancement of Science, indicates, without describing, two genera, *Allorchestes* Dana and *Galanthis*, *gen. nov.*, which, as appears from his subsequent descriptions, were based upon the trivial character of a different relative length of the first and second antennæ, and a *differently formed telson*; Dana's name, *Allorchestes*,\* being restricted to those species in which the first antennæ are (at least) as long

\* Gay's *Historia de Chile*. Zool., III. 237, 1849.

as the peduncle of the second antennæ and the telson entire, and his own name *Galanthis* including the species with the two pairs of antennæ subequal and short and the telson cleft or double. In 1861 he suppressed the name *Galanthis* in favor of Nicolet's *Nicea*. The proportion of the antennæ and the form of the telson brought together by Bate in his generic diagnoses are not in reality always concomitant, and Heller for the first time properly distinguished the two genera by the character of the telson alone. Grube\* adopts the relative length of the two pairs of antennæ (at most a specific character) as the generic distinction. All his species of *Allorchestes* have a double telson, and should be transferred to *Nicea*.

Boeck,† apparently misled by the fact that Bate carelessly describes *Nicea Nilssonii* with an entire telson, and places it under *Allorchestes*,‡ would unite the two genera, giving as a generic character "*appendix caudalis brevis, crassa et fissa*." He furthermore considers both *Allorchestes* and *Nicea* synonymous with Rathke's older *Hyale*,§ the type of which, *H. Pontica*, was carefully described and figured with the posterior caudal stylets two-branched. Boeck has not had access to Rathke's type, as far as I can learn; but in a specimen from the Mediterranean, "which is doubtless Rathke's species," he finds the last pair of saltatory appendages one-branched. This assumption of identity, it seems to me, cannot outweigh the careful description and illustration of the founder of the genus, unless confirmed by examination of the type of *Hyale Pontica*.

In 1874 Professor S. I. Smith described a new amphipodous genus, *Hyalella*, from the fresh waters of the United States, differing from "*Hyale*" in having a styliform fifth segment to the palpus of the maxillipeds and an entire telson. The so-called fifth segment may perhaps be more correctly regarded as a movable spine, like those seen both lateral and terminal on the caudal stylets, or like the *unguis* which tips the dactylopodite of the thoracic legs. However this may be, it is quite as well developed in several species of "*Hyale*" (*Nicea*), and is not therefore a generic character. *Hyalella* is then a synonyme of *Allorchestes*.

\* Beitr. z. Kennt. d. istrischen Amphipodenfauna, Arch. f. Natur. 1866. pp. 382, 387.

† De Skandinaviske og Arktiske Amphipoder, beskrevne af Axel Boeck. Første Hefte. 1872. I am indebted to Dr. Hagen for a translation of Boeck's Norwegian.

‡ Doubtless a large number of the species placed under *Allorchestes* by Bate in his Catalogue of the *Amphipoda* in the British Museum have in reality a divided telson. In fact, it would seem that the telson is cleft in *most* of the marine forms, and such probably formed the bulk of Dana's original genus *Allorchestes*. The only types of Dana's species that I can discover are two specimens of *A. media* in the Museum of Comparative Zoölogy. In these the telson is cleft to the base. This, however, will not affect the synonymy as given above.

§ Zur Fauna der Krym, p. 87, Pl. V. Figs. 20 - 28, 1836.



*Allorchestes armatus*, sp. nov.

Fig. 1.

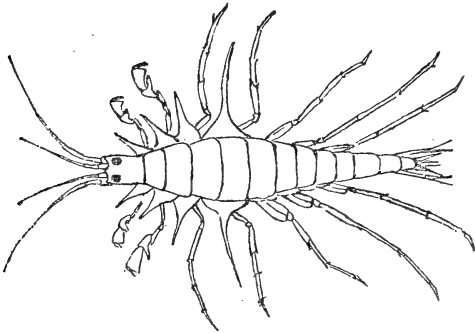


Fig. 2.

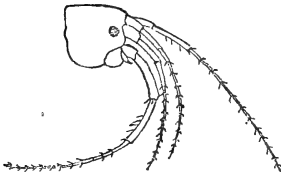


Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Figs. 1-9. *Allorchestes armatus*: 1. Female, dorsal view (nat. s. 9mm). — 2. Head. — 3. 1st maxilla. 4. 2d maxilla. — 5. Mandible. — 6. Maxilliped. — 7. Distal end of 4th segment of maxilliped bearing a movable spine. — 8. 1st thoracic leg. — 9. 2d thoracic leg of male.

Fig. 10.



Fig. 11.



Fig. 12.



Fig. 14.

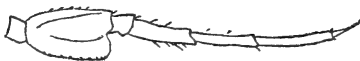


Fig. 13.

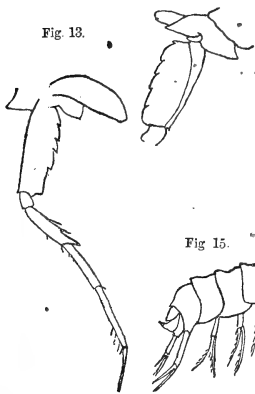


Fig. 16.

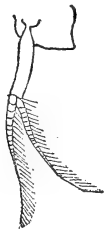


Fig. 17.



Fig. 18.

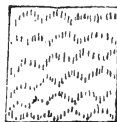


Fig. 15.



Figs. 10-18. *Allorchestes armatus*: 10. 2d thoracic leg of female, with epimeron, gill and incubatory plate.—11. 3d thoracic leg.—12. Section of body of female (4th thoracic segment) showing the incubatory pouch with two eggs.—13. 5th thoracic leg.—14. 7th thoracic leg.—15. Abdomen, side view.—16. 2d abdominal leg.—17. Caudal stylets.—18. Hairs on the integument under 625 diameters.

Body stout. Hind margin of the segments raised so as to form conspicuous transverse ridges. Fore margin of the head produced into a point

between the first antennæ, and on each side in front of the eyes. Eyes round. Epimera of the first four thoracic segments produced into prominent spines. The spines of the first and second pair are of about the same length; the third somewhat longer; the fourth longest, being about twice as long as the third, and exceeding the breadth of the broadest segment of the body. The first three pairs are directed downward and forward, while the fourth project at nearly right angles to both the longitudinal and vertical axes of the body. Telson broad, entire.

Peduncle of first antenna reaching the middle of the last segment of the peduncle of second antennæ; flagellum composed of twelve segments. Second antenna much longer than first antenna; basal segment clearly separated from the head; olfactory denticle prominent; flagellum composed of thirteen segments. Carpopodite of first pair of legs triangular, as broad as the propodite, furnished with setæ on its distal margin; palm of propodite slightly concave, transverse; dactylopodite curved. Second pair of legs in the male very large; meropodite armed with prominent setæ at the antero-inferior angle; carpopodite with a long process, setiferous at its extremity, projecting downward and forward between the propodite and the meropodite; propodite large, convex above and below, palm oblique, straight, with small setæ; dactylopodite slender, curved. In the female, the second pair of legs are smaller, the propodite similar to the corresponding segment of the first pair, and not broader than the meropodite; the palm nearly perpendicular to the straight lower margin; lower angle of the meropodite projecting under the propodite as a blunt process, much shorter than the same process in the male. Fifth pair of legs about as long as the fourth. Sixth and seventh of about equal length, much longer than the fifth; when extended backward reaching considerably beyond the end of the longest caudal stylets. Hind margin of the basipodites of the fifth, sixth, and seventh pair of legs slightly serrate. Third pair of caudal stylets very small, curved upward, so as to project but little beyond the telson.

The shell viewed under the microscope is furnished with rows of very minute hairs, arranged as in Fig. 18.

Length from front of head to end of telson, 8<sup>mm.</sup> to 10<sup>mm.</sup> Breadth from tip to tip of fourth pair of epimeral spines, 6<sup>mm.</sup> to 10<sup>mm.</sup>

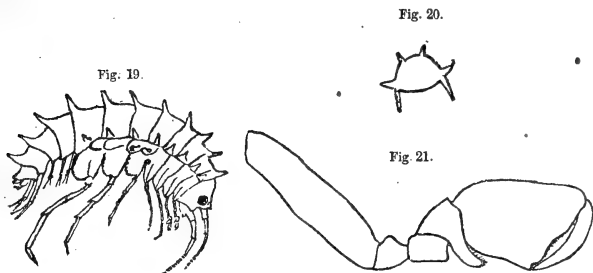
Collected at the following places in the lake:—

Achacache, 11 fathoms,	countless specimens.
Gulf of Puno,	88 specimens.
Gulf of Desaguadero,	1 specimen.
Chuquito, 40 fathoms,	4 specimens.
Juli, 60 fathoms,	25 specimens.
Between Taquilli and Amantane, 66 fathoms,	2 specimens.

This seems to be the commonest crustacean of Lake Titicaca. The length

of the lateral spines is variable. In specimens from the deeper soundings they are much longer than in those from shallower depths. The specimens from 66 fathoms measure 10<sup>mm.</sup> between the tips of the fourth pair of spines; length of a single spine, 4<sup>mm.</sup>; from front of head to end of telson, 8<sup>mm.</sup> Average specimens from Achacache, 11 fathoms, measure 7<sup>mm.</sup> from tip to tip of fourth pair of spines; 9<sup>mm.</sup> from front of head to end of telson. The former are also lighter colored and more transparent than the latter. Many of the females are with eggs under the thorax.

**Allorchestes echinus, sp. nov.**



Figs. 19-21. *Allorchestes echinus*: 19. Female (nat. s. 6<sup>mm.</sup>). — 20. Vertical section of body (4th thoracic segment). — 21. 2d thoracic leg of male.

Body short and very stout, with four longitudinal rows of spines. One row on each side of the median line of the back; each spine of this row arises from the hind margin of the terga of the first thoracic to the fourth abdominal segment inclusive. Another row of eight smaller spines lower down on each side of the body; these arise from the terga of the first thoracic to the first abdominal segments inclusive, near their line of junction with the epimera. Slight projection downward and forward from front margin of the head between the first antennæ; a tubercle on each side below the eyes. Eyes round, large, somewhat protuberant. Epimera of first four thoracic segments large, triangular, their apices directed downward; a ridge extends from the base down through the centre of each of these epimera to the apex. The fourth epimeron has beside the ridge a small tubercle on the hind margin. Fifth epimeron bilobed, with a tubercle on each lobe. Telson entire.

Flagellum of first antenna composed of six to eight segments. Basal joint of second antenna swollen and distinct from the head; olfactory den-

ticle prominent; flagellum composed of nine segments. Second pair of legs large in the male; inferior angle of carpopodite produced; palm of propodite concave, notched just above the lower angle and beset with setæ. In the female the carpopodite and propodite of the second pair of legs are of nearly equal size; lower angle of carpopodite produced as in the male. Sixth and seventh pair of legs very long, — one third longer than the fifth. Basipodites of fifth, sixth, and seventh legs serrate on their hind margin. Length from front of head to end of telson, 5mm. to 7mm.

Llampopata,  
Juli,

10-20 fathoms, 2 ♂ 1 ♀  
60 fathoms, 1 ♂

**Allorchestes longipes, sp. nov.**

Fig. 22.

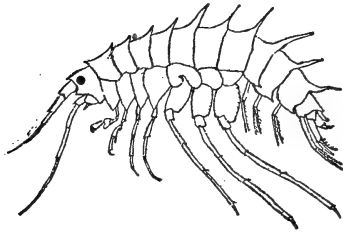


Fig. 23.



Fig. 25.

Fig. 24.



Figs. 22-25. *Allorchestes longipes*: 22. Female (nat. s. 10mm.). — 23. 2d thoracic leg of male. — 24. End of abdomen, from above. — 25. Posterior dorsal margin of 4th abdominal segment of another individual.

A longitudinal row of eleven spines along the middle of the back. The first spine arises from the fore margin of the first thoracic segment; the rest from the hind margin of the first thoracic to the third abdominal segments. The first five are short, the others long, — the eighth and ninth being the longest. Eye round, protuberant. First to fourth pair of epimera long, produced into a point at their lower extremities. Infero-posterior angles

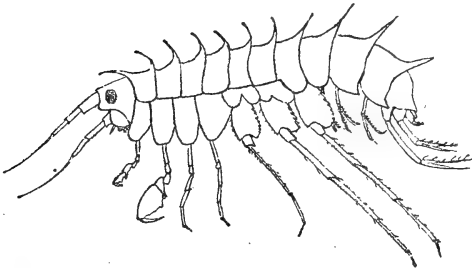
of the first three abdominal segments slightly produced. Hind margin of fourth abdominal segment in some examples has a median projection over the telson, but in others this is reduced to the bold convexity of the whole border (Figs. 24, 25). Telson entire. First antenna equal in length to the distance from the eye to the fifth dorsal spine; flagellum composed of thirteen segments. Second antenna equal to distance from the eye to the sixth dorsal spine; basal segment distinct; olfactory denticle prominent; flagellum composed of fourteen segments. Carpodite of second pair of legs in the male produced at the lower angle; propodite not very large (but larger in the male than in the female) with a slight projection at the lower angle; a few setæ on the lower margin. Sixth and seventh pair of legs very long, about equal to the distance between the first and ninth dorsal spines. Third pair of caudal stylets very short; a few setæ on the hind margin of penultimate segment, and one very slender seta at the tip of the terminal segment. Length from front of head to end of telson, about 10<sup>mm</sup>.

Achacache, 11 fathoms,	12 specimens.
Gulf of Puno,	10 specimens.
Gulf of Desaguadero,	1 specimen.
Chuquito, 40 fathoms,	1 specimen.

The specimen from Chuquito is a female with eggs. It is more transparent than the others, the first two dorsal spines longer and curved forward as in *A. lucifugax*. The epimera of the first four thoracic segments are also longer in this specimen than those obtained from other localities.

***Allorchestes lucifugax*, sp. nov.**

Fig. 26.



*Allorchestes lucifugax*, male (nat. s. 11mm.).

A longitudinal row of eleven spines along the median line of the back. The first spine arises from the fore margin of the first thoracic segment; the

others from the hind margin of the first thoracic to the third abdominal segments. The first spine of the series projects, almost parallel with the longitudinal line of the body, as far as the front of the head. The six following are curved forward. The last three are somewhat longer than the others. Eye oval. First four pairs of epimera long, rounded at their lower ends. Infero-posterior angles of the first three abdominal segments slightly produced.

First and second antennæ of nearly equal length. Propodite of second pair of legs of male with a slight projection at the lower end of the palmary edge; carpopodite produced below. Sixth and seventh pairs of abdominal legs very long, extending far beyond the telson. Telson entire. Length from front of head to end of telson, 11<sup>mm</sup>.

Juli, 60 fathoms,  
Chuquito, 40 fathoms,

1 specimen.  
1 specimen.

The two specimens of this species which were taken are males. The integument is delicate and transparent, as in all the specimens dredged in deep water.

This species resembles the last, but differs from it in the longer and pro-curved anterior spines, and the shape of the four anterior pairs of epimera.

*Allorchestes latimanus*, *sp. nov.*

Fig. 27.

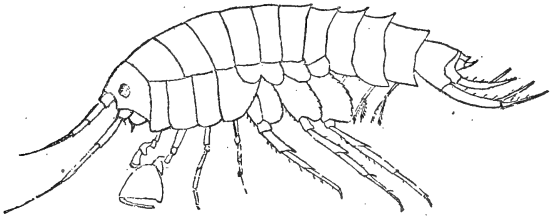


Fig. 28.

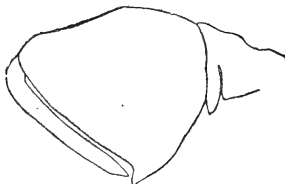


Fig. 27. *Allorchestes latimanus*, male (nat. s. 12<sup>mm</sup>).—28. Hand of second thoracic legs more enlarged.



Body thick. Hind margin of the sixth thoracic to the third abdominal segments inclusive produced into a spiniform tooth on the median dorsal line. Eye nearly round. Epimera of first four thoracic segments quadrilateral, their lower angles rounded. Infrero-posterior angles of the first, second, and third abdominal segments prolonged backward. Peduncle of first antenna reaching the middle of the last segment of the peduncle of the second antenna; length of entire first antenna two thirds the length of second antenna. Second antenna equal to distance from front of the head to fifth thoracic segment; basal segment and olfactory denticle conspicuous. Carpopodite of second pair of legs in the male produced below; propodite broader than long, palm nearly straight, with a projection at its lower end. (In the female the propodite is small, as usual in this sex.) Seventh pair of thoracic legs of moderate length, not extending much beyond the telson when stretched backward. The last pair of caudal stylets reach a little way beyond the telson, which is broad and entire. Length, exclusive of antennæ and caudal appendages, 7<sup>mm.</sup> to 12<sup>mm.</sup>

Llappopata, 10 - 20 fathoms,

11 specimens.

*Allorchestes longipalmus*, *sp. nov.*

Fig. 29.

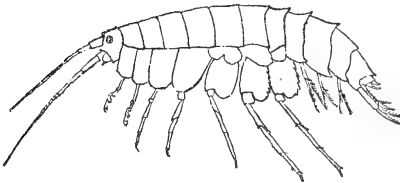


Fig. 30.

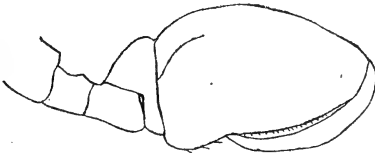


Fig. 31.



Figs. 29-31. *Allorchestes longipalmus*: 29. Female (nat. s. 11mm.).—30. Part of 2d thoracic leg of male.—31. Shell seen under a high magnifying power.

Hind margin of fifth thoracic to third abdominal segments produced into spine-shaped teeth on the median line of the back. Eye round. Epimera of the first four thoracic segments quadrilateral, their lower angles rounded. Infrero-posterior angles of the first three abdominal segments produced be-

hind. Telson entire, with a seta on each side of the hind margin. Peduncle of first antenna about as long as the head and first two thoracic segments together; flagellum composed of fifteen segments. Basal joint of second antenna distinct; olfactory denticle prominent; distal segment of peduncle much longer than the antecedent segment; flagellum longer than the flagellum of first antenna, composed of fifteen segments. Propodite of second pair of legs in the male large and swollen; palmary edge sinuous and very long, encroaching upon the lower margin, armed with setæ; lower margin of propodite short; inferior angle of carpopodite produced between the meropodite and propodite. In the female, as usual in the genus, the second pair of legs are weak, the propodite not larger than the meropodite, the palm making nearly a right angle with the lower margin. Seventh abdominal legs, when extended backward, reach the end of the caudal stylets. The shell, seen under a high magnifying power, is furnished with small scattered hairs, with here and there one of those cross-shaped figures seen in the integument of so many of the *Orchestidæ*. Length of body 9<sup>mm.</sup> to 13<sup>mm.</sup> About two dozen individuals of this species were taken in the lake; the exact locality is not preserved, nor the depth of water. It is closely related to the preceding species, but may be easily distinguished from it by the hand of the second pair of legs.

*Allorchestes cupreus*, *sp. nov.*

Fig. 32.

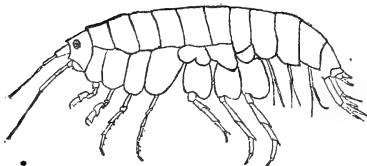


Fig. 33.



Fig. 34.



Figs. 32-34. *Allorchestes cupreus*: 32. Female (nat. s. 10<sup>mm.</sup>). — 33. 2d thoracic leg of male. — 34. Terminal segment of palpus of maxilliped.

Body smooth, without dorsal spines or teeth. Eyes nearly round. Epimera of first four thoracic segments quadrilateral, lower angles rounded. Infero-posterior angles of first three abdominal segments hardly produced backward. Telson entire.

About ten segments in flagellum of first antennæ. Second antenna considerably longer than first antenna, equal to about a third the distance from forehead to the end of the abdominal stylets. Carpopodite of second pair of legs produced downward between the meropodite and propodite; propodite swollen; palm convex, setiferous, with a prominence at its base, against which the tip of the dactylopodite closes; dactylopodite curved, closing against the palm throughout its whole length. Fifth, sixth, and seventh thoracic legs short, with large basipodites lightly serrate on their hind border. Fifth pair much shorter than the sixth and seventh, which are of about equal length. The seventh pair, when stretched backward, reach to the end of the telson. Many parts of the body display a coppery lustre.

In the female, the propodite of the second pair is long and narrow, not broader than the carpopodite; the carpopodite has but a short blunt process at its lower angle in place of the long projection in the male. Length of body, 9<sup>mm</sup>. to 11<sup>mm</sup>. About twenty-four specimens, particular locality not preserved.

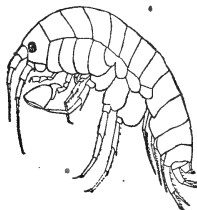
This is a stout species, resembling the last described, but differing in the shape of the propodite of second thoracic legs, want of dorsal teeth, etc.

**Allorchestes dentatus, var. inermis.**

*Hyalella dentata*, Smith, Rep. U. S. Fish Comm. for 1872 and 1873, p. 647, 1874.

*Hyalella inermis*, Smith, Rep. U. S. Geogr. Geolog. Survey of Colorado for 1873, p. 609, 1874.

Fig. 35.



*Allorchestes dentatus, var. inermis, male (nat. s. 5mm.).*

Six specimens were taken from the shallow water of the "Marjal," a marshy tract on the western side of the lake, overflowed during a part of the year.

They differ from specimens from the United States in having a firmer and less transparent shell, and a little differently shaped propodite to the second pair of thoracic legs in the male; hardly enough to warrant the establishment of a new species when one considers the variability of the species within the limits of the United States.

After an examination of a large number of *Hyalella dentata* and *H. inermis* from Utah, I am satisfied that they are but varieties of one species. The form with dorsal teeth on the first and second abdominal segments is very probably synonymous with *Amphitoe aztecus* Saussure\* and *Allorchestes Knickerbockeri* Bate,† as pointed out by Professor Smith himself.

This species (var. *inermis*) was also collected by Mr. Agassiz at San Antonio, Peru, in saline water, 3,300 feet above the sea; nitrate district of Pisagua. The specimens differ slightly from the type described from the United States in having the fifth pair of thoracic legs a little shorter in proportion to the sixth pair.

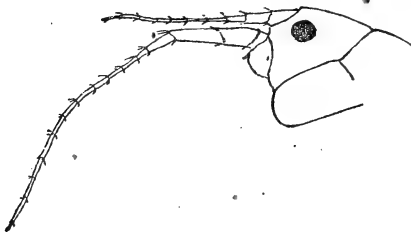
It may be well to announce here the discovery of this species during the voyage of the "Hassler" at Puerto Bueno, Smyth Channel, Straits of Magellan. The specimens do not differ from var. *inermis* from the United States. The ticket accompanying the specimens does not indicate their fresh-water origin; but Count Pourtalès tells me that some animals were collected at Puerto Bueno by Dr. Steindachner and himself in a fresh-water pond and an outlet stream. The *Allorchestes* were probably among them.‡

\* Mémoire sur divers Crustacés nouveaux du Mexique et des Antilles, p. 58, Pl. V. Fig. 33, 1858.

† Catalogue of the Specimens of Amphipodous Crustacea in the Collection of the British Museum, p. 36, Pl. VI. Fig. 1, 1862.

‡ Among the Crustacea collected by the Thayer Expedition in Brazil are two species of *Allorchestes*. One is represented by a unique female specimen taken from a canal

Fig. 36.



*Allorchestes dentatus*, var. *gracilicornis*, head.

at Campos by C. F. Hartt. It differs from *A. dentatus*, var. *inermis*, only in the second pair of antennæ, which are half as long as the body and twice as long as the first pair;

## ORDER OSTRACODA.

## FAMILY CYPRIDIDÆ.

GENUS *CYPRIS*.*Cypris Donnetii*?

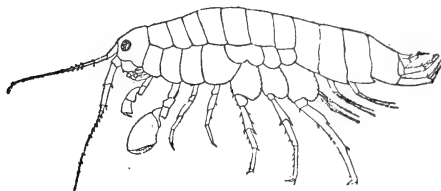
? *Cypris Donnetii*, Baird, Proc. Zoölog. Soc. London, Pt. XVIII. p. 254, 1850.

A great many specimens of *Cypris* were collected by Mr. Garman among the plants growing in the shallow water of the "Marjal." They answer to Baird's description of *C. Donnetii* from fresh-water ponds, Coquimbo.

flagellum composed of thirteen segments. Length of body, 4mm. In the absence of more specimens, I would consider this a variety (*gracilicornis*) of *Allorchestes dentatus*.

The second species is represented by several specimens. It may be called *Allorchestes longistilus*, *sp. nov.* Body smooth, long, and slender. Eyes nearly round. Epimera of

Fig. 37.



*Allorchestes longistilus*, male (nat. s. 6mm.).

first four thoracic segments quadrilateral. Infero-posterior angles of first three abdominal segments produced. Telson entire, with two long setæ on the hind margin. First antenna nearly as long as the second; flagellum composed of thirteen segments. Carpopodite of second thoracic legs produced below; propodite large, broadest at distal end; palm oblique, with large setæ and a projection at the lower angle. Fifth, sixth, and seventh thoracic legs subequal, the seventh, when extended backward, reaching a short distance beyond the end of the telson. Last pair of caudal stylets very long, extending far beyond the tip of the telson, almost to the end of the second pair of stylets. The female has shorter antennæ and small, long, and narrow propodite to second pair of legs. Length of body, 3mm. to 6mm. Swamp three miles south of Campos. Hart. Differs from *A. dentatus*, var. *inermis*, in its slenderer body, longer antennæ, and especially in the length of the third pair of caudal stylets.









Mar. Invert.

2

Journal of the Acad. Nat. Sci. Philad. v. 1 - 1878

## Description of Lucifer Typus. M. Edw.?

BY WALTER FAXON, *Museum of Comp. Zoölogy of Harvard College.*

DURING the early part of August a few specimens of the genus *Lucifer* were taken at night with the hand net, at the surface of the water, in the vicinity of Fort Wool, by Mr. August Schmidt.

As far as I know, this is the first record of the occurrence of this interesting genus on our shores. Messrs. Smith and Harger took a few specimens (species undescribed and undetermined) east of George's Bank, Lat. 41° 25' N., Long. 65° 5' to 30' W., (Note 1.) The described species have come from various points in the Mediterranean, Atlantic, Pacific and Indian Oceans.

### DESCRIPTION.

Antennary segment twice as long as the carapace. A small spine (Figure 1, *s*.) projects from its anterior margin at the base of the eye-stalks.

There is no clear line of demarcation between the antennary segment and the carapace.

Carapace about as long as the first abdominal segment. Its inferior borders crenate. A minute spine on each side. (Figure 1, ζ.)

The first five segments of the abdomen are about equal in size, their latero-inferior margins produced into an obtuse angle at the middle. The sixth segment of the abdomen is almost twice as long as the preceding ones, and is furnished with two teeth on the lower border on either side; the anterior tooth is pointed; the posterior, blunt.

The eye-stalks are clavate, and less than one-half as long as the antennary segment.

The peduncle of the first antennae is composed of a basal segment nearly equal in length to the ocular peduncle, and two short segments. The proximal end of the basal segment is slightly enlarged for the accommodation of the auditory sac with its enclosed otolith. (Figure 1, ε.) (Note 2.) The peduncle bears a long multiarticulate flagellum, the proximal annuli of which are furnished with short setae.

The peduncle of the second antennae is composed of two segments. Of these, the first is very short, and bears a short "olfactory denticle." The second segment is much longer, but not equal to the proximal segment of the first

antennae. The flagellum is apparently about as long as the flagellum of the first pair. The second antennae bear at their base, externally, an "antennal scale," (Figure 1, *d*,) which is fringed with numerous setae, and equals the eye-stalks in length.

The mouth is bounded in front by a large labrum, (Figure 1, *e*; Figure 2, *a*,) then follow a pair of mandibles, (Figure 2, *b*,) and a bilobed metastoma. (Figure 2, *c*,) The first maxillae consist of a small setiferous inner lobe, (Figure 2, *d'*,) a larger outer lobe (Figure 2, *d''*,) also armed with setae, and a palpus. (Figure 2, *d'''*,) The second maxillae (Figure 2, *e'*,) possess a "scaphognathite," (Figure 2, *e''*,) but their structure was not made out in detail. The first maxillipeds (Figure 2, *f*,) are two-jointed, the terminal segment beset with setae on its inner border.

The second maxillipeds (Figure 1, *f*, Figure 2, *g*,) are made up of six segments, the three distal bent back upon the preceding ones. All the segments of this appendage and the four following pairs bear scattered setae.

The four following pairs of appendages (third maxillipeds and first, second and third "deca-podal" legs,) are bent forward. The second pair is the shortest, next in length comes the first pair, next the third, the last being the longest, and furnished with a minute claw at the extremity.

There is no trace of the fourth and fifth pair of "decapodal" legs, nor of outer branches on any of the thoracic pairs.

The first pair of abdominal appendages in this (male) specimen are armed with the peculiar prehensile organ (Figure 1, *m'*), which is commonly found in the males of this genus. It consists of a movable piece (Figure 3, *a*), which closes upon a blunt process, (Figure 3, *b*), tipped with minute teeth. There is but one terminal branch.

The second pair of abdominal appendages have three terminal branches, (Figure 1, *n'*, *n''*, *n'''*), the remaining four pairs possess two terminal branches. The outer branch of the last pair (Figure 1, *r'*) is longer than the inner branch, (about one-third longer than the telson,) and is produced at postero-lateral angle into a sharp tooth. The terminal branches of all the abdominal limbs are furnished with setae, excepting the short plate-like third branch of the second pair, (Figure 1, *n'''*.)

Length, 9 millimetres.

The single specimen obtained agrees in most respects with the description of the earliest known species by J. R. Thompson, (Note 3.) It differs noticeably, however, in the shorter eye-stalks. In this it agrees better with *Lucifer Regnaudii*, M. Edw., (Note 4.) In view of the unsatisfactory description of the known species, I have thought best not to impose a new specific name upon this

specimen until sufficient material is at hand for a critical revision of the species.

CAMBRIDGE, *January 9th, 1879.*

#### NOTES.

1. Report on the Dredgings in the region of St. George's Banks, in 1872. By S. J. Smith and O. Harger. Trans. Conn. Acad. Arts and Sci., III, 26, 1874.

2. The auditory apparatus of *Lucifer* was first observed by SOULEYET, (Comptes Rendus, XVII, 665, *note*, 1843; Froriep's Neue Notizen, XXVIII, 84, *note*, 1843.) Later it was described and figured by HUXLEY. (Notes and Observations made on board H. M. S. Rattlesnake during the years 1846-50. Ann. Mag. Nat. Hist., 1851, p. 305, Pl. XIV, Fig. 1.) *Cf.* also, KRÖYER, Forsøg til en mongraphisk Fremstilling af Kræbsdyrslægten Sergestes. Med Bemærkninger om Dekapodernes Horeredskaber. Kong. Dansk. Vidensk. Selsk. Skrifter. V, Naturvidensk og Math., Afd. IV, 293, Tav. V, Fig. 20, 1859. HEUSEN, Studien über das Gehörorgan der Decapoden. Zeits. Wiss. Zool., XIII, 383, 1863.

3. Zoölogical Researches and Illustrations, p. 58, Pl. VII, Fig. 2, 1829. Thompson's specimen was taken in the Atlantic, Lat.  $11^{\circ} 56' N.$ , Long.  $32^{\circ}$

55' W. He described it under the generic name simply. The trivial name *typus* was given later by Milne Edwards, (Hist. Nat. des Crustacés, II, 469, 1837.)

4. *Loc. cit.*, Pl. 26, Fig. 10. From the Indian Ocean.

Besides the above cited works, *cf.*, with reference to *Lucifer*, DANA, Crust. U. S. Explor. Exped., pp. 668-675, Pl. 44, Fig. 9; 45, Figs. 1-3, 1852.

SEMPER, Zeits. Wiss. Zool., XI, 106-107, 1862.

CLAUS, Ueber einige Schizopoden und niedere Malacostruken Messina's. Zeits. Wiss. Zool. XIII, 433-437, Taf. XXVIII, Fig. 21-26, 1863.

A. DOHRN, Untersuchungen über Bau und Entwicklung der Arthropoden. Zeits. Wiss. Zool., XXI, 356-359, Taf. XXVII, Fig. 1-10, 1871.

WILLEMÖES-SUHM, "Preliminary Remarks on the Development of some Pelagic Decapods." Ann. Mag. Nat. Hist., XVII, 163, 1876. (An interesting note on the development of *Lucifer*, showing that Dana's genus *Erichthina* is a young stage of *Lucifer*. See also, CLAUS, Untersuchungen zur Erforschung der genealogischen Grundlage des Crustacien-Systems, p. 40, 112, 113, 1876.)

STREETS, Contr. to the Nat. Hist. of the Hawaiian and Fanning Islands and Lower California Bull. U. S. National Museum, No. 7, p. 122, 1877.







## EXPLANATION OF FIGURES.

FIGURE 1.—*Lucifer typus* M. Edw.? 9 mm. in length. *a*, eye-stalk; *b*, antenna of first pair; *c*, antenna of second pair; *d*, "scale" of second antenna; *e*, labrum; *f*, second maxilliped; *g*, third maxilliped; *h, i, k*, appendages corresponding to the first, second and third pairs of legs of the higher Decapods; *l*, sac at the end of the *vas deferens*? *m*, first abdominal appendage; *m'*, copulatory organ on the first abdominal appendage; *m''*, terminal branch of the first abdominal appendage; *n, n', n'', n'''*, second abdominal appendage with its three terminal branches; *o, p, q*, third, fourth and fifth abdominal appendages with their two terminal branches; *r, r', r''*, basal segment, outer and inner branches of the sixth abdominal appendage; *s*, antennary segment; *s'*, spine on antennary segment; *t*, carapace; *v, x, y, z, a, β*, first to sixth abdominal segments; *γ*, telson; *δ*, nervous cord in the thorax; *ε*, auditory organ in basal segment of first antenna; *ζ*, spine on the carapace.

FIGURE 2.—Do. Mouth-parts of left side. *a*, labrum; *b*, mandible; *c*, metastoma; *d'*, outer lobe of first maxilla; *d''*, inner lobe of first maxilla; *d'''*, palpus of first maxilla; *e'*, second maxilla; *e''*, scaphognathite; *f*, first maxilliped; *g*, second maxilliped.

FIGURE 3.—Do. Prehensile male organ on the anterior border of the first pair of abdominal appendages,  $\frac{1}{2}$  inch objection. *a*, movable piece which closes upon the process *b*; *c*, muscles which move *a*.



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ON SOME YOUNG STAGES IN THE DEVELOPMENT OF HIPPA,  
PORCELLANA, AND PINNIXA. BY W. FAXON.

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JUNE, 1879.



No. 11. — *On some Young Stages in the Development of Hippa, Porcellana, and Pinnixa.* By WALTER FAXON.

I. *Hippa talpoida.*

DURING the month of August, 1877, I procured large numbers of *Hippa talpoida* on the bathing-beach near Nobska Point, Wood's Hole, Massachusetts, the locality made known by Professor S. I. Smith. Among them were many ovigerous females, from which I obtained the first stage of the larva. As a supplement to Professor Smith's paper on the early stages of this animal,\* I present the following description and figures of the first zoëa-stage, Smith's series beginning with what he presumes to be the second zoëa-stage.

The carapace (Plate I. Figs. 5, 6, 15) is oval, smooth, strongly convex above, curving downward and inward on the sides. It sends a long blunt process forward below the eye-stalks (Plate I. Fig. 6 *b*). Behind, it presents a deep sinus for the accommodation of the abdomen (Plate I. Fig. 15 *b*). Anteriorly it is produced between the eye-stalks into a short, broad, rather blunt rostrum. The carapace has no dorsal or lateral spines. At the points where the lateral spines appear after subsequent moults, there is a thickening of the integument, producing a very slight bulge on the outer surface, a stronger one within (Plate I. Fig. 15 *a*).

The abdomen has nearly the same form as in the later stages of the zoëa. It consists of but five segments, counting the telson. The first abdominal segment of the adult is fused with the second or with the thorax, the sixth with the telson. The fourth segment in the abdomen of the larva is considerably wider behind than in front. The telson is quite different from the telson as seen in Smith's figures of the later stages. Its breadth now slightly exceeds its length, and the curve of the sides is such that nearly the maximum width is reached but a short distance from the anterior border. From the middle it narrows slightly posteriorly, to be produced at the posterior angles into a stout tooth. As in the later stages, the convex posterior margin of the telson is furnished with spines and minute teeth (Plate I. Figs. 13, 14). The number of spines is the same as in the later stages, namely, twenty-six, the eighth, counting from either side, being the longest; but the number of denticles between the spines is much less than in the later stages. Starting with the single median denticle, the spines are separated by single denticles until the tenth spine is

\* The Early Stages of *Hippa talpoida*, with a note on the Structure of the Mandibles and Maxillæ in *Hippa* and *Remipes*. By Sidney I. Smith. Trans. Conn. Acad. III. pp. 311 - 342; Pl. XLV. - XLVIII. 1877.

reached on either side ; the three following interspaces contain two denticles ; the wider space between the outer spine on either side and the lateral tooth gives room for four denticles. Thus we have thirty-nine denticles in all, in place of about one hundred in the stage described by Smith as the second. There is no vestige of appendages upon any of the abdominal segments.

The first pair of antennæ (Plate I. Fig. 8) are nearly as in the earliest stage as described by Smith ; but in some specimens I detected the rudiment of the secondary flagellum in the shape of a small tubercle at their base (*a*). On this point, however, there may be some doubt, as the secondary piece does not appear, according to Mr. Smith's observations, until the megalopa-stage is reached.

In the second pair of antennæ (Plate I. Fig. 9) the rounded prominence which represents the rudimentary flagellum in the "second" stage of the zoëa is so slightly developed as to be scarcely discernible (*c*).

The labrum (Plate I. Fig. 6 *a*) is enormously developed, and seems to be almost prehensile when one watches the motions of the living animal. The oral appendages and the first and second pairs of maxillipeds (natatory legs) (Plate I. Figs. 5, 6, 10-12) are similar in structure to those of the youngest stage observed by Professor Smith ; the outer lobe of the first pair of maxillæ (Plate I. Fig. 11 *b*), however, has but two slender teeth instead of three, as in the later stage, and the outer branches of the natatory legs (Plate I. Figs. 5, 6) bear four long plumose setæ instead of eight. Other differences will be most readily seen by comparing my figures with Professor Smith's. There is no trace of any appendages back of the second maxillipeds.

Length, including the abdomen, about 1 mm.

The heart is plainly visible through the transparent carapace, on the dorsal side of the cephalo-thorax. It has the form of a large, irregular pentagon, lying within a lozenge-shaped pericardial sac, with which it is connected by six delicate threads. The pericardium itself is attached to the walls of the body by stronger ligaments.

The heart gives off three arteries. Of these, one proceeds from the anterior angle, in the median line of the body, in the shape of a large tube to the base of the rostrum, where it suddenly diminishes in volume, but persists as a very minute canal to the tip of the rostrum. At the base of the rostrum, just where the diminution of the median artery occurs, a large lateral tube is given off on each side, which convey the bulk of the blood from the median channel to the eye-stalks. These arteries, which might be appropriately termed the rostral and ophthalmic arteries, are together equivalent to the ophthalmic artery of the adult, the small terminal branches to the eyes in the adult being here found in the form of long and capacious vessels, in relation to the large size of the eyes and their distance apart in the larva.

From the posterior part of the heart, two arteries are given off in the middle line of the body. The upper one is small, extends backward through the abdomen on the dorsal side, and ends in the telson. The other has its origin at nearly the same point as the first, but plunges down to the lower face of

the body. Its further course was not determined. The two posterior vessels correspond to the superior abdominal and sternal arteries of the adult. I was unable to discover any vessels answering to the antennary and hepatic arteries of the adult.

After issuing from the ends of the arteries, the blood may be seen coursing through the cavities of the body back to the heart. Two of these currents are evident in the abdomen, one above, and the other below, the abdominal artery. The venous blood in the cephalo-thorax streams back from the head along the border of the carapace and upward to the heart. No traces of gills exist at this stage. The blood is aerated in a great measure, probably, through the thin walls of the carapace, currents of water being kept up, as in the gill-bearing adult, by the constant motion of the scaphognathite of the second pair of maxillæ.

The integument is nearly colorless and transparent, with a few blotches of bright red pigment. The largest of the pigment-spots are, one on the lower side just back of the mouth, two on the carapace at the points where the lateral spines subsequently appear, and two on the telson (one on either side of the anal opening). Beside these there are a few smaller specks of pigment on the carapace and on the second, third, and fourth segments of the abdomen.

It will be seen, from the foregoing description and from the figures, that we have the same stage of the larva as that noticed by Fritz Müller on the coast of Brazil in the case of *Hippa emerita*. Of this a brief notice and an unsatisfactory figure are given in his work "Für Darwin."\* Up to the time of Smith's observations this was all there was known of the developmental history of *Hippa*. The notice is very brief: "The zoëa of the Tatuira [*Hippa emerita*] (Fig. 25) also appears to differ but little from those of the true crabs, which it likewise resembles in its mode of locomotion. The carapace possesses only a short, broad frontal process; the posterior margin of the tail is edged with numerous short setæ."

Professor Smith says: "Very nearly fully developed embryos, when removed from the egg, were found to possess all the normal articulated appendages of the fully formed zoëæ, but there was no appearance of lateral spines upon the carapax, and the rostrum was broad and obtuse. In this stage the embryo agrees almost perfectly with the figure of the zoëa of *Hippa emerita* from the coast of Brazil, given by Fritz Müller in his work entitled 'Für Darwin.' The difference between the embryo in this stage and the second zoëa-stage [i. e. the stage presumed to be the second] (Plate XLV. Fig. 1), in which the rostrum and lateral spines are enormously developed, suggests the possibility that Müller had observed only imperfectly developed young zoëæ in which the rostrum and lateral spines were not expanded. It seems scarcely probable that such a difference could exist between the first stage of the zoëa, when the veiling membrane, in which, on first escaping from the egg, the

\* Für Darwin. 1864. English Translation by W. S. Dallas, pp. 53, 54; Fig. 25. 1869.



young are usually enveloped, has been entirely cast off, and the lateral spines and the rostrum are fully expanded, and the second zoëa-stage about to be described.\*

As I have now shown that the first stage is really devoid of lateral spines, and has only a short and broad rostrum, it is to be inferred that the so-called "second zoëa-stage" (which was taken in the towing-net) is in reality a later one in the development.† I was unable, with the greatest care, to rear any larvæ through the first moult into the second stage, but I think that one if not more stages remain to be discovered between the first and the earliest described by Smith.

## II. *Porcellana (Polyonyx) macrocheles*.

Among the interesting Crustacean larvæ which the Gulf Stream bears to the southern shores of New England from more southern latitudes, is the peculiar zoëa of *Porcellana macrocheles*. Not uncommon on the coast of the Carolinas, the adult has been found but once, as far as I know, on the coast of New England, Mr. Alexander Agassiz having detected it under stones on the shore at Newport, R. I. In the same category are the young of *Calappa marmorata* and *Ocypoda arenaria*, which are found, the former rarely, the latter quite commonly, as far north as Cape Cod, but which rarely, if ever, survive our rigorous winter.‡

\* *Op. cit.*, pp. 314, 315.

† Professor Smith's "numerous attempts to obtain newly hatched young, by keeping egg-carrying females in aquaria, failed from the parent's invariably casting off the eggs before they were fully matured." (*Op. cit.*, p. 314.) By selecting females with eggs considerably advanced toward maturity, and placing them in a cool place, in shallow vessels covered at the bottom with clean sand, and renewing the water twice a day *directly from the sea*, I found no difficulty in obtaining several broods of young at various times between the 1st and 30th of August. I succeeded best by covering the sand with but a slight depth of water, and tipping up the vessel a little so that part of the sand was above water, thus imitating the natural beach, where at low tide the *Hippæ* are found in the wet sand just above the water-mark. I observed that in vessels so placed the *Hippæ* for a large part of the time preferred the wet sand above the water-line.

For the free use of the laboratory and apparatus of the United States Fish Commission at Wood's Hole, in the summer of 1877, I am indebted to Professor S. F. Baird, U. S. Commissioner of Fish and Fisheries.

‡ Professor S. I. Smith found small, young specimens of *Ocypoda arenaria* in the latter part of August and in September on Fire Island Beach, Long Island, but careful search failed to reveal a single specimen of the adult or half-grown crab. (*Amer. Jour. Sci. and Arts*, 3d Series, VI. p. 68. 1873. *Invert. Animals of Vineyard Sound*, p. 241. 1873.) No one has found the zoëa of this animal so far north, although the megalopa is not uncommon. The zoëæ of *Porcellana* which I collected at Newport were nearly all in the last stage of their development. From these facts it is highly probable that these species are not *natives* of the New England coast.

On several warm, still mornings in August, 1878, the zoëæ of *Porcellana* swarmed in the streaks of smooth water on the edge of the tidal currents at the mouth of Narragansett Bay.\* They are sluggish, and move either forward or backward. The little spines with which their enormously developed rostra are armed serve to accumulate the minute particles floating in the water to such an extent that the little creatures often become quite conspicuous by virtue of the load of dirt which they carry.

Of the numerous specimens which I collected almost all were in the stage immediately preceding the youngest stage of the crab, into which they readily developed in confinement, and some of which were taken from the sea with the zoëæ.

Specimens in the last zoëa-stage (Pl. II. Fig. 1) measure about 16 mm. from the tip of the rostrum to the tips of the posterior spines of the carapace. The rostrum is 11 mm. long, the posterior spines 2.5 mm.

Viewed from the side, the carapace is of a long oval form, extending forward as an enormous rostrum, and backward into two horns curved slightly downward at their ends. The rostrum is furnished with five rows of little spines disposed as shown in the cross-section (Pl. II. Fig. 3). The posterior horns have a single row of spines below (Pl. II. Figs. 2, 4). The first pair of antennæ (Pl. II. Fig. 6) are composed of a long peduncle which is obscurely divided into two or three segments. At its base there is a slight enlargement which contains the auditory apparatus (*a*). The peduncle bears a blunt process (*b*), and a longer segment (*c*) which is furnished with several sensory threads (*d*). The second pair of antennæ consist of a two-jointed peduncle, in the basal segment of which may be seen the orifice of the renal organ (*c*). Of the two branches borne by the peduncle, the inner (*a*) is the longer, and within its transparent integument is seen the multi-articulate flagellum of the antenna of the crab, to be disclosed at the next moult. The outer branch (*b*) is styliform. The mandibles have a many-toothed crown (Pl. II. Fig. 8), and the palpus is represented by a very small protuberance (*a*).† The bilobed metastoma is armed with short setæ on the inner margin of each lobe (Pl. II. Fig. 9). The first pair of maxillæ consist of an inner lobe (Pl. II. Fig. 10 *a*) and

\* I am indebted to Mr. Agassiz for the facilities for investigation afforded by his laboratory at Newport, R. I.

† Although this is certainly the last stage of the zoëa (I obtained the young crab from it after a single cast of the skin), the mandibular palpus is not developed to anything like the extent seen in Dohrn's figure of a *Porcellana* zoëa. (Untersuchungen über Bau und Entwicklung der Arthropoden. Zeits. Wiss. Zool. XXI. p. 373; Taf. XXIX. Fig. 51. 1871.) Claus, describing a *Porcellana* zoëa from Nice in a stage corresponding to the one before us (Marburger Sitzungsberichte, 1867, p. 15), states that the mandibles are destitute of palpi; but in his later work, "Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems," 1876 (p. 58), describing the same stage, he says the rudiment of the palpus exists as a simple prominence.

an outer lobe (*b*) ; the outer lobe bears the palpus (*c*). All the parts which compose the first maxilla are furnished with plumose setæ. The second pair of maxillæ (Pl. II. Fig. 11) consist of four lobes of about equal size, a narrower lobe, and a scaphognathite (*a*) ; all of these lobes are fringed with plumose setæ on their margins.

The two pairs of swimming-feet (first and second maxillipeds) (Pl. II. Fig. 1) are very similar to each other in form. The outer branch is two-jointed, the inner branch four-jointed. The third pair of maxillipeds (Pl. II. Figs. 1, 12) are rudimentary, sac-like structures, which can hardly as yet be of much functional value. They are, however, developed so far as to project beyond the border of the carapace. The inner branch (Fig. 12 *a*) is much longer than the outer (*b*). The latter is tipped with long setæ. Through the transparent sac-like integument the segments of the outer maxilliped of the next stage may be indistinctly seen.

The five pairs of ambulatory limbs of the future crab are doubled up under the carapace (Pl. II. Fig. 1). By removing them from the body of the zoëa their whole form is seen as represented in Pl. II. Fig. 13. Through the thin investing membrane the segmentation of the limbs is quite distinctly seen as it exists in the following stage after the tegument has been thrown off. Even the hooks on the last segment of the second, third, and fourth pairs are visible (*b'*). At the base of the thoracic appendages the gills (six pairs) have already attained a considerable size (Figs. 1, 13 *f*).

The abdomen is composed of six segments. The telson (Pl. II. Fig. 5) is produced on either side into a strong tooth ; the posterior margin is very convex, scalloped, and ornamented with twelve beautiful, feather-like setæ. In specimens about to moult the telson is seen to contain the sixth abdominal segment (*b*) with its appendages (*c*, *d*), as well as the telson (*a*) of the crab. There is a pair of simple unsegmented appendages on the second, third, fourth, and fifth segments of the abdomen (Pl. II. Figs. 1, 14).

The stomach shows through the transparent carapace just back of the base of the rostrum. On either side are four lobes of the liver, two directed forward, two backward. The intestine is straight and simple, and ends in the fore part of the telson below. The heart lies under the centre of the carapace ; from its anterior angle the median artery can be traced nearly to the end of the rostrum ; the sternal artery reaches the lower floor of the thorax near the roots of the third pair of maxillipeds, passing through the great thoracic nerve-mass ; here it forks, one branch proceeding forward, giving off in its course lateral branches to the anterior appendages, the other backward to the abdomen.

The nervous system departs widely from its primitive condition even in this immature stage. The thoracic ganglia are consolidated into an enormous mass which sends nerves to the thoracic appendages. From this thoracic nerve-mass two parallel nerve-cords extend through the abdomen, binding together the ganglia, which lie one in each abdominal segment.

The integument is nearly colorless, with some spots of vermilion pigment on the basal segments of the first and second pairs of maxillipeds, on the tel-

son, and on the lower side of the cephalo-thorax. There is also vermilion in the wall of the intestine.

A few specimens were collected in a younger stage than that described above. They were somewhat smaller than the other specimens; the first pair of antennæ were simple, with three or four sensory threads at the tip; the Decapodal legs were very small buds, much more rudimentary than in the later stage; the third pair of maxillipeds were also smaller, with the inner branch much shorter in proportion to the outer branch; the four pairs of abdominal limbs were present, but of smaller dimensions; the telson displayed but ten plumose setæ on its posterior margin. In other respects they agreed pretty closely with the older individuals.

Many of the specimens in my aquaria developed from the oldest zoëa-stage directly into the first stage of the crab (Plate III. Fig. 1), described further on, in which there is not the slightest trace left of the rostrum or posterior spines of the zoëa. In one instance I detected the young crab in the very act of disengaging itself from its zoëa-case. In another young crab which had just emerged from the zoëa, the shrivelled remnant of the artery and other soft parts within the rostrum of the zoëa was still sticking to its front.

Fritz Müller was right, then, when he surmised that the oldest *Porcellana* zoëa observed by him at Santa Catharina (which was in the same stage as the oldest zoëa described above) would pass through the next moult into a form not differing essentially from the adult *Porcellana*,\* although Claus thinks it probable that there is an intervening form corresponding to the youngest megalopa-stage of the *Brachyura*.†

*First Porcellana-stage* (Plate III. Figs. 1-10). The carapace is now about 2 mm. long; its breadth is about the same as its length. It is suborbicular in its outline, the front broad and furnished with minute hairs.

\* Die Verwandlung der Porcellanen. Arch. f. Naturgeschichte, 1862, 1, p. 198.

† After describing the same stage as the oldest one observed by Müller, Claus says: "Ueber die späteren Entwicklungsstadien fehlen mir leider Beobachtungen, doch wird es nach Analogie mit der Krabbenmetamorphose wahrscheinlich, dass sich noch ein Zwischenglied, etwa dem jüngsten Megalopastadium entsprechend, einschleibt. Fr. Müller bemerkt zwar, dass das mit der nächsten Häutung hervorgehende Thier kaum wesentlich von der erwachsenen *Porcellana* verschieden sei, da die Porcellanen auf die Stufe der *Megalopa* stehen geblieben sind. Indess ist dabei zu bemerken, dass es sich hier um das Endglied der Megalopaformen handelt, zu welchem auch bei den Krabben die Zoëa nicht unmittelbar, sondern durch Zwischenformen führt." (Untersuchungen, p. 59.) In reality, one sees in the young *Porcellana* no zoëa-characters persisting in the shape of large eyes, form and armature of the carapace, such as are found in the youngest stages of megalopæ. In these regards it is as far removed from the youngest megalopa-stage as the adult is. The abdomen, moreover, is relatively no larger than in the mature animal, and, as far as I observed, but little used as a swimming-organ. True, the abdomen is furnished with two-branched setiferous appendages (Pl. III. Fig. 10), but this is not a peculiarity of the youngest megalopa-stage of *Brachyura*; as will be seen further on in *Pinnixa*, like appendages are retained (in both sexes, apparently), even in the youngest crab-stages.

The abdomen is relatively no larger than in adult specimens, and is bent underneath against the sternum. The telson consists of a single piece, with a faint indication of the median suture of the adult. After the next moult the diagonal sutures appear (Fig. 8) and the telson assumes the polymeric character of the adult.\* The posterior border of the telson is fringed with long and delicate setæ.

The first pair of antennæ (Figs. 3, 6 *b*) have an enormously developed basal (auditory) segment (Fig. 3 *a*), followed by a three-jointed peduncle bearing two flagella (*b*, *c*), of which the outer (*c*) is the longer.

The second pair of antennæ are very long (longer than in the adult), composed of about thirty-four segments.

The oral appendages have almost exactly the structure of the corresponding appendages of the adult, which are represented on Plate III. Figs. 13-18. The mandibular palpus has attained its perfect, tri-articulate structure, and is as large in relation to the size of the body of the mandible as it is in the full-grown specimens. This is remarkable when one considers its rudimentary form in the last zoëa-stage (Plate II. Fig. 8 *a*).

The chelipeds are longer than in the adult (Fig. 11). One (commonly the right) is larger than its fellow. Like the four following pairs of thoracic legs, they are beset with setæ on either border.

The ambulatory pairs are also longer than in the adult. The dactylus (Fig. 4) is armed with hooks like those in the full-grown specimens (Fig. 19), but it is much more slender.

The posterior thoracic legs are rudimentary and terminated with a didactyle claw (Fig. 5), as perfectly formed as in the adult.

The second, third, fourth, and fifth abdominal segments bear peculiar two-branched appendages (Fig. 10), furnished with long, feather-like setæ. The large number of individuals which I examined (which it is fair to presume included both sexes) showed no difference in the number and shape of the appendages of the abdomen. In the adult these appendages take on a very different form in both sexes. In the female they become one-branched, slender organs (Fig. 20), and the pair belonging to the second segment disappears.† In the male only one pair persists (on the second segment, Fig. 21); here the second branch exists as a rudiment (*a*). The series of changes through which the abdominal appendages of the young are converted into the adult form I was unhappily unable to follow. In specimens from South Carolina, 6 mm. across the carapace, the external sexual characters are already acquired.

My specimens underwent but little change, before I left Newport in Septem-

\* Milne Edwards thought that the sutures in the telson of *Porcellana* showed that it was formed by a consolidation of the seventh abdominal segment with a pair of appendages belonging to the same segment (*Histoire Naturelle des Crustacés*, II. p. 249. 1837). It is plain from the development that this theory of the structure of the telson is false.

† In the adult females of many species of *Porcellana* the first, second, and third abdominal segments are destitute of appendages.

ber. Several individuals moulted once or twice, but beyond a slight increase in size, a growing opacity of the shell, and the change in the telson noticed above, little alteration was discernible.

On looking at the proportions of the adult *Porcellana macrocheles* (Fig. 11; the carapace of this specimen measured 9 mm. in length by 12.5 mm. in width) one might be inclined to doubt its identity with our young form; but I have material at hand to show that the widening of the carapace is the gradual result of growth. In a specimen 3.5 mm. broad, caught, free-swimming, at Newport on the 30th August, 1865, by Mr. Alexander Agassiz,\* of which he made a sketch at the time, the breadth of the carapace exceeds its length by one fifth. In a specimen from Charleston, S. C., 6 mm. broad, the carapace is less than one fourth broader than long.

As the delicate integument of the young becomes indurated by the deposition of calcareous salts, and the aëration of the blood devolves more and more exclusively upon the gills, the carapace broadens with the expansion of the respiratory chamber. This change in the proportions of the carapace is commonly seen in the *Brachyura* when a graduated series from very small to adult specimens is examined, and Carcinologists cannot be warned too often against establishing new species upon juvenile characters.

#### *List of Works relating to the Development of Porcellana.*

HAILSTONE and WESTWOOD. Descriptions of some Species of Crustaceous Animals.

By S. HAILSTONE, JUN., ESQ. With Illustrations and Remarks, by J. O. WESTWOOD, ESQ., F. L. S., etc. Loudon's Magazine of Natural History, Vol. VIII. pp. 261-277; Figs. 28, 29, May, 1835.

This paper contains descriptions and figures of a series of young specimens of *Porcellana* from Hastings, England (*P. minuta* Westw.; probably the young of *P. longicornis*, M. Edw.). The smallest of these specimens measured 2 mm. in length, and was used by Westwood as an argument against the probability of a metamorphosis in *Porcellana*, which had recently been announced by J. V. Thompson.

THOMPSON, J. V. Memoir on the Metamorphosis in *Porcellana* and *Portunus*. Entomological Magazine, Vol. III. pp. 275-277, Fig. 1, Oct. 1835.

This is the first published notice of the zoëa of *Porcellana*.† Thompson actually

\* Mr. Agassiz has another drawing of a young *Porcellana* raised from the zoëa at Newport, August 17, 1875, which seems to indicate the occurrence of a second species on the coast of New England. In this form the front is prominent and triangular, the dactyli of the ambulatory feet long and without the accessory claws of *Polyonyx*. The length of the carapace is 3 mm., its breadth slightly less.

† According to Claus, who ignores the observations of Thompson, Couch, and Dujardin (Marburger Sitzungsberichte, 1867, p. 12; Untersuchungen über Crustaceen, p. 57), the larva of *Porcellana* was described under the name of *Lonchophorus anceps* as early as 1825 by Eschscholtz. (Bericht über die zoologische Ausbeute während der Reise von Kronstadt bis St. Peter- und Paul. Isis von Oken. 1825, 1, col. 734; Taf. V. Fig. 1.) The animal here referred to, as is evident from the figure, is the Brachyuran zoëa afterwards described by Dohrn (Zeits. Wiss. Zool. XXI.

obtained the larvæ of one of the British species from the eggs, and gives a rude figure of the first stage of the zoëa.

COUCH, R. Q. "On the Metamorphosis of the Decapod Crustaceans. Ann. Rep. and Trans. Cornwall Polytechnic Society, 1843."

An account of Couch's observations (I have not been able to see the original paper) is given in Bell's "History of the British Stalk-eyed Crustacea," Introduction, pp. lv-lvii, Figs. *f*, *g*, *h*. 1853. Couch reared the larvæ of *Porcellana platycheles* from the egg, but it is difficult to understand his confused account and figures as reproduced by Bell. It appears as if Fig. *f*, which is said to represent the larva on its first escape from the egg, must represent one prematurely extracted from the egg while still clad in the intra-oval veiling membrane, with the rostrum folded under the breast.

DUJARDIN, FÉLIX. Observations sur les métamorphoses de la *Porcellana longicornis*, et description de la Zoë, qui est la larve de ce crustacé. Comptes Rendus, XVI. pp. 1204-1207. 1843.

First stage of zoëa, obtained from the eggs. *The horns of the carapace are described as segmented.*

DANA, J. D. United States Exploring Expedition. Crustacea. Pp. 684, 685. Pl. 45, Fig. 12. 1852.

Dana's *Zoëa longispina*, taken in the Sooloo Sea, Feb., 1842, is doubtless the larva of a *Porcellana*.

MÜLLER, FRITZ. Die Verwandlung der Porcellanen. Archiv für Naturgeschichte, 1862, 1, pp. 194-199; Taf. VII.

——— Für Darwin, 1864. (Eng. Trans. p. 53, Fig. 24. 1869.)

Müller observed the zoëæ of three species at Desterro, Brazil, in two stages of development. His first stage, with simple first antennæ and lack of appendages back of the second maxillipeds, is probably the earliest stage of the zoëa after quitting the egg. The second form is doubtless the last zoëa-stage, as Müller himself suspected, although he did not rear it into the *Porcellana*. Müller did not fail to see the Brachyuran character of the development of *Porcellana*.

CLAUS, CARL. Ueber den Entwicklungsmodus der Porcellana-Larven im Vergleich zu den Larven von Pagurus. Sitzungsberichte der Gesellschaft zur Beförderung der gesammten Naturwissenschaften zu Marburg. 1867, pp. 12-16.

——— Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, pp. 57-59; Taf. VII. Figs. 1-13. 1876.

Describes zoëæ from the Mediterranean Sea and the Atlantic Ocean in three developmental stages. In the second of these stages the first antennæ are still unsegmented, the third maxilliped and the five pairs of ambulatory limbs exist in the shape of six pairs of short sacs. This is apparently a younger stage than the earliest observed by me, in which the abdominal legs have already appeared. Claus' first and third stages are the earliest and last zoëa-stages (see above, p. 259).

DOHRN, ANT. Untersuchungen über Bau und Entwicklung der Arthropoden.

11. Zweiter Beitrag zur Kenntniss der Malacostraken und ihrer Larvenformen,

Zeits. Wiss. Zool. XXI. pp. 372, 373; Taf. XXIX. Figs. 48-51. 1871.

p. 373; Taf. XXX. Fig. 52, 1871), and by Claus himself under the name of *Pluteocaris* (Untersuchungen über Crustaceen, p. 65; Taf. XII. Figs. 1-7)! Claus' reference, moreover, is incorrectly "Froriep's Notizen" instead of "Isis."

### III. *Pinnixa*.

As long ago as 1835 the zoëa of *Pinnotheres* was raised from the egg and figured by J. V. Thompson.\* Although this was one of the earliest known cases of metamorphosis among the *Crustacea*, Thompson's memoir has remained the sole contribution to the developmental history of the *Pinnotheridæ* up to the present time.

In the latter part of August, 1878, a large zoëa was not uncommon in Narragansett Bay, which developed in the aquarium into a species of *Pinnixa*. The development of this species is remarkable for the complete suppression of the megalopa-stage, the zoëa figured on Plate IV. (Figs. 5-15) passing directly into the first stage of the crab, represented on Plate V.

In the last zoëa-stage (Plate IV. Figs. 5-15) the carapace is armed with long frontal, dorsal, and lateral spines. The natatory feet are very short in proportion to the size of the body, the inner branch of the second pair (Fig. 11, *a*) rudimentary, as usual with Brachyuran zoëæ. The third pair of maxillipeds and the five following pairs of thoracic feet are folded under the carapace. On dissecting them out from the body, they are seen to be quite perfectly formed, as shown by Fig. 7. The third maxillipeds (Fig. 8) possess their three constituent parts (*a*, *b*, *c*) and a gill (*d*) at their base.

The abdomen (Fig. 10) is short, its penultimate segment expanded laterally into two lobes, which extend backward on each side of the terminal segment.† The terminal segment is ovate, produced posteriorly into a long spine on either side. Between the lateral spines and a small median sinus are three short, finely feathered setæ on either side.

There are four pairs of simple abdominal appendages.

There is a black pigment spot at the base of the dorsal spine, one near the base of each of the lateral spines, and several on the abdominal somites.

From tip of frontal spine to posterior border of carapace, 2.5 mm. From tip to tip of lateral spines, 2 mm. Length of frontal spine, 1 mm.

In the first crab-stage (Plate V.), which immediately follows the last zoëa-stage just described, the carapace measures less than 1 mm. in length by 1.5 mm.

\* Memoir on the Metamorphosis and Natural History of the *Pinnotheres* or Pea-Crabs. By W. [J. V.] THOMPSON, F. L. S. Entomological Magazine, Vol. III. pp. 85-90. Figs. 1, 2. April, 1835.

† This peculiarity is also seen in the undetermined zoëa, figured by Claus, "Untersuchungen," etc. Taf. XIV. Figs. 1, 2 (p. 65). The abdomen of the zoëa of *Pinnotheres pisum* apparently has a like form, judging from Thompson's rude figures (*l. c.*), in which the penultimate and ultimate segments are represented as a single piece.

In "Für Darwin" Fritz Müller figures the tail of a *Pinnotheres* (Fig. 19). It has the shape generally seen in Brachyuran zoëæ, while Fig. 22, "of unknown origin," represents a tail like that of *Pinnixa* and Thompson's *Pinnotheres*. Is there no confusion here?



in breadth. The front is nearly straight, the branchial regions expanded laterally so as to form a prominent shoulder at the point where they meet the hepatic areas. A row of small, irregularly disposed spines on the sides of the carapace. The second and third pairs of maxillipeds (Figs. 6, 7) have the same structure as in adult *Pinnixa*, the terminal segment of the inner limb being articulated with the penultimate segment near the proximal end of the latter, in such a fashion as to form a sort of didactyle claw.

The chelæ are didactyle, the dactylus closing against a long process of the antecedent segment. The following pairs of ambulatory appendages are extremely long, the last pair being much smaller than the rest, as in the adults of this genus.

The abdomen is small, closely folded against the sternum, and not used as a swimming organ. It carries four pairs of appendages (Fig. 3), which consist of a basal segment which supports two branches. The outer branch is much larger than the inner, and bears about nine setæ on its border. The telson is broader than long, its posterior margin regularly convex and fringed with setæ.

Blotches of dark pigment, of dendritic forms, occur on the carapace, sternum, and abdomen, arranged as represented in Figs. 1, 2.

The young crabs underwent hardly any change during my stay at Newport, and it is impossible to determine to which of the several species of *Pinnixa*, described from the eastern coast of the United States, these immature specimens belong. According to Smith, the only species found on the New England coast is *Pinnixa cylindrica* White.\* I found no adult specimens at Newport.

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Since the above account was prepared, I have received, through the courtesy of Professor Smith, a pair of adult *Pinnixa* from Buzzard's Bay, Massachusetts, and a few zoëæ "hatched at Noank, Connecticut, August 3, 1874, from eggs of a specimen apparently exactly like the adults sent." I identify the adults with *Pinnixa chætopterana* Stimpson † (Plate V. Fig. 8, chela of male; Fig. 9, chela of female). The zoëæ (Plate IV. Figs. 1-4) are less than a millimeter in length. The spines of the carapace are proportionately shorter than in the older zoëa described above, the swimming-feet and abdomen longer. The appendages back of the second pair of maxillipeds are wanting. The abdomen is very like the abdomen in the older zoëa, but has a small, triangular, terminal piece (Fig 2 b) between the setæ of the telson.

Professor Smith informs me that he observed, in 1875, the direct change

\* Report upon the Invertebrate Animals of Vineyard Sound and Adjacent Waters, with an Account of the Physical Features of the Region. By A. E. Verrill and S. I. Smith. In Baird's Report on the Condition of the Sea-Fisheries of the South Coast of New England in 1871 and 1872, p. 546. 1873.

† Notes on North American *Crustacea* in the Museum of the Smithsonian Institution. No. II. Ann. Lye. Nat. Hist. N. Y. Vol. VII. p. 235. 1862.

from the zoëa to the crab in the species described in this paper, and that he had, besides, another zoëa, apparently distinguished from mine only by its slightly smaller size and shorter spines, which passed into a megalopa phase ! In this stage (a tracing of which is enclosed in Professor Smith's letter) the carapace is broad and crab-like, without a vestige of the spines of the zoëa. This megalopa subsequently changed into a young crab very nearly like that which developed *immediately* from the long-spined zoëa.\*

It would seem, therefore, that two species of *Pinnixa* occur, at least in the young stages, on the southern shore of New England, which present a remarkable difference in their development. While the one goes through the customary megalopa condition, the other passes, by a syncopated development, from the zoëa directly into the brachyurous state.

CAMBRIDGE, January, 1879.

## EXPLANATION OF THE PLATES.

NOTE. I am greatly indebted to my brother, Mr. Charles E. Faxon, for preparing my drawings for the heliotypic process.

### PLATE I. *Hippa talpoida*.

- Fig. 1. Cluster of segmented eggs taken from the abdominal appendages of a female. The eggs are spherical, about 1.5 mm. in diameter, of a bright orange-yellow color.
- Fig. 2. Egg with the enclosed embryo in the "nauplius-stage": *a*, labrum; *b*, antenna of the first pair; *c*, antenna of the second pair; *d*, mandible; *e*, abdomen; *f*, yolk.
- Fig. 3. Embryo further advanced: *a*, rostrum; *b*, cephalic plate; *c*, antenna of first pair; *d*, antenna of second pair; *e*, mandible; *f*, first maxilla; *g*, second maxilla; *h*, first maxilliped; *i*, second maxilliped (even at this early stage, the appendages back of the mandible are double); *k*, abdomen (the likeness of the abdomen in this embryonic stage to the abdomen of prawn-zoëæ is suggestive).
- Fig. 4. The same, from a different point of view: *a*, antenna of first pair; *b*, antenna of second pair; *c*, mandible; *d*, first maxilla; *e*, second maxilla; *f*, first maxilliped; *g*, second maxilliped; *h*, hind border of carapace.

\* Professor Smith has also kindly sent me tracings of the zoëa of *Pinnotheres maculatus* raised from eggs. It has a long dorsal spine (wholly wanting in Thompson's figures of the zoëa of *Pinnotheres pisum*), and the abdomen is like that figured by Fritz Müller as *Pinnotheres*, "Für Darwin," Fig. 19 (*v. supra*, p. 263, note †). Altogether the zoëa bears less resemblance to the zoëa of *Pinnotheres pisum*, as represented by Thompson, than the zoëa of *Pinnixa* does ! It should be noted that the accuracy of Thompson's figures is attested by Bell ("British Stalk-eyed Crustacea," p. 125).

- Fig. 5. First zoëa-stage.  
 Fig. 6. The same, viewed from below : *a*, labrum ; *b*, process of the carapace extending forward under the eyes ; *c*, mandible ; *d*, metastoma ; *e*, first maxilla ; *f*, outer branch of first maxilliped ; *g*, inner branch of first maxilliped ; *h*, outer branch of second maxilliped ; *i*, inner branch of second maxilliped ; *k*, anus ; *l*, telson.  
 Fig. 7. Eye-stalk and eye of the same stage.  
 Fig. 8. First antenna of the same : *a*, rudiment of the secondary flagellum ?  
 Fig. 9. Second antenna of the same : *a*, *b*, dentiform processes ; *c*, rudiment of the future flagellum.  
 Fig. 10. Mandible.  
 Fig. 11. First maxilla : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.  
 Fig. 12. Second maxilla : *a*, inner lobe ; *b*, scaphognathite.  
 Fig. 13. Posterior border of the telson ( $\frac{1}{2}$  in. obj.). The arrow indicates the median line of the telson.  
 Fig. 14. A spine and two adjacent denticles of the same, more highly magnified ( $\frac{1}{10}$  in. obj.).  
 Fig. 15. Posterior part of the carapace, viewed from behind and below : *a*, thickening of the integument at the point where the lateral spines appear in later stages of the zoëa ; *b*, abdominal sinus.

## PLATE II. *Porcellana (Polyonyx) macrocheles*.

### *Last zoëa-stage.*

- Fig. 1. Lateral view of the zoëa.  
 Fig. 2. Posterior portion of the carapace from below.  
 Fig. 3. Cross-section of the rostrum.  
 Fig. 4. Cross-section of one of the posterior horns of the carapace.  
 Fig. 5. Telson : *a*, the antecedent abdominal segment ; *b*, the sixth abdominal segment of the next stage, showing through the integument of the zoëa ; *c*, *d*, *e*, the inner and outer branches of the last abdominal appendages and the telson of the next stage showing through the telson of the zoëa.  
 Fig. 6. First antenna : *a*, swelling at the base for the lodgment of the auditory organ ; *b*, inner branch ; *c*, outer branch ; *d*, sensory hairs on the outer branch.  
 Fig. 7. Second antenna : *a*, internal branch (the annuli of the flagellum of the antenna of the next stage are seen within) ; *b*, external branch ; *c*, outlet of the "green gland."  
 Fig. 8. Mandible : *a*, rudiment of the palpus.  
 Fig. 9. Metastoma.  
 Fig. 10. First maxilla : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.  
 Fig. 11. Second maxilla : *a*, scaphognathite.  
 Fig. 12. Third maxilliped : *a*, internal branch ; *b*, external branch.  
 Fig. 13. The five following pairs of appendages (Decapodal legs) as they appear when removed from under the carapace of the zoëa : *a*, cheliped ; *b*, *c*, *d*, *e*, ambulatory pairs ; *f*, gills. The chelæ of the first and fifth pairs

and the hooks on the terminal segment of the intervening three pairs (from which the genus *Polyonyx* takes its name) are seen through the outer, investing membrane.

- Fig. 14. One of the abdominal appendages : *a*, the appendage to be disclosed at the next moult.

PLATE III. *Porcellana (Polyonyx) macrocheles*.

- Figs. 1-10. First stage of the crab.  
 Fig. 2. One of the minute hairs of the front, highly magnified.  
 Fig. 3. First antenna : *a*, basal (auditory) segment ; *b*, inner branch ; *c*, outer branch.  
 Fig. 4. Terminal segment of one of the ambulatory limbs.  
 Fig. 5. Chela of the last thoracic appendage.  
 Fig. 6. View from the front : *a*, eye ; *b*, first antenna ; *c*, second antenna ; *d*, carapace ; *e*, basal segment of cheliped.  
 Fig. 7. Abdomen.  
 Fig. 8. Telson, after the first moult.  
 Fig. 9. Third maxilliped : *a*, inner branch ; *b*, outer branch ; *c*, gill.  
 Fig. 10. Appendage of fifth abdominal segment, right side from beneath : *a*, inner branch ; *b*, outer branch. Similar appendages are found on the second, third, and fourth abdominal segments.  
 Figs. 11-21. Adult specimen from South Carolina.  
 Fig. 12. First antenna of the right side, from below : *a*, basal (auditory) segment ; *b*, inner branch ; *c*, outer branch.  
 Fig. 13. Left mandible, seen from beneath : *a*, palpus.  
 Fig. 14. First maxilla of the left side, seen from beneath : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.  
 Fig. 15. Second maxilla of the left side, seen from beneath : *a*, scaphognathite.  
 Fig. 16. First maxilliped of the left side, seen from beneath.  
 Fig. 17. Second maxilliped of the left side, seen from beneath : *a*, inner branch ; *b*, outer branch.  
 Fig. 18. Third maxilliped of the left side, seen from beneath : *a*, inner branch ; *b*, outer branch.  
 Fig. 19. Terminal segment of one of the ambulatory limbs.  
 Fig. 20. Appendage of right side of third abdominal segment of female. A pair of similar appendages exists on the third and fourth abdominal segments.  
 Fig. 21. Appendage of second abdominal segment of the male : *a*, rudimentary second branch. In this sex there is only one pair besides the swimmerets of the sixth segment.

PLATE IV. *Pinnixa*.

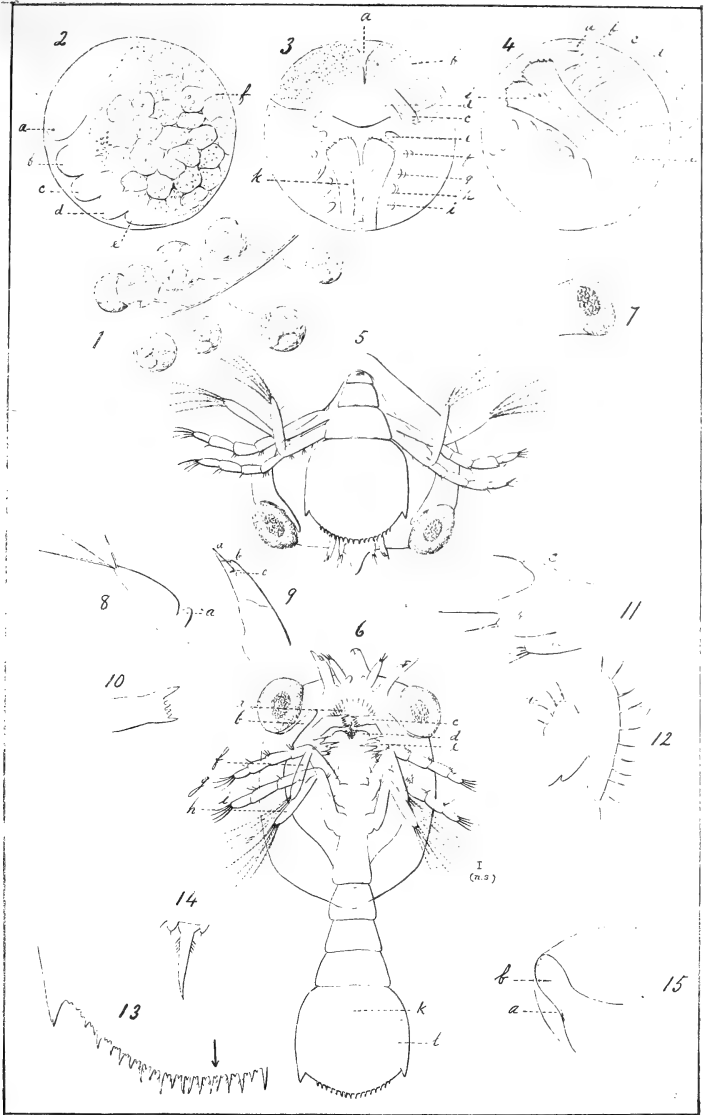
- Fig. 1. First stage of the zoëa of *Pinnixa chaetoptera*, from Noank, Conn.  
 Fig. 2. Abdomen of the same : *a*, spine ; *b*, terminal piece of the telson.  
 Fig. 3. Second maxilliped of the same : *a*, inner branch ; *b*, outer branch.

- Fig. 4. First maxilliped of the same : *a*, inner branch ; *b*, outer branch.  
 Figs. 5-15. Last stage of the zoëa of a *Pinnixa*, from Newport, R. I.  
 Fig. 5. Anterior view.  
 Fig. 6. Posterior view.  
 Fig. 7. Third maxilliped, cheliped, and ambulatory appendages of the future crab, removed from under the carapace of the zoëa : *a'*, *a''*, *a'''*, inner, middle, and outer branches of the third maxilliped ; *b*, cheliped ; *c*, *d*, *e*, *f*, ambulatory appendages ; *g*, gills.  
 Fig. 8. Third maxilliped : *a*, inner branch (endognathite) ; *b*, middle branch (exognathite) ; *c*, outer branch (epignathite) ; *d*, gill.  
 Fig. 9. Second maxilla : *a*, scaphognathite.  
 Fig. 10. Abdomen : *a*, *b*, *c*, *d*, first, second, third, and fourth pairs of abdominal appendages.  
 Fig. 11. Second maxilliped : *a*, inner branch ; *b*, outer branch.  
 Fig. 12. First maxilliped : *a*, inner branch ; *b*, outer branch.  
 Fig. 13. First maxilla : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.  
 Fig. 14. *a*, first antenna ; *b*, second antenna.  
 Fig. 15. Metastoma.

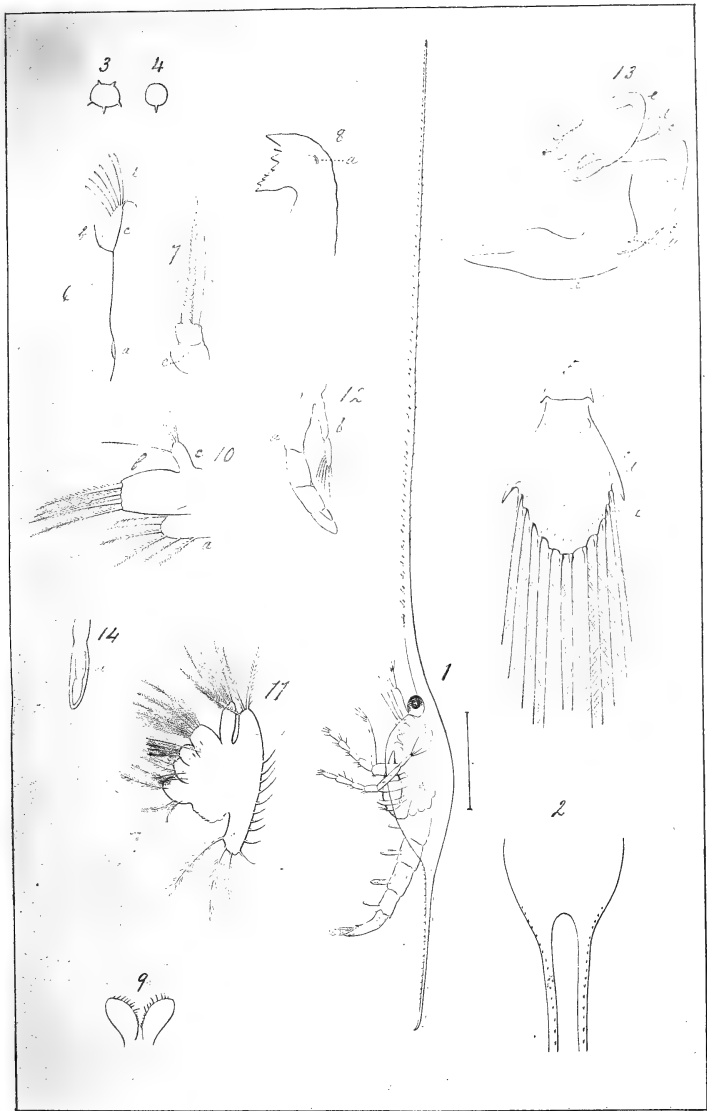
NOTE. Figs. 9 and 11-15 were drawn from the exuvie of a zoëa which had changed into a crab.

#### PLATE V. *Pinnixa*.

- Fig. 1. First crab-stage of a *Pinnixa*, from Newport, R. I. (developed at one moult from the zoëa represented on Plate IV. Figs. 5-15). Dorsal view.  
 Fig. 2. The same ; ventral view.  
 Fig. 3. The same ; abdomen viewed from beneath, with its appendages.  
 Fig. 4. The same ; first antenna.  
 Fig. 5. The same ; first maxilliped.  
 Fig. 6. The same ; second maxilliped : *a*, endognathite ; *b*, exognathite.  
 Fig. 7. The same ; third maxilliped : *a*, endognathite ; *b*, exognathite ; *c*, epignathite.  
 Fig. 8. Left chela of adult male *Pinnixa chatopterana* from Buzzard's Bay. The carapace of this specimen measures 4 mm. in length by 7.5 mm. in breadth.  
 Fig. 9. Right chela of a small adult female of the same. Carapace, 3 mm. × 5.5 mm.

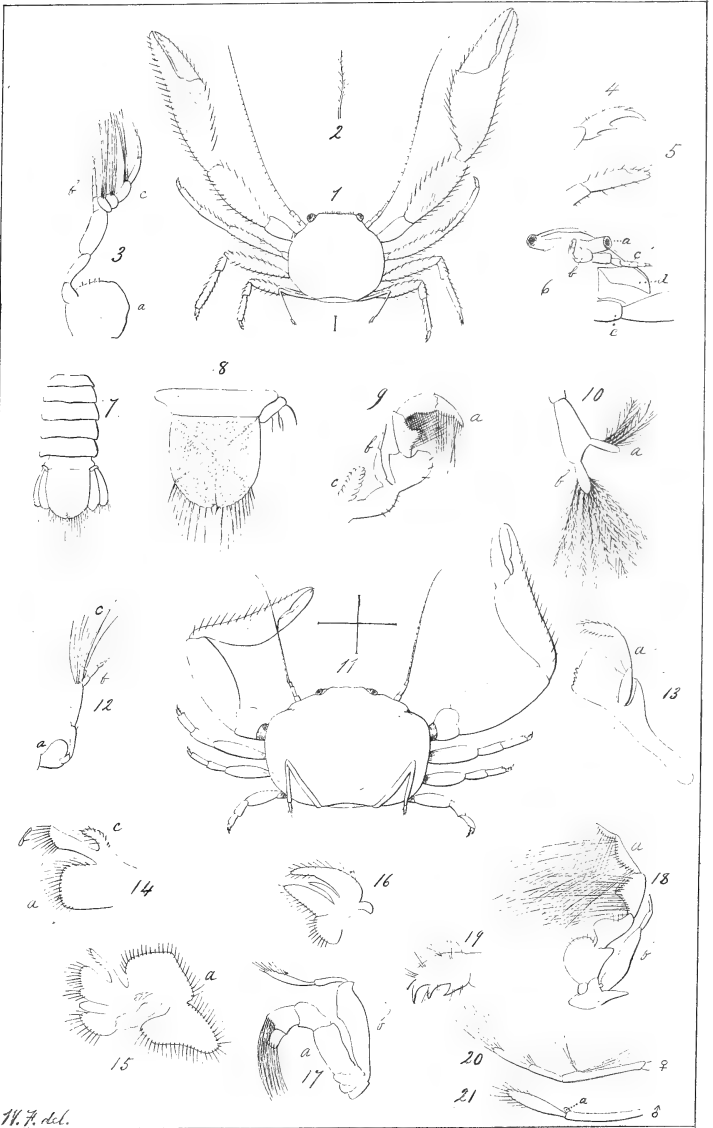




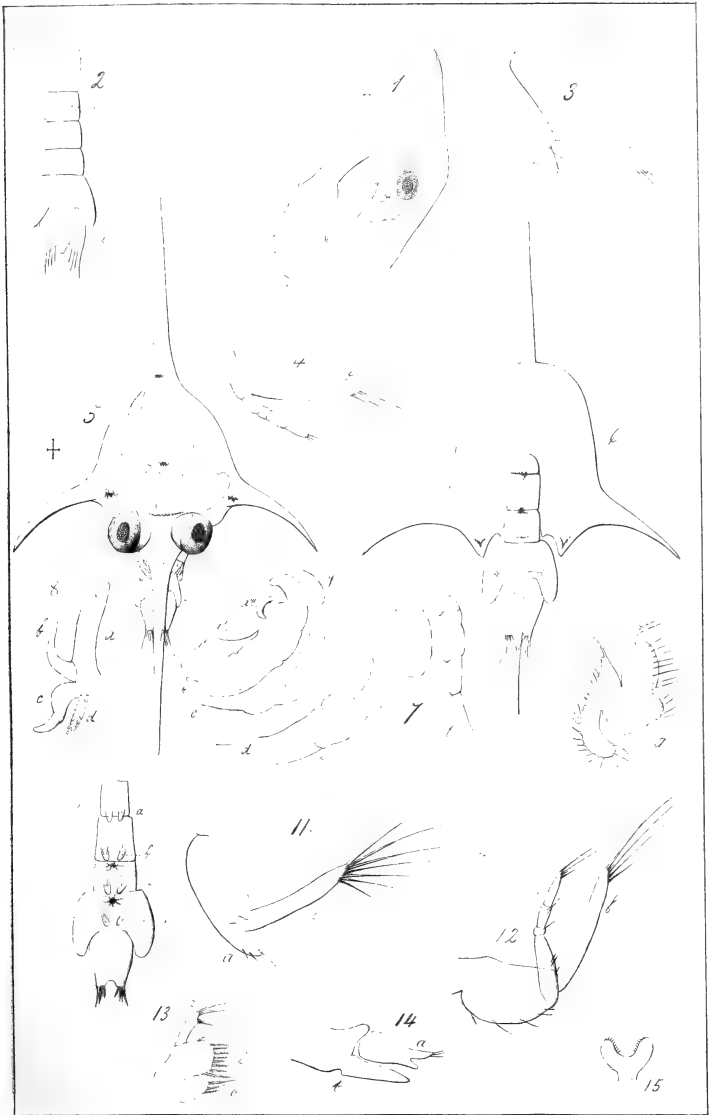




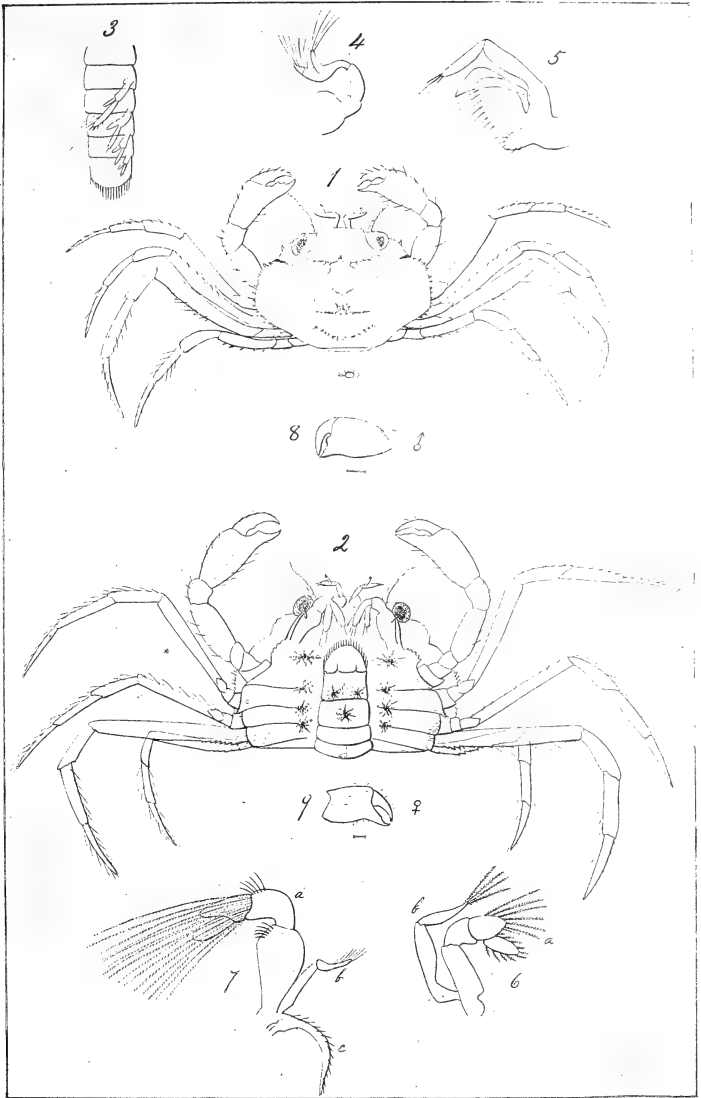


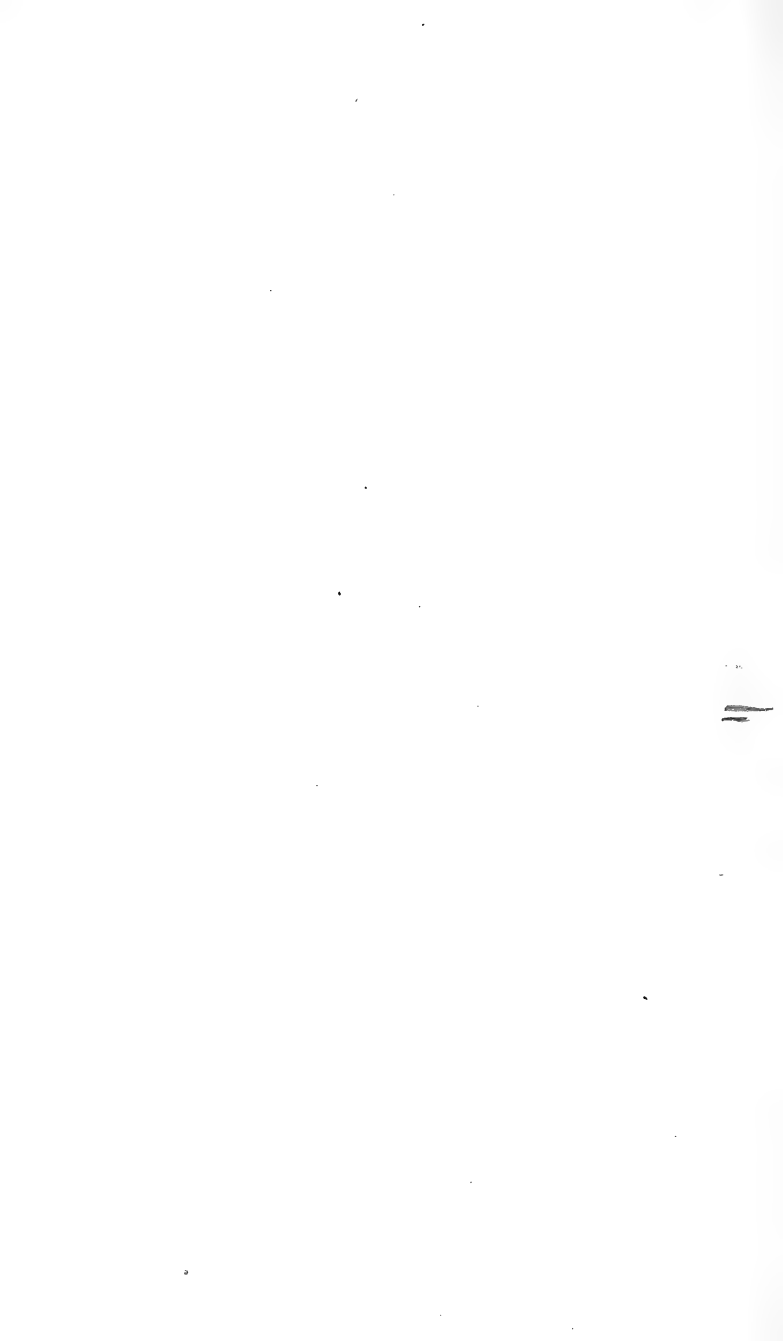












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4

ON THE DEVELOPMENT OF *PALÆMONETES VULGARIS*.

BY WALTER FAXON.



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Museum of Comparative Zoölogy, Cambridge, Mass.

*With the compliments of*

*ALEXANDER AGASSIZ.*



No. 15. — *On the Development of PALEMONETES VULGARIS.*  
By WALTER FAXON.

THE observations recorded in this paper were made during the summers of 1876 and 1877 in the laboratories of Mr. Alexander Agassiz, at Newport, R. I., and of the United States Commission of Fish and Fisheries, at Wood's Hole, Mass. I am under great obligations to Mr. Agassiz, and Professor S. F. Baird, United States Commissioner of Fish and Fisheries, for placing at my disposal every means for the collection and study of specimens.

The difficulty of rearing the larvæ of *Crustacea* in confinement, and the uncertainty of finding all the stages in the development of a species by collecting with the hand-net or tow-net, perhaps account for the fact that we have so few life-histories of Decapod *Crustacea* which are in any way complete.

The common prawn of our coast, *Palaemonetes vulgaris* Stimpson, is one of the most typical of the long-tailed Decapods, and affords an excellent opportunity for obtaining the life-history of a Macrouran, which undergoes a metamorphosis after quitting the egg. The present paper is a contribution to that history.

The opacity of the eggs and larvæ making it impossible to follow the development of the internal organs in detail, I have confined myself chiefly to the growth of the hard parts.

This species was first described by Say, in 1818, under the name of *Palaemon vulgaris*;\* again described, and figured for the first time, by De Kay, in 1844.† In 1869, the genus *Palaemonetes* was established by Heller for the reception of *Palaemon varians* Leach, from the North Sea and fresh waters of the Mediterranean basin.‡ It differs from *Palaemon* in lacking mandibular palpi. In the armature of the carapace it agrees with *Palaemon*, subgen. *Leander*, i. e. an antennal and a branchiostegal spine are present, but no hepatic spine.

\* An Account of the *Crustacea* of the United States. Jour. Acad. Nat. Sci. Phila., Vol. I. pp. 248, 249. 1818.

† Zoölogy of New York, Part VI. Crustacea, pp. 29, 30, Pl. IX. Fig. 30. 1844.

‡ Zur näheren Kenntniss der in den süßen Gewässern des südlichen Europa vorkommenden Meerescrustaceen. Zeitschr. wissensch. Zool., Vol. XIX. p. 160. 1869.

Our species was properly placed in the genus *Palæmonetes* by Stimpson in 1871.\*

A figure of the adult, by J. H. Emerton, is given on Plate II. of Verrill and Smith's "Report upon the Invertebrate Animals of Vineyard Sound and the Adjacent Waters," and on page 235 of the same work is a description of the first larval stage by Smith.†

This species is common in shallow water along the eastern coast of the United States from Hampton, N. H. (! Coll. Mus. Comp. Zoöl.), to the St. John's River, Fla. (G. Brown Goode). It is especially common on sandy bottoms among the eel-grass, where, as Verrill well observes, its color admirably adapts it for concealment.‡ It ascends far up into the brackish water of estuaries and rivers. I have found it abundant in the Charles River marshes, Cambridge, Mass., and Mr. G. Brown Goode collected it in the St. John's River, Fla., twenty-two miles from the mouth, where the water was perfectly fresh to the taste.§ On the coast of New Jersey and the Carolinas it is associated with a nearly allied species, *Palæmonetes Carolinus* Stimpson.|| It is represented in the fresh waters by a smaller and slenderer species, *Palæmonetes exilipes* Stimpson,¶ which has a wide distribution in the rivers and lakes of the Western and Southern States.

\* Notes on North American *Crustacea* in the Museum of the Smithsonian Institution, No. III. Ann. Lyc. Nat. Hist. N. Y., Vol. X. p. 129. 1871.

† Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872, p. 529, Pl. II. Fig. 9. 1873. The description of the larva also appears in Smith's "Early Stages of the American Lobster (*Homarus Americanus* Edwards)." Trans. Conn. Acad., Vol. II. p. 377. 1873.

‡ *Op. cit.*, p. 479.

§ *Vide* S. I. Smith's "Stalk-eyed Crustaceans of the Atlantic Coast of North America north of Cape Cod." Trans. Conn. Acad. Arts and Sci., Vol. V. p. 37. 1879.

|| *Op. cit.*, p. 129.

¶ *Op. cit.*, p. 130. This is probably the species described, from imperfect specimens, under the name of *Hippolyte paludosa*, by Gibbes, in 1850 (On the Carcinological Collections of the Cabinets of Natural History in the United States. Proc. Amer. Ass. Adv. Sci., 1850, p. 197), as claimed by Kingsley (Notes on the North American *Caridea* in the Museum of the Peabody Academy of Science at Salem, Mass. Proc. Acad. Nat. Sci. Phila., 1878, p. 97).

I observe in an ovigerous female of this species from Kentucky, preserved in alcohol, that the eggs are much larger in size and fewer in number than those of *Palæmonetes vulgaris*. While the eggs of the latter, shortly after laying, measure about .5 mm. in long diameter, those of the former (the embryo has seemingly hardly begun to form) measure 1.25 mm. in length. Whether the fresh-water *Palæmonetes* hatches from the egg in a more advanced phase of development than its marine rela-

In June, July, and the early part of August, the females of *Palæmonetes vulgaris* may be found carrying their eggs (which will afford different phases of development in different individuals simultaneously) fixed to the hairs on the peduncle\* of the abdominal appendages, from the first to the fourth pair inclusive. Here they receive not only the protection of the parent, but also a constant aëration by means of the gentle backward and forward movement of the abdominal appendages. This aëration of the eggs seems to be essential to their development, for if detached from the mother they invariably die, unless the enclosed embryo has very nearly reached the point of hatching.

All the eggs are not attached directly to the appendages of the abdomen, as in *Astacus*, but many of them are joined to one another by delicate threads drawn out from the secretion which invests each egg. Thus large clusters are formed, in which comparatively few eggs are fixed immediately to the abdominal appendages. These clusters, again, are different from the botryoidal clusters so common among the *Brachyura*, in which the eggs are only indirectly connected with each other through the mediation of a common stalk from which the eggs depend by short pedicels.

Soon after the escape of the young the parent prawn casts her integument, thus ridding herself of the egg-shells which are indissolubly fastened to her legs. I have found this moult to take place almost invariably within a few hours after the hatching of the eggs.† Commonly this happens in the night, morning discovering the newly-hatched brood of zoëæ collected at the surface of the aquarium, on the side toward the light, and the discarded integument of the parent prawn sunk to the bottom. I have never seen the prawn practise that economy observed in certain insect larvæ, which devour their cast-off skin.

The newly-laid eggs are elliptical, about .5 mm. in long diameter.

tive, is an interesting question for our Western zoölogists to answer. The young of the fresh-water *Caridina Desmarestii*, as we know from the observations of Joly (Études sur les Mœurs, le Développement et des Métamorphoses d'une petite Salicoque d'Eau Douce (*Caridina Desmarestii*). Ann. Sci. Nat., 2d series, Vol. XIX. 1843), are hatched as zoëæ, and undergo a subsequent metamorphosis before attaining the adult form.

\* Not to the *inner branches*, as is stated to be the case with *Palæmon serratus*, by J. V. Thompson (Memoir on the Metamorphoses in the *Macroureæ* or Long-tailed *Crustacea*, exemplified in the Prawn (*Palæmon serratus*). Edinburgh New Philosophical Jour., Vol. XXI. p. 223. 1836).

† Joly observed the same thing in *Caridina Desmarestii* (*op. cit.*, p. 55).

The gluey secretion which attaches the eggs to the abdominal limbs of the mother hardens into a structureless membrane, which invests each egg so closely that it is difficult to separate it from the proper egg-membrane. The yolk is of a greenish color, heavily charged with deutoplasmic elements in the shape of minute granules and larger spherical vesicles, intermixed with oil-globules.

The cleavage of the egg begins in two planes almost simultaneously. These planes are at right angles with each other, passing through the long and the short axes of the egg. The egg is thus divided into four cleavage-spheres, each provided with a nucleus and nucleolus. Delicate lines of protoplasm extend like rays from the nuclei into the surrounding yolk (Pl. I. Fig. 1).

The opacity of the eggs prevented my determining whether the cleavage passed completely through the yolk.\*

The cleavage proceeds regularly (Plate I. Fig. 2), forming eight, six-

\* Bobretzky, who has made sections of the eggs of *Palæmon*, is uncertain how deep the clefts enter the yolk in the earliest stages of segmentation, owing to the imperfection of his sections. (On the Embryology of Arthropods [in Russian]. *Zapiski Kiefs. Obshtshest. Yestestvoisпитatalyei*, Vol. III. p. 190. 1873. A short and unsatisfactory abstract of Bobretzky's paper, in German, by Hoyer, appears in Hofmann and Schwalbe's "Jahresberichte," Vol. II. pp. 312-318. 1875. I have had certain parts of the original paper translated from the Russian for me by Mr. Ivan Panin.) By the time that 128 cleavage products are formed they have the shape of long pyramids, whose apices are fused in the common undivided granular mass at the core of the egg, while the clear protoplasm, involving the nuclei, collects at the surface of the egg, in the bases of the pyramids. Later the boundaries of the pyramids become obliterated, and their protoplasmic bases thus form a cellular superficial blastoderm, enclosing the opaque nutritive yolk (Pl. V. Fig. 18 *et seq.*).

In *Crangon vulgaris*, according to E. Van Beneden (*Recherches sur la Composition et la Signification de l'Œuf*. *Mém. Cour. Acad. Roy. Belg.*, Vol. XXXIV. p. 142, Pl. X. Fig. 20. 1870), the cleavage is at first total, then a separation takes place between the deutoplasm and the protoplasm of the vitelline segments; the former accumulating at the centre of the egg, the latter, carrying with it the nuclei of the segments, is borne to the periphery to constitute the cells of the blastoderm.

The egg of *Peneus (membranaceus?)*, as observed by Haeckel (*Die Gastrula und die Eifurchung der Thiere*. *Jenaische Zeitschr. f. Naturwissenschaft*, Vol. IX. pp. 447, 448, Pl. XXIII. Fig. 82), in the stage with four cleavage-cells, showed on cutting that the furrows extended less than half-way to the centre of the egg, leaving a large, elliptical, central mass of nutritive yolk undivided.

In *Eupagurus Prideauxii*, as we learn from P. Mayer (*Zur Entwicklungsgeschichte der Dekapoden*. *Jenaische Zeitschr. f. Naturwissenschaft*, Vol. XI. p. 212, Pl. XIII. 1877), eight segments, completely separated from one another, are formed before the segregation of the deutoplasm from the protoplasm begins.

teen, thirty-two segments, and so on, until the whole surface of the egg is made of minute, polygonal cells (perimorula). No polar globules are emitted.\*

Twenty-four hours after the cleavage began, an egg was found in the gastrula-stage, as represented on Plate I. Fig. 3. The cavity is very small compared with the size of the egg, and its orifice (*g*) is bounded by elliptical cells, which form a light-colored disk on the surface of the egg. The orifice apparently closed a little later, and the further history of the cavity was not obtained.

The yelk now shrinks away from its membrane in the vicinity of the light-colored disk, and becomes transparent and free from granules preparatory to the appearance of the parts of the embryo.

The parts of the embryo which first appear are the abdomen, the labrum and cephalic disks, and the first three pairs of appendages. These appear almost simultaneously. A protuberance from the surface of the yelk, near the place where the gastrula opening appeared, is the rudiment of the abdomen. Another fold over against the first is the beginning of the formation of the labrum, and in front of this two disks appear, which are the first trace of the eyes and front part of the head of the embryo.

The projection of the two folds which form the abdomen and labrum is such that the free ends are toward one another. Thus the abdomen, from the time of its earliest appearance, is bent forward underneath the breast of the future prawn. On each side of the labrum and abdomen are three lobes, which are the rudiments of the two pairs of antennæ and the mandibles. The first pair are on a level with the labrum, the third pair with the end of the abdomen. All three pairs are simple. This is the nauplius-stage of the embryo.†

\* P. Mayer observed occasionally in fresh-laid eggs of *Eupagurus* "a sort of *Richtungsbälchen*," but he considers these cases abnormal. They were probably the result of disintegration of the egg (*op. cit.*, p. 223).

† Joly's account of the order of appearance of the appendages of the embryo of *Caridina*, — first, the three pairs of thoracic legs (i. e. the maxillipeds), then the maxillæ, mandibles, and antennæ, — is without doubt incorrect (*op. cit.*, pp. 59, 60). In an abstract of a paper "On the Development of the Crustacean Embryo, and the Variations of Form exhibited in the Larvæ of 38 Genera of Podophthalmia" (Proc. Royal Soc. London, Vol. XXIV. p. 378. 1876), Spence Bate states his belief "that he has demonstrated that the three pairs of mobile appendages in the cirripedal or *Nauplius* form of larva homologize with the eyes and two pairs of antennæ, and not with the antennæ and mandibles, as stated by Fritz Müller, Anton Dohrn, and others." (!) It is to be hoped that the evidence will not long be withheld from publication.



The appendages back of the mandibles now appear in regular succession in the form of hyaline protuberances from the opaque yelk. Four days after the gastrula-stage (Pl. I. Fig. 3), the embryo has the form portrayed on Plate I. Fig. 4.

The rudiments of the appendages have appeared as far back as the sixth pair (first pair of maxillipeds). The second pair of antennæ (Pl. I. Fig. 4, *II*), are now double appendages, the two parts representing the flagellum and scale of the future antenna. The appendages behind the mandibles are bilobed from the time of their earliest appearance. The labrum (*lb*) has moved backward, so as now to lie on a line with the second pair of antennæ.

The antennæ rapidly increase in length, assuming the form of ribands which lie along the outer side of the following appendages, parallel with the abdomen. Three days after the stage last described they reach as far back as the first pair of maxillipeds (Pl. I. Fig. 5). The first pair (*I*) lie on the outer side of the second pair (*II*), and are slightly shorter than these. The outer branch of the second pair, again, is a little longer than the inner branch. Even at this early period traces of setæ are seen on the extremities of both pairs of antennæ. The rudiments of the appendages are now formed as far back as the third pair of maxillipeds (Pl. I. Fig. 5, *VIII*), the abdomen (*ab*) extends forward so far as to meet the labrum (*lb*), but is still unformed along the median dorsal line. Some scattered blotches of a dark color (*oc*) are the first indications of the pigment of the compound eye.\*

On the following day (Aug. 5) I observed the first appearance of the median simple eye in the form of a black pigment-spot in the middle line of the head.

The embryo gradually encroaches upon the unabsorbed yelk-mass on the dorsal side of the egg. The outline of the carapace (Pl. I. Fig. 6, *cp*, four days before hatching) comes into view, extending posteriorly beyond the third pair of maxillipeds. Under the posterior part of the carapace the heart appears as a transparent pulsating sac (*ht*). The abdomen (*ab*) becomes divided into segments by transverse constrictions which begin on the ventral side, the side which is applied to the ventral face of the cephalo-thorax of the embryo. Within the abdomen are seen the ganglia of the nervous system (Pl. I. Fig. 6, *ng*). The end of the abdomen is produced into two blunt lobes, on the borders of which the setæ are already visible.

\* The development of the eye certainly lends no countenance to the view that its stalk is an appendage homologous with the antennæ, etc.

Plate I. Fig. 8, represents an embryo further advanced. The abdomen has lengthened to such an extent that it entirely conceals the labrum, and extends forward so as to almost meet the tip of the rostrum (*rs*), which lies bent beneath the head. The maxillipeds have increased in length, and extend forward as two-branched appendages on each side of the abdomen. At the base of the rostrum is the simple median eye (*ocl*); the permanent eyes (*oc*) show through the egg-shell as oval black spots.

In the still older embryo in the egg represented on Plate I. Fig. 9, the unabsorbed yelk (*vt*) has so diminished as to appear as a large greenish patch on the dorsal side of the embryo. The whole margin of the carapae is clearly defined, and its posterior or cardiac portion is unobscured by underlying yelk. The eyes (*oc*) now form two black roundish spots at the anterior end of the embryo, so large that they are very conspicuous to the naked eye. The corneae and cones are now formed, and the eye is thrust out a little upon a very short stalk. The antennae of the first pair (*I*) are divided into two segments, a long proximal and a short oval distal one. The latter is furnished with a few setae at its tip. The two branches of the second antennae (*II*) are also tipped with setae.

In the course of the development of the embryo within the egg, the egg has become larger than it was when first laid. A few hours before hatching (Pl. I. Fig. 10), it measures 1 mm. in long diameter. A small patch of yellowish green (*vit*) just behind the eyes is the only remnant of the unabsorbed yelk. The abdomen (*ab*) has lengthened to such an extent that it reaches far beyond the mouth, between the eyes, to the dorsal side of the head. The basal segment and the two branches of the second pair of antennae are now clearly defined, and have acquired very nearly the form which they have in the larva after hatching. The maxillipeds have grown to a very large size, and conceal the oral appendages in front of them.

Embryos removed from the egg an hour before hatching (Pl. I. Fig. 11) disclosed two pairs of two-branched sac-like appendages (Figs. 11, 13, *IX*, *X*), concealed between the bases of the first maxillipeds. These are the rudiments of the two pairs of chelipeds of the adult prawn. The structure of the embryo is now the same as during the first larval stage.

*First Larval Stage* (Pl. I. Figs. 14–18; Pl. II. Fig. 1). — When it first issues from the egg the young prawn is  $2\frac{1}{2}$  mm. in length. The carapace is broad, produced between the eyes into a long, pointed rostrum. At the base of the rostrum is a small simple eye. The com-

pound eyes are of huge dimensions, and supported upon short, thick stalks. The abdomen is composed of six segments only, the telson being not yet clearly separated from the preceding segment. The width of the abdomen suddenly diminishes at the fourth segment. The sixth segment consists of a long, cylindrical piece, which terminates in a broad, triangular fin. The hind border of the terminal fin is slightly convex, the angles truncated and notched. It is armed with fourteen long setæ, which are finely feathered on both sides, excepting the outer two pairs, which are feathered only on the inner side. The spaces between the long setæ are slightly concave, and furnished with about four very minute setæ (Pl. I. Fig. 18).\* The anus lies on the lower side of the base of the terminal fin, and the intestine shows through the transparent shell as a slender tube passing in a direct line from the stomach to the anus.

The first pair of antennæ (Pl. I. Fig. 15) are short, simple, composed of a large basal segment followed by a small, oval, setiferous, terminal segment. The distal end of the proximal segment also bears a long seta on the inner side of, and longer than, the terminal segment.

The second pair of antennæ (Pl. I. Fig. 16) are about as long as the first pair. They are composed of a short basal segment which bears two branches. The inner branch (*ri*), which develops into the flagellum of the second pair of antennæ in the adult, is a slender piece tipped with a long seta. The outer branch (*re*), which represents the "scale," is at this stage much larger than the inner, divided into segments for some distance from its tip, and furnished with setæ on its inner border.

The mouth is bounded in front by a large, prominent, triangular labrum (Pl. I. Fig. 17, *lb*). The mandibles (Pl. I. Fig. 17, *III*) are slender, and taper gradually to the tips, which are armed with three teeth. There is no trace of a mandibular palpus at any stage in the development.

The first pair of maxillæ (Pl. I. Fig. 17, *IV*), consist of two lobes, the outer of which bears a one-jointed palpus. Both lobes, as well as the palpus, are furnished with setæ on their borders.

The second pair of maxillæ (Pl. I. Fig. 17, *V*; Fig. 12) are composed of an inner plate, the inner edge of which is divided into five lobes, and an outer plate, the scaphognathite, which lies under the carapace and projects far beyond the inner plate toward the eye-stalk. All the lobes are beset with setæ. The scaphognathite is in constant motion,

\* The caudal fin of the first zöia-stage of *Palæmon serratus* is figured by P. Mayer (*op. cit.*, Jena. Zeitschr., Vol. XI. Pl. XV. Fig. 49).

balancing the water out from the branchial chamber before the least trace of the gills has appeared. As the currents of blood in the zoëa stream along the sides of the carapace, they are aerated through the delicate integument by the constant flow of water kept up by the movement of the scaphognathite, which thus plays the same part as in the gill-bearing adult.

Next follow the three pairs of maxillipeds, which, in the early stages of development, serve as swimming-organs. The first pair is the smallest. Its basal segment (Pl. I. Fig. 17, VI) has a strongly convex inner margin, which is beset with setæ. This part of the limb acts as a jaw, while the rest of the limb is used for locomotion. In this the appendage recalls the structure of the limbs in the *Merostomata*. The inner branch is composed of one segment. The outer branch (Pl. I. Fig. 14) is obscurely divided into two segments, and is considerably longer than the inner branch.

The second pair of maxillipeds (Pl. I. Fig. 14, VII) consist in like manner of a basal segment and two branches. The inner branch consists of three segments, of which the proximal and middle are of about equal length, the distal very short. The outer branch is longer than the inner, and is indistinctly divided into five or six segments. Of these the first and second are of equal length, and form together the bulk of the branch. The following segments are crowded together near the tip of the branch, and the lines of division between them can barely be discerned.

The third pair of maxillipeds (Pl. I. Fig. 14, VIII) exceed the second pair in length, but have essentially the same structure. The second pair, again, are longer than the first pair. The branches of all the maxillipeds are furnished with long setæ.

Behind the third pair of maxillipeds are seen the rudiments of the two following pairs of thoracic appendages (Pl. I. Figs. 14, 17, IX, X; Fig. 13). They are two-branched, each branch having the form of a simple sac, without trace of a division into segments.\*

There are as yet no traces of abdominal appendages.†

\* Du Cane (Ann. Nat. Hist., Vol. II. Pl. VI. Fig. 2. 1839) and Bobretzky (*op. cit.*, p. 204, Pl. V. Fig. 17) both represent the first larval stage of *Palæmon* with the rudiments of the first three pairs of walking-feet in the form of simple sacs. I am inclined to believe that a more careful dissection would have revealed, in both cases, the structure which I have found in *Palæmonetes vulgaris*, viz. two pairs of double sacs.

† According to Krøyer (Monografisk Fremstilling af Slægten Hippolyte's nordiske

Just behind the eye-stalks, on the front part of the carapace, are two large blotches of dark pigment. Two similar pigment-spots are seen in most individuals on the hinder part of the carapace, and one in the median line of the body on the dorsal side of the second abdominal segment. The distribution of pigment-spots varies considerably, however, in different individuals.

*Second Larval Stage* (Pl. II. Figs. 2-4). — After the first moult the larva measures 3 mm. from the tip of the rostrum to the end of the abdomen. It now has the same general shape as in the preceding stage, but the carapace is provided with a dorsal spine which is directed forward at the base of the rostrum, and a lateral spine on each side, on the anterior margin. This spine is the supra-orbital of Stimpson's nomenclature.\* The posterior margin of the fifth abdominal segment is produced into a tooth-like process on each side.

The first pair of antennæ have acquired an additional (third) segment, but are still simple.

The second pair of antennæ are of the same shape as in the first larval stage, as are also the mandibles and maxillæ.

The maxillipeds have increased in length, and the second and third pairs are longer in proportion to the first pair than they were in the foregoing stage. The first pair have gained a segment in both the inner

Arter. Kongel. Dansk. Vidensk. Selsk. naturvid. og mathem. Afhandl. IX Deel, pp. 245-251, Tab. VI. Figs. 120-132. 1849), the young of *Hippolyte polaris* extracted from the egg have the five pairs of walking-feet in the form of small, simple, jointed appendages, the first pair with the chela already formed. Five pairs of double abdominal limbs are also present, but no sign of the sixth or posterior pair.

We thus see among the *Caridea* a very great difference in the degree of development in which the larvæ leave the egg. At one extreme we have *Peneus* quitting the egg as a nauplius (Fritz Müller, Die Verwandlung der Garneelen. Arch. f. Naturg., Vol. XXIX. pp. 8-23, Taf. II. 1863), at the other *Hippolyte*, provided with all the appendages of the adult excepting the last abdominal. Here the walking-feet are simple from the first, and the larva does not pass through a Schizopod stage. Between these extremes are larvæ like those of *Caridina* (Joly), *Palæmonetes*, etc., which hatch with appendages developed as far back as the third pair of maxillipeds inclusive, or the second pair of walking-feet, and which pass through a *Mysis*-state.

It is to be observed, however, that in the larva doubtfully referred to *Hippolyte* by Claus (Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, pp. 44, 45, Figs. 14-18. 1876), the rudiments of the walking-feet appear subsequently to the earliest larval stage, — first the two anterior pairs simultaneous with the swimmerets (the earliest to appear of the abdominal limbs), then the three following pairs. Here all the walking-feet of the adult are split-feet in the larva.

\* Prodromus Descriptionis Animalium Evertibratorum, etc. Proc. Acad. Nat. Sci. Phila., 1860, p. 24.

and outer branches, which are now two- and three-jointed respectively. The second and third pairs retain the same number of segments as before.

The anterior of the two pairs of double sac-like appendages, which lay behind the third pair of maxillipeds in the last stage, have disclosed a pair of two-branched swimming-feet (Pl. II. Figs. 2, 3, 4, *IX*). These swimming-feet, which ultimately become the anterior pair of chelipeds in the adult, have about the same structure as the antecedent maxillipeds, but are somewhat shorter.

At the base of the appendages just mentioned are the rudiments of the following two pairs in the shape of small double sacs (Pl. II. Fig. 4, *X*, *XI*). The second pair are very small, and appear now for the first time.

There is still no trace of the abdominal limbs, except in some specimens about to moult, in which the last pair (swimmerets) are visible through the transparent integument within the caudal fin (Pl. II. Fig. 3, *XIX*). They have the shape of oval plates lying within the sides of the triangular telson.

*Third Larval Stage* (Pl. II. Figs. 5-9).—Larvæ in this stage of development were frequently taken free-swimming at the surface of the water, both at Newport and Wood's Hole, in July and early August. From their slight advance upon the preceding form, I have little doubt of their coming from it by a single moult, although I did not succeed in raising this stage in confinement.

In general form the larva still bears a close likeness to the stage last described. The telson, however, has lost its broad, triangular shape, and now, flanked by the free, bilobed swimmerets, renders this stage distinguishable at a cursory glance from either of the preceding ones.

In addition to the spines seen on the carapace in the second larval stage, there is now a minute one on the anterior border, below the supra-orbital spine. This seems to correspond to the antennal spine in the adult.

The first pair of antennæ are no longer simple, the rudiments of the inner flagellum having appeared as a small bud (Pl. II. Fig. 5, *I*, *r i*) from the inner side of the distal end of the second segment. It is tipped by a long seta. The segment which terminated the simple antennule of the previous stage now appears as the rudimentary external flagellum (Pl. II. Fig. 5, *I*, *r e*).

In the second pair of antennæ the inner branch (Pl. II. Fig. 5, *II*, *r i*), which becomes the chief part of the antenna in the adult, has

become divided by a transverse suture near its base, so that it now consists of two segments, a short proximal and a long, slender, distal one. The external branch of the second antennæ (Pl. II. Fig. 5, *II*, *r e*) has increased in size, but otherwise has suffered little modification.

The posterior border of the labrum, which bounds the mouth in front (Pl. II. Fig. 7), when viewed under a high magnifying power is seen to be serrate with minute teeth.

The mandibles and maxillæ (Pl. II. Figs. 5, 8, 9) have undergone little change.

A fifth pair of swimming-feet (Pl. II. Fig. 5, *X*) has developed from the anterior of the sac-like buds behind the last pair of swimming-feet of the preceding stage. This pair of swimming feet corresponds to the second or larger pair of chelipeds of the adult *Palæmonetes*. They are similar in make to the preceding pairs, but somewhat shorter. The antecedent pair of swimming-feet have gained in length, so that they now equal, if they do not slightly exceed, the pair in front of them. The segmentation of the inner branches of all the swimming-feet is more distinct than at first, dividing them into four segments, at least in the hindmost three pairs.

A new pair of sac-like appendages (Pl. II. Fig. 5, *XII*?) have developed behind the swimming-feet, so that we still have two pairs (*XI* and *XII*?), which will disclose swimming-feet after the next moult. The gills have begun to develop at the base of the swimming-feet.

The broad triangular fin which terminated the abdomen in the last stage has by exuviation freed the posterior pair of abdominal appendages (Pl. II. Fig. 5, *XIX*), of which we have seen the rudiments through the transparent integument in the previous stage. Both branches of these appendages are developed as two oval plates, of which the outer is two thirds the length of the telson, the inner about one third. The larger plate is fringed with fine setæ on its inner, and on the hinder portion of its outer, border. The telson itself, as before said, is much narrower than before, and is separated by a suture from the sixth abdominal segment. Its hind margin now bears but twelve long setæ, the external one on each side having disappeared.

On the lower side of the thorax, between the bases of the swimming-feet, is a good deal of green pigment beautifully arranged in dendritic figures. Other parts of the body also are rendered conspicuous by spots of red, green, and yellow.

Length, 3.5 mm.

*Fourth Larval Stage* (Pl. II. Figs. 10 - 15 ; Pl. III. Figs. 1 - 3). — At

the next moult the larva assumes the form represented on Plate II. Fig. 10. Considerable structural advance appears in the antennæ, in the acquisition of another pair of swimming-feet, and the rudiments of all the abdominal appendages.

The carapace now has two spines pointing forward in the median dorsal line. The inferior side of each of these is armed with minute, recurved teeth. The successive unfolding of the swimming-feet from before backwards has been accompanied by a lengthening of the carapace in a posterior direction, so that when the last pair has appeared the bases of the whole line of limbs are covered by the branchiostegite.

The rudimentary inner flagellum of the first pair of antennæ (Pl. II. Fig. 11, *r i*) has increased a little in size, but is still composed of one segment. The inner branch of the second antenna (Pl. II. Fig. 12, *r i*) has gained in length in relation to the outer branch, and is now divided into three segments, of which the first and second are short and thick, the third long and style-shaped.

The sixth pair of biramous natatory appendages (the third pair of Decapodal legs) are now present, and the first sign of the formation of chelæ on the two antecedent pairs appears in the slight production of the antero-internal angle of the penultimate segment of their inner branches. As will be seen further on, this angle becomes produced more and more until at last it forms a thumb opposable to the dactylus. The first two pairs of swimming-feet are now quite small compared with the following pairs, and begin to assume the proper function of maxillipeds. Behind the sixth pair of swimming-feet are the rudiments of the following two pairs of thoracic appendages (Pl. III. Fig. 1, *XII, XIII*; Figs. 2, 3). The seventh pair (Fig. 2) are double; the eighth pair, or hindmost thoracic appendages (Fig. 3), simple, sac-like structures. They are bent forward underneath the thorax, and concealed by the appendages in front of them.

The appendages of the abdominal segments from the first to the fifth inclusive are now for the first time seen (Pl. II. Fig. 10, *XIV-XVIII*). They are simple buds from the lower face of the abdomen, and in a side view they are almost concealed by the pleuræ. The appendages of the sixth segment of the abdomen (Pl. II. Fig. 15) have now acquired a shape nearly like those of the adult prawn. The inner plate (*r i*) is almost as long as the outer (*r e*), and both are clearly defined from one another and from the basal segment (protopodite). Both plates are provided with long and delicately fringed setæ arranged as represented in the figure.



The posterior border of the telson (Pl. II. Fig. 15, *t*) now but slightly exceeds the anterior end in width. It is deeply concave, and furnished with but eight long setæ. The spaces between the long setæ contain two very small setæ; those in the median interspace are longer than the rest.

It appears from my notes that on the 8th of August, 1878, a specimen in the stage described above as the third moulted in one of my aquaria, and then appeared in a shape differing in one respect from that which I have just described as the fourth larval stage. Besides the acquirement of the sixth pair of swimming-feet, the *seventh* pair were developed in this specimen as biramose, clearly segmented, setiferous appendages (Pl. II. Fig. 14), but very small in size compared with the sixth and preceding pairs. The last pair of thoracic limbs were simple, sac-like organs. This early development of the seventh pair of swimming-feet I regard as premature; in the normal course of development it is anticipated by the eighth pair, as will appear presently.\*

*Fifth Larval Stage* (Pl. III. Figs. 4 - 13).— This stage was reared from the fourth stage in one of my jars. The most important structural advance upon the preceding stage consists in the full development of the hindmost pair of thoracic appendages. The flagellum of the second pair of antennæ has increased in length, and the long terminal segment shows a faint indication of division into four segments. There is a short spine (Fig. 4, *II, sp.*) on the outer side of the distal end of the posterior antennæ, which becomes larger in later stages of the development. This spine is more highly developed in the larvæ of *Paguridæ*, and represents the enormously developed spinous process of the second pair of antennæ so frequently found in the zoëæ of the *Brachyura*. From the exuvie of one individual I obtained for the first time the complete structure of the mandible (Fig. 7, *III*). It is composed of two branches, as in the adult, but the anterior branch, instead of presenting a molar crown, as in the full-grown animal (Pl. IV. Fig. 19), ends in multidenticulate incisor edge. This branch is concealed beneath the fleshy labrum, and hence escaped detection in the earlier stages.

The chela of the fourth pair of swimming-feet is more perfectly formed than before, the penultimate segment being much enlarged, with its internal angle produced as far as the middle of the terminal segment

\* I find among some larvæ which I preserved in alcohol one specimen with five pairs of natatory appendages (in this agreeing with the third stage above described), but in every other respect agreeing with the fourth stage. Behind the last pair of swimming-feet are the double, sac-like rudiments of the two following pairs. Length, 4 mm.

(Fig. 4, *IX*). The chela of the following pair of appendages is not so much developed as yet. The penultimate pair of thoracic legs (Fig. 4, *XIII*) are still rudimentary, unsegmented, double sacs.

The last pair of thoracic legs, however, are fully developed as long, simple, 5- or 6-jointed appendages (Fig. 4, *XIII*). This pair alone of all the thoracic appendages are destitute of external branches from their very earliest appearance. They are generally borne curved forward under the sternum, in which position the distal segment (which bears a long, coarse terminal bristle) reaches forward to the maxillæ. The inner branches of the double thoracic legs are in the same way tucked under the breast when the animal swims.

The appendages of the first, second, third, fourth, and fifth abdominal somites have gained in size. The second, third, and fourth pairs (Fig. 11) present a little lobe on the inner side (*r i*), which is the beginning of the formation of the inner branch.

The telson (Fig. 13, *t*) is at this stage narrower behind than in front. Its hind margin is armed with eight setæ.

Length, 5.5 mm.

*Sixth Larval Stage* (Pl. III. Figs. 14 - 16 ; Pl. IV. Figs. 1-8). — The larva issues from the next moult provided for the first time with all the swimming-legs. The sacs which represented the penultimate pair previous to the moult have set free a pair of two-branched limbs similar to those in front, but with quite small external branches. This is the nearest approach to a true *Mysis*-stage which appears in the development. It differs from the Schizopod in the lack of the outer branch of the last thoracic feet.

Besides the unfolding of the penultimate pair of thoracic appendages, there is but little change from the phase immediately before the last moult. The inner branch of the second antennæ (Pl. III. Fig. 14, *r i*) is clearly divided into six or seven segments. The chelæ (Pl. III. Figs. 15, 16) are more perfectly formed. The two lobes of the abdominal appendages (Pl. III. Fig. 17) have become enlarged and marked off by constriction from the basal portion of the limb. The posterior border of the telson (Pl. III. Fig. 18, *t*) is cut into a shallow notch, and bears three pairs of long setæ. In the interval between the central pair are two much smaller setæ.

Length from tip of the rostrum to end of the telson, 6 mm.

I succeeded in rearing this stage through two successive moults. The resulting forms differed so little from the one just noticed (no new structures appearing), that I have included all three under the name of *sixth larval stage*.

After the first moult the larva had the form represented on Plate IV. Fig. 1. The general shape is very much like the adult, but all the feet except the last pair are provided with an outer swimming branch. The armature of the carapace is now as follows: two large spines in the median dorsal line, the anterior of which lies over the base of the eye-stalks; one on each side near the anterior margin, on a level with the eye-stalks; all of these are directed forward and furnished with minute recurved teeth on their lower sides; in addition to these there is a small antennal spine on each side of the carapace on the anterior margin on a level with the base of the second pair of antennæ, and a very minute spine at the antero-inferior angle of the carapace just below the antennal spine; this is probably the branchiostegal spine in the adult. The rostrum is furnished with hairs on its upper edge in front of the anterior dorsal spine. The peduncle of the first pair of antennæ is now divided into three segments; both the inner and outer branches have increased in length. The flagellum of the second pair of antennæ (Fig. 2, *r i*) exceeds the scale in length, and its distal half is divided up into six or seven segments. The first pair of maxillipeds (Fig. 1, *VI*) are very small compared with the Decapodal legs; the second and third pairs increase in length successively. The chelipeds (*IX, X*) are terminated by a perfect claw, in which the process of the penultimate segment is equal in length to the dactylus; both dactylus and the opponent process are furnished with a few plumose setæ. The exopod of the penultimate thoracic limbs has now attained a size equal to that of the limbs in front. The appendages of the abdomen (*XIV-XVIII*) are much larger than before the last moult; a small projection from the inner border of the internal rami of the second to the fifth pairs (Fig. 5, *s*) is the beginning of the slender stylet in the adult (Fig. 26, *s*); both branches are now furnished with long plumose hairs; the inner branch of the first pair (Fig. 4, *r i*) is rudimentary.

One individual of the form just noticed died during the process of exuviation in one of my aquaria. It sufficed to show that the larva after the moult differed in no important regard from the antecedent form. The tooth on the outside margin of the outer blade of the swimmerets, which is so conspicuous in the adult (Fig. 29), is beginning to appear (Fig. 8). The telson is still armed with three pairs of long bristles (Fig. 8); within the inner pair are two of very minute size.

Length, 8 mm.

I failed to rear any of the larvæ in confinement beyond this stage. The next form in the series which I have met with is the one repre-

sented by Fig. 15 of Plate IV. This was frequently taken in the hand-net free-swimming at the surface of the sea. Although but eight millimetres long, the larva has acquired the form and almost every character of the adult prawn.

Among the drawings of Crustacean larvæ made by Mr. Agassiz at Newport, which he has generously placed at my disposal, are some details of the structure of a larval stage of *Palæmonetes vulgaris* which happily fills in some measure the gap between the sixth larval stage and the adult form. This phase in the development I will designate as the

*Seventh Larval Stage* (Pl. IV. Figs. 9 - 14). — There is no sketch of the general form of this stage among Mr. Agassiz's drawings. The rostrum (Pl. IV. Fig. 9) is long and scymitar-shaped, with six teeth above and two below. Between the teeth of the dorsal side are hairs, as in the adult. The anterior third of the rostrum is destitute of teeth. The carapace is armed, moreover, with an antennal and a minute branchiostegal spine on each side. The supra-orbital spine is reduced to a mere rudiment.

The natatory branch of the maxillipeds and legs (Pl. IV. Figs. 10, 11, 13, *r e*) is reduced to a short style composed of one segment. In this we see an interesting transition state between the Schizopod and the Decapod leg. The inner branches of the first and second pair of maxillipeds have also diminished, and now consist of one and two segments respectively (Pl. IV. Figs. 10, 11). The segments of the internal branches of the chelipeds and ambulatory appendages are clearly seven in number. The last pair of thoracic legs (Pl. IV. Fig. 14) is of course without the external styliform appendage.

The antennæ, swimmerets, and telson are not represented in Mr. Agassiz's figures, nor is the natural size indicated.

Specimens in the sixth larval stage may measure eight millimetres from the tip of the rostrum to the tip of the telson. This is as long as specimens which have attained the adult form, such as is represented by Figure 15 of Plate IV. Hence I infer that but few stages intervene. It is highly probable, however, that the larva suffers one or two moults between the seventh stage and the attainment of the shape of the adult prawn.

*Early Stage of the Adult Form* (Pl. IV. Fig. 15). — Although measuring only eight millimetres from the tip of the rostrum to the end of the telson, the prawn has now the true Decapod structure; although still a free-swimming surface-dweller. Every trace of the external swimming-branches of the five pairs of legs has vanished, and the structure is in

almost every detail like that of the adult prawn, parts of which are represented on Plate IV. Figs. 16 – 31. The integument, however, is much thinner and more transparent, the legs are longer, and the external plate of the swimmerets is not divided by a transverse suture. The rostrum (Pl. IV. Fig. 32) is nearly as long as the portion of the carapace behind it. Viewed in profile, it increases in depth from the root to beyond the middle, thence tapers with a gentle upward curve to a fine point at the tip. It is armed above with seven, below with three, teeth. The second tooth, counting from the base, lies over the proximal end of the eye-stalks. They are all directed forward, and in the intervals between them are two or three hairs.

As the prawn develops, new teeth are added between the older ones and the tip of the rostrum. In a specimen which measures 9 mm. in length, the dental formula is  $\frac{8}{3}$  (Pl. IV. Fig. 33). In the mature prawn the number of teeth on the rostrum is commonly nine above and four below (Pl. IV. Fig. 30), but is subject to great variation. Thus, I find on looking over a large series of specimens measuring from 28 mm. to 42 mm. in length, the following formulæ for the rostral teeth :

$$\frac{11}{4}, \frac{10}{4}, \frac{10}{3}, \frac{9}{4}, \frac{8}{3}, \frac{8}{2}, \frac{8}{3}, \frac{8}{3}, \frac{8}{2}, \frac{7}{2}, \frac{6}{3}, \frac{6}{2}.$$

Hence will appear the folly of those zoölogists who have taken the form of the rostrum as a means for distinguishing species in the group of *Caridea*. The carapace is provided, moreover, with an antennal and a branchiostegal spine on the fore margin of each side. There is now no trace left of the large supra-orbital spine which was so conspicuous in most of the larval stages. The pterygostomial angle is rounded off as in the full-grown individuals. The pleuræ of the fifth abdominal segment extend backward over the following somite, but are not drawn out into a long spine as in the larval stages.

The telson has the same form and armature as in full-grown specimens. It tapers posteriorly to a very narrow hind margin which is produced in the middle in the form of a stout tooth. From the lower face of this median tooth issue a pair of long, plumose setæ. On each side of the median tooth is a long spine, which is articulated with the telson, and outside of these is a short spine, similarly articulated with the external angle of the posterior border of the telson. The dorsal surface of the telson has four small spines arranged as in the mature prawn.

The third flagellum of the first pair of antennæ is now present as a short, two-jointed appendage tipped by fine hairs (Pl. IV. Fig. 15, *r e'*). It does not issue from the peduncle of the antennule, but from the inner

side of the third segment of the primary (external) flagellum. In full-sized individuals the free portion of the tertiary flagellum may have as many as thirteen or fourteen segments, and the distance between its base and the base of the primary flagellum may contain as many as eight segments.

The second pair of antennæ are about as long as the body. The mandibles (Fig. 18) are two-branched. One of the branches is terminated by a molar surface (Fig. 19), the other by *three* incisor teeth in the right mandible (Fig. 18), *four* in the left (Fig. 20).

The first pair of maxillæ (Fig. 21) consist of two lobes (*a*, *b*), which are fringed with setæ on their inner borders, and a palpus (*r i*) bilobed at its free end.

The second pair of maxillæ (Fig. 22) are composed of a bifid inner plate (protognath, *a*) fringed on its internal border with setæ, a middle piece (endognath, *r i*) composed of one segment, and a large ear-shaped scaphognathite (exognath, *r e*), whose margin is beset with long and delicate hairs.

The first pair of maxillipeds (Fig. 23) have a very complicated structure. The inner, prehensile portion consists of two thin, foliaceous lobes (*a*, *b*), of which the distal (*b'*) is the larger. The edges of both are provided with setæ. The other parts of the organ are probably tactile and respiratory in their function, and consist of a tongue-shaped middle piece (*r i*); an external, large, oval plate which gives off a long palpiform appendage (*r e*); and two small oval plates (*e p*, *e p'*) at the base of the larger external plate. The inner margin of the latter, and the distal third of its appendage, are fringed with fine setæ. The two smaller external plates (*e p*, *e p'*) are of a soft consistency, and very probably serve in a measure to aërate the blood.

The penultimate segment of the endognath of the second pair of maxillipeds (Fig. 24) is produced on the inner side into a large lobe, to the distal margin of which the terminal segment is articulated. The two segments together thus form a broad oval blade, which is reflected upon the inner side of the antecedent segments, and lined with setæ on its oral border. The exognath (*r e*) is long and slender. At the base of the limb, on the external side, are a small roundish epignath (*e p*) and a small but well-formed gill (*b r*).

The third pair of maxillipeds (Fig. 16) are composed of the same parts as the second maxillipeds, but the inner branch (*r i*) is pediform and twice the length of the external branch (*r e*).

The structure of the following thoracic appendages is so well known

that a detailed description of them would be superfluous. In specimens 8 mm. or 9 mm. long the transverse suture of the exopod of the swimmerets (Fig. 15, XIX, *re*) has not yet appeared. As in full-grown individuals, the inner side of the tip of the styliform appendage of the preceding abdominal members (Fig. 26, *s*) is furnished with microscopic curled hairs (Fig. 27), whose function I cannot imagine. They occur in both sexes. The internal branch of the second pair of abdominal members in mature male specimens presents a second slender inner appendage (Fig. 28, *s'*) fringed with hairs on its outer margin. The small endopod of the first pair of abdominal appendages, moreover, is differently shaped in the two sexes. In the male, the distal third widens and trends slightly inward; on the inner margin, near the base, are some long setæ; the distal portion bears short, plumous setæ. In the female, the endopod narrows gradually from its root to the tip, and is fringed at the end and along the internal border by long feather-like hairs.

In the above-described series of larval forms I have never obtained the third stage directly from the second, but with this exception I have actually reared in confinement each successive stage from its predecessor, from the first to the sixth inclusive.

The only larva known to me on this coast liable to be confounded with *Palæmonetes* is that of *Virbius zostericola* Smith. In specimens 6.5 mm. long, still in the Schizopod condition, the carpus of the second pair of feet is already tri-articulate, and the setæ of the telson, form of the antennal scale, and other characters serve to distinguish it from the young *Palæmonetes*.

It appears, from what precedes, that *Palæmonetes* issues from the egg in the zoëa-form, i. e. provided with a pair of compound eyes, two pairs of antennæ, two pairs of maxillæ, and three pairs of swimming-feet, the future maxillipeds. Behind the third pair of swimming-feet are the rudiments of the following two pairs of appendages in the shape of double sac-like structures. No gills exist, the aëration of the blood being accomplished through the general integument, and especially under the sides of the carapace, by means of a current of water maintained, as in the gill-bearing adult, by the constant motion of the broad external plate of the second maxillæ. The abdomen is wholly devoid of appendages, and the telson is not clearly marked off from the sixth abdominal segment.

As development proceeds, the rest of the thoracic legs are unfolded in succession from before backward. The only break in the regular order of succession is caused by the unfolding of the last pair earlier than the

penultimate. All the thoracic appendages, excepting the last pair, are furnished with external natatory branches. By subsequent moults the natatory branches are reduced in size, and finally disappear altogether. During the evolution of the thoracic limbs, the abdominal appendages make their appearance, first the posterior pair (which develop within the caudal plate or telson), then the anterior pairs.

The different forms which the individual assumes during its development are in this case the result of gradual growth, each successive moult developing a form which shows but a slight advance upon the one immediately preceding it. It is, nevertheless, a true metamorphosis, involving the acquirement of new structures, the atrophy of others, and change of function of still others; the structural difference between the young larva and the adult prawn being much greater than in insects with a so-called incomplete metamorphosis, like the *Orthoptera*.

I am inclined to think there is error in many of the observations recorded of consecutive stages in the development of the *Macroura* captured with the hand-net or tow-net. In most of these cases the great difference in form between the specimens warrants the assumption that intervening stages are missing. Consecutive stages which I have actually reared in confinement often do not differ appreciably from one another in size, so that one cannot be sure from the relative size alone of his larvæ that links are not wanting in his chain of forms.

Excepting the statement of Agassiz that *Palæmonetes vulgaris* hatches from the egg as a *Cuma*,\* the only notice of the developmental history of this species, with which I am acquainted, is the short description of the first larval stage, by S. I. Smith, already cited.†

But few observations have been made upon the development of the European species of *Palæmon*, which is somewhat strange when one considers how common some of them are.

The first naturalist who published anything concerning the development of the genus was Rathke, who made some observations in 1833 upon the growth of the embryo within the egg of *Palæmon adspersus* Rathke (= *P. rectirostris* Zaddach, according to Heller),‡ and *Palæmon squilla*.§ These observations are so full of error that they have only an historical interest. Prejudiced by his studies upon the devel-

\* Amer. Jour. Sci. and Arts, 2d Series, Vol. XIII, p. 426. 1852.

† *Supra*, p. 304.

‡ Die Crustaceen des südlichen Europa, p. 270. 1863.

§ Ueber die Entwicklung der Decapoden. Müller's Archiv, 1836, pp. 187-192. Zur Morphologie, Reisebemerkungen aus Taurien, pp. 81-93, 179-184, Pl. IV. Figs. 1-10. 1837.



opment of *Astacus*, Rathke came to the conclusion that the prawn too acquires, while still within the egg, all the external parts (excepting the sexual organs) which are found in the adult, and that it is subject to no greater structural changes after leaving the egg than a bird is! After further researches upon the development of Decapods, Rathke acknowledged his error, and his handsome tribute to J. V. Thompson, in this connection, is a notable example of candor.\*

The changes which the young suffers after leaving the egg were first observed by J. V. Thompson. In the summer of 1828 he obtained the first stage of the larva by hatching the eggs of *Palæmon serratus*, and in a paper published in 1836 † gave a rough figure of this, together with two older larval prawns which he supposes to belong to the same species, although they were captured free-swimming.

How much allowance must be made for inaccuracy in Thompson's figures it is hard to say. The first stage is represented with but two pairs of cleft members; in the second stage the larva has acquired an additional pair of swimming-feet, the sixth pair of abdominal appendages are present, and form with the telson a terminal fin about like that in our third larval stage. There is yet no dorsal spine on the carapace, and the first pair of antennæ are still simple.

The third stage apparently represents a phase somewhat more advanced than our sixth stage. The carapace is now armed with three spines on the median dorsal line, and a supra-orbital spine on each side. All of the appendages are now present, the chelæ are well formed, and all of the thoracic members, not excepting the posterior pair, are furnished with a natatory branch. The flagellum of the second pair of antennæ is in the condition of the adult, being divided into an indefinite number of annuli. In other respects the young prawn agrees pretty well with the sixth stage of *Palæmonetes*.

The most complete account of the larval stages of *Palæmon* up to the present time is that of Captain DuCane, published in 1839, in the second

\* Zur Entwicklungsgeschichte der Dekapoden. Arch. f. Naturgesch., 1840, I. p. 248.

Beiträge zur vergleichenden Anatomie und Physiologie, Reisebemerkungen aus Skandinavien, p. 46. Neueste Schriften der Naturforsch. Gesell. in Danzig, Vol. III. 1842.

† Memoir on the Metamorphosis in the Macrouræ or Long-tailed Crustacea, exemplified in the Prawn (*Palæmon serratus*). Edinburgh New Philosoph. Jour., Vol. XXI. pp. 221-223, Pl. I. 1836. A short notice of this paper appears in the "Abstracts of the Papers printed in the Philosophical Trans. of the Royal Soc.," Vol. III. p. 371. 1836.

volume of the *Annals of Natural History*.\* In this communication the author gives a brief description and rude figures of four larval stages of the ditch prawn, *Palæmon variabilis* [*Palæmonetes varians* Heller?]. The earliest form represented is that which the larva assumes immediately after exclusion from the egg. The first pair of antennæ are portrayed with *two* terminal, one-segmented branches, a condition not seen in any other figures of the first larval stage of *Palæmon*. As in Thompson's figure of the same stage, only two pairs of swimming-feet are represented. Behind them are the rudiments of the true legs in the shape of three pairs of small, simple, two-jointed processes. The number of abdominal segments is plainly exaggerated.

In the second stage, "ascertained by observing the moult of the former," the carapace is armed with a dorsal spine at the base of the rostrum, and all the thoracic legs are present! The posterior pair are destitute of the natatory branches; the chelæ are developed. It is noteworthy that the author expressly states that the abdominal appendages have begun to appear, excepting the last pair. If this be correct, it is certainly an exceptional order of development among the *Macroura*. Commonly in this group the posterior pair appear before the other abdominal appendages.

In the third stage, "also ascertained by witnessing the moult," the carapace has two dorsal and supra-orbital spines, and the posterior pair of abdominal limbs have appeared.

The fourth stage was not obtained directly from the third by observing the moult. The larva now has three dorsal spines, and, excepting the want of external branches to the last pair of thoracic legs, agrees well with Thompson's third stage. The next moult brought it to the condition of the adult prawn.

It is obvious from the above account that the number of forms passed through by the larva before reaching the adult shape is much smaller than in the case of *Palæmonetes vulgaris*, unless there is error in the observations of DuCane.

The next observation bearing upon the development of *Palæmon* is found in Fritz Müller's "Für Darwin." † It consists of a brief description, accompanied by a wood-cut, of what seems to be the first larval stage.

The researches of Bobretzky upon the development of *Palæmon*, published in the Russian language, at Kief, in 1873,‡ have already been

\* Letter from Captain DuCane, R. N., . . . on the subject of the Metamorphosis of *Crustacea*, *Ann. Nat. Hist.*, Vol. II. pp. 178-181, Pl. VI, VII. 1839.

† Für Darwin. 1864. English Trans. by W. S. Dallas, p. 55, Fig. 27. 1869.

‡ Zapiski Kiefs. Obshtshest. Yestestvoisпитatalyei, Vol. III. pp. 186-252, Pl. IV-VI. 1873. Hofmann und Schwalbe's "Jahresberichte," Vol. II. pp. 317, 318. 1875.

referred to. They relate almost exclusively to the intra-oval development, and for this part of the history are the completest yet made, the microtome having been used for getting sections of the egg in the different stages of its growth.

In 1874 Anton Stuxberg published an incomplete description of the embryo before hatching, and of the first larval stage of *Palæmon squilla*.\*

In an abstract of a paper on the development of *Crustacea*, by Spence Bate, in the Proceedings of the Royal Society of London, 1876,† (the full paper has never been published to my knowledge), the author makes the surprising statement, that in the embryo of *Palæmon*, etc., the anterior of the three earliest formed pairs of lobes (nauplius-appendages) develop directly into the eyes, while the posterior two pairs are cast off with an early moult and replaced by the permanent antennæ!

CAMBRIDGE, June 1, 1879.

\* Karcinologiska iakttagelser. Öfversigt af Kongl. Vetenskaps-Akad. Forhandl., 1873, No. 9, pp. 16-19. 1874.

† "On the Development of the Crustacean Embryo, and the Variations of Form exhibited in the Larvæ of 38 Genera of Podophthalmia." Proc. Royal Soc. London, Vol. XXIV. pp. 375-379. 1876.

I believe I have not misrepresented Spence Bate here, but will quote in full:—  
 "The author has taken this opportunity of making a close examination into the earlier stages in the development of the embryo, and comparing the progress within the ovum of some of the larvæ that arrive at or near maturity before being hatched, with those of the larval forms that are hatched in a more immature condition; and he states that, as soon as the protoplasm assumes anything like a definite plan, distinct lobes, corresponding in position with those of the several appendages in the *Nauplius*, together with an embryonic or ocular spot, are present; that in the *Nauplius* forms they exist as deciduous appendages only, and are soon cast aside and replaced by others more adapted to the wants of the adult existence.

"In the embryos of other *Crustacea* the anterior pair of lobes enlarge in size with little alteration of form, while the posterior two pairs are developed into appendages that have but a deciduous value, since they never fulfil the office of permanent organs, and are generally cast off with an early moult.

"This is observable within the ovum in *Palæmon*, *Crangon*, etc., and also in the marsupial embryo of *Mysis* after it has quitted the ovum.

"The relation of these parts to the permanent organs the author has closely traced, and believes that he has demonstrated that the three pairs of mobile appendages in the cirripedal or *Nauplius* form of larva homologize with the eyes and two pairs of antennæ, and not with the antennæ and mandibles, as stated by Fritz Müller, Anton Dohrn, and others."

## EXPLANATION OF THE PLATES.

The appendages, from the first to the last pair, are indicated throughout by consecutive Roman numerals. They correspond with the appendages of the adult as follows :—

<i>I</i> , first antenna.	<i>XI</i> , third pair of legs.
<i>II</i> , second antenna.	<i>XII</i> , fourth “ “
<i>III</i> , mandible.	<i>XIII</i> , fifth “ “
<i>IV</i> , first maxilla.	<i>XIV</i> , first pair of abdominal appen-
<i>V</i> , second maxilla.	[dages.
<i>VI</i> , first maxilliped.	<i>XV</i> , second “ “ “
<i>VII</i> , second maxilliped.	<i>XVI</i> , third “ “ “
<i>VIII</i> , third maxilliped.	<i>XVII</i> , fourth “ “ “
<i>IX</i> , first pair of legs (cheliferous).	<i>XVIII</i> , fifth “ “ “
<i>X</i> , second “ “	<i>XIX</i> , sixth “ “ “

The Arabic numerals denote the somites of the abdomen.

<i>a b</i> , abdomen.	<i>ng</i> , nerve-ganglion.
<i>a r</i> , artery.	<i>oc</i> , compound eye.
<i>c d</i> , cephalic disk.	<i>ocl</i> , ocellus.
<i>c p</i> , carapace.	<i>re</i> , external branch of appendages.
<i>h t</i> , heart.	<i>ri</i> , internal “ “
<i>i n</i> , intestine.	<i>rs</i> , rostrum.
<i>l b</i> , labrum.	<i>t</i> , telson.
<i>m</i> , mouth.	<i>vt</i> , yelk.

## Plate I.

- Fig. 1. Egg with four segments produced by an equatorial and a meridional cleavage. Each segment contains a nucleolated nucleus (*n*), around which delicate lines of protoplasm are disposed like rays.
- Fig. 2. Egg with sixteen cleavage spheres.
- Fig. 3. The surface of the yelk is now divided into small polygonal blastomeres. *g*, orifice of gastrula-cavity.
- Fig. 4. Profile view of the embryo, four days after the gastrula-stage. The appendages have appeared from the first to the sixth pair. Excepting the first pair, they are bilobed or double.

- Fig. 5. Embryo three days later, from the ventral side. The rudiments of the appendages are now seen from the first to the eighth pair (third pair of maxillipeds).
- Fig. 6. Egg with the enclosed embryo further advanced, viewed from the side.
- Fig. 7. The same, from above.
- Fig. 8. Older embryo, from the ventral side.
- Fig. 9. Still older embryo, from the side.
- Fig. 10. Egg as it appears a few hours before hatching. *p*, the gluey secretion which fixes the egg to the abdominal appendages of the mother.
- Fig. 11. Embryo extracted from the egg just before hatching. The rostrum (*rs*) lies bent under the head. The appendages of the right side are spread out in order that their structure may be seen.
- Fig. 12. Second maxilla of the same.
- Fig. 13. Appendages of the ninth and tenth pairs of the same (representing the two pairs of chelipeds in the adult).
- Fig. 14. First larval stage, viewed from below. *an*, anus.
- Fig. 15. The same; antenna of the first pair.
- Fig. 16. The same; antenna of the second pair. The inner branch (*ri*) develops into the flagellum; the outer branch (*re*) into the scale.
- Fig. 17. The same; parts about the mouth.
- Fig. 18. The same; two adjacent long setæ of the telson, with four very minute setæ in the interspace.

### Plate II.

- Fig. 1. First larval stage, viewed from the side.
- Fig. 2. Second larval stage, viewed from the side.
- Fig. 3. The same, viewed from above.
- Fig. 4. The same; oral and thoracic appendages.
- Fig. 5. Third larval stage, from below.
- Fig. 6. The same; anterior part of the carapace, viewed from the side. *x*, dorsal spine. *y*, supra-orbital spine. *z*, antennal spine.
- Fig. 7. The same; posterior border of the labrum.
- Fig. 8. The same; first maxilla. *a*, inner lobe. *b*, outer lobe. *ri*, palpus.
- Fig. 9. The same; second maxilla. Only a small part of the scaphognathite (*re*) is represented.
- Fig. 10. Fourth larval stage, side view.
- Fig. 11. The same; first antenna. *ri* and *re*, rudimentary flagella.
- Fig. 12. The same; second antenna.
- Fig. 13. The same. *lb*, labrum. *m*, mouth. *III*, mandible. *ms*, metastoma. *IV*, first maxilla. *a*, *b*, *ri*, as in Fig. 8.
- Fig. 14. The same; abnormally developed appendage of the penultimate thoracic pair.
- Fig. 15. The same; telson and swimmeret.

## Plate III.

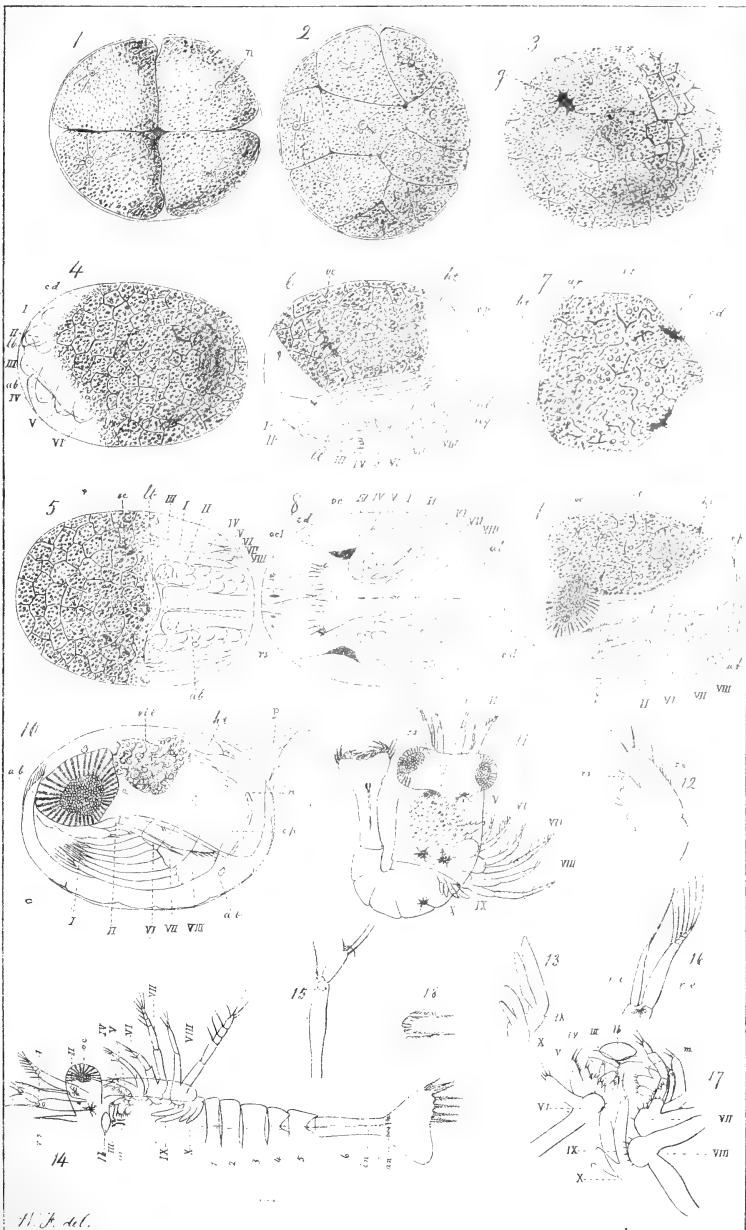
- Fig. 1. Fourth larval stage ; cephalo-thorax, from below.  
 Fig. 2. The same ; penultimate thoracic appendage.  
 Fig. 3. The same ; last thoracic appendage.  
 Fig. 4. Fifth larval stage ; cephalo-thorax viewed from below. *sp*, spinous process of second pair of antennæ.  
 Fig. 5. The same ; anterior part of the carapace.  
 Fig. 6. The same ; fifth abdominal somite, viewed from the side.  
 Fig. 7. The same ; labrum (*lb*) and mandibles (*III*).  
 Fig. 8. The same ; second maxilla.  
 Fig. 9. The same ; natatory branch of the tenth pair of appendages.  
 Fig. 10. The same ; abdominal appendage of the first pair.  
 Fig. 11. The same ; abdominal appendage of the second pair (those of the third and fourth pairs have the same form).  
 Fig. 12. The same ; abdominal appendage of the fifth pair.  
 Fig. 13. The same ; telson and swimmerets.  
 Fig. 14. Sixth larval stage, one moult after the fifth larval stage ; antenna of the second pair ; *sp*, spinous process.  
 Fig. 15. The same ; first cheliped.  
 Fig. 16. The same ; second cheliped.  
 Fig. 17. The same ; one of the abdominal appendages.  
 Fig. 18. The same ; telson and swimmerets.

## Plate IV.

[NOTE. Figs. 9-14 are from drawings by Mr. A. Agassiz.]

- Fig. 1. Sixth larval stage, two moults after the fifth larval stage, lateral view.  
 Fig. 2. The same ; second antenna ; *sp*, spinous process.  
 Fig. 3. The same ; cheliped with its external, natatory branch (*re*).  
 Fig. 4. The same ; first abdominal appendage.  
 Fig. 5. The same ; second abdominal appendage.  
 Fig. 6. The same ; posterior margin of the telson.  
 Fig. 7. Sixth larval stage, three moults after the fifth larval stage ; anterior end of first antenna.  
 Fig. 8. The same ; telson and swimmeret.  
 Fig. 9. Seventh larval stage ; rostrum and eye.  
 Fig. 10. The same ; second maxilliped.  
 Fig. 11. The same ; third maxilliped.  
 Fig. 12. The same ; chela.  
 Fig. 13. The same ; rudimentary external branch (*re*) of thoracic legs.  
 Fig. 14. The same ; posterior thoracic leg.  
 Fig. 15. Young prawn, 8 mm. long, which has acquired most of the characters of the adult.  
 Fig. 16. Adult ; third maxilliped.  
 Fig. 17. The same ; scale of second antenna.

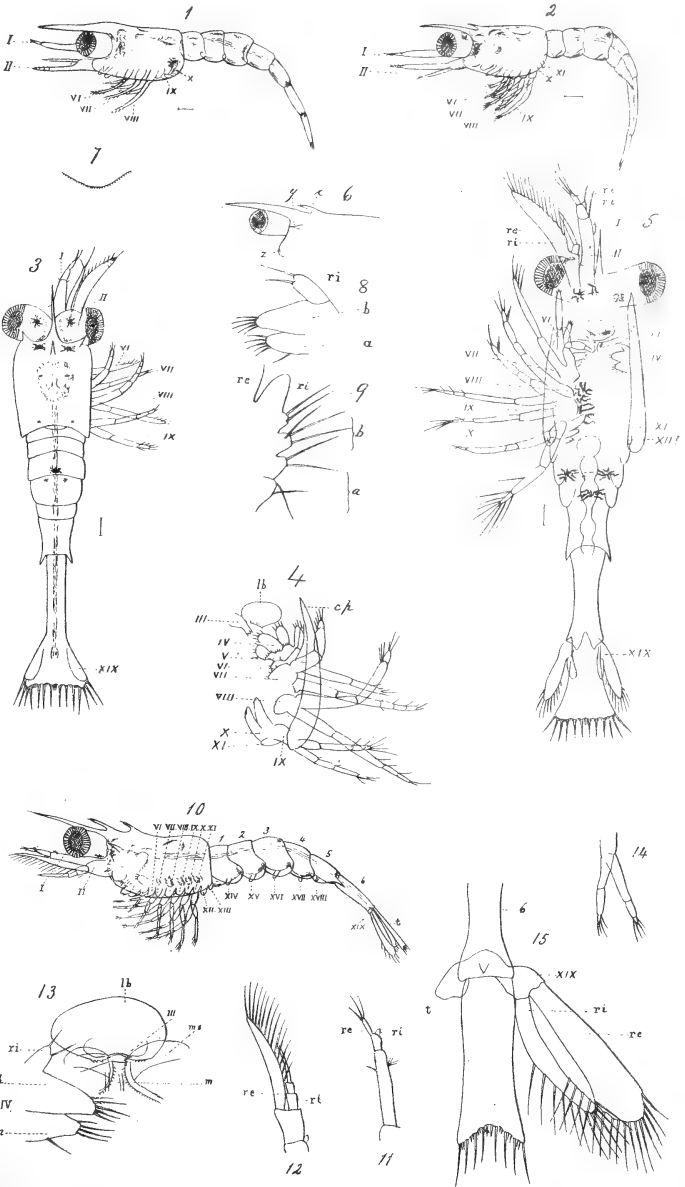
- Fig. 18. The same ; right mandible.
- Fig. 19. The same ; molar crown of mandible.
- Fig. 20. The same ; end of incisor branch of left mandible.
- Fig. 21. The same ; first maxilla. *a*, inner lobe. *b*, outer lobe. *ri*, palpus. *ep*, epignath.
- Fig. 22. The same ; second maxilla. *a, b*, lobes of protognath. *ri*, *ramus internus*. *re*, *ramus externus*, or scaphognathite.
- Fig. 23. The same ; first maxilliped. Letters as before.
- Fig. 24. The same ; second maxilliped. *br*, gill.
- Fig. 25. The same ; first abdominal appendage.
- Fig. 26. The same ; fourth abdominal appendage. *s*, appendage on inner side of the internal branch.
- Fig. 27. The same ; tip of the styliform appendage (*s* of the preceding figure) of abdominal limbs, highly magnified to show the curled hairs.
- Fig. 28. The same ; inner branch of second abdominal appendages in the male, bearing *two* slender appendages, *s* and *s'*.
- Fig. 29. The same ; telson and swimmerets.
- Fig. 30. The same ; carapace.
- Fig. 31. Rostrum of another adult specimen.
- Fig. 32. Rostrum of the specimen represented by Fig. 15.
- Fig. 33. Rostrum of an individual 9 mm. long.



H. J. del.

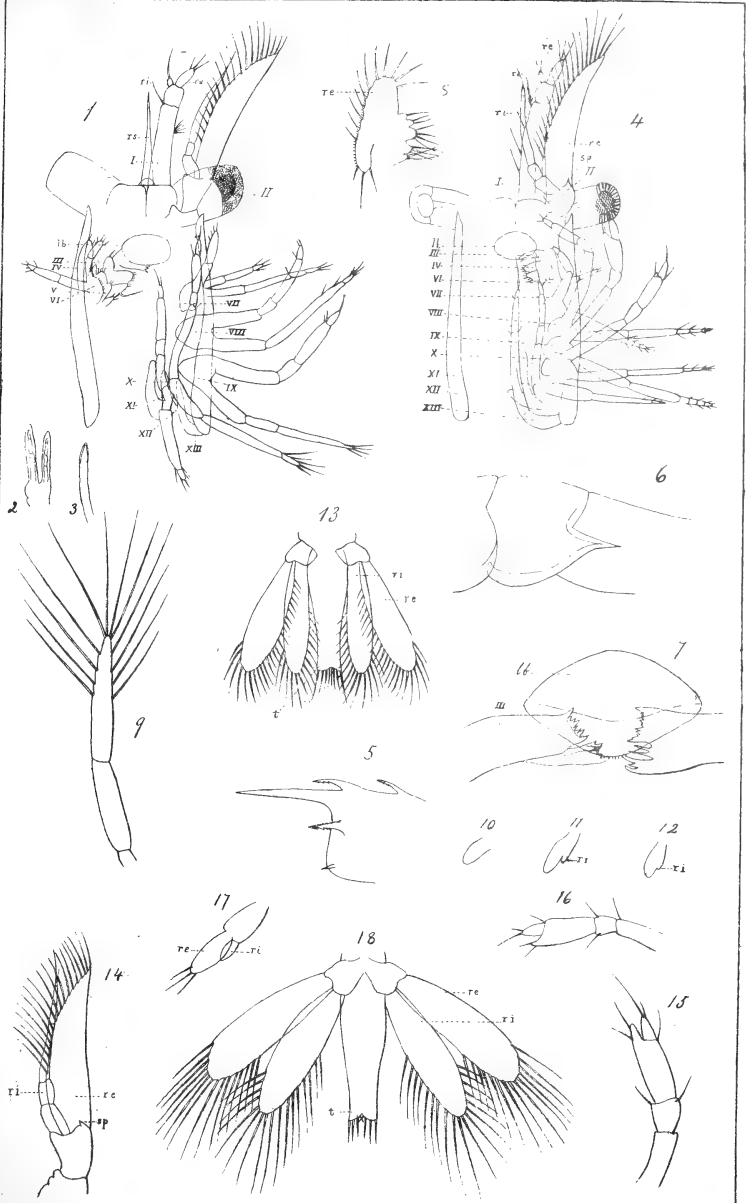






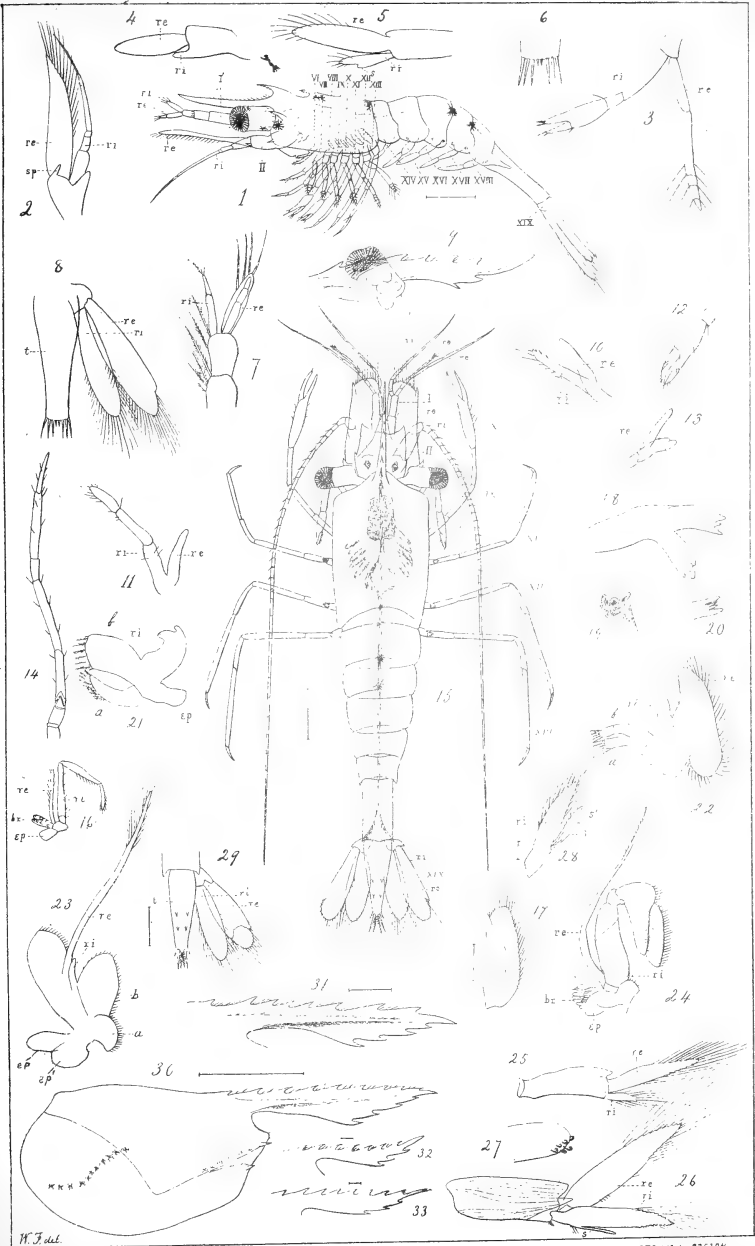
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at Harvard College, CAMBRIDGE, Mass.

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No. 10.

ON SOME POINTS IN THE STRUCTURE OF THE EMBRYONIC  
ZOËA. BY WALTER FAXON.

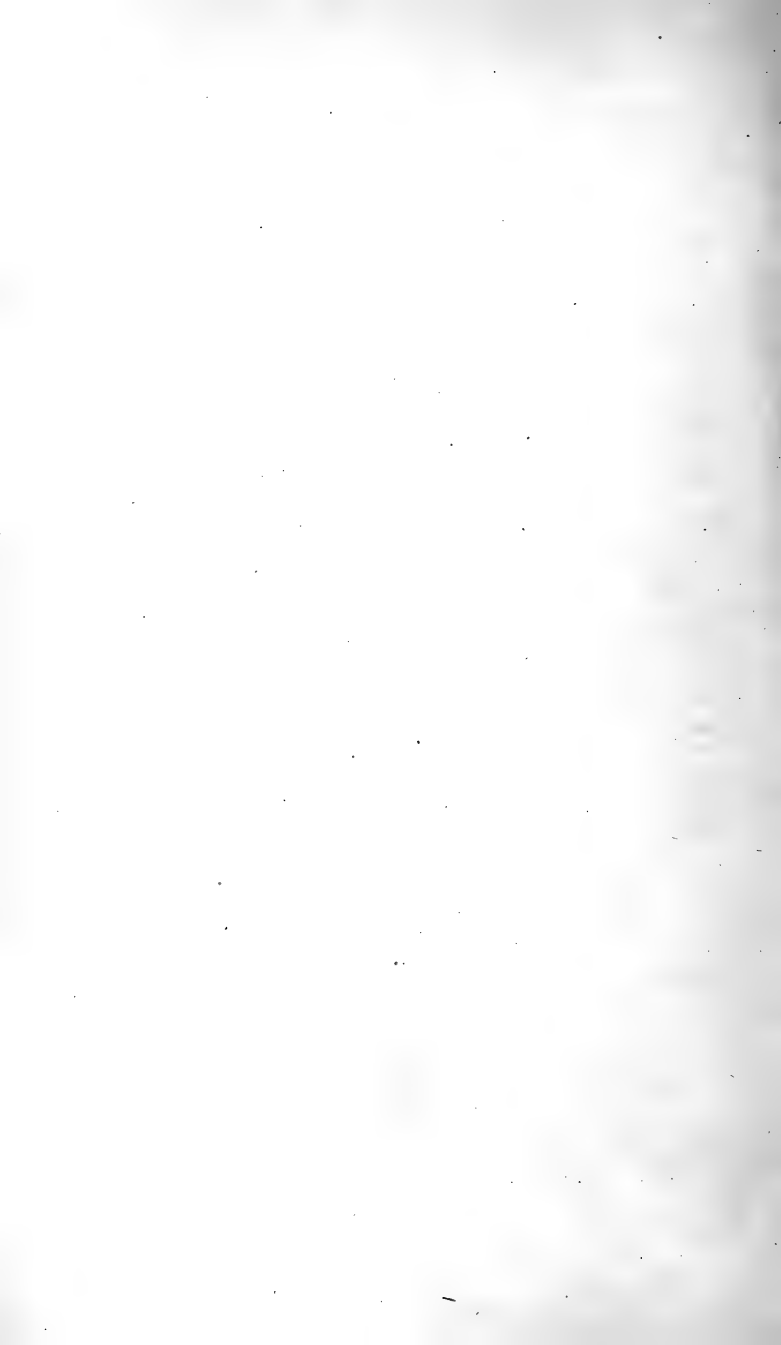
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OCTOBER, 1880.





No. 10. — *On some Points in the Structure of the Embryonic Zoëa.*  
By WALTER FAXON.

THE embryonic cuticle which clothes the larvæ of the higher *Crustacea* at the time when they leave the egg has been studied with more or less care by Du Cane,\* Spence Bate,† Fritz Müller,‡ Gerbe,§ A. Dohrn,|| Stuxberg,¶ Claus,\*\* and P. Mayer.†† Müller first called attention to the fact that the tail of this embryonic skin in certain genera of *Brachyura* (*Achæus*, *Maia*) resembles that of the larvæ of shrimps and prawns, and working upon this hint Mayer has shown the great morphological and phylogenetic value of a careful comparison of the caudal fin of the embryo with that of the following free-swimming stage.

While in Mr. Agassiz's laboratory at Newport, R. I., in the summer of 1879, I made some observations upon the youngest larval stages of a few *Brachyura*, especially *Carcinus mænas* and *Panopeus Sayi*. Although the former species is the subject of Spence Bate's elaborate memoir on the development of Decapod *Crustacea*, I am induced to publish my observations on account of the important discrepancies between them and those of Bate.

***Carcinus mænas.*‡‡**

The young of this species are peculiarly favorable for a study of the embryonic membrane, since it is often retained for twenty-four hours after emerging from the egg. In most species, on the contrary, the first moult takes place within an hour or so after hatching; indeed, in the case of *Gelasimus pugnax* Smith, which I raised from the egg for the express purpose of examining the embryonic cuticle, I have only succeeded

\* Ann. Nat. Hist., Vol. III. p. 438, Pl. XI. 1839.

† Phil. Trans. Roy. Soc. London, Vol. CXLVIII. p. 589, Pl. XL. 1859.

‡ Für Darwin, 1864. Eng. Trans. by W. S. Dallas, p. 53. 1869.

§ Comptes Rendus, Vol. LIX. p. 1102. 1864.

|| Zeitschr. Wiss. Zool., Vol. XX. p. 621, Pl. XXX. 1870.

¶ Öfvers. Kongl. Vetensk.-Akad. Förhandl., XXX. (1873), No. 9, p. 6. 1874.

\*\* Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, p. 62, Pl. X. Fig. 9. 1876.

†† Jenaische Zeitschr., Vol. XI, p. 246, Pl. XV. 1877.

‡‡ It may not be superfluous to append a list of those who have treated of the development of this common and widely distributed crab: —

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in obtaining it by extracting the embryo prematurely from the egg. In this case escape from the egg and the first moult appear to take place simultaneously.

The bursting of the egg-membranes is effected by the convulsive attempts of the imprisoned embryo to extend its abdomen, which is closely applied to the sternum within the egg. The forked tail first extricates itself (Pl. I. Fig. 1), the antennæ then protrude through the breach thus made (Pl. I. Fig. 2), and in a very short time the contortions of the animal have completely torn away the egg envelope. The embryo, swathed in a delicate, perfectly transparent cuticle, now lies on the bottom of the aquarium supinely awaiting its first moult. It is as yet incapable of swimming about and taking food, its only movements consisting of extension and flexion of the abdomen. It is not until the veil is cast off that the animal loses its embryonic character, and assumes the part of an active, free-swimming larva, with mouth parts adapted for seizing prey.

On issuing from the egg, the young measures  $\frac{1}{4}$  mm. in length (Pl. I. Fig. 3). Within the transparent cuticle the zoëa may be distinctly seen as it will emerge on the first moult. The cuticle is not conformable to the underlying larval integument, as it has neither dorsal nor frontal horns, and the antennæ and tail are very different. The carapace does not at first extend far enough back to cover the base of the swimming-feet, so that the abdomen appears much longer relatively than it does a short time after hatching.

At the joints between the segments of the abdomen of the zoëa the cuticle does not follow the indentations, but otherwise rests conformably upon it. The two prongs of the forked tail of the zoëa are compressed into a very small space by means of a complex folding produced by an invagination of the middle third of the prongs, which does not involve

J. V. THOMPSON, *Phil. Trans.*, 1835, p. 359, Pl. V.

HEINRICH RATHKE, *Zur Morphologie*, p. 97. 1837.

C. DU CANE, *Ann. Nat. Hist.*, Vol. III. p. 438, Pl. XI. 1839.

H. D. S. GOODSIR, *Edinburgh New Phil. Jour.*, Vol. XXXIII. p. 181, Pl. III. 1842.

M. P. ERDL, *Entwicklung des Hummereies*, p. 27, Pl. II. 1843.

R. Q. COUCH, "Ann. Rep. and Trans. Roy. Cornwall Polytechnic Soc. for 1843." (I have not seen this memoir. Some account of it is given in Bell's *History of the British Stalk-eyed Crustacea*, Introduction, pp. xlix. - liv., Figs. c, d, e, and pp. 79 - 81. 1853.)

C. SPENCE BATE, *Phil. Trans.*, Vol. CXLVIII. p. 589, Pl. XL.-XLVI. 1859.

V. HENSEN, *Zeitschr. Wiss. Zool.*, Vol. XIII. pp. 340, 362, Pl. XX. Fig. 25. 1863. (Auditory organ of the young.)

ANTON STUXBERG, *Öfvers. Kongl. Vetensk.-Akad. Förhandl.*, XXX. (1873), No. 9, p. 7. 1874.

the distal third which lies within the invaginated portion like a sword within its sheath. The same thing is seen in the spines which are found on each border of the caudal prongs (Pl. I. Figs. 6, 7, 12).\* The tail of the embryo has an entirely different form. Each half of the fork is produced into seven long spines (Pl. I. Fig. 7). Of these, the three inner correspond to the three internal spines on the tail of the zoëa (Pl. II. Fig. 2). The fourth is the homologue of the prong itself, while the fifth, sixth, and seventh answer to the three minute ones (Pl. II. Figs. 2, 5, 6, 7), which are situated on the outer side of the fork. Curiously enough, the spines of the two stages tend to an inverse proportion, the fourth, or smallest in the embryo, being homologous with the prong of the zoëa tail, while the fifth, or largest, is replaced by one of the small external spines (5') in the subsequent stage. The fourth and seventh are naked; the rest are fringed with delicate hairs. In a few instances I found the spines of the embryonic skin invaginated in the way already described in the case of the spines of the caudal fin of the zoëa. In one example this invagination affected the second, third, and fifth spines (counting from the inside), (Pl. I. Fig. 6,) in another the third and fifth, in another the third only. Without doubt all the longer spines are thus invaginated within the egg.†

The two pairs of antennæ of the embryo, again, have a much greater development than in the zoëa, exceeding in length the swimming-feet, and reaching, when stretched backwards, beyond the base of the abdomen (Pl. I. Fig. 3). The first pair (Pl. I. Fig. 4) consists of a basal segment, within which lies the antennule of the zoëa, and which bears two branches, viz. a long one furnished with three longitudinal rows of fine setæ, and a very short one.

The second antennæ (Pl. I. Fig. 5) divide a short distance from the base into two branches, one of which has the form of a simple, blunt, finger-like process (*a*); the other divides again into three branches (1, 2, 3), which are fringed with delicate hairs. In some specimens, at the moment of issuing from the egg, one or more of these branches is infolded like an inverted glove-finger. The short and blunt process (*a*) encloses the spinous process (Spence Bate) of the antenna of the zoëa, while the triple branch (*b*), which forms the bulk of the antenna of the embryo, has its homologue in the external branch, or scale (*squamiform*

\* According to Milne Edwards, the hairs of the new test of adult crabs which are about to moult are invaginated in a similar way. (*Histoire Naturelle des Crustacés*, Vol. I. p. 55. 1834.)

† Cf. Goodsir, *op. cit.*, Pl. III. Fig. 17; Claus, *op. cit.*, Pl. X. Fig. 9.

appendage of Spence Bate), of the enclosed zoëa. The flagellum of the antenna of the adult, seen in the first zoëa stage as a small protuberance (Pl. I. Fig. 10, *c*), has no representative in the embryonic antenna. The spinous process and scale of the zoëa antenna are much shortened by invagination, like the structures of the tail already described.\*

*Morphology of the Antennæ.*—One can hardly avoid the conclusion that, in the same way that the seven-spined forked tail of the embryo is a reminiscence of the *Gabelschwanz* (P. Mayer) of the primitive Decapod, so the greatly developed, setiferous antennæ are an inheritance from ancestors in which these appendages subserved locomotive functions, as in the *Nauplius*. The typical second antenna of the *Zoëa* consists of a basal stem produced at its distal end into a long serrate spine (Pl. I. Fig. 10, *a*; Pl. II. Fig. 3, ii. *a*), and bearing besides an articulated squamiform appendage (*b*). The spine is seen in a rudimentary form in the larvæ of the shrimps, prawns, and *Paguridæ*. The squamiform appendage is homologous with the external branch of the second antenna of the larval *Macroura*, and with the antennal "scale" of the adult *Macroura*. Both the spinous process and the squamiform appendage become aborted in the development of the *Brachyura*. The flagellum of the second pair of antennæ of the adult crab is wanting in the youngest zoëa stages, or is represented by a small papilla merely (*c*).

If the relation of the embryonic antenna to the *Nauplius* antenna, suggested above, be correct, it follows that the bulk of the antenna of the *Nauplius* is not represented by any homologous part in the permanent antenna of the crab. If, on the contrary, it be claimed that the large fringed lobes of the embryonic antennæ simply represent antennal setæ, they still point back to a primitive condition in which the first two pairs of appendages were provided with *Schwimborsten*, and served as natatory organs.

The labrum, mandibles, metastoma, and maxillæ have nearly the same form which they have in the zoëa stage which follows. The long swimming-setæ of the first and second maxillipeds, which play so conspicuous a part in the life of the zoëa, are very much shortened by invagination, and entirely covered by the embryonic cuticle.

The third pair of maxillipeds and the two following pairs of appendages of the zoëa show through the transparent membrane as three pairs of small buds (Pl. I. Fig. 3, viii., ix., x.), but there are no corresponding structures in the embryo.

\* A. Dohrn, who observed similarly formed antennæ in the embryo of a species of *Portunus* (*l. c.*), has confounded the two pairs.

The young remains in this embryonic condition for about twenty-four hours (at least in confinement). In the mean while it has increased in size to such a degree that the delicate investing membrane is no longer ample enough for the enclosed zoëa and the first exuviation takes place. The cuticle of the abdomen is cast first, commonly coming off in one piece (Pl. I. Fig. 9, 9'). The dorsal spine, which has been invaginated like the parts already described, and laid forward over the back, begins to be evaginated, and to erect itself, and thus aids in splitting the membrane along the back. The rostrum, which has been applied to the breast, also emerges, and the abdomen, freed from the embryonic cuticle, is now used to clear the appendages of the cephalo-thorax, in this wise: the ends of the two prongs of the tail-fork are bent so as to form minute hooks (Pl. I. Fig. 12): when the abdomen is flexed, these little hooks catch in the membrane covering the cephalo-thoracic appendages, and on extending the abdomen again the membrane is torn off (Pl. I. Fig. 9).

The dorsal horn is commonly evaginated, and assumes its position with a slight backward curve even before the embryonic skin is entirely got rid of. In specimens which have just cast the embryonic skin, a break in the trend of the spine indicates the rim of the former invagination (Pl. I. Fig. 14). The rostral spine now projects downward at a right angle with the long axis of the body. The setæ on the various parts of the body unroll themselves, the mouth parts become functional jaws, enabling the young animal to feed; the two pairs of swimming-feet, provided each with four long swimming-setæ on their external branches, become active agents for locomotion, and now, in place of the inert and pupa-like embryo, we have a vigorous free-swimming larva.

Besides the great difference between the two stages caused by the sudden development of the dorsal and frontal spines, the two pairs of antennæ and the tail have an entirely different form. Both pairs of antennæ are now of relatively small size. Those of the first pair are composed of but one segment, which carries three long sensory threads at the tip. This segment corresponds to the basal segment of the first antenna of the embryonic stage.

The second pair of antennæ consist of a basal piece with a long serrate spinous process (Pl. I. Fig. 10, *a*; Pl. II. Fig. 3, *a*), which lies in the short, blunt process of the antenna of the embryonic stage (Pl. I. Fig. 5, *a*), and a short, blunt protuberance (Pl. I. Fig. 10, *c*), the rudiment of the antenna of the adult crab.

In addition to these processes, there is articulated to the basal piece

a long joint with a long and a short hair on its extremity (Pl. I. Fig. 10, *b*; Pl. II. Fig. 3, *b*). This is the homologue of the "scale" of the antenna in *Macroura*, and appears to represent the main, triple portion of the embryonic antenna (Pl. I. Fig. 10, *b*).

The tail (Pl. II. Fig. 2) has now the form so characteristic of the zoëa of *Brachyura*. It is a forked piece, each prong of the fork bearing three setæ on the inner side near the base, and three minute ones on the outer side. The prongs of this forked tail themselves are homologous with the fourth spine of the embryo tail, as before pointed out. The outer three (5, 6, 7) diminish in size successively.

Although I succeeded in keeping some of these zoëæ alive for seven days, none passed through another moult.

In Spence Bate's classic memoir on the development of *Carcinus mænas*, the embryonic membrane which covers the zoëa when it first quits the egg is described and figured as conformable to the whole animal, the tail and antennæ not excepted. Thus are ignored the most interesting and suggestive structural features of the embryo. This error of observation is the more remarkable, since the structures in question were figured with approximate accuracy twenty years before by that close observer, Captain Du Cane.\*

H. D. S. Goodsir† also seems to have seen the same structures, although his description and figures are very incorrect. The "curious brush-shaped appendages of the embryo," which "drop off when the animal has escaped from the ovum, and are replaced by spines,"‡ are evidently the invaginated caudal spines of the embryonic cuticle, such as are represented in our Plate I. Fig. 6. Spence Bate's identification of the two pairs of swimming-feet of the zoëa with the second and third pairs of maxillipeds of the adult, instead of with the first and second pairs, was not so strange; but why does he persist in the old error, even in his latest papers,§ after it has been particularly pointed out by Fritz Müller,|| Stuxberg,¶ Claus,\*\* and others?

\* *Op. cit.*, Pl. XI. Figs. 1, 5.

† Edinburgh New Philosoph. Jour., Vol. XXXIII. p. 182, Pl. III. Figs. 16, 17. 1842.

‡ Pp. 182, 191, Pl. III. Fig. 17.

§ Report on the Present State of our Knowledge of the Crustacea. Rep. Brit. Assoc. Adv. Sci., 1875, p. 48; 1876, p. 89; 1877, p. 44; 1878, pp. 7, 8.

|| *Op. cit.*, Eng. Trans., p. 52.

¶ *Op. cit.*, p. 10.

\*\* Würzb. naturw. Zeitschr., 1861, p. 30. Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, p. 62. 1876.

**Panopeus Sayi.**

The remarkable zoëa represented on Plate II. Fig. 4, a very common form on the southern shore of New England, I raised from the eggs of *Panopeus Sayi* in the summer of 1876. It differs strikingly from all other zoëæ with which I am acquainted in the structure of the second pair of antennæ (II.), which consist of a single monstrously developed spine equal in length to the rostrum. In other regards the zoëa is not specially noteworthy. The carapace has, in addition to the rostral and dorsal spines, a pair of short lateral spines. In the middle line of the back, well forward toward the eyes, is a well-marked hump.

The caudal fork (Fig. 5) bears but four pairs of spines; the two exterior pairs (6 and 7 in *Carcinus*) are wholly wanting.

To which part of the typical second antenna of the zoëa, as described on page 162, does the long, rod-like antenna in this species correspond? In order to answer this question we must examine the cuticle of the embryo. This is represented by Fig. 8 of the plate. It has a form similar to that previously described in *Carcinus mænas* (Pl. I. Fig. 5); but here the branch marked 3 is split nearly to the base, making an apparently quadruple structure in place of the triple branch of *Carcinus*. The blunt, finger-like process (*a*) encloses the antenna of the zoëa (*a'*), which is marvellously shortened by evagination. The homology of the zoëa antenna in this case is thus fixed. It represents the spine of the normal antenna.

The cuticle covering the first pair of antennæ (Fig. 7) has the same parts as the corresponding structure in *Carcinus*, and the same with the tail (Fig. 6), in which the two external spines (6 and 7), which are entirely wanting in the first stage of the zoëa, are well developed.

CAMBRIDGE, July, 1880.



## EXPLANATION OF THE PLATES.

PLATE I. *Carcinus mænas*.

- Fig. 1. Embryo beginning to emerge from the egg.  
 Fig. 2. The same, a little further along.  
 Fig. 3. Embryo shortly after hatching.  
 Fig. 4. First antenna of the same.  
 Fig. 5. Second antenna of the same. The branch (3) invaginated: *a'*, spine of the antenna of the zoëa seen through the cuticle; *b'*, squamiform appendage of the antenna of the zoëa.  
 Fig. 6. Tail of the same: the enclosed tail of the zoëa is shaded; spines 2, 3, and 5 are invaginated.  
 Fig. 7. The same: all the spines of the embryonic tail evaginated.  
 Fig. 8. Invaginated rostrum of the zoëa, as seen through the embryonic cuticle.  
 Fig. 9. Young in the act of exuviating the embryonic cuticle.  
 Fig. 9'. The cuticle of the abdomen, just cast from Fig. 9.  
 Fig. 10. Second antenna of the zoëa: *a*, spine; *b*, squamiform appendage; *c*, rudiment of the flagellum of the adult. The spine and squamiform appendage are still invaginated.  
 Fig. 11. To show the way the dorsal spine lies at the time of the first moult. It has become evaginated, but not yet erected.  
 Fig. 12. Extremity of a prong of the caudal fork, to show the unfolding of the distal part, and the terminal hook.  
 Fig. 13. Rostrum and antennæ of a zoëa at the moment of exuviating the embryonic cuticle.  
 Fig. 14. Dorsal spine of zoëa immediately after casting the embryo skin. The break near the middle of the spine shows the rim of the invagination during the earlier period.

## PLATE II.

Figs. 1-3. *Carcinus mænas*.

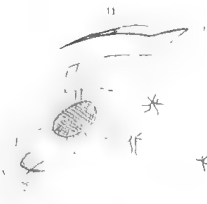
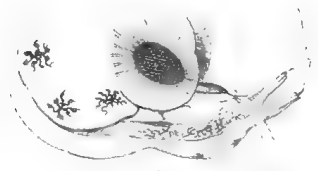
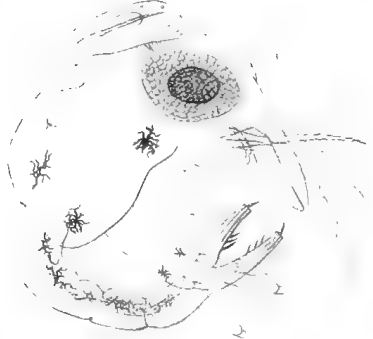
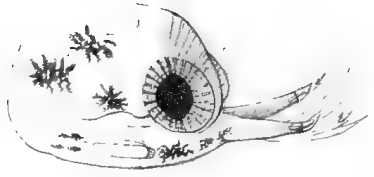
- Fig. 1. First stage of the zoëa. The appendages are marked by consecutive Roman numerals.  
 Fig. 2. Tail of the same.  
 Fig. 3. First and second antennæ of the same.

Figs. 4-10. *Panopeus Sayi*.

- Fig. 4. First stage of the zoëa.  
 Fig. 5. The same, viewed from behind.  
 Fig. 6. Tail, with the embryonic cuticle.  
 Fig. 7. First antenna of the embryo.  
 Fig. 8. Second antenna of the embryo: *a'*, antenna of the zoëa seen through the embryonic antenna.  
 Fig. 9. Second maxilla of embryo. The shaded part represents the appendage of the zoëa within.  
 Fig. 10. End of swimming-branch of first maxilliped. The long swimming-setæ are shortened by invagination and closely invested by the embryonic cuticle.  
 Fig. 11. Tail of *Gelasimus pugnax*, Smith, first stage of the zoëa. Spines 5, 6, 7, are entirely wanting.







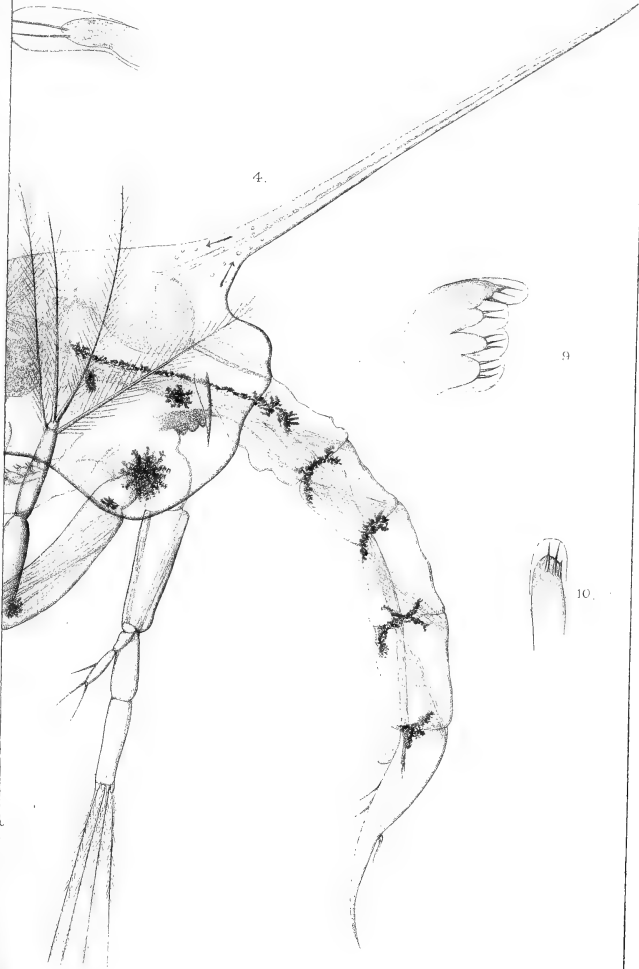


7.

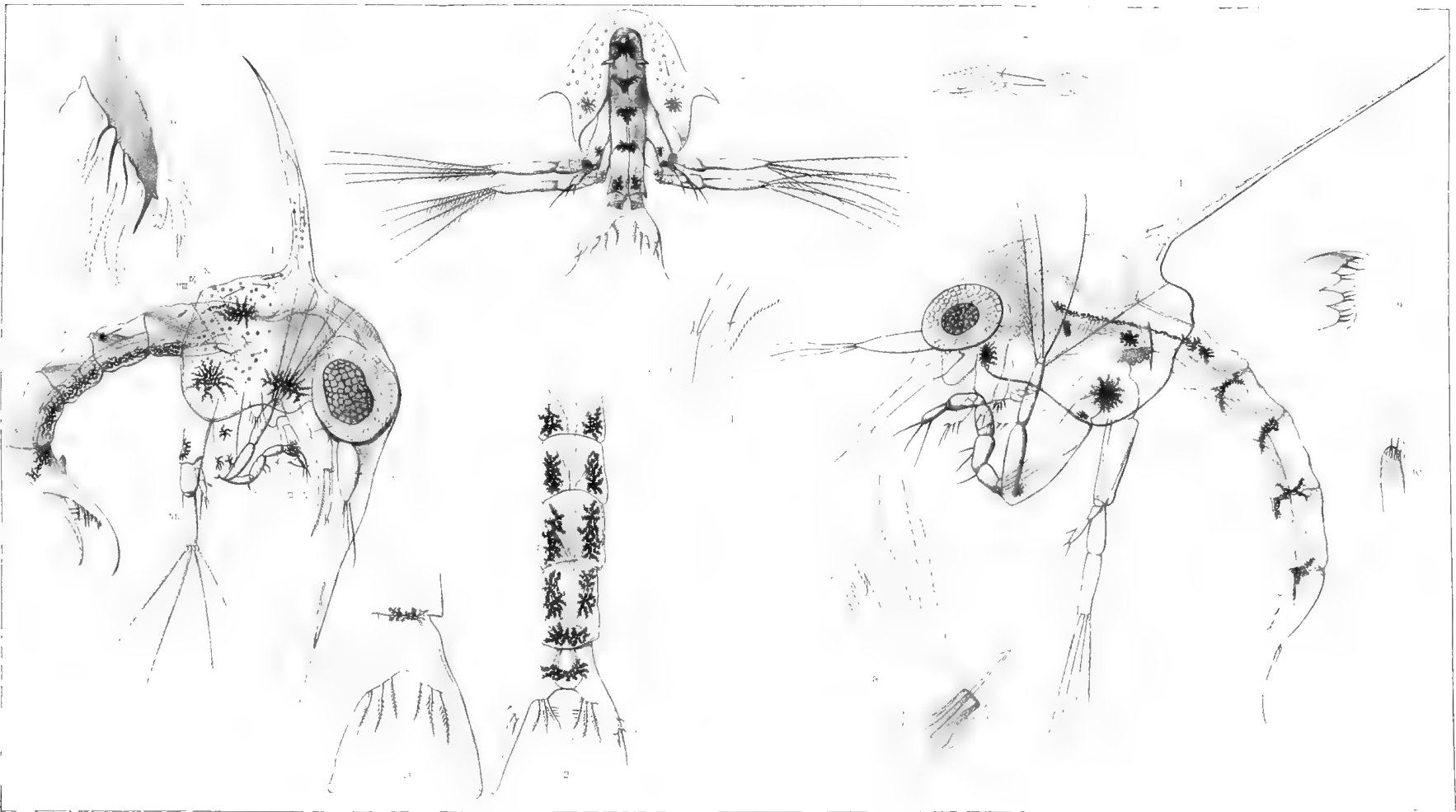
4.

9.

10.











*Wm. Nathorn*

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AT HARVARD COLLEGE.  
VOL. VIII. No. 13.

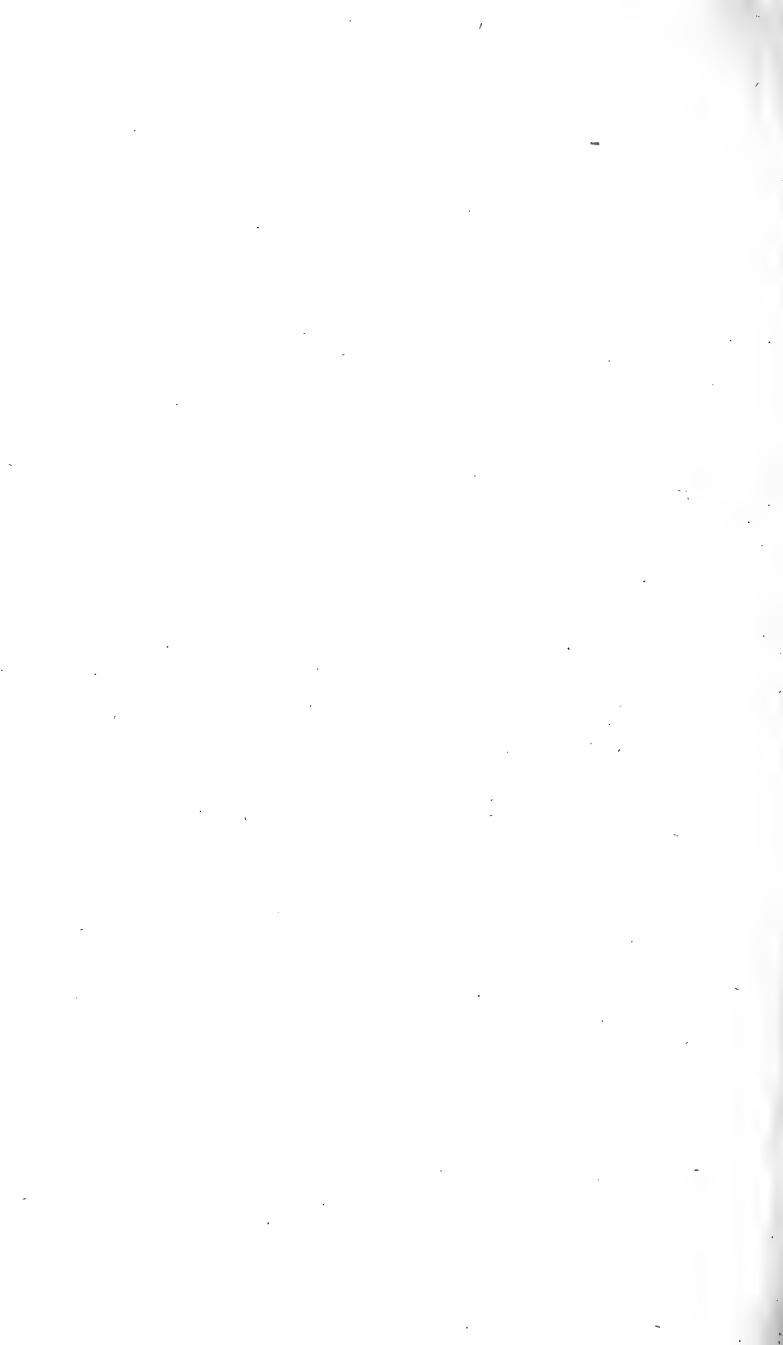
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No. 13.

ON SOME CRUSTACEAN DEFORMITIES. BY WALTER FAXON.

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CAMBRIDGE:  
PRINTED FOR THE MUSEUM.  
MARCH, 1881.



No. 13. — *On some Crustacean Deformities.* By WALTER FAXON.

IN November, 1879, the Museum bought of K. D. Atwood, a fish-dealer of Portland, Me., a collection of nearly two hundred deformed lobster claws. The malformations range from slight deformities resulting from incomplete restoration of lost parts, abnormal curvature of the fingers, etc., to such as may, from the enormous development of abnormal outgrowths or the duplication of parts, be truly called monstrosities. Some of the most remarkable of these specimens are here described and figured. One (Plate I. fig. 16) from the collection of the Peabody Academy of Science, Salem, Mass., for which I am indebted to Prof. E. S. Morse, a deformed claw of *Callinectes hastatus* from Chesapeake Bay (Plate II. fig. 5) kindly communicated by Dr. S. F. Clarke, of Johns Hopkins University, and an abnormal lateral spine of the carapace of the same species (Plate II. fig. 8) in the Museum of Comparative Zoölogy, are also figured. Most of these irregularities have clearly resulted, as Rösel long ago remarked of similar malformations in the European crayfish, from injuries received after moulting, before the new cuticle had become calcified.

*Plate I. Fig. 1* (right chela).\* — In this claw the dactylus (*a*) is curved strongly outwards towards the index, and thrust upwards from its normal plane so that it does not meet, but crosses, the index when closed. The prehensile power of the claw is thus destroyed. From the inner border of the dactylus there is developed an enormous flattened process, which divides at the tip into two prongs (*b*, *c*), which are toothed on their opposed edges. Near the middle of the process is a deep scar (*d*), visible on both sides.

There is a specimen quite similar to this, for a drawing of which I am indebted to Prof. S. I. Smith, in the Museum of Yale College, New Haven, Conn.

*Plate I. Fig. 2* (left chela). — In this specimen the dactylus is curved and bent from its true plane as in the last specimen. From the inner edge of the dactylus (*a*) arise two diverging horns (*b*, *c*), which are furnished with teeth upon their opposed edges, and simulate very closely the dactylus and index of a normal claw. The dentition of the proximal

\* All the figures on Plate I. are *Homarus Americanus*, one half natural size.

horn (*b*) resembles that of the index (*a*), while the teeth of the distal horn (*c*) mark it as the analogue of the index. There is no trace of articulation at the base of either horn.

There are several specimens similar to this in the collection of the Peabody Academy of Science, Salem, and two or three in the collection of the Boston Society of Natural History.

*Plate I. Fig. 3* (right chela). — Dactylus (*a*) slightly flexed from the plane of the index and broken off about an inch from the tip. From the inner side of the dactylus, near the fracture (*d*), arise two toothed processes (*b, c*), directed forwards, which repeat in form the lost tip of the dactylus and the tip of the index. A short, blunt process, directed upward and forward, projects from the inner margin of the dactylus, at a point a little beyond the middle.

*Plate I. Fig. 4* (right chela). — Here the dactylus (*a*), a short distance from its articulation with the hand, is bent at a right angle with its normal trend, and thrown out from the plane of the hand so that it crosses the index when closed. The tip is broken off. From the untoothed margin of the dactylus, near the proximal end, proceed two processes (*b, c*) at an angle of about  $45^\circ$  to one another, the distal one (*c*) taking the normal direction of the index. Both of these processes are toothed on their opposed margins, but it is noteworthy that the teeth of the two processes are not directed exactly toward each other, but are inclined a little downward, as if by attraction to the teeth of the thumb. It is curious to observe that the toothed margins of the index and thumb are beset with an uncommonly large number of stiff setæ, and that this character is repeated in the toothed edges of the monstrous processes *b, c*.

*Plate I. Fig. 5* (left chela). — Similar to Fig. 2, but the processes *b* and *c*, instead of diverging from one another, cross one another near their tips like the index finger and thumb of the claw when closed.

*Plate I. Fig. 6* (right chela). — In this claw, unlike what we have seen in those before noticed, the prehensile power has not been lost, the dactylus closing accurately upon the index. Just beyond the middle of the dactylus springs a simple branch directed forwards at an angle of  $45^\circ$  with the long axis of the dactylus. This branch shows no tendency to form teeth.

*Plate I. Fig. 7* (left chela). Here the dactylus (*a*) is bent near the middle, at almost a right angle with its normal direction, away from the index, but is thrown very little, if any, from its true plane of motion. It has acquired an abnormal length, and developed two processes from

its toothed margin. One of these (*b*) seems to be developed in order to recover the prehensile power which was lost by the distortion of the dactylus. The other (*c*) is broken off near its tip, but corresponds to the process *c* described in the next figure.

There is another dactylus in the collection quite similar to this.

*Plate I. Fig. 8* (right chela). — This deformity belongs to the same category as the one represented by the last figure. The dactylus (*a*) is curved strongly away from the index, and lengthened. At *d* is the scar resulting from the wound that probably caused the curvature of the dactylus. An outgrowth (*b*) provided with teeth, and meeting the thumb when the claw is closed, replaces functionally the distorted extremity of the dactylus. In addition to this a second process (*c*) projects at a right angle with the deflected part of the dactylus. This process presents a line of teeth opposite to those on *a*. My reason for considering *a* rather than *b* to be the end of the original dactylus, and *b* and *c* to be secondary outgrowths, comes from the arrangement of the punctures and the striæ on the cuticle of these parts, which seem clearly to show that *b* and *c* are the newer portions.

*Plate I. Fig. 9* (right chela). — The index here is split into two parts. The outer (*a*) is toothed on its inner border. The inner (*b, c*) is toothed on both margins, and shows a tendency to divide at the end. The lines on the cuticle show that *a* is the original index, and *b, c*, a secondary process developed from it. The dactylus does not meet the index when closed.

*Plate I. Fig. 10* (right chela). — The dactylus is abnormally short and curved, and its proximal half produced into a large roundish plate, toothed on its margin, only the basal part of which closes against the index.

*Plate I. Fig. 11* (left chela). — A large triangular crest, directed outward and forward from the middle of the outer margin of the penultimate segment. This crest-like process has a strong curve downward.

There are several claws similar to this in the collection.

*Plate I. Fig. 12* (right chela). — The inner border of the hand is distorted by a wound (*d*) which has resulted in the outgrowth of a simple, blunt, movably-jointed segment (*a'*), which evidently represents an abortive supernumerary dactylus. On its upper side (the figure shows the lower surface), near the articulation with the hand, is the small spine characteristic of the normal dactylus. The abnormal finger moves in a plane at right angles to the plane of motion of the normal dactylus.

There is another specimen in the collection similar to this, — a left

chela with a supernumerary dactylus articulated with the lower face of the hand. The dactylus is lost.

*Plate I. Fig. 13* (right chela). — This specimen, like the last, is didactyle. The two dactyli ( $a$ ,  $a'$ ) are here articulated with the hand side by side; both are thrust to one side, so that they do not close against the index finger. The index itself shows a tendency to duplication; first, by a slight bifurcation at the end; secondly, in the alteration of the tooth-bearing edge into a flat surface, bearing a row of teeth on each margin, directed toward the dactyli, but not met by them on closure.

One can easily believe that this is a congenital monstrosity, while most if not all the others on the plate are more naturally explained as malformations arising from injuries received after moulting.

*Plate I. Fig. 14* (right chela). — A severe injury to the hand has resulted in the growth of a process ( $c$ ) from near the base of the index, which duplicates the index. It is curved downward and inward, under the lower face of the primary index, and furnished with sharp teeth on its inner border. At the base of the toothed margin of the secondary index springs a very small process ( $b$ ), which shows a line of very minute teeth on its inner border, and seems to be a rudimentary third index. The dactylus does not meet the primary index when the claw is shut.

*Plate I. Fig. 15* (left chela). — The dactylus is here bent upward and outward at a right angle, at a point midway between the base and the tip. Two finger-like processes ( $b$ ,  $b'$ ) arise near one another from the bend of the dactylus. Of these the proximal ( $b$ ) is a little longer than the distal ( $b'$ ). Both lie in the normal trend of the dactylus, and present a row of teeth directed towards the teeth of the distal end of the index. When the dactylus is closed, however, the teeth of neither of these processes exactly meet the teeth of the index, but fall on each side.

*Plate I. Fig. 16* (left chela). This specimen resembles Fig. 12 of the same plate. From the inner and lower part of the hand arises a process ( $x$ ) which is not articulated with the main portion of the hand. On its upper surface (turned away from the observer in the figure) is a prominent spine, like those developed along the inner margin of the normal hand. Articulated with the distal extremity of this process is a long, curved, pointed, toothless segment ( $a'$ ), which is an imperfectly developed duplication of the dactylus ( $a$ ). On the upper face of this supernumerary dactylus, close to its articulation with the process  $x$ , is the short spine characteristic of that point in the normal dactylus. The secondary dactylus almost equals in length the primary one, and, as in the example represented by Fig. 12 of the same plate, swings in a

plane nearly at right angles with the plane of motion of the normal dactylus (*a*). Here, then, in addition to the duplication of the dactylus seen in Fig. 12 (*a'* indicating homologous parts in the two figures), one sees an imperfect attempt to duplicate the propodite in the process *x*.

*Plate I. Fig. 17* (left chela). — This monstrous claw is similar to the one described and figured by Lucas (*Homarus vulgaris*, in No. 7 of the Bibliography). The dactylus (*a*) does not close upon the index. From the base of the index there arises from the upper side a very large unjointed appendage, which shows a strong tendency to divide into two branches (*b, c*), each furnished with a row of teeth. The teeth of the branch *b* point toward the teeth of the index, while those of the branch *c* are directed toward the row of teeth on the dactylus when the latter is opened. The tendency seems to be to duplicate the dactylus in *b*, the index in *c*. As there is no articulation at the base of the monstrous appendage, the teeth on the branch *b* are useless, and as the branch *c* is not in the plane of motion of the dactylus its teeth are likewise functionless. Thus, although these two extra lines of teeth are developed, there are no two in the claw which can be applied to one another.

*Plate II. Fig. 1* (*Homarus Americanus*, dactylus of right chela).\* — Beyond the middle, this dactylus is bent downward at nearly a right angle. From the upper side are developed two processes (*b, b'*), which are forked at their ends and furnished with two rows of teeth within. The propodite is lost. Resembles the dactylus of the claw figured on Plate I. fig. 15, but differs in the fission of the processes *b* and *b'*.

*Plate II. Fig. 2* (*Homarus Americanus*, one of the small chelipeds). — This leg is provided with two chelæ. One of them has the ordinary form and structure, but is bent at a strong angle with the long axis of the leg. The second claw appears to have budded off from an amputated surface of the propodite. It consists of two fingers, which have the form of the normal dactylus and index, but neither is articulated with the other at the base. The two fingers together seem to be morphologically equivalent to a single segment, and represent a two-branched supernumerary dactylus.

*Plate II. Fig. 3* (*Homarus Americanus*, left chela). — In this small chela the index is curved sharply upward and deeply channelled on its lower face. Unlike all those previously noticed in this paper, this is a simple malformation through distortion, without any development of accessory parts.

*Plate II. Fig. 4* (*Homarus Americanus*, dactylus of right chela). —

\* All the figures on Plate II. are of natural size.



Near the base the dactylus divides into two branches, a long one (*a*), which appears to be the distal part of the original dactylus bent so as to make almost a right angle with its proximal portion, and a shorter one which forks at the end (*b*, *c*), and presents a row of teeth on both the inner and outer borders. This shorter branch has the normal direction of the dactylus, and is probably a secondary outgrowth from the primitive dactylus. This malformation resembles that seen in Plate I. figs. 7 and 8. The propodite is lost.

*Plate II. Fig. 5 (Callinectes hastatus, left chela).*—The dactylus is divided longitudinally, nearly to its base, and furthermore the lower of the two branches thus produced forks at a point midway between the base and the tip. One of the prongs of the fork (*c*) inclines toward the upper branch of the dactylus (*b*), the other prong (*a*) is curved downward toward the index finger. The dactylus thus becomes tridactyle instead of monodactyle. The superior branch (*b*) is toothed along its lower edge, the inferior branch along both its upper and lower edges, the teeth of the upper edge being continued along the upper margin of the upper prong (*c*), while the teeth of the lower edge are continued along the lower margin of the lower prong (*a*). All the branches are much shorter than the index finger. The teeth on *a* do not strike against those on the index when the claw is shut. Even the coloration of *a*, *b*, and *c* is like that of the normal fingers.

This monstrosity is like that described and figured by Lucas (*Carcinus manas*, in No. 7 of the Bibliography). I differ from Lucas in the interpretation of the finger-like parts of the tridactyle segment. He considers *b* to be the normal dactylus, and *a* and *c* to be supernumerary fingers, *a* being the analogue of the dactylus (*b*), and *c* the analogue of the index. From the analogy of this deformity with those represented on Plate I. figs. 1–5, I conceive *a* to represent the original dactylus, and *b* and *c* to be the supernumerary parts, representing the dactylus (*a*) and the index respectively.

*Plate II. Fig. 6 (Homarus Americanus, right cheliped).*—The first segment (coxa) is wanting. The second and third segments, instead of having their normal flattened form, are subcylindrical. The third segment (meros) further shows a tendency to divide, a deep groove running across the distal end. The upper half of this segment repeats antitropically, or in a reverse manner, the lower half: thus the spine *sp* on the anterior border is symmetrically repeated in *sp'*, and the articulating process *z* has its homotype in *z'*. The symmetry of the segment is not complete, however, inasmuch as the two or three short spines on the

internal border of the segment (turned away from the reader in the figure) are not duplicated on the homologous margin of the upper half of the segment. Articulated with the distal end of this segment are two carpi (4, 4'). The supernumerary carpus (4') does not have the exact form of the normal carpus (4), but is slenderer, subcylindrical, and much more spiny. The normal carpus is followed by a propodus and dactylus (5, 6) of the regular form. The supernumerary carpus bears at its distal extremity an abortive propodus (5') in the shape of a small stump-like segment, bifurcated at the end and armed with a blunt spinous tubercle ( $y'$ ) on its inner margin. This tubercle is homologous with the tubercle  $y$  at the proximal end of the external border of the normal propodus. Curiously, the supernumerary carpus is set upon the meros in a position almost the reverse of that of the normal carpus, so that the surface of the accessory carpus and propodus, which is homologous with the upper surface of the regular carpus and propodus, looks in almost the opposite direction. It is as if the abnormal carpus were rotated upon the meros through nearly 180° to the left. It thus comes about that the articular tubercle  $x'$  falls on the same side with its homotype,  $x$ , instead of on the opposite side, as one would expect from the reversed symmetry of the two carpi. If the two propodal segments (5, 5') were flexed at the same time, they would move in nearly opposite directions. This distortion seems to me very singular, and I think nothing like it has been observed among the many cases of double legs in insects.

In this specimen we have the nearest approach to complete duplication of a limb yet observed among Crustacea. It reminds one of the monstrosities among insects, frequently described by entomologists, in which the duplication of a leg may involve all the joints down to the trochanter. Whether this monstrosity be congenital, or the result of injuries received later in life, I cannot tell.

*Plate II. Fig. 7 (Homarus Americanus, left chela).* — In this small chela only a rudiment of the index is present, and the dactylus is curled underneath it in the form of a semicircle.

*Plate II. Fig. 8 (Callinectes hastatus, left lateral portion of the carapace).* — The lateral horn, instead of being simple, as in normal specimens, has three spines, one directed forward, outward, and downward, one backward, outward, and upward; and one, very small in size, backward, outward, and downward.

*Plate II. Fig. 9 (Homarus Americanus, right chela).* — The whole of the index as well as part of the hand is wanting in this sadly mutilated

claw. The amputated part was evidently removed when the shell was soft, and the wound has completely healed. The dactylus has the form of a cylindrical stunted segment, with an imperfectly developed line of teeth on its cutting surface. The character of the shell leads me to believe that the amputation passed through the line indicated by *x*, and that the part of the hand distal to this, as well as the dactylus, was reproduced by budding after the wound was received.

Although as early as 1671 the fanciful Von Berniz (No. 1) described and figured two misshapen Crustacean claws, the number of deformities among animals of this class recorded by naturalists is small compared with those observed in insects. Of the thirty cases which I find hitherto recorded, fifteen belong to the European crayfish (*Astacus fluviatilis*).\* Leaving out of account the claw represented by Fig. 3 on Plate II., in which we have a simple distortion arising from an abnormal curvature of the fingers, it appears that all the deformities just described belong to the two categories of *monstrositates per defectum* and *monstrositates per accessum*. The former (such as Plate II. figs. 7, 9) are without doubt the result of an accidental amputation of certain parts when the animal was soft-shelled, which parts would probably have been restored after subsequent moults if the animal had lived. Such deformities can hardly be termed true monstrosities, and are of minor interest. The latter, — in which category all the other cases figured will be included, — while accompanied in most cases by a distortion of normal structures, and probably for the most part the result of injuries, present irregular, secondary outgrowths, and are of considerable interest. Among these we have, *first*, cases of duplication of joints in a limb (as in Plate I. figs. 12, 13, 16, Plate II. fig. 6), similar to the many cases described among insects; *secondly*, processes budding out from either the propodus (Plate I. figs. 9, 11, 14, 17) or the dactylus (Plate I. figs. 1-8, 15, Plate II. figs. 1, 4, 5) without any articulation. These processes frequently simulate a true claw in a marvellous manner, e. g. Plate I. figs. 1-5, and are worthy of especial attention. A Crustacean claw is, morphologically viewed, a composite structure involving two segments of the series of seven which are found in the typical leg. The ultimate segment of the series develops teeth along its inner border, and when flexed closes against an immovable toothed process from the penultimate segment. But in these fictitious claws (see Plate I. figs. 2, 5, etc.) the two

\* It is remarkable that in the vast number of American crayfishes examined by Hagen in the preparation of his *Monograph of the North American Astacida*, no deformities, strictly speaking (see p. 269), were observed.

digits *b*, *c*, are simply processes developed from the ultimate segment of the leg without the least mobility. We have here a structure which is neither morphologically nor functionally a claw, but only a counterfeit of one. What force produces the perfect development of teeth on the opposed edges of these immovable digits, where they cannot be of the slightest service? It is to be observed that these spurious chelæ are always found on the dactylus of claws which have lost their function through the displacement of the dactylus. In such cases there seems to be a futile effort to form a new claw in the way indicated. When one sees how perfectly the dactylus *a* (e. g. in Plate I. fig. 5) is repeated in the process *b*, and the index in the process *c*, even to the details of dentition and setæ, he is at once tempted to call upon Darwin's hypothesis of pangenesis † to explain the resemblances. It will be observed (see Plate I. figs. 13, 16, Plate II. fig. 6) that a movable dactylus may be duplicated on the propodal segment, but in no case is an *articulated* segment developed from the dactylus.

It would be extremely interesting to know whether these monstrous developments are perpetuated throughout the life of the individual, or whether they are got rid of by exuviation. The latter seems hardly probable. Huxley ‡ says the deformities persist, but whether this statement be based on observation or not, I do not know.

As the specimens which have come under my observation are dry, and the soft parts removed, I can record nothing concerning the arrangement of the muscles, nerves, and arteries in those deformed claws. What modifications of the soft parts are brought about by the deformities would be a most interesting subject of study for any one who may come into possession of such specimens in a fresh or alcoholic state.

Almost all the malformations of the hard parts of Crustacea which have been described are confined to the big claws. These claws, being the chief weapons of offence and defence, are much more liable to receive wounds than any other part of the body, and, as before pointed out, deformities such as are described in this paper are undoubtedly in most cases the result of injuries. Rösel (No. 4) speaks of deformities of the rostrum of crayfishes; Herklots (Nos. 11, 15) describes and figures a triple dactylus of the second pair of legs in *Lithodes arctica*; A. Milne

\* In such specimens as that figured on Plate I. fig. 8, where the chela has its functional power, the spurious claw is formed in a different way, *a* being the original dactylus. See p. 258.

† The Variation of Animals and Plants under Domestication, Vol. II. Ch. XXVII.

‡ The Crayfish. An Introduction to the Study of Zoölogy, p. 39, 1880.

Edwards (No. 12, see p. 268) records a monstrosity affecting the eye-stalk of *Palaemon penicillatus*; and finally Packard (No. 17) has noticed a deformity of the caudal spine of *Limulus Polyphemus*. The last is probably not so rare as Packard supposes, as I have found two specimens of *Limulus* with similarly deformed spines. There is also in the Museum of Comparative Zoölogy a small deformed specimen of *Limulus Polyphemus*, in which the left side of the gill-bearing segment of the body is marked by a deep concavity and absence of the lateral spines. Further, Figs. 2 and 8 on Plate II. of this paper portray deformities of other parts than the great claws. Fig. 2 represents a monstrous condition of one of the small chelipeds of the lobster, and there is another specimen in the Museum in which the index or immovable finger of the chela of either the first or second pair of legs is double. Another lobster presents a deformity of one of the third pair of maxillipeds, the terminal segment being divided into three lobes. Plate II. fig. 8 represents a deformed lateral spine of the carapace of *Callinectes hastatus*.

Reviewing all the deformities which have been described among Arthropods, I would divide them into five categories, as follows.

Deformities : — *a*, of deficiency.

*b*, of excess.

*c*, of transformation.

*d*, of arrested development.

*e*, of hermaphroditism.

*a*. In individuals affected with deformities of this class, certain parts normally present are wanting. Among Crustacea such cases are, as far as I am aware, never congenital, but result from accidental amputation of parts commonly restored by new growths, as before observed.

*b*. *Monstra per accessum*. Under this head fall the majority of the monstrosities that have been described among Arthropods. Among insects the numerous cases recorded by Asmus,\* Mocquerys,† various contributors to the *Annales de la Société Entomologique de France*, and lately by Jayne,‡ etc., etc., for the most part belong here. In these cases it is commonly the antennæ and legs which are the seat of the monstrous developments, which usually take the form of a duplication, or even triplication, of the appendage. In most cases such double or triple appendages are single at the base, the duplication or triplication

\* *Monstrositates Coleopterorum*, 1835.

† *Recueil de Coléoptères anormaux*, 1859.

‡ Descriptions of some Monstrosities observed in North American Coleoptera, *Trans. Amer. Ent. Soc.*, VIII. p. 155, 1880.

involving only the distal segments. In the leg, for instance, all the segments beyond the coxa may be duplicated, while in other cases one or two of the distal joints of the tarsi alone will be repeated.

Among Crustacea the examples of a real duplication or triplication of segments in an appendage are very rare. The most marked instance of the kind is afforded by the lobster cheliped figured on Plate II. (Fig. 6) of this paper, in which there is a clear tendency to duplication, at least from the coxa onward. Duplication of the dactylus is seen in Plate I. figs. 12, 13, 16, and in Plate II. fig. 2.\* Jäger (No. 10, p. 38, figs. 12, 13) has described and figured a claw of *Uca una* with two dactyli, and a similar case in *Eriphia spinifrons* has been published by Herklots (No. 15, figs. 6, 7, 8).

On seeing such a specimen as the *Prionus* figured by Jayne,† in which the tibiæ and tarsi are duplicated in all the legs, and perfectly symmetrical on the two sides of the body, one cannot doubt that in insects at least these monstrosities by duplication may be referred to a *vitium primæ conformationis*, and in examples from Crustacea such as those represented by Fig. 13, Plate I., and Fig. 6, Plate II., of this paper, it is very probable that we are dealing with a monstrosity which is not the result of injury.

Most of the *deformities by excess* among Crustacea, however, do not result from a true duplication of more or fewer segments of an appendage, but from the outgrowth of unarticulated processes of various shapes, often furnished with teeth, and simulating true segments. But in such cases, e. g. where there is a process that has the form of a supernumerary dactylus, we find that it is commonly developed from the normal dactylus, and devoid of any articulation, instead of joining by an articular surface with the propodus as a true supernumerary dactyle would do.

In this category the *Astaci* noticed by Emmanuel Rousseau (No. 8) and Eugène Desmarest (No. 9) will also be included. In these abnormal female specimens an extra pair of vulvæ were present on the basal segment of the fourth pair of legs, the oviduct of each side dividing into two branches after leaving the ovary.

c. Monstrosities of this class result from an organ being replaced wholly or in part by another organ. Such monstrosities are common in plants, but exceedingly rare in animals. A few have been described

\* There are two or three lobster claws with two dactyli in the collection of the Peabody Academy of Science, Salem.

† *Op. cit.*, Plate IV. fig. 12.

among Arthropods. I am indebted to Dr. Hagen for references to the following cases among insects:—

1. *Prionus coriarius* with two perfect legs in place of the elytra.\*
2. *Cimbex axillaris* with a claw like those of the tarsi, on the end of the left antenna.†
3. *Zygæna filipendulæ* with one of the hind legs replaced by a wing.‡

Among Crustacea the only example of this kind of monstrosity is the *Palinurus penicillatus* described by A. Milne Edwards (No. 12), in which a flagellum like one of those of the antennules is developed from the centre of a rudimentary cornea on the end of the eye-stalk.

Monstrosities of this class are especially interesting on account of their bearing on the morphology of organs. If we admit teratological conditions as evidence of homology, as the botanists do in the case of the metamorphosis of the parts of a flower, we must regard the wings and legs of insects, as well as the eye-stalks and antennæ of Crustacea, as morphological equivalents,§ a view which is not supported by the mode of development of these parts in the embryo.

\* Saage, *Preussische Provinzial Blätter*, Vol. XXII. p. 191, 1839; *Stettin. Entomol. Zeitung*, Vol. I. p. 48 (cited from Hagen, On some Insect Deformities, *Mem. Mus. Comp. Zool.*, Vol. II. No. 9, p. 22, 1876).

† G. Kraatz, Ueber eine merkwürdige Monstrosität bei *Cimbex axillaris* (Hymenopt.), *Deutsche Ent. Zeits.*, XX. Heft II. p. 377, Taf. I. fig. 8 a, a, b, 1876.

‡ N. M. Richardson, *Nature*, Vol. XVI. p. 361, August 30, 1877. Dr. Hagen tells me that he is sure he has seen another similar case recorded, but he has lost the reference to it.

§ Dr. Hagen (in his lectures) also adduces evidence from comparative anatomy of insects to support the theory of the homology of wings and legs. Most authors (Gegenbaur, Lubbock, Fritz Müller, etc.) who have discussed the question of the morphology of insects' wings consider them to have originated independently of the ventral appendages, as tracheal gills or otherwise. Balfour (*Treatise on Comparative Embryology*, Vol. I. p. 337, 1880) even doubts whether the antennæ of insects have the same morphological value as the succeeding appendages! None of these writers take notice of the above-mentioned monstrosities in this connection.

With reference to the homology of eye-stalks and antennæ in Crustacea, A. Milne Edwards (No. 12), Gerstaecker (*Bronn's Klassen und Ordnungen des Thier-Reichs*, V., 1 Abt., 1 Hälfte, pp. 202, 343, 1868), and Rolleston (*Forms of Animal Life*, pp. 113, 119, 1870) bring forward the abnormal development of an antennular flagellum from the eye-stalk in the *Palinurus* mentioned above as proof of the homology of the eye-stalk with the antenna, a view long ago advanced by Savigny and H. Milne Edwards. The embryologists on the other hand, as Claus and Fritz Müller, generally deny the equivalence of the parts in question. E. van Beneden says of the eye-stalk in *Mysis*: "Ce pedicule n'apparaît aucunement comme les autres appendices, et paraît avoir une autre valeur morphologique." (*Bull. Acad. Roy. de Belgique*, 2 Ser.,

d. The existence of dimorphism among the males of the genus *Cambarus*, first observed by Agassiz, has been fully discussed by Hagen (No. 16), who conjectures from the resemblance of the "second form" males to young individuals and the small development of the internal organs of generation, that they are sterile. In *Lupa* and some other genera of *Brachyura* dimorphism occurs in the females, many full-grown specimens having a narrow and acute abdomen, instead of the broad, roundish abdomen of the normally developed individuals. Agassiz learned from anatomical examination that the females with a narrow triangular abdomen were sterile.

These sterile forms may be properly classed among abnormal variations caused by arrest of sexual development.\*

e. *Hermaphroditism*.—While numerous cases of hermaphroditic insects have been put on record by entomologists, I can find but two undoubted cases of hermaphroditism among Crustacea outside of those groups in which it is the normal condition, viz. the Cirripeds and parasitic Isopods. The first case is that of a lobster (*Homarus vulgaris*) described and figured by F. Nicholls, in 1730, in the Philosophical Transactions of the Royal Society of London (No. 3 of the bibliographical list appended to this paper). In this specimen the right half of the body was female, the left half male, as regards both internal and external organs. The second case is a similar one of *Eubranchipus vernalis*, lately described by Gissler (No. 18).

E. von Martens (No. 14) has published an account of three specimens of *Cheraps* from Adelaide, with openings in the first segment of the third pair of legs answering to the sexual apertures of the normal female, coexisting with the normal male sexual orifices in the first segment of the fifth pair of legs. An examination of the internal parts showed the coiled *vasa deferentia* of the normal male opening out through the apertures in the fifth pair of legs. No ovary or duct leading to the openings in the third pair of legs was detected. The specimens had lain in alcohol some seven years, however, so that the evidence against the existence of any internal female organs cannot be taken as positive. Similar open-  
XXVIII., 1869). Gegenbaur (Grundzüge der vergleichenden Anatomie, 2<sup>te</sup> Aufl., p. 397, 1870) also excludes the eye-stalk from the series of appendages.

\* Among insects the *Phalæna heteroclitæ* [*Bombyx monacha* ?], described by O. F. Müller (an imago with the head of the larva), is probably to be explained as a deformity arising from arrest of development. In other cases recorded of the retention of the larval head by a perfect insect, the head of the imago was probably within the head of the larva, which was not cast off at the time of transformation. See Hagen, On some Insect Deformities, *Mem. Mus. Comp. Zoöl.*, Vol. II. No. 9, 1876.



ings were seen in the third pair of legs of male *Parastacus pilimanus* and *P. Brasiliensis*.

Abnormal cases of hermaphroditism in Decapods acquire a peculiar interest in the light of the recent discovery of hermaphroditism as the normal condition in another group of the higher Crustacea, viz. the parasitic Isopods.\* Mayer has even found indications of hermaphroditism in *Cirolana* and *Conilera*, genera of free Isopods.†

\* Bullar, The Generative Organs of the Parasitic Isopoda, *Jour. Anat. and Physiol.*, XI. p. 118, 1876. Id., Hermaphroditism among the Parasitic Isopoda, *Ann. Mag. Nat. Hist.*, 4 Ser., XIX. p. 254, 1877.

Paul Mayer, Ueber den Hermaphroditismus bei einigen Isopoden, *Mittheilungen aus der Zoolog. Station zu Neapel*, I. p. 165, 1878.

† *Op. cit.*, p. 177.

CAMBRIDGE, March, 1881.

## BIBLIOGRAPHY.

1. MARTINUS BERNHARDUS A BERNIZ. Chela Astaci marini monstrosa. *Miscellanea Curiosa Medico-Physica Academicæ Naturæ Curiosorum, Annus secundus, Observatio C.*, p. 174 (fig.). 1671.  
Chela Astaci marini monstrosa alia. *Op. cit.*, Observatio CI., p. 175 (fig.) The figure is reproduced in MICHAEL BERNHARD VALENTINI'S *Museum Museorum*, Zweyter Theil, p. 177. 1714.  
(This "chela monstrosa et tota petrefacta" evidently does not belong to a lobster.)
2. J. E. VALENTINI. Chela Astaci fluviatilis tribus Apicibus prædita. *Acta Acad. Cæs. Leopold. Carol. Naturæ Curiosorum*, Vol. II., Observatio CXXVI., p. 285. 1730.  
(Cited after HERKLOTS in No. 15 of this list.)
3. F. NICHOLLS. An Account of the Hermaphroditic Lobster presented to the Royal Society by Mr. Fisher, examined and dissected. *Philosophical Transactions of the Royal Society of London*, Vol. XXXVI. No. 413, p. 290. 1730. [*Abridgment*, Vol. VII. Part III. p. 421, Pl. IV. 1734.]  
(Right side female, left side male. See p. 269.)
4. AUGUST JOHANN RÖSEL VON ROSENHOF. Fernere Beschreibung des hiesigen Fluskrebse und seiner merkwürdigen Eigenschafften. *Der monatlich-herausgegebenen Insecten-Belustigung dritter Theil*, p. 344, Tab. LX. fig. 28, 29, Tab. LXI. fig. 30-33. 1755. Figures copied in *Encyclopédie Méthodique*, Vol. 191, Pl. 290, fig. 1-6, 1830, and by JÄGER in No. 10, fig. 4-6, 9-11.
5. F. TIEDEMANN. Beschreibung einiger seltenen Thier-Missgeburten. *Deutsches Archiv für die Physiologie*, Vol. V. p. 127, Pl. II. fig. 2. 1819. Figure reproduced by JÄGER in No. 10, fig. 8.
6. GEORG JÄGER. Zwei Beispiele missgebildeter Krebsscheeren. *Archiv für Anatomie und Physiologie*, Jahrgang 1826, p. 95, Tab. II. fig. 3, 4. Figures reproduced by the same author in No. 10, fig. 1, 3.  
(*Astacus fluviatilis*).
7. H. LUCAS. Notice sur quelques Monstruosités observées dans des Crustacés appartenant aux Genres *Carcinus*, *Lupa*, *Homarus* et *Astacus*. *Annales de la Société Entomologique de France*, 2<sup>e</sup> Série, Tome II. p. 41, Pl. I. 1844.
8. EMMANUEL ROUSSEAU. *Annales de la Société Entomologique de France*, 2<sup>e</sup> Série, Tome VI. p. 481. 1848.  
(Female *Astacus fluviatilis* with two pairs of vulvæ on the base of the third and fourth pairs of legs.)

9. EUGÈNE DESMAREST. Note sur une Disposition anormale des Organes Génitaux observée dans l'*Astacus fluviatilis* Fabricius. *Annales de la Société Entomologique de France*, 2<sup>e</sup> Série, Tome VI. p. 479, Pl. 13. 1848.  
(Female *Astacus fluviatilis* with four vulvæ disposed as in the one described by ROUSSEAU. Two oviducts on each side pass from the genital apertures to unite in a common trunk before reaching the ovary.)
10. G. JÄGER. Vergleichende Darstellung der missgebildeten Scheeren des gemeinen Flusskrebse (*Astacus fluviatilis*) und der missgebildeten Scheere einer Krabbe (*Cancer uca* Linn. *Uca Una* Latr.) aus Surinam. *Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg*, Jahrg. VII., p. 33, Pl. I. 1851.
11. J. A. HERKLOTS. Notice Carcinologique. *Bijdragen tot de Dierkunde. Uitgegeven door het Koninklijk Zoologisch Genootschap Natura Artis Magistra*, Amsterdam, Deel I. Afl. 5, p. 37, fig. B. 1852. Figure reproduced by the same author in No. 15.  
(Deformed dactylus of the second pair of legs of *Lithodes arctica*.)
12. ALPHONSE MILNE EDWARDS. Sur un Cas de Transformation du Pédoncule oculaire en une Antenne, observé chez une Langouste. *Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences*, Tome LIX. p. 710. 1864.  
(Antennular flagellum developed from the end of the eye-stalk in a *Palinurus penicillatus* from Mauritius.)
13. SIDNEY I. SMITH. A Fiddler-Crab, with two large Hands. *The American Naturalist*, Vol. III. p. 557, 1869.  
Notes on American Crustacea. No. I. Ocypodoidea. *Transactions of the Connecticut Academy of Arts and Sciences*, Vol. II. p. 133, 1870.  
(Notice of an anomalous specimen of *Gelasimus pugnax* Smith, in which the chelipeds were nearly equal in size and form.)
14. E. VON MARTENS. *Sitzungs-Bericht der Gesellschaft naturforschender Freunde zu Berlin* am 18 Jan., 1870, p. 1.  
(Male specimens of *Cheraps plebejus*, *Parastacus pilimanus*, and *Parastacus Brasiliensis*, with openings in the first segment of the third pair of legs representing the genital orifices of the female. See p. 269.)
15. J. A. HERKLOTS. Misvormingen bij Schaaldieren waargenomen. *Tijdschrift voor Entomologie, uitgegeven door de Nederlandsche Entomologische Vereeniging*, XIV. Jaargang, p. 69, Pl. I. 1871.  
(Malformation of the claw of *Xantho punctulatus*, *Eriphia spinifrons*, and the deformed dactylus of *Lithodes arctica*, previously published by the same author in No. 11.)
16. HERMANN A. HAGEN. Monograph of the North American Astacidæ. *Illustrated Catalogue of the Museum of Comparative Zoölogy, at Harvard College* [*Memoirs*, Vol. II.], No. III. p. 21 et seq. 1871.  
(Variation of form accompanying sterility (?) in *Cambarus*, *Lupa*, etc. See p. 269.)

17. A. S. PACKARD, JR. The Development of *Limulus Polyphemus*. *Memoirs of the Boston Society of Natural History*, Vol. II. p. 201, fig. 36. 1872.

(Forked caudal spine.)

18. C. F. GISSLER. Description of a Hermaphroditic Phyllopod Crustacean (*Eubbranchipus*). *The American Naturalist*, Vol. XV. p. 136, fig. 1-3. 1881.

(*Eubbranchipus vernalis*, showing lateral hermaphroditism both in the external claspers, etc. and in the internal genital organs. The internal female organs are but poorly represented, — although a single egg was observed in the ovarian string, — while the internal male organs have their normal size and shape.)

## EXPLANATION OF THE PLATES.

[NOTE. — A detailed description of the specimens figured in the plates will be found on pp. 257-264. Unless otherwise stated, the specimens are in the Museum of Comparative Zoölogy, and were obtained from K. D. Atwood, Portland, Me. Those figured on Plate I. are reduced one half. Those figured on Plate II. are of the natural size.]

## PLATE I.

Fig. 1. *Homarus Americanus*, right chela.

- |       |   |   |       |   |
|-------|---|---|-------|---|
| " 2.  | " | " | left  | " |
| " 3.  | " | " | right | " |
| " 4.  | " | " | right | " |
| " 5.  | " | " | left  | " |
| " 6.  | " | " | right | " |
| " 7.  | " | " | left  | " |
| " 8.  | " | " | right | " |
| " 9.  | " | " | right | " |
| " 10. | " | " | right | " |
| " 11. | " | " | left  | " |
| " 12. | " | " | right | " |
| " 13. | " | " | right | " |
| " 14. | " | " | right | " |
| " 15. | " | " | left  | " |
| " 16. | " | " | left  | " |

(From Mus. Peabody Acad. Science, Salem, Mass.)

" 17. *Homarus Americanus*, left chela.

## PLATE II.

Fig. 1. *Homarus Americanus*, dactylus of right chela.

- |      |   |   |                             |
|------|---|---|-----------------------------|
| " 2. | "   | " | one of the small chelipeds. |
| " 3. | "   | " | left chela.                 |
| " 4. | "   | " | dactylus of right chela.    |
| " 5. | <i>Callinectes hastatus</i> , left chela. |   |                             |

(From Chesapeake Bay; coll. Dr. S. F. Clarke.)

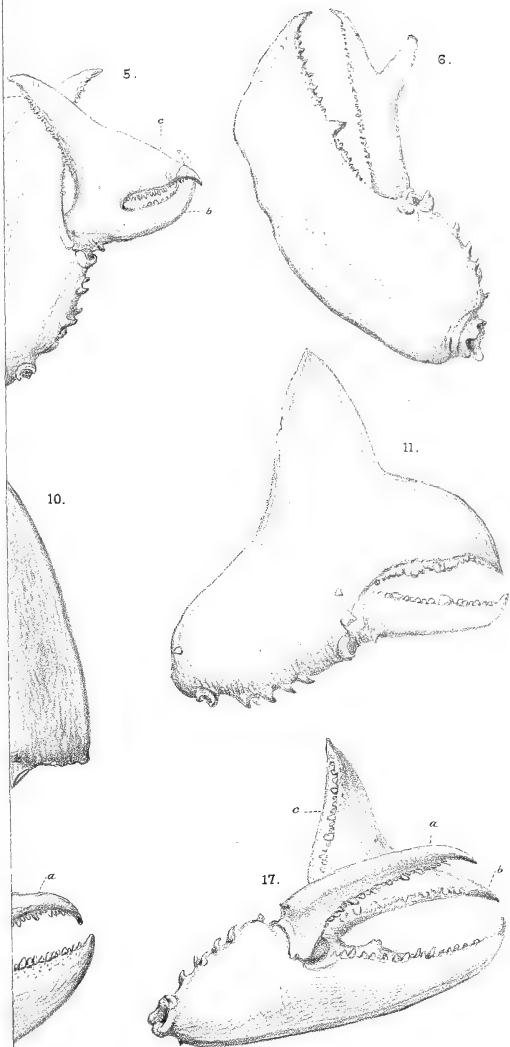
" 6. *Homarus Americanus*, right cheliped.

" 7. " " left chela.

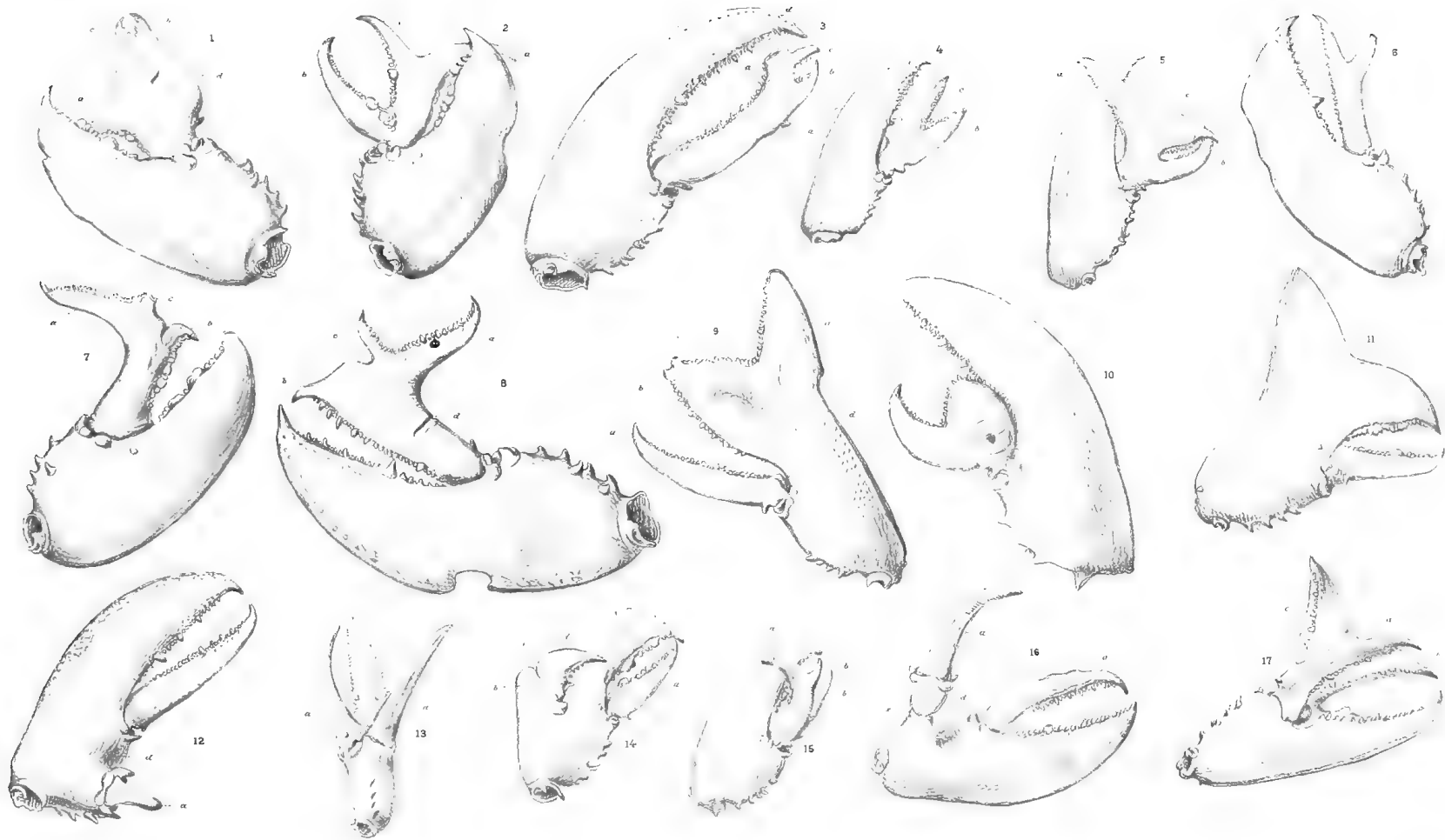
" 8. *Callinectes hastatus*, left lateral part of the carapace with branched spine.

(Coll. M. C. Z.)

" 9. *Homarus Americanus*, right chela.

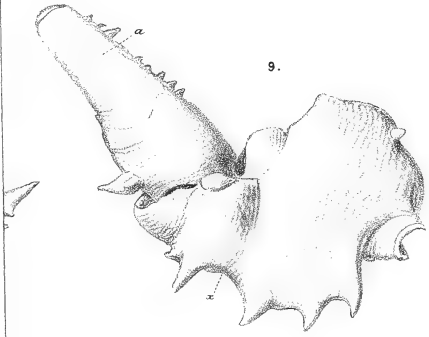
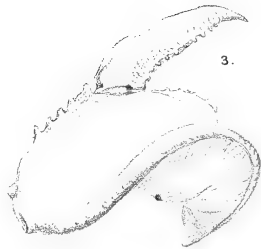






















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BIBLIOGRAPHY

TO ACCOMPANY "SELECTIONS FROM EMBRYOLOGICAL  
MONOGRAPHS" COMPILED BY ALEXANDER AGASSIZ,  
WALTER FAXON, AND E. L. MARK.

I.—CRUSTACEA. BY WALTER FAXON.

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MARCH, 1882.





No. 6. — *Bibliography to accompany "Selections from Embryological Monographs" compiled by ALEXANDER AGASSIZ, WALTER FAXON, and E. L. MARK.*

I.

CRUSTACEA.

BY WALTER FAXON.

[It is proposed to issue in the Memoirs of the Museum a "Selection from Embryological Monographs," which will give to the student, in an easily accessible form, a more or less complete iconography of the embryology of each important group of the animal kingdom. This selection is not intended to be a handbook, but rather an atlas to accompany any general work on the subject.

The plates will be issued in parts, as fast as practicable, each part covering a somewhat limited field. The parts devoted to Echinoderms, Acalephs, and Polyps are well advanced, and a beginning has been made for the Crustacea. Occasional appendices may be published, to prevent the plates from becoming antiquated.

The quarto illustrations will be accompanied by a carefully prepared explanation, and by a bibliography, in octavo, to be made as complete as possible. Although a large part of this bibliographical literature may be found in the general works of Kölliker, Balbiani, and Balfour, and in some of the more recent special monographs, a fuller list on special subjects, comprising the scattered references now accessible only with much cost of time and labor, will be convenient for students.

The present Bulletin contains the first instalment of this bibliography. It will be followed at an early date by similar lists for the Echinoderms, the Acalephs, the Polyps, and the Fishes.

ALEXANDER AGASSIZ.

THE embryological literature of the Arthropod groups *incertæ sedis*, viz. *Xiphosura*, *Trilobita*, and *Pycnogonida*, will be found at the end of this list. An asterisk (\*) before a title denotes that the work cited has not been seen by me.

December 3, 1881.

W. F.]

**Agassiz, Alexander.**

[On the Development of the *Porcellanidæ*.] *Proc. Boston Soc. Nat. Hist.*, X. p. 222. Oct. 18, 1865.

(*Zoëa* of *Porcellana (Polyonyx) macrocheles* recorded from Newport, R. I.)

Instinct? in Hermit Crabs. *Amer. Journ. Sci. & Arts* [3], X. pp. 290, 291. Oct. 1875.

(Habits of young.)

**Agassiz, Louis.**

Twelve Lectures on Comparative Embryology, delivered before the Lowell Institute, in Boston, December and January, 1848-49. Boston, 1849. 104 pp.

(Eggs of *Pinnotheres*, p. 67, Pl. XXII. Development of *Palæmon*, pp. 67, 68, Pl. III. *Cumæ* the young of *Palæmon*, *Hippolyte*, and *Mysis*, p. 68.)

Zoölogical Notes from the Correspondence of Prof. Agassiz. *Amer. Journ. Sci. & Arts* [2], XIII. pp. 425, 426, 1852; XXII. pp. 285, 286, 1856.

(Cumæ the young of *Crangon*, *Palæmon*, and *Hippolyte*.)

**Allman [George James].**

On the Development of *Notodelphys*, Allm., a new Genus of *Entomostraca*. *Rep. Brit. Assoc. Adv. Sci. for 1847*, p. 74. 1848.

**Anderson, John.**

On the Anatomy of *Sacculina*, with a Description of the Species. *Ann. Mag. Nat. Hist.* [3], IX. pp. 12-19, Pl. I. 1862.

(Larva, pp. 13, 14, fig. 1.)

**Aurivillius, P. O. Christopher.**

On a new Genus and Species of *Harpacticida*. *Bihang till K. Svenska Vetensk.-Akad. Handl.*, V. No. 18. 1879. 14 pp., 4 pl.

(*Balaenophilus unisetus*. Development, pp. 10-15, Pl. III., IV.)

\**Balaenophilus unisetus* nov. Gen. et Sp. Ett Bidrag till Kännedomen om Harpacticidernas Utvecklingshistoria och Systematik. Stockholm, 1879. 26 pp., 4 pl. (Akadem. Afhandl.)

**Baird, W.**

The Natural History of the British *Entomostraca*. London, 1850. 364 pp., 36 pl.

Previously in *Mag. Zoöl. Bot.*, I. pp. 35-41, 309-333, 514-526, Pl. VIII.-X., XVI., 1837; II. pp. 132-144, 400-412, Pl. V., 1838. *Ann. Nat. Hist.*, I. pp. 245-256, Pl. IX., 1838. *Ann. Mag. Nat. Hist.*, XI. pp. 81-95, Pl. II., III., 1843.

(Young stages, *passim*.)

**Balbani [G.].**

Observations relatives à une Note récente de M. Gerbe, sur la Constitution et le Développement de l'Œuf ovarien des Sacculines. *Comptes Rendus de l'Acad. des Sci., Paris*, LXVIII. pp. 615-618. 1869.

Sur la Constitution et le Mode de Formation de l'Œuf des Sacculines. *Comptes Rendus de l'Acad. des Sci., Paris*, LXIX. pp. 1320-1324. 1869. *Ann. Mag. Nat. Hist.* [4], V. pp. 303-306. 1870.

Sur la Constitution et le Mode de Formation de l'Œuf des Sacculines. Remarques concernant une Note récente de M. Ed. Van Beneden. *Comptes Rendus de l'Acad. des Sci., Paris*, LXIX. pp. 1376-1379. 1869.

**Balfour, Francis M.**

A Treatise on Comparative Embryology. Vol. I. Chapter XVIII. Crustacea. Pp. 380-443. London, 1880.

(General work.)

**Bate, C. Spence.**

- Notes on Crustacea. *Ann. Mag. Nat. Hist.* [2], VI. pp. 109-111, Pl. VII. 1850.  
(On the mode of escape of *Pagurus* larva from the egg, p. 111.)
- On the Development of the *Cirripedia*. *Ann. Mag. Nat. Hist.* [2], VIII. pp. 324-332, Pl. VI.-VIII. 1851.
- On the British *Edriophthalmia*. Part I. The *Amphipoda*. *Rep. Brit. Assoc. Adv. Sci. for 1855*. 1856.  
(On the development of the young, pp. 55, 56.)
- On the British *Diastylidæ*. *Ann. Mag. Nat. Hist.* [2], XVII. pp. 449-465, Pl. XIII.-XV. 1856.  
(On the development, p. 463. Zoëa of *Hippolyte varians*, pp. 461, 462, Pl. XV. fig. 8.)
- On the Development of *Carcinus Mænas*. *Proc. Roy. Soc. London*, VIII. pp. 544-546. 1857.  
(Abstract of paper given in full in *Phil. Trans. Roy. Soc. London*, CXLVIII.)
- On the Genus *Cuma*. *Ann. Mag. Nat. Hist.* [2], XIX. pp. 106, 107. 1857.  
(On the affinity of *Cumæ* with young *Macroura*.)
- On *Praniza* and *Anceus*, and their Affinity to each other. *Ann. Mag. Nat. Hist.* [3], II. pp. 165-172, Pl. VI., VII. 1858.
- On the Development of Decapod Crustacea. *Phil. Trans. Roy. Soc. London*, CXLVIII. pp. 589-605, Pl. XL.-XLVI. 1859. (Received May 1, read June 18, 1857.)  
(Development of *Carcinus Mænas*.)
- On the Morphology of some *Amphipoda* of the Division *Hyperina*. *Ann. Mag. Nat. Hist.* [3], VIII. pp. 1-16, Pl. I., II. 1861.  
(Young described.)
- [Review of Fritz Müller's *Für Darwin*.] *Rec. Zoölog. Lit.* (1864), I. pp. 261-270. 1865.
- [Review of Z. Gerbe's *Métamorphoses des Crustacés marins*.] *Rec. Zoölog. Lit.* (1865), II. pp. 321, 322. 1866.
- Report of the Committee appointed to explore the Marine Fauna and Flora of the South Coast of Devon and Cornwall. No. 1. *Rep. Brit. Assoc. Adv. Sci. for 1865*. 1866.  
(*Glaucothoë* the young of *Pagurus*, p. 53.)
- Also published with title, Carcinological Gleanings, No. II., in *Ann. Mag. Nat. Hist.* [3], XVII. p. 26. 1866.
- Carcinological Gleanings. No. III. *Ann. Mag. Nat. Hist.* [4], I. pp. 442-448, Pl. XXI. 1868.  
(Believes *Alima* to be the second stage of *Squilla*. Young of *Uca*, see CUNNINGHAM, ROBERT O.)

- Report of the Committee appointed to explore the Marine Fauna and Flora of the South Coast of Devon and Cornwall. No. 2. *Rep. Brit. Assoc. Adv. Sci. for 1867. 1868.*  
 (Larvæ of *Porcellana*, *Pagurus*, *Palinurus*, pp. 279-282, Pl. I., II.)  
 Also published with title, Carcinological Gleanings, No. IV., in *Ann. Mag. Nat. Hist.* [4], II. pp. 113-117, Pl. IX., X. 1868.
- Fourth Report on the Fauna of South Devon. *Rep. Brit. Assoc. Adv. Sci. for 1872. 1873.*  
 (Observation on the development of *Homarus*, &c., p. 52.)
- Report on the Present State of our Knowledge of the Crustacea. Parts I. and II. On the Homologies of the Dermal Skeleton. *Rep. Brit. Assoc. Adv. Sci. for 1875*, pp. 41-53, Pl. I., II. 1876. *Do. for 1876*, pp. 75-94, Pl. II., III. 1877.  
 (Remarks on development, *passim*.)
- On the Nauplius Stage of Prawns. *Ann. Mag. Nat. Hist.* [5], II. pp. 79-85. 1878.  
 (Thinks Fritz Müller's "*Peneus-nauplius*" may be a larval Schizopod or parasitic Suctorian. Larva of *Galatea* noticed, p. 82.)
- Report on the Present State of our Knowledge of the Crustacea. Part IV. On Development. *Rep. Brit. Assoc. Adv. Sci. for 1878*, pp. 193-209, Pl. V.-VII. 1879.  
 (*Gelasimus*, *Trapezia*, *Dromia*, *Porcellana*, *Galatea*, *Astacus*, *Crangon*, *Palæmon*, &c.)
- Report on the Present State of our Knowledge of the Crustacea. Part V. On Fecundation, Respiration, and the Green Gland. *Rep. Brit. Assoc. Adv. Sci. for 1880*, pp. 230-241. 1880.  
 (Account of recent observations of CHANTRAN, GERBE, WILLEMOES-SUHM, &c.)
- On the *Penæidea*. *Ann. Mag. Nat. Hist.* [5], VIII. pp. 169-196, Pl. XI., XII. 1881.  
 (Genus *Euphema* M. Edw. a young form of *Peneus*? p. 192.)
- Bate (C. Spence) and Müller (Fritz).**  
 The Nauplius Stage of Prawns. *Ann. Mag. Nat. Hist.* [5], II. pp. 426, 427. 1878.
- Bate, C. Spence [and Power, Wilmot Henry].**  
 On the Development of the Crustacean Embryo, and the Variations of Form exhibited in the Larvæ of thirty-eight Genera of Podophthalmia. *Proc. Roy. Soc. London*, XXIV. pp. 375-379. 1876. *Ann. Mag. Nat. Hist.* [4], XVIII. pp. 174-177. 1876.
- Bate (C. Spence) and Westwood (J. O.).**  
 A History of the British Sessile-eyed Crustacea. 2 vols. London, 1861-1868. lvi. + 507 + 536 pp.  
 (Observations on development, pp. xliii.-xlvi., 1868 (C. S. Bate), *et passim*.)

**Bell, Thomas.**

A History of the British Stalk-eyed Crustacea. London, 1853. lxx. + 386 pp.  
(Metamorphosis, pp. xxxviii.-lxi., et passim.)

**Beneden. See Van Beneden.****Bessels, Emil.**

Einige Worte über die Entwicklungsgeschichte und den morphologischen  
Werth des kugelförmigen Organes der Amphipoden. *Jenaische Zeitschr.*,  
V. pp. 91-101. 1870.

See also Van Beneden, Édouard.

**Birge, Edward A.**

Notes on *Cladocera*. *Trans. Wisconsin Acad. Sci., Arts, & Letters*, IV. pp. 77-  
112, Pl. I., II. 1878.

(Some notes on young, *passim*.)

**Boas, J. E. V.**

*Amphion* und *Polycheles* (*Willemoesia*). *Zoolog. Anzeig.*, II. pp. 256-259.  
May, 1879.

(*Amphion* the larva of *Polycheles*?)

Studier over Decapodernes Slægtskabsforhold. Avec un Résumé en français.  
*K. Danske Vidensk. Selsk. Skr.* [6], *naturvidensk. og mathemat. Afd. I.*  
pp. 25-210, 7 pl. 1880.

Abstr. in *Journ. Roy. Microscop. Soc.* [2], I. pp. 450-452. 1881.

(Development, *passim*.)

**Bobretzky, N.**

K Embriologii Tshlenistonogikh [On the Embryology of Arthropods].  
*Zapiski Kiefskavo Obshtchestva Yestestvoisпитatelyei*, III., 1873. [*Mem.*  
*Kieff Naturalists' Soc.*, III. pp. 129-263, Pl. I.-VI. 1873.]

Abstr. in German by HOYER in *Hofmann u. Schwalbe's Jahresberichte*,  
II. pp. 31-2318. 1875.

(*Astacus* and *Palæmon*.)

Zur Embryologie des *Oniscus murarius*. *Zeitschr. f. wissensch. Zool.*, XXIV.  
pp. 179-203, Taf. XXI., XXII. 1874.

**Boeck, Axel.**

\*Om det norske Hummerfiski og dets Historie. *Tidsskrift for Fiskeri*, Kjø-  
benhavn, 3<sup>die</sup> Aargangs, pp. 28-43, 1868; pp. 145-189, 1869.

Translated in *United States Commission of Fish and Fisheries*, Part III.  
*Report of the Commissioner for 1873-74 and 1874-75*, pp. 223-258. 1876.

(Observations on development of *Homarus*, pp. 226, 227.)

**Bosc, L. A. G.**

Histoire Naturelle des Crustacés. Paris, 1802.

(Genus *Zoëa* founded for reception of the Brachyuran larva described by  
SLABBER under the name of *Monoculus taurus*.)

**Bovallius, Carl.**

Embryologiska Studier. I. Om Balanidernas Utveckling. Stockholm, 1875.  
44 pp., 5 pl.

**Brandt, Eduard.**

Ueber die Jungen der gemeinen Klappenassel (*Idothea entomon*). *Bull. Acad. Impér. des Sci. de St.-Petersbourg*, XV. pp. 403-409 (*Mélanges Biologiques*, VII. pp. 649-657), 1 pl. 1870.

**Brauer, Friedrich.**

Beiträge zur Kenntniss der Phyllopoden. *Sitzungsber. d. kais. Akad. d. Wissensch. Wien. Math.-naturw. Cl.*, LXV. pp. 279-291. 1872.

Abstr. *Anzeiger d. Akad. d. Wissensch. Wien*, May 31, 1872, p. 100.  
*Ann. Mag. Nat. Hist.* [4], X. p. 152, 1872. \**Zeitschr. gesammt. Naturwissen.* [2], VI. pp. 314, 315, 1872.

(Parthenogenesis of *Apus*, &c.)

Vorläufige Mittheilungen über die Entwicklung und Lebensweise des *Lepidurus productus* Bosc. *Sitzungsber. d. kais. Akad. d. Wissensch. Wien. Math.-naturw. Cl.*, LXIX., I. Abt. pp. 130-140, Taf. I., II. 1874.

**Bree, W. T.**

Ecdysis, or the Casting of the Skin or Shell, in Crustaceous Animals. *Mag. Nat. Hist. (Loudon's)*, VIII. pp. 468, 469. August, 1835.

(*Astacus* hatched in the adult form.)

**Brightwell, T.**

Description of the Young of the Common Lobster, with Observations relative to the Questions of the Occurrence and Non-occurrence of Transformations in Crustaceous Animals. *Mag. Nat. Hist. (Loudon's)*, VIII. pp. 482-486. September, 1835.

(*Homarus*, *Astacus*.)

**Brooks, W. K.**

The Larval Stages of *Squilla Empusa* Say. *Chesapeake Zoölogical Laboratory. Scientific Results of the Session of 1878*, pp. 143-170, Pl. IX.-XIII. February, 1879.

Also published as *Studies from the Biological Laboratory of Johns Hopkins University*, I. Part 3.

The Rhythmical Character of the Process of Segmentation. *Amer. Journ. Sci. & Arts* [3], XX. p. 293. October, 1880.

(Observed in eggs of *Lucifer*.)

The Young of the Crustacean *Lucifer*, a Nauplius. *Amer. Naturalist*, XIV. pp. 806-808. November, 1880.

(Also records obs. of E. B. WILSON that zoëa of *Libinia* has full number of thoracic appendages when it leaves egg. WILSON has also raised zoëæ from eggs of *Porcellana*, *Pinniza*, *Sesarma*, *Pinnotheres*, and *Callinectes*.)

The Embryology and Metamorphosis of the *Sergestidæ*. *Zoolog. Anzeig.*, III. pp. 563-567, 15 Nov., 1880.

Also brief notice in *Fifth Annual Report of the Johns Hopkins University, Baltimore, Maryland*, 1880, Appendix F, "Report of Chesapeake Zoölogical Laboratory for the Third Year, Summer of 1880, Beaufort, N. C.," p. 57. 1880.

(*Lucifer, Acetes?*)

*Lucifer*: a Study in Morphology. (Abstract.) *Proc. Roy. Soc. London*, No. 212, 1881. 3 pp.

(Development of *Lucifer, Acetes?*)

**Brooks (W. K.) and Wilson (E. B.).**

The First Zoëa of Porcellana. *Studies from the Biological Laboratory of Johns Hopkins University*, II. No. 1, pp. 53-64, Pl. VI., VII. 1881.

**Buchholz, Reinhold.**

Ueber *Hemioniscus*, eine neue Gattung parasitischer Isopoden. *Zeitschr. f. wissenschaft. Zool.*, XVI. pp. 303-327, Taf. XVI., XVII. 1866.

Beiträge zur Kenntniss der innerhalb der Ascidien lebenden parasitischen Crustaceen des Mittelmeeres. *Zeitschr. f. wissenschaft. Zool.*, XIX. pp. 99-155, Taf. V.-XI. 1869.

(Figures nauplii of several *Notodelphyidæ*.)

See also Münter, Jul.

**Bullar, J. F.**

On the Development of the Parasitic *Isopoda*. *Phil. Trans. Roy. Soc. London*, CLXIX. pp. 505-521, Pl. XLV.-XLVII. 1878. Abstr. in *Proc. Roy. Soc. London*, XXVII. pp. 284-286. April 4, 1878.

(*Cymothoë*.)

**Burmeister, Hermann.**

Beiträge zur Naturgeschichte der Rankenfüsser (*Cirripedia*). Berlin, 1834. viii. + 60 pp., 2 pl.

(Development, pp. 12-27, Pl. I.)

**Cane.** See DuCane.

**Carbonnier, Pierre.**

L'Écrevisse. Mœurs — Reproduction — Education. Paris, 1869. 197 pp.

(Notes on hatching and young, Ch. VI. pp. 49-56.)

**Cavolini, Filippo.**

\*Memoria sulla Generazione dei Pesci e dei Granchi. Napoli, 1787.

Germ. transl. by E. A. W. ZIMMERMANN. Abhandlung über die Erzeugung der Fische und der Krebse. Berlin, 1792. 192 pp., 3 pl.

(Zoëa of *Brachyura* [*Grapsus varius?*], young of *Entoniscus*, *Rhizocephala*, &c.)

**Chantran, Samuel.**

Observations sur l'Histoire Naturelle des Écrevisses. *Comptes Rendus de l'Acad. des Sci., Paris*, LXXI. pp. 43-45. 1870

Trans. in *Ann. Mag. Nat. Hist.* [4], VI. pp. 265-267. 1870. *Journ. de l'Anat. et de la Physiol. (Robin's)*, VIII. pp. 236-238. 1872. *Rev. Mag. Zool.* [2], XXIII. pp. 75-78. 1871-72.



Nouvelles Observations sur le Développement des Écrevisses. *Comptes Rendus de l'Acad. des Sci., Paris*, LXXIII. pp. 220, 221. 1871.

Trans. in *Ann. Mag. Nat. Hist.* [4], VIII. pp. 219, 220. 1871. *Journ. de l'Anat. et de la Physiol.* (Robin's), VIII. p. 233. 1872. *Rev. Mag. Zool.* [2], XXIII. pp. 78, 79. 1871-72.

**Claparède, A. René Edouard.**

Beobachtungen über Anatomie und Entwicklungsgeschichte wirbelloser Thiere an der Küste von Normandie angestellt. Leipzig, 1863. viii. + 120 pp., 18 pl.

(Development of *Mysis*, pp. 92-94, Pl. XVII. figs. 1-6; *Lepas anatifera*, pp. 98-101, Pl. XVII. figs. 15-26; *Phoxichilidium*, pp. 104, 105, Pl. XVIII. figs. 13, 14.)

**Claus, Carl.**

Ueber den Bau und die Entwicklung parasitischer Crustaceen. Cassel, 1858. 34 pp., 2 pl.

(*Chondracanthus*, *Lernanthropus*, *Kroyeria*.)

Zur Anatomie und Entwicklungsgeschichte der Copepoden. *Arch. f. Naturgesch.*, XXIV. 1, pp. 1-76, Taf. I.-III. 1858.

\*Zur Kenntniss der Malacostracenlarven. *Würzburg. naturwiss. Zeitschr.*, II. pp. 23-46. 1861.

Ueber die morphologischen Beziehungen der Copepoden zu den verwandten Crustaceengruppen der Malacostraken, Phyllopoden, Cirripeden und Ostracoden. *Würzburg. naturwiss. Zeitschr.*, III. pp. 159-167. 1862.

Ueber den Bau und die Entwicklung von *Achtheres percarum*. *Zeitschr. f. wissensch. Zool.*, XI. pp. 287-308, Taf. XXIII., XXIV. 1862.

Die frei lebenden Copepoden mit besonderer Berücksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeeres. Leipzig, 1863. x. + 230 pp., 37 pl.

(Development, pp. 72-83. Figures several nauplii.)

Ueber einige Schizopoden und niedere Malacostraken Messina's. *Zeitschr. f. wissensch. Zool.*, XIII. pp. 422-454, Taf. XXV.-XXIX. 1863.

(Development of *Palinurus*, *Sergestes*, *Euphausia*.)

Zur näheren Kenntniss der Jugendformen von *Cypris ovum*. *Zeitschr. f. wissensch. Zool.*, XV. pp. 391-398, Taf. XXVIII., XXIX. 1865.

Abstr. by C. SPENCE BATE in *Rec. Zoöl. Lit.* (1865), II. pp. 344, 345. 1866.

Die Copepoden-Fauna von Nizza. Ein Beitrag zur Charakteristik der Formen und deren Abänderungen "im Sinne Darwin's." *Schriften d. Gesell. zur Beförderung d. gesamm. Naturwissen. zu Marburg*, IX. Suppl. 1. 34 pp., 5 pl. 1866.

(Young *Calanella*, p. 9, Taf. V. fig. 22. *Calanus mastigophorus?* pp. 10, 11, Taf. V. figs. 20, 21.)

- Ueber *Lernaeocera esocina* v. Nordm. (Vorläufige Mittheilung.) *Sitzungsber. d. Gesell. zur Beförderung d. gesammt. Naturwissen. zu Marburg, 1867*, pp. 5-12.  
(Development, pp. 11, 12.)
- Ueber den Entwicklungsmodus der *Porcellana*-Larven im Vergleiche zu den Larven von *Pagurus*. *Sitzungsber. der Gesell. zur Beförderung d. gesammt. Naturwissen. zu Marburg, 1867*, pp. 12-16.
- Ueber die Metamorphose und systematische Stellung der Lernaeen. *Sitzungsber. d. Gesell. zur Beförderung d. gesammt. Naturwissen. zu Marburg, 1868*, pp. 5-13.
- Beiträge zur Kenntniss der Ostracoden. I. Entwicklungsgeschichte von *Cypris*. *Schriften d. Gesell. zur Beförderung d. gesammt. Naturwissen. zu Marburg, IX*. pp. 151-166, 2 pl. 1868.  
Abstr. in *Ann. Mag. Nat. Hist.* [4], IV. pp. 291, 292. 1869. \**Arch. Sci. Phys.*, XXXV. pp. 312-314. 1869.
- Beobachtungen über *Lernaeocera*, *Peniculus* und *Lernaea*. Ein Beitrag zur Naturgeschichte der Lernaeen. *Schriften d. Gesell. zur Beförderung d. gesammt. Naturwissen. zu Marburg, IX*. Suppl. 2. 32 pp., 4 pl. 1868.  
(Young of *Lernaeocera esocina*. Metamorphosis of *Lernæa branchialis*, pp. 16-27, Taf. IV.)
- Die *Cypris*-ähnliche Larve (Puppe) der Cirripeden und ihre Verwandlung in das festsitzende Thier. Ein Beitrag zur Morphologie der Rankenfüssler. *Schriften d. Gesell. zur Beförderung d. gesammt. Naturwissen. zu Marburg, IX*. Suppl. 5. 17 pp., 2 pl. 1869.
- Die Metamorphose der Squilliden. *Nachrichten Kön. Gesell. Wissensch. Göttingen, 1871*, pp. 169-180. (Abstract.) *Abh. Kön. Gesell. Wissensch. Göttingen, XVI*. pp. 111-163, Taf. I.-VIII. 1871. (Full memoir.)
- Zur Kenntniss des Bau's und der Entwicklung von *Apus* und *Branchipus*. *Nachrichten Kön. Gesell. Wissensch. Göttingen, 1872*, pp. 209-225. \**Zeitschr. gesammt. Naturwissen.*, VI. pp. 200, 201. 1872.
- Zur Kenntniss des Baues und der Entwicklung von *Branchipus stagnalis* und *Apus cancriformis*. *Abh. Kön. Gesell. Wissensch. Göttingen, XVIII*. pp. 93-140, Taf. I.-VIII. 1873.
- Ueber die Entwicklung, Organisation und systematische Stellung der Arguliden. *Zeitschr. f. wissenschaft. Zool.*, XXV., pp. 217-284, Taf. XIV.-XVIII. 1875.
- \*Das System der Crustaceen im Lichte der Descendenzlehre. I. Die Metamorphose der Malakostraken. Wien, 1875.
- Zur Kenntniss der Organisation und des feinern Baues der Daphniden und verwandter Cladoceren. *Zeitschr. f. wissenschaft. Zool.*, XXVII. pp. 362-402, Taf. XXV.-XXVIII. Aug., 1876.  
(Structure of ovary, eggs, &c., pp. 389-399, Taf. XXVII. figs. 15-20.)

Grundzüge der Zoologie. Zum Gebrauche an Universitäten und höheren Lehranstalten sowie zum Selbststudium. 3te Aufl. Marburg und Leipzig, 1874, 1876. xii. + 1254 pp.

(Development of Crustacea, pp. 450-562, *passim*. 1876.)

Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems. Ein Beitrag zur Descendenzlehre. Wien, 1876. viii. + 114 pp., 19 pl.

Noticed by EDUARD VON MARTENS in *Zoölog. Rec.* (1876), XIII. *Crust.*, pp. 2, 3. 1878.

(General work on development of Crustacea.)

Neue Beiträge zur Kenntniss der Copepoden unter besonderer Berücksichtigung der Triester Fauna. *Arbeiten aus d. zoolog. Inst. d. Universität Wien u. d. zoolog. Station in Triest*, III. pp. 313-332, Taf. XXIII.-XXV. 1881.

(Young males of certain species resemble the female in the segmentation of the antennæ, &c.)

#### Coldstream, John.

On the Structure and Habits of the *Limnoria terebraus*, a minute Crustaceous Animal, destructive to marine wooden Erections, as Piers, &c. *Edinburgh New Philosoph. Journ.*, XVI. pp. 316-334, Pl. VI. 1834.

(Young, p. 325, Pl. VI. figs. 17, 18.)

#### Cornalia (Emilio) and Panceri (Paolo).

Osservazioni zoologico-anatomiche sopra un nuovo Genere di Crostacei Isopodi sedentarii (*Gyge branchialis*). *Memorie della Reale Accad. d. Scienze di Torino*, [2], XIX. 1858. 36 pp., 2 pl.

(Development, pp. 21-27, Pl. I. figs. 6-25.)

#### Costa, Oronzio-Gabriele.

Fauna del Regno di Napoli, &c. Napoli, 1829, *et seqq.*

(Embryo of *Callianassa subterranea*, Decapodi Macrouri, Tav. I<sup>bis</sup>, fig. 2, pp. 9, 10. Feb. 1847.)

A few plates are missing from the copy of this work in the library of the Museum of Comparative Zoölogy. According to Leuckart, *Arch. f. Naturgesch.*, 1859, 1, p. 246, the embryo of *Notopterophorus* is figured.

#### Coste [P.].

Note sur la Larve des Langoustes. *Comptes Rendus de l'Acad. des Sci., Paris*, XLVI. pp. 547, 548. 1858. *Ann. Mag. Nat. Hist.* [3], I. p. 466. 1858.

(*Phyllosoma* the larva of *Palinurus*.)

Études sur les Mœurs et sur la Génération d'un certain Nombre d'Animaux marins. *Comptes Rendus de l'Acad. des Sci., Paris*, XLVII. pp. 45-50. 1858.

Trans. in *Ann. Mag. Nat. Hist.* [3], II. pp. 197-202. 1858.

**Couch, R. Q.**

On the Metamorphoses of the Decapod Crustaceans. *The Eleventh Annual Report of the Royal Cornwall Polytechnic Society, 1843*, pp. 28-43, Pl. I. Falmouth.

(*Carcinus Mænas*, *Portunus plicatus*, *Cancer pagurus*, *Maia verrucosa*, *Inachus dorynchus*, *Pisa Gibbsii*, *Homarus vulgaris*, *Palinurus vulgaris*, *Galatea squamifera*.

*Xantho floridus*, *X. rivulosus*, *Pilumnus hirtellus*, *Polybius Henslowii*, *Portunus puber*, and several others hatched as zoëæ.)

See BELL's *Hist. Brit. Stalk-eyed Crustacea*. London, 1853.

On the Metamorphosis of the Crustaceans, including the *Decapoda*, *Entomostraca*, and *Pycnogonidæ*. *The Twelfth Annual Report of the Royal Cornwall Polytechnic Society, 1844*, pp. 17-46, Pl. I. Falmouth.

(*Carcinus Mænas*, *Palinurus vulgaris*, *Homarus vulgaris*, *Crangon vulgaris*, *Palæmon serratus*, *Porcellana platycheles*, *Cyclops quadricornis*, *Orithyia coccinea*, *Nymphon gracile*.)

See BELL's *Hist. Brit. Stalk-eyed Crustacea*. London, 1853.

[Letter to C. Spence Bate on the Larvæ of *Cuma*.] *Ann. Mag. Nat. Hist.* [2], XIX. pp. 106, 107. 1857.

On the Embryo State of *Palinurus vulgaris*. *Nat. Hist. Rev.*, IV., Proc. Soc., pp. 250-257, Pl. XVII. 1857. *Rep. Brit. Assoc. Adv. Sci. for 1857*, Trans. of Sect., pp. 102, 103. 1858.

(Larva referred to *Phyllosoma* by GERSTÆCKER, *Arch. f. Naturgesch.* 1858, 2, p. 455.)

**Cunningham, Robert O.**

[Letter to C. Spence Bate,] *Carcinological Gleanings*, No. III., *Ann. Mag. Nat. Hist.* [4], I. pp. 442-446. 1863.

(*Uca Cunninghami* Bate with live, fully developed young ones under the pleon.)

**Czerniavsky. See Tscherniawsky.****Dana, James D.**

United States Exploring Expedition, during the Years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes, U. S. N. Vol. XIII. Crustacea. Philadelphia, 1852. xii. + 1618 pp., 96 pl.

(*Passim*.)

**Danielssen [D. C.]. See Koren, J.****Darwin, Charles.**

A Monograph on the Sub-Class *Cirripedia*, with Figures of all the Species. The *Lepadidæ*, or Pedunculated Cirripedes. London, 1851. xii. + 400 pp., 10 pl.

(Metamorphoses, pp. 8-28.)

The *Balanidæ*, or Sessile Cirripedes, the *Verrucidæ*, &c., &c. London, 1854. viii. + 684 pp., 30 pl.

(Metamorphoses, pp. 102-133.)

De Filippi. *See* Filippi.

De Geer. *See* Geer.

De La Valette St. George. *See* La Valette St. George.

Dohrn, Anton.

Die embryonale Entwicklung des *Asellus aquaticus*. *Zeitschr. f. wissenschaftl. Zool.*, XVII. pp. 221–278, Pl. XIV., XV. 1867.

On the Morphology of the Arthropoda. *Journ. of Anat. and Physiol.*, II. ([2], I.) pp. 80–86. 1868.

Abstr. in *Rep. Brit. Assoc. Adv. Sci. for 1867*, Trans. of Sect., p. 82. 1868.

Untersuchungen über Bau und Entwicklung der Arthropoden. 1. Ueber den Bau und die Entwicklung der Cumaceen. *Jenaische Zeitschr.*, V. pp. 54–81, Taf. II., III. 1870.

Untersuchungen über Bau und Entwicklung der Arthropoden. 3. Die Schalendrüse und die embryonale Entwicklung der Daphnien. *Jenaische Zeitschr.*, V. pp. 277–306, Taf. X. 1870.

Untersuchungen über Bau und Entwicklung der Arthropoden. 4. Entwicklung und Organisation von *Praniza (Anceus) maxillaris*. *Zeitschr. f. wissenschaftl. Zool.*, XX. pp. 55–80, Taf. VI.–VIII. 1869.

Untersuchungen über Bau und Entwicklung der Arthropoden. 5. Zur Kenntniss des Baues von *Paranthura Costana*. *Zeitschr. f. wissenschaftl. Zool.*, XX. pp. 81–93, Taf. IX. 1869.

(Observations on development in *Nachtrag*.)

Untersuchungen über Bau und Entwicklung der Arthropoden. 6. Zur Entwicklungsgeschichte der Panzerkrebse (*Decapoda Loricata*). *Zeitschr. f. wissenschaftl. Zool.*, XX. pp. 249–271, Taf. XVI. 1870.

(*Scyllarus arctus*, *Palinurus vulgaris*.)

Untersuchungen über Bau und Entwicklung der Arthropoden. 7. Zur Kenntniss vom Bau und der Entwicklung von *Tanais*. *Jenaische Zeitschr.*, V. pp. 293–306, Taf. XI., XII. 1870.

Untersuchungen über Bau und Entwicklung der Arthropoden. 8. Die Ueberreste des Zoëa-Stadiums in der ontogenetischen Entwicklung der verschiedenen Crustaceen-Familien. *Jenaische Zeitschr.*, V. pp. 471–491. 1870.

Untersuchungen über Bau und Entwicklung der Arthropoden. 9. Eine neue Nauplius-Form (*Archizoëa gigas*). *Zeitschr. f. wissenschaftl. Zool.*, XX. pp. 597–606, Taf. XXVIII., XXIX. 1870.

(*Cirripedia*.)

Untersuchungen über Bau und Entwicklung der Arthropoden. 10. Beiträge zur Kenntniss der Malacostraken und ihrer Larven. *Zeitschr. f. wissenschaftl. Zool.*, XX. pp. 607–626, Taf. XXX.–XXXII. 1870.

(*Amphion*, *Lophogaster*, *Portunus*, *Pandalus*, *Galatea*, *Elaphocaris*.)

Untersuchungen über Bau und Entwicklung der Arthropoden. II. Zweiter Beitrag zur Kenntniss der Malacostraken und ihrer Larven-formen. *Zeitschr. f. wissenschaft. Zool.*, XXI. pp. 356-379, Taf. XXVII.-XXX. 1871.

(Zoëa, pp. 372-378, Taf. XXIX., XXX.)

Geschichte des Krebsstammes, nach embryologischen, anatomischen und palaeontologischen Quellen. *Jenaische Zeitschr.*, VI. pp. 96-156. 1871.

Der Ursprung der Wirbelthiere und das Princip des Functionswechsels. Genealogische Skizzen. Leipzig, 1875. 87 pp.

(Contains remarks on development of various Crustacea, *passim*.)

#### DuCane, C.

Letter from Captain DuCane, R. N., to the Rev. Leonard Jenyns, on the subject of the Metamorphosis of Crustacea. Extract from a Letter on the same subject from Captain DuCane, R. N., to W. S. MacLeay, Esq. *Ann. Nat. Hist.*, II. pp. 178-181, Pl. VI., VII. 1839.

(*Palæmon*, Crangon.)

On the Metamorphoses of the Crustacea. *Ann. Nat. Hist.*, III. pp. 438-440, Pl. XI. 1839.

(*Carcinus Mænas*.)

#### Dujardin, Félix.

Observations sur les Métamorphoses de la *Porcellana longicornis*, et Description de la Zoë, qui est la Larve de ce Crustacé. *Comptes Rendus de l'Acad. des Sci.*, Paris, XVI. pp. 1204-1207. 1843.

Duthiers. See Lacaze-Duthiers.

Edwards. See Milne Edwards.

#### Erdl, M. P.

Entwicklung des Hummereies von den ersten Veränderungen im Dotter an bis zur Reife des Embryo. München, 1843. 40 pp., 4 pl.

Noticed in *Ann. Mag. Nat. Hist.*, XIII. pp. 213, 214. 1844.

(Plate II. figs. 1-10, *Carcinus Mænas in ovo*.)

#### Eschscholtz, Fr.

Bericht über die zoologische Ausbeute während der Reise von Kronstadt bis St. Peter-und-Paul. *Isis*, 1825, 1, col. 733-747, Taf. V.

(*Lonchophorus anceps*, col. 734, Taf. V. fig. 1, described as a Macrouran, is a Brachyuran zoëa, described by A. Dohrn, *Zeitschr. f. wissenschaft. Zool.*, XXI. p. 373, Taf. XXX. fig. 52, 1871, and by Claus, under the name of *Pluteocaris*, "Untersuchungen," &c., p. 65, Taf. XII. figs. 1-7, 1876.)

#### Faxon, Walter.

On some Young Stages in the Development of *Hippa*, *Porcellana*, and *Pinnixa*. *Bull. Mus. Comp. Zool. at Harvard Coll.*, in Cambridge, V. pp. 253-268, 5 pl. June 30, 1879.

(Includes notice of unpublished observations of S. I. SMITH on development of *Pinnixa*, pp. 264, 265, and *Pinnotheres*, p. 265, foot-note.)

On the Development of *Palaemonetes vulgaris*. *Bull. Mus. Comp. Zool. at Harvard Coll., in Cambridge*, V. pp. 303-330, 4 pl. Sept. 1879.

(Includes notice of schizopod stage of *Virbius zostericola*, p. 322.)

On some Points in the Structure of the Embryonic Zoëa. *Bull. Mus. Comp. Zool. at Harvard Coll., in Cambridge*, VI. pp. 159-166, 2 pl. Oct. 19, 1880.

(*Carcinus Menas*, *Panopeus Sayi*, *Gelasimus pugnax*.)

**Filippi, F. de.**

Osservazioni Zoologiche. Seconda Nota sulla *Dichelaspis Darwinii*. *Archivio di Zoologia*, I. pp. 200-206, Tav. XII., XIII. 1861.

(Development, pp. 200-203, Tav. XII., XIII. figs. 10, 11.)

\*Ueber die Entwicklung von *Dichelaspis Darwinii*. *Moleschott's Untersuchungen zur Naturlehre des Menschen und der Thiere*, IX. pp. 113-120, 2 pl. 1863.

**Fischer, Sebastian.**

Abhandlung über das Genus *Cypris*, und dessen in der Umgebung von St. Petersburg und von Fall bei Reval vorkommenden Arten. *Mém. des Savants étrangers prés. à l'Acad. Impér. des Sci. de St.-Petersbourg*, VII. pp. 127-167, 11 pl. 1854.

Also printed separately, with date 1851.

(Young individuals of several species represented.)

Beitrag zur Kenntniss der Ostracoden. *Abhandl. d. K. bayr. Akad. d. Wissensch. München. Math. phys. Cl.*, VII. pp. 635-666, Taf. XIX., XX. 1855.

(Young *Cypris*, pp. 643, 644, Taf. XIX. figs. 7, 8.)

**Fraisse, Paul.**

Die Gattung *Cryptoniscus* Fr. Müller (*Liriope* Rathke). *Arbeit. aus dem zoolog.-zootom. Inst. in Würzburg*, IV. pp. 239-296, Taf. XII.-XV. 1878.

(Includes development. Nauplius of *Peltogaster Rodriguezii*, Taf. XV. fig. 57.)

*Antoniscus Cavolinii* n. Sp., nebst Bemerkungen über die Umwandlung und Systematik der Bopyriden. *Arbeit. aus dem zoolog.-zootom. Inst. in Würzburg*, IV. pp. 382-440, Taf. XX., XXI. 1878.

**Frey (Heinrich) and Leuckart (Rudolph).**

Beiträge zur Kenntniss wirbelloser Thiere mit besonderer Berücksichtigung der Fauna des Norddeutschen Meeres. Braunschweig, 1847. 170 pp., 2 pl.

(Development of *Mysis*, pp. 127-130.)

**Frič. See Fritsch.**

**Fritsch, Anton.**

Ueber das Vorkommen von *Apus* und *Branchipus* in Böhmen. *Verhandl. d. Kais.-Königl. zoolog.-botan. Gesell. in Wien*, XVI. pp. 557-562. 1866.

(On the influence of desiccation on the development of the egg, &c.)

**Gamroth, Alois.**

Beitrag zur Kenntniss der Naturgeschichte der Caprellen. *Zeitschr. f. wissenschaftl. Zool.*, XXXI. 101-126, Taf. VIII.-X. 1878.

(Development, pp. 122, 123, Taf. VIII. figs. 15-21.)

**Geer, Charles De.**

Mémoires pour servir à l'Histoire des Insectes. Tome VII. Stockholm, 1778. 7<sup>e</sup> Mém. Des Monocles, pp. 443-491, Pl. XXVII.-XXX.

Germ. transl. by J. A. E. GOEZE. Abhandlungen zur Geschichte der Insekten. Bd. VII. Nürnberg, 1783. Pp. 164-181, Pl. XXVII.-XXX.

(Larvæ of *Cludocera*, *Copepoda*, *passim*.)

**Geoffroy Saint-Hilaire, Isid.**

Rapport fait à l'Académie royale des Sciences, sur un Mémoire de M. Milne Edwards, intitulé: Observations sur les Changements de Forme que les Crustacés éprouvent dans le jeune Âge. *Ann. Sci. Nat.* [1], XXX. pp. 360-372. 1833.

**Gerbe, J.**

Sur les *Sacculina*. Extrait d'une Lettre de M. J. Gerbe, adressée à M. Van Beneden. *Bull. Acad. Roy. Belgique*, [2], XIII. pp. 339, 340. 1862.

(On development.)

Recherches sur la Constitution et le Développement de l'Œuf ovarien des Sacculines. *Comptes Rendus de l'Acad. des Sci., Paris*, LXVIII. pp. 460-462, 22 Feb. 1869.

Abstr. in *Rev. Mag. Zool.* [2], XXI. pp. 79, 80. 1869. *Ann. Mag. Nat. Hist.* [4], III. pp. 321, 322. 1869.

Réponse aux Observations de M. Balbiani, sur le Rôle des deux Vésicules que renferme l'Œuf primitif. *Comptes Rendus de l'Acad. des Sci., Paris*, LXVIII. pp. 670, 671. Mar. 15, 1879.

(Egg of *Sacculina*.)

**Gerbe, Z.**

Métamorphoses des Crustacés marins. *Comptes Rendus de l'Acad. des Sci., Paris*, LIX. pp. 1101-1103. 1864. *Rev. Mag. Zool.* [2], XVII. pp. 79-83. 1865. *Ann. Mag. Nat. Hist.* [3], XV. pp. 237, 238. 1865.

Notice by C. SPENCE BATE in *Rec. Zoölog. Lit.* (1865), II. pp. 321, 322. 1866.

(*Phyllosoma* the young of *Palinurus*. Embryonic skin with invaginated spines in numerous genera.)

Métamorphoses des Crustacés marins. Deuxième Note. *Comptes Rendus de l'Acad. des Sci., Paris*, LX. pp. 74-77. 1865. *Rev. Mag. Zool.* [2], XVII. pp. 83-87. 1865. *Ann. Mag. Nat. Hist.* [3], XV. pp. 356-358. 1865.

(Internal structure of *Phyllosoma* and other larvæ.)



Appareils vasculaire et nerveux des Larves des Crustacés marins. *Comptes Rendus de l'Acad. des Sci., Paris*, LXII. pp. 932-937. Apr. 23, 1866.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], XVIII. pp. 7-12. 1866.

(*Porcellana, Homarus, Phyllosoma, Nymphon, &c.*)

Métamorphose des Crustacés marins. Quatrième Note. *Comptes Rendus de l'Acad. des Sci., Paris*, LXII. pp. 1024-1027. May 7, 1866. *Ann. Mag. Nat. Hist.* [3], XVIII. pp. 69-71. July, 1866.

(Conclusions from observations recorded in three preceding notes.)

### Gerstaecker, A.

Bericht über die wissenschaftlichen Leistungen im Gebiete der Entomologie während des Jahres 1857. *Arch. f. Naturgesch.* 1858, 2, p. 455.

(Larva of *Palinurus*, described by R. Q. COUCH (*Nat. Hist. Rev.* IV., *Rep. Brit. Assoc. Adv. Sci. for 1857*), referred to *Phyllosoma*.)

Vol. V. (Arthropoda) of BRONN'S *Klassen und Ordnungen des Thier-Reichs*. Leipzig und Heidelberg, 1866 et seqq.

(Development, *passim*.)

[On *Ornitholepas australis* Targ. Tozz.] *Sitz.-Ber. Gesell. naturf. Freunde zu Berlin*, 1875, pp. 113-115.

(An immature form. See AD. TARGIONI TOZZETTI, *Bull. Soc. Entomol. Italiana*, IV. pp. 84-96, Tav. I. 1872.)

### Giard, Alfred.

Contributions à l'Histoire Naturelle des Synascidies. *Arch. Zool. Expér.*, II. pp. 481-514. 1873.

(Nauplius of *Ophioseides apoda*, Pl. XIX. fig. 2.)

Sur les Cirripèdes Rhizocéphales. *Comptes Rendus de l'Acad. des Sci., Paris*, Vol. LXXVII. pp. 945-948. 1873.

Sur l'Embryogénie des Rhizocéphales. *Comptes Rendus de l'Acad. des Sci., Paris*, Vol. LXXIX. pp. 44-46. 1874.

Trans. in *Ann. Mag. Nat. Hist.* [4], XIV. pp. 381-383. 1874.

Sur les Isopodes parasites du Genre *Etoniscus*. *Comptes Rendus de l'Acad. des Sci., Paris*, Vol. LXXXVII. pp. 299-301. 1878.

Trans. in *Ann. Mag. Nat. Hist.* [5], II. pp. 346-348. 1878.

("Nauplius-eye" in embryo.)

Notes pour servir à l'Histoire du Genre *Etoniscus*. *Journ. de l'Anat. et de la Physiol. (Robin et Pouchet's)*, XIV. pp. 675-700, Pl. XLVI. 1878.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [5], IV. pp. 137-156, Pl. X. 1879.

(Development, pp. 693-698. On the eye of *Cypris*-larva of *Cirripedia*, p. 695, *foot-note*.)

On the Nauplius and Pupa Stage of *Suctorina*. *Ann. Mag. Nat. Hist.* [5], II. pp. 233, 234. Sept. 1878.

(Fritz Müller's "*Peneus*-nauplius" not a larval Suctorian.)

**Gissler, Charles F.**

Contributions to the Fauna of the New York Croton Water. Microscopical Observations during the Years 1870-71. New York, 1872. 23 pp., 5 pl.  
(Young of *Cyclops* and *Cypris*.)

**Goodsir, Henry D. S.**

On a New Genus, and on Six New Species of Crustacea, with Observations on the Development of the Egg, and on the Metamorphoses of *Caligus*, *Carcinus*, and *Pagurus*. *Edinburgh New Philosoph. Journ.*, XXXIII. pp. 174-192, Pl. II., III. 1842.

The section on development of *Caligus* trans. in *Ann. Sci. Nat.* [2], Zool., XVIII. pp. 181-184. 1842.

On the Sexes, Organs of Reproduction, and Mode of Development, of the Cirripeds. Account of the Maidre of the Fishermen, and Descriptions of some New Species of Crustaceans. *Edinburgh New Philosoph. Journ.*, XXXV. pp. 88-104, 336-339, Pl. III., IV., VI. 1843. *Froriep's Neue Notizen*, XXX. col. 193-200, 209-215. 1844.

**Gosse, Philip Henry.**

A Naturalist's Rambles on the Devonshire Coast. London, 1853. xvi. + 451 pp., 28 pl.

(Young of *Hyperia* [?], p. 368, Pl. XXII. fig. 15.)

Tenby: a Sea-side Holiday. London, 1856. xx. + 400 pp., 24 pl.

(Development of *Balanus*, pp. 115-118, Pl. III., IV. Last zoëa stage and first megalopa stage of *Galatea* [*Porcellana*?], pp. 169-172, Pl. VII., VIII.; also brief notice in *A Year at the Shore*, p. 194, London, 1865.)

**Gray [J. E.].**

Reproduction of *Cirrhipeda*. *Proc. Zoölog. Soc. London*, Pt. I. pp. 115, 116. 1833.

(*Balanus Cranchii*.)

**Grobben, Carl.**

Die Entwickelungsgeschichte der *Moina rectirostris*. Zugleich ein Beitrag zur Kenntniss der Anatomie der Phyllopoden. *Arbeiten aus d. zoolog. Inst. d. Universität Wien u. d. zoolog. Station in Triest*, II. pp. 203-268, Taf. XI.-XVII. 1879.

Abstr. by P. MAYER in *Zoolog. Jahresber.* 1879, I. pp. 395, 399-401, 1880; in English, by J. S. KINGSLEY, in *Amer. Naturalist*, XIV. pp. 114-116, 7 figs., February, 1880.

(Also contains observations on larva of *Cyclops* and *Ergasilus*.)

Die Entwicklungsgeschichte von *Cetochilus septentrionalis* Goodsir. *Arbeiten aus d. zoolog. Inst. d. Universität Wien u. d. zoolog. Station in Triest*, III. pp. 243-282, Taf. XIX.-XXII., 2 cuts. 1881.

Abstr. in *Journ. Roy. Microscop. Soc.* [2], I. pp. 734-736. 1881.

(Also contains observations on the formation of the mesoderm in *Phyllopora* and *Cirripedia*, pp. 29-31.)

**Grube, Adolph Eduard.**

Bemerkungen über die Phyllopoden, nebst einer Uebersicht ihrer Gattungen und Arten. *Arch. f. Naturgesch.*, 1853, 1, pp. 71-172, Taf. V.-VIII.

(Observations on development, *passim*.)

**Guérin-Méneville, Felix Eduard.**

\*IN RAMON DE LA SAGRA'S *Historia Fisica, Politica, y Natural de la Isla de Cuba. II. Parte, Historia Natural*, VII. p. xx. ff., Tab. III. Paris, 1856.

**Guilding, L.**

Desultory Remarks relative to Points in the Economy of various Crustacea. *Mag. Nat. Hist. (London's)*, VIII. pp. 276, 277. May, 1835.

(Young of "mountain crab" [?] "leave the egg perfect.")

Cf. BELL'S *Hist. Brit. Stalk-eyed Crustacea*, Introd., p. xliv. London, 1853.

**Haeckel, Ernst.**

Die Gastrula und die Eifurchung der Thiere. *Jenaische Zeitschr.*, IX. ([2], II.) pp. 402-508, Taf. XIX.-XXV. 1875.

(*Peneus*, pp. 447-452, Taf. XXIII.)

**Hailstone, S.**

An Illustrated Description of a Species of *Eurynome*, supposed to be hitherto undescribed; and Notices of some Instances of some Change of Form which occurs in certain cited Species of Crustaceous Animals. *Mag. Nat. Hist. (London's)*, VIII. pp. 549-551. October, 1835.

**Hailstone (S.) and Westwood (J. O.).**

Descriptions of some Species of Crustaceous Animals, by S. HAILSTONE, JR., Esq.: with Illustrations and Remarks, by J. O. WESTWOOD, Esq., F.L.S., etc. *Mag. Nat. Hist. (London's)*, VIII. pp. 261-276. May, 1835.

(Young of several *Decapoda*.)

**Hartmann, Robert.**

Beiträge zur anatomische Kenntniss der Schmarotzer-Krebse. 2. *Lernaeocera Barnimii* Mihi. *Arch. f. Anat., Physiol. u. wissenschaft. Med.*, 1870, pp. 726-752, Taf. XVII., XVIII.

(Development, p. 749, Taf. XVIII. figs. 21-28.)

**Hartog, Marcus.** See Addendum, p. 244.**Haswell, William A.**

Note on the Phyllosoma Stage of *Ibacus Peronii* Leach. *Proc. Linn. Soc. New South Wales*, IV. pp. 280-282. 1879.

**Henneguy, L. F.**

Note sur l'Existence de Globules polaires dans l'Œuf des Crustacés. \**Bull. Soc. Philomath., Paris* [7], IV. p. 135, 10 April, 1880. Trans. in *Ann. Mag. Nat. Hist.* [5], VI. p. 465. December, 1880.

(Seen in ovum of *Asellus aquaticus*.)

**Hensen, V.**

Studien über das Gehörorgan der Decapoden. *Zeitschr. f. wissenschaft. Zool.*, XIII. pp. 319-412, Taf. XIX.-XXII. 1863.

(Auditory apparatus of zoëa of *Carcinus Mænas*, pp. 340, 362, Taf. XX. fig. 25.)

**Herrick, C. L.**

Microscopic *Entomostraca*. *Geolog. & Nat. Hist. Survey of Minnesota, 7th Ann. Rep. for the Year 1878*, pp. 81-123, Pl. I.-XXI. 1879.

(Nauplii, *passim*.)

**Hesse, Eugène.**

Mémoire sur les Pranizes et les Ancées. *Ann. Sci. Nat.* [4], Zool., IX. pp. 93-119. 1858.

Complete memoir in *Mém. prés. par divers Savants à l'Inst. Impér. de France*, XVIII. 1864.

Mémoire sur les Moyens à l'Aide desquels certains Crustacés Parasites assurent la Conservation de leur Espèce. *Ann. Sci. Nat.* [4], Zool., IX. pp. 120-125, 1858. *Comptes Rendus de l'Acad. des Sci., Paris*, XLVI. pp. 1054, 1055, 1858.

(Parasitic Copepoda.)

Complete memoir in *Mém. prés. par divers Savants à l'Inst. Impér. de France*, XVIII. 1864.

Mémoire sur les Métamorphoses que subissent pendant la Période Embryonnaire les Anatifes appelés Scalpels Obliques. *Ann. Sci. Nat.* [4], Zool., XI. pp. 160-178, 1859. Short Notice in *Comptes Rendus de l'Acad. des Sci., Paris*, XLVIII. p. 911. 1859.

(See later paper in *Revue des Sci. Nat.*)

Mémoire sur deux nouveaux Genres de l'Ordre des Crustacés Isopodes Sédentaires et sur les Espèces Types de ces Genres. *Ann. Sci. Nat.* [4], Zool., XV. pp. 91-116, Pl. VIII., IX. 1861.

(Development of *Athelgue*, pp. 100-102, Pl. VIII. figs. 2h-2k.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France. 1<sup>er</sup> Art. Du Coiliacole sétigère (Nobis), *Coiliacola setigera*. *Ann. Sci. Nat.* [4], Zool., XVIII. pp. 343-355, Pl. XVIII. 1862.

(Few observations on development.)

Recherches sur quelques Crustacés rares ou nouveaux des Côtes de France.

2<sup>e</sup> Mémoire. De la Lernée branchiale et de celle qui vit sur le Gade barbu.

3<sup>e</sup> Mémoire. Famille des Lernéogastriens, Nobis. Genre Naobranchie, Nobis. *Ann. Sci. Nat.* [4], Zool., XX. pp. 101-132, Pl. I. 1863.

Mémoire sur les Pranizes et les Ancées et sur les Moyens curieux à l'Aide desquels certains Crustacés Parasites assurent la Conservation de leur Espèce. *Mém. prés. par divers Savants à l'Inst. Impér. de France*, XVIII. 1864. 74 pp., 5 pl.

Abstr. in *Ann. Mag. Nat. Hist.* [3], XIV. pp. 405-417. 1864. (Memoir on the *Praniza* and *Ancei*.)

Reviewed by C. SPENCE BATE in *Rec. Zoöl. Lit.*, I. (1864), pp. 296-299. 1865.

(*Praniza*, *Anceus*, and parasitic Copepoda.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
3° Art. *Ann. Sci. Nat.* [5], Zool., I. pp. 333-358, Pl. XI, XII. 1864.

(Embryos of some species parasitic in Ascidians.)

Mémoire sur des Crustacés rares ou nouveaux des Côtes de France. 4° Art.  
Sacculinidés. *Ann. Sci. Nat.* [5], Zool., II. pp. 275-288, Pl. XIX. A. 1864.

(Includes observations on development.)

Recherches sur les Crustacés rares ou nouveaux des Côtes de France. Com-  
plément du 3° Art. Crustacés parasites vivant dans les Ascidies Phallu-  
siennes. 5° Art. Genre *Pleurocrypte*, Nobis. *Ann. Sci. Nat.* [5], Zool.,  
III. pp. 221-242, Pl. IV. 1865.

Abstr. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], XVI. pp. 162-  
167. 1865.

(Young of *Notopterophorus bombyx*, pp. 225, 226; *Pleurocrypta Galatea*,  
pp. 233-235, Pl. IV. figs. 18-28.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
6° Art. *Ann. Sci. Nat.* [5], Zool., IV. pp. 229-258, Pl. VI., VII. 1865.

(Young of several species found parasitic in compound Ascidians.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
7° Art. Mémoire sur un nouveau Crustacé parasite appartenant à l'Ordre  
des Lernéidiens, formant la Famille des Lernéosiphoniens et le Genre Le-  
posphile. *Ann. Sci. Nat.* [5], Zool., V. pp. 265-279, Pl. IX. 1866.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], XVIII. pp. 73-  
82. 1866.

(Larva, pp. 269, 270, figs. 23-26.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
9° Art. Recherches sur les Genres *Doropygus* et *Dyspontius* de M. Thorell.  
Description de quatre nouveaux Genres: *Gastrode*, *Cheratrichode*, *Ophthal-*  
*mopache* et *Platydurax* (Nobis). *Ann. Sci. Nat.* [5], Zool., VI. pp. 51-  
87, Pl. IV. 1866.

(Young of *Doropygus*, a parasite of Ascidians, pp. 57, 65.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
10° Art. *Peltogastres* et *Sacculinidiens*. *Ann. Sci. Nat.* [5], Zool., VI.  
pp. 321-360, Pl. XI., XII. 1866.

(Includes observations on development.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
11° Art. Mémoire concernant deux Crustacés nouveaux trouvés parmi des  
*Balanes sillonnées* (*Balanus sulcatus*) et des *Anatifes lisses* (*Anatifa lævis*).  
*Ann. Sci. Nat.* [5], Zool., VII. pp. 123-152, Pl. II., III. 1867.

(Includes observations on larvæ of *Cirripedia*.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
14° Art. Description de deux *Sacculinidiens*, d'un *Peltogastre*, d'un  
*Polychliniophile* et de deux *Cryptopodes* nouveaux. *Ann. Sci. Nat.* [5],  
Zool., VIII. pp. 377-381, 1867; IX. pp. 53-61, 1868.

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
15° Art. Description d'un nouveau Crustacé appartenant au Genre Limnorie. *Ann. Sci. Nat.* [5], Zool., X. pp. 101-120, Pl. IX. 1868.

(Young, pp. 108, 109, figs. 4, 5.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
16° Art. *Ann. Sci. Nat.* [5], Zool., X. pp. 347-371, Pl. XIX. 1868.

(Embryo of *Cuma terginigra*, pp. 353, 354, fig. 19.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
17° Art. Description d'un nouveau Crustacé Type d'une nouvelle Famille des Annelidicoles; du Genre des Chelonidiformis; du nouveau Genre Aplopode et de plusieurs autres Crustacés, encore inédits, appartenant aux Genres Polychliniophile, Cryptopode, Botryllophile, Bothacus, Adranesius, Lygephile et Doropygus. *Ann. Sci. Nat.* [5], Zool., XI. pp. 275-308. 1869.

(Observations on young, *passim*.)

Observations sur des Crustacés rares ou nouveaux des Côtes de France.  
18° Art. Description d'une nouvelle Espèce de Crustacé parasite des l'Ordre des Lernéidiens de la Famille des Lernéoceriens, et du Genre Lernée: Lernée du Gade-petit, *Lernæa Gadni minutus* [*Gadi minuti*] (Nobis). *Ann. Sci. Nat.* [5], Zool., XIII., Art. 4. 30 pp., Pl. I. 1870.

(Embryology, pp. 7-15, Pl. I.)

Mémoire sur des Crustacés rares ou nouveaux des Côtes de France.  
21° [20°] Art. Mémoire sur la Famille des Sphéromiens, à l'Occasion des Affinités et des Relations sexuelles qui paraissent exister entre les Sphéromiens et les Cymodocéens d'une part, et les Dynaméniens et les Néséens d'autre part. *Ann. Sci. Nat.* [5], Zool., XVII., Art. 1. 35 pp., Pl. I.-III. 1873.

(Treats of young, *passim*.)

Mémoire sur des Crustacés rares ou nouveaux des Côtes de France.  
21° Art. Description de Crustacés nouveaux appartenant à la Légion des Edriophthalmes, de l'Ordre des Amphipodes, de la Famille des Piscicoles, de la Tribu des Enoplopes, Nobis, du Genre des Ichthyomyzoques, Nobis. *Ann. Sci. Nat.* [5], Zool., XVII., Art. 7. 16 pp., Pl. IV. 1873.

(Young of *Ichthyomyzocus Lophii* resembles adult, p. 11.)

Observations biologiques concernant les Cymothodiens parasites et notamment le Cymothoé Œstre, *Cymothoa Œstrum*. *Revue des Sci. Nat.*, II. pp. 1-13. June, 1873.

(Remarks on the young.)

Mémoire sur des Crustacés rares ou nouveaux des Côtes de France.  
23° Art. Pranizes et Ancées nouveaux. *Ann. Sci. Nat.* [5], Zool., XIX., Art. 8. 29 pp., Pl. XXI., XXII. 1874.

Description des Crustacés rares ou nouveaux des Côtes de France. 25<sup>e</sup> Art. Description du *Pagurus misanthropus*; son Ontogénie, sa Physiologie et sa Biologie. — Description d'un Larve trouvée mêlée à celles de ce Crustacé. — Observations concernant les *Pagurus Ulidianus* et *Prideauxii*. *Ann. Sci. Nat.* [6], Zool., III., Art. 5. 42 pp. Pl. V., VI. 1876.

Description des Crustacés rares ou nouveaux des Côtes de France. 26<sup>e</sup> Art. Nouvelles Observations sur les Métamorphoses embryonnaires des Crustacés de l'Ordre des Isopodes sédentaires. — Description de trois nouvelles Espèces de ces Crustacés, dont deux appartiennent au Genre Athelgue et l'autre au Genre Pleurocrypte. *Ann. Sci. Nat.* [6], Zool., IV., Art. 2. 48 pp., Pl. VII.-IX. 1876.

Description de la Série complète des Métamorphoses que subissent, durant la Période embryonnaire, les Anatifes désignés sous le Nom de Scalpel oblique ou de Scalpel vulgaire. *Revue des Sci. Nat.* [after 1874]. 31 pp., 2 pl.

Description d'un nouvel Ancée, l'Ancée du Congrè, *Anceus Congeri*, faite sur des Individus vivants. 25 pp., 1 pl. Ex. de la *Revue des Sci. Nat.*, IV. Mars, 1876.

(Includes young or *Praniza* state.)

Remarques sur le Genre Chalime. *Ann. Sci. Nat.* [6], Zool., V., Art. 10. 3 pp. 1877.

(This so-called genus is a larva.)

Description des Mâles, non encore connus, des Lernanthropes de Gisler et de Kroyer, ainsi que de la Femelle d'une Espèce nouvelle, dessinés et peints d'après des Individus vivants. 30 pp., 3 pl. Ex. de la *Revue des Sci. Nat.*, VI., déc., 1877; VII., juin, 1878.

Description des Crustacés rares ou nouveaux des Côtes de France décrits et peints sur des Individus vivants. 29<sup>e</sup> Art. Description de dix nouveaux Crustacés, dont sept appartiennent du Genre *Cycnus* de Kroyer et trois au Genre *Kroyeria* de Van Beneden, tous décrits et dessinés sur des Individus vivants. *Ann. Sci. Nat.* [6], Zool., VIII., Art. 11. 34 pp., Pl. XIX.-XXI. 1879.

(Larva of *Kroyeria*, a parasitic Copepod, Pl. XXI. fig. 10.)

Description des Crustacés rares ou nouveaux des Côtes de France décrits sur des Individus vivants. 30<sup>e</sup> Art. Description d'un nouveau Crustacé parasite appartenant à la Sous-Classe des Crustacés suceurs, de l'Ordre des Lernéides, formant la nouvelle Famille des Lernéopalmiens et le nouveau Genre des *Stylophores*, décrits et dessiné d'après des Individus vivants. *Ann. Sci. Nat.* [6], Zool., VIII., Art. 15. 16 pp., Pl. XXVIII. 1879.

(Young of *Stylophorus hippocephalus*, p. 6, figs. 22-25.)

**Hoek, P. P. C.**

\*Eerste Bijdrage tot een nauwkeuriger Kennis der Sessile Cirripeden. 1875.  
94 pp., 2 pl. (Inaugural Dissertation.)

Zur Entwicklungsgeschichte der Entomostraken. I. Embryologie von *Balanus*. *Niederländisches Arch. f. Zool.*, III. pp. 47-82, Taf. III., IV. 1876.

Zur Entwicklungsgeschichte der Entomostraken. II. Zur Embryologie der freilebenden Copepoden. *Niederländisches Arch. f. Zool.*, IV. pp. 55-74, Taf. V., VI. 1877.

**Hosius, A.**

Ueber die *Gammarus*-Arten der Gegend von Bonn. *Arch. f. Naturgesch.* 1850,  
1, pp. 233-248, Taf. III., IV.

(Young, pp. 243 *et seq.*, figs. 23, 24.)

**Huxley, Thomas H.**

Lectures on General Natural History. Lecture XI. *The Medical Times and Gazette*, new ser., XIV. pp. 638, 639, fig. 1. June 27, 1857.

Also in *Trans. Linn. Soc. London*, XXII., Pt. III., 1858 (see next title),  
and *A Manual of the Anatomy of Invertebrated Animals*, pp. 350-355, fig.  
79, London, 1877.

(Development of *Mysis*.)

On the Agamic Reproduction and Morphology of *Aphis*, Pt. II. § 2. Embryogeny of *Mysis*, as exemplifying the *Crustacea*. § 3. Embryogeny of *Scorpio*, as exemplifying the *Arachnida*. § 4. Generalizations regarding the Embryogeny of the *Articulata*, and Morphological Laws based on them. § 5. The Embryogeny of *Articulata*, *Mollusca*, and *Vertebrata* compared. *Trans. Linn. Soc. London*, XXII., Pt. III. pp. 225-234. 1858.

The Crayfish. An Introduction to the Study of Zoölogy. London and New York, 1880. 371 pp., 81 cuts.

(Development, pp. 39-44, 205-226, figs. 8, 57-60.)

**Joly, N.**

Histoire d'un petit Crustacé (*Artemia salina* Leach), auquel on a faussement attribué la Coloration en Rouge des Marais salants Méditerranéens, suivie de Recherches sur la Cause réelle de cette Coloration. *Ann. Sci. Nat.* [2], Zool., XIII. pp. 225-290, Pl. VII., VIII. 1840.

(Development, pp. 257-262, Pl. VII.)

Also printed with the same title at Montpellier, 1840. 72 pp., 3 pl.

Recherches Zoologiques, Anatomiques et Physiologiques sur l'*Isaura cycladoïdes*, nouveau Genre de Crustacé à Test bivalve, découvert aux Environs de Toulouse. *Ann. Sci. Nat.* [2], Zool., XVII. pp. 293-349, Pl. VII.-IX. A. 1842.

(*Estheria*. Development, pp. 321-330, Pl. IX. A.)



Sur les Métamorphoses d'un Crustacé de la Tribu des Salicoques, trouvé dans le Canal du Midi. *Comptes Rendus de l'Acad. des Sci., Paris*, XV. pp. 36, 37. 1842.

(*Caridina Desmarestii*.)

Études sur les Mœurs, la Développement et les Métamorphoses d'une petite Salicoque d'Eau douce (*Caridina Desmarestii*), suivies de quelques Réflexions sur les Métamorphoses des Crustacés Décapodes en général. *Ann. Sci. Nat.* [2], XIX. pp. 34-86, Pl. III., IV. 1843.

Also published under the following title:—

Recherches sur le Développement et les Métamorphoses d'une petite Salicoque d'Eau douce (*Caridina Desmarestii* Nobis, *Hippolyte Desmarestii* Millet), suivies de quelques Réflexions sur les Métamorphoses des Crustacés Décapodes en général. Toulouse, 1843. 59 pp., 2 pl.

**Jurine, Louis.**

Mémoire sur l'Argule foliacé (*Argulus foliaceus*). *Ann. du Mus. d'Hist. Nat.*, VII. pp. 431-458, Pl. XXVI. 1806.

(Development, pp. 452-456.)

Histoire des Monocles qui se trouvent aux Environs de Genève. Genève, 1820. 258 pp., 22 pl.

(Young of *Copepoda*, *Cladocera*, *Ostracoda*, *passim*.)

Translation of the Memoir of SHÄFFER, Sur les Monocles à queue, ou Pucés d'Eau rameuses, pp. 181-197.

(Development, pp. 196, 197.)

Mémoire sur le Chirocéphale. Par BÉNÉDICT PREVOST, pp. 201-244, Pl. XX.-XXII.

(Development, pp. 214-220.)

**Kellicott, D. S.**

A Larval Argulus. *The North American Entomologist*, I. pp. 57-60, Feb. 1880.

**Kinahan [John Robert].**

Notes on the foregoing Paper [Melville's Carcinological Notes], with a Supplement to his List of Dublin Crustacea. \**Proc. Dublin Nat. Hist. Soc.*, II. pp. 43-51. 1856-59. *Nat. Hist. Rev.*, IV. Proc. Soc., pp. 153-162. 1857.

(Zoëa of *Pirimela denticulata*, pp. 156, 157, Pl. IX. figs. 4-6.)

Remarks on the Zoë of *Eurynome aspera*, and the Habits of the Animal in Confinement. \**Proc. Dublin Nat. Hist. Soc.*, 4 Dec. 1857. \**Nat. Hist. Rev.*, V. Proc. Soc., pp. 37-39. 1858. *Ann. Mag. Nat. Hist.*, [3], I. pp. 233-235. 1858.

**Kollar, Vincenz.**

Beiträge zur Kenntniss der Lernaecenartigen Crustaceen. *Annalen des Wiener Museums der Naturgeschichte*, I. pp. 79-92, Taf. IX., X. 1836.

(Development of *Basanistes Huchonis*, pp. 87-90, Taf. X.)

**Koren (J.) and Danielssen (D.).**

Bidrag til Cirripedernes Udvikling. *Nyt Mag. Naturvid.*, V. pp. 262-264,  
Tab. II. figs. 1-3. 1848. *Isis*, 1848, col. 204, 205, Taf. II. figs. 11-13.

(*Alepa squalicola*.)

**Kossman, Robby.**

Beiträge zur Anatomie der schmarotzenden Rankenfüssler. *Arbeit. aus dem  
zoolog.-zootom. Inst. in Würzburg*, I. pp. 97-137, Taf. V.-VII. 1872.  
*Verhandl. d. physikal.-medizin. Gesell. in Würzburg* [2], III. pp. 296-335,  
Taf. XVI.-XVIII. 1872.

(Development, pp. 115-118, Taf. VII. 1-6.)

*Suctorina* und *Lepadidae*. Untersuchungen über die durch Parasitismus  
hervorgerufenen Umbildungen in der Familie der *Pedunculata*. *Arbeit.  
aus dem zoolog.-zootom. Inst. in Würzburg*, I. pp. 179-207, Taf. X.  
1872-74. *Verhandl. d. physikal.-medizin. Gesell. in Würzburg* [2], V.  
pp. 129-157, Taf. I., II. 1873.

(Development, pp. 195-200, Taf. X., XI.)

Studien über Bopyriden. II. *Bopyrina Virbii*; Beiträge zur Kenntniss der  
Anatomie und Metamorphose der Bopyriden. *Zeitschr. f. wissenschaft. Zool.*,  
XXXV. pp. 666-680, Taf. XXXIV., XXXV. 1881.

**Krøyer, Henrik.**

*Bopyrus abdominalis*. *Naturhistorisk Tidsskr.*, III. pp. 102-112, 289-299,  
Taf. I., II. 1840. *Isis*, 1841, col. 693-698, 707-713, Taf. II., III.

Trans. by LEREBoullet in *Ann. Sci. Nat.* [2], Zool., XVII. pp. 142-  
152, Pl. VI. 1842.

(Contains observations on development.)

Monografisk Fremstilling af Slægten *Hippolyte*'s nordiske Arter. Med Bidrag  
til Dekapodernes Udviklingshistorie. *K. Danske Vidensk. Selsk. naturvid.  
og mathem. Aft.*, IX. pp. 209-360, 6 pl. 1842.

(Larval stages of *Hippolyte*, *Homarus*, and *Cymopolia*, pp. 245-262, Pl. V.  
figs. 111-119, VI.)

In GAIMARD'S *Voyages de la Commission Scientifique du Nord en Scandinavie,  
en Laponie au Spitzberg et aux Ferøe pendant les Années 1838, 1839 et  
1840, sur la Corvette la Recherche*. Paris, 1842-45. Zoologie. Crus-  
tacés.

(Young *Caridea*, Pl. VII.; *Mysis*, Pl. IX.; *Bopyrus*, Pl. XXVIII.; *Pycno-  
gonida*, Pl. XXXIX.)

[On the Development of *Peltogaster* and *Sylon*.] *Overs. K. Danske Vidensk.  
Selsk. Forhandl.* 1855, Nr. 4, p. 130.

Trans. by CREPLIN in *Zeitschr. gesammt. Naturwissen.*, VIII. pp. 421,  
422. 1856.

Bidrag til Kundskab om Snyltekrebsene. *Naturhistorisk Tidsskr.* [3], II.  
pp. 75-426, Tab. I.-XVIII. 1863-64.

(Larva of *Lesteira Lumpi*, Tab. XVIII. figs. 5 f, 5 g. 1864.)

**Krohn, August.**

Beobachtungen über die Entwicklung der Cirripeden. *Arch. f. Naturgesch.*, 1860, 1, pp. 1-8, Taf. I. figs. 1-3.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], VI. pp. 423-428, Pl. VII. figs. 1-3. 1860.

**Lacaze-Duthiers, Henri de.**

Mémoire sur un Mode nouveau de Parasitisme observé sur un Animal non décrit. *Comptes Rendus de l'Acad. des Sci., Paris*, LXI. pp. 838-841. 1865.

Abstr. in *Ann. Mag. Nat. Hist.* [3], XVII. pp. 155, 156. Feb., 1866.  
(*Laura Gerardia*. Development, p. 841.)

Histoire de la *Laura Gerardia*, Type nouveau de Crustacé parasite. *Archives de Zool. Expér.*, VIII. pp. 537-581. 1879-80. 7 cuts.

Ex. from *Mém. Acad. Sci.*, where it appears *in extenso*, with 8 plates.

(Parasitic Cirriped. Development, pp. 575-577, fig. 7.)

**Lang, Arnold.**

\*Ueber die Metamorphose der Naupliuslarven von *Balanus* mit Rücksicht auf die Gestaltung der Gliedmassen und die Verwandlung in die *Cypris*-ähnliche Larve. *Mitth. aarg. nat. Gesell.*, I. pp. 104-115, 1 Taf. 1878.

Die Dotterfurchung von *Balanus*. *Jenaische Zeitschr.*, XII. ([2], V.), pp. 671-674, Taf. XX., XXI. 1878.

**Latreille [P. A.].**

In CUVIER'S *Règne Animal*. Paris.

(Young *Isopoda* at birth like parent form, 1st ed., III. p. 50, 1817. So also with *Astacus*, 2d ed., IV. p. 90, 1829. Young stage of *Squilla* made a genus under the name *Erichthus*, 1st ed., III. p. 43, 1817.)

**La Valette St. George, Adolphe de.**

Ueber die Entwicklungs-Geschichte der Amphipoden. *Sitzungsber. Niederrhein. Gesell. f. Natur- u. Heilkunde zu Bonn*, XVI. pp. 94-98. 1859.

Studien über die Entwicklung der Amphipoden. *Abh. d. naturfor. Gesell. Halle*, V. pp. 153-166, 2 pl. 1860.

Ueber die Entwicklung der Isopoden. *Amtlicher Bericht über die 39 Versamml. Deutsch. Naturforsch. u. Aerzte zu Giessen*, 1864, p. 168. 1865.

**Leach, William Elford.**

Malacostraca Podophthalmata Britanniae; or Descriptions of such British Species of the Linnean Genus *Cancer* as have their Eyes elevated on Footstalks. London, 1815. 44 pl.

(Genus *Megalopa* founded upon young stage of *Brachyura*, Pl. XVI.)

In \**Journ. de Physique*, 1818, and \**Appendix to Tuckey's Expedition to explore the Source of the River Zaire*, London, 1818 (see *Isis*, 1818, col. 2083-2086), Leach founded the genera *Phyllosoma*, *Alima*, *Smerdis*, &c., for the reception of what are now known to be larval stages of Crustacea.

For the various systematic works on zoölogy in which the many so-called species of these and other genera established upon young stages have been described, see MILNE EDWARDS, *Hist. Nat. Crust.*, II.; F. C. LUKIS, *Mag. Nat. Hist.*, VIII. p. 461, &c.

**Lereboullet, A.**

Résumé d'un Travail d'Embryologie Comparée sur le Développement du Brochet, de la Perche et de l'Écrevisse. Suite Deuxième Partie. Embryologie de l'Écrevisse. *Ann. Sci. Nat.* [4], Zool., II. pp. 39-80. 1854.

Recherches d'Embryologie Comparée sur le Développement du Brochet, de la Perche et de l'Écrevisse. *Mém. prés. par divers Savants étrangers à l'Acad. des Sci. de l'Inst. Impér. de France*, XVII. pp. 447-805, 6 pl. 1862.

(*Astacus*, pp. 650-768, Pl. IV.-VI.)

Observations sur la Génération et le Développement de la Limnachie de Hermann (*Limnadia Hermannii* Ad. Brongn.). *Ann. Sci. Nat.* [5], Zool., V. pp. 283-308, Pl. XII. 1866.

**Leuckart, Rudolph.**

Carcinologisches. Einige Bemerkungen über *Sacculina* Thomps. (*Pachybdella* Dies., *Peltogaster* Rathke, p. p.). *Arch. f. Naturgesch.* 1859, I, pp. 232-241, Taf. VI.

(Embryo, p. 239.)

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], IV. pp. 422-429, Pl. VII. 1859.

(Embryo, p. 428.)

See also Frey, Heinrich.

**Leydig, Franz.**

Ueber *Argulus foliaceus*. Ein Beitrag zur Anatomie, Histologie, und Entwicklungsgeschichte dieses Thieres. *Zeitschr. f. wissenschaft. Zool.*, II. pp. 323-349, Taf. XIX., XX. 1850.

(Development, pp. 344-347, Taf. XX. fig. 8.)

Ueber *Artemia salina* und *Branchipus stagnalis*. Beitrag zur anatomischen Kenntniss dieser Thiere. *Zeitschr. f. wissenschaft. Zool.*, III. pp. 280-307, Taf. VIII. 1851.

(Development, pp. 304-306.)

Naturgeschichte der Daphniden (*Crustacea Cladocera*). Tübingen, 1860. 252 pp., 10 pl.

(Reproduction, pp. 58-75.)

Reviewed by J. LUBBOCK in *Nat. Hist. Rev.*, 1861, pp. 22-33.

**Liljeborg, Wilh.**

Norges Crustaceer. *Öfvers. K. Svenska Vetensk.-Akad. Förhandl.*, VIII. (1851), pp. 19-25. 1852.

(Young of *Hyas*. *Zoëa pelagica* Bosc the young of *Hyas*? pp. 20, 21, 25.)

De Crustaceis ex Ordinibus Tribus: Cladocera, Ostracoda et Copepoda, in Scania occurrentibus. Om de inom Skåne förekommande Crustaceer af ordningarne *Cladocera*, *Ostracoda* och *Copepoda*. Lund, 1853. 222 pp., 26 pl.

(Young *Canthocamptus*, pp. 148, 149, Pl. XVI. fig. 6; *Cyclops*, pp. 156-158, Pl. XXVI. fig. 19.)

Les Genres *Liriope* et *Peltogaster* H. Rathke. *Nova Acta Reg. Soc. Scient. Upsal.* [3], III. pp. 1-35, Pl. I.-III. 1859. (\**Arsskr.*, I. pp. 137-147. 1860.)

Abstr. in English in *Ann. Mag. Nat. Hist.* [3], VI. pp. 162-173, 260-267, Pl. IV. 1860.

(Includes development.)

Supplément au Mémoire sur les Genres *Liriope* et *Peltogaster* H. Rathke. *Nova Acta Reg. Soc. Scient. Upsal.* [3], III. pp. 73-102, Pl. VI.-IX. 1860.

Abstr. in *Ann. Mag. Nat. Hist.* [3], VII. pp. 47-63, Pl. II., III. 1861. *Ann. Sci. Nat.* [5], Zool., II. pp. 289-355, Pl. XX. 1864.

(Includes development.)

*Liriope* och *Peltogaster* H. Rathke. *Öfvers. K. Svenska Vetensk.-Akad. Förhandl.*, XVI. (1859), pp. 213-217. 1860. *Forhandl. Skand. Naturforsk.*, VIII. (1860), pp. 677-684. Kiöbenhavn, 1861.

Beskrifning öfver tvenne märkliga Crustaceer af Ordningen *Cladocera*. *Öfvers. K. Svenska Vetensk.-Akad. Förhandl.*, XVII. (1860), pp. 265-271, Taf. VII., VIII. 1861.

Trans. in *Ann. Mag. Nat. Hist.* [3], IX. pp. 132-136, Pl. VIII. 1862.

(Young *Leptodora hyalina*, p. 267, Taf. VII. fig. 2; *Bythotrephes longimanus*, Taf. VIII. fig. 24.)

#### Lindström, G.

Om Larven till en Art af Slägtet *Peltogaster*. *Öfvers. K. Svenska Vetensk.-Akad. Förhandl.* XII. (1855), pp. 361-363, Tab. XIII. B. 1856.

#### Lubbock, John.

An Account of the Two Methods of Reproduction in *Daphnia*, and of the Structure of the Ephippium. *Phil. Trans. Roy. Soc. London*, CXLVII. pp. 79-100, Pl. VI., VII. 1857.

#### Ludwig, Hubert.

Ueber die Eibildung im Thierreiche. *Arbeit. aus dem zoolog.-zootom. Inst. in Würzburg*, I. pp. 287-510, Taf. XIII.-XV. 1874. *Verhandl. d. physikal.-medicin. Gesell. in Würzburg* [2], VII. pp. 33-256, Taf. I.-III. 1874.

(On the Crustacean egg, pp. 379-401 [125-147], Taf. XIII., XIV. [I., II.] )

**Mayer, Paul.**

Zur Entwicklungsgeschichte der Dekapoden. *Jenaische Zeitschr.*, XI. ([2], IV.) pp. 188–269, Taf. XIII.–XV. 1877.

(Embryology of *Eupagurus Prideauxii*, pp. 188–246, Taf. XIII., XIV. Morphology of the caudal fin of the zoëa (*Zur Kenntniss der Zoëa-Gestalt*), pp. 246–262, Taf. XV.)

Abstr. in *Hofmann u. Schwalbe's Jahresber.*, VI. 2<sup>e</sup> Abt. pp. 160–162. 1878.

Carcinologische Mittheilungen. III. Ueber einige Jugendstadien von *Peneus Caramote*. *Mittheil. aus der zoolog. Station zu Neapel*, I. pp. 49–51. 1878.

Carcinologische Mittheilungen. VII. Ein neuer parasitischer Copepode. *Mittheil. aus der zoolog. Station zu Neapel*, I. pp. 515–521, Taf. XVII. 1879.

(*Ive Balanoglossi n. sp.* Nauplius, p. 519, Taf. XVII. figs. 10–12.)

Carcinologische Mittheilungen. IX. Die Metamorphosen von *Palaeomonetes varians* Leach. *Mittheil. aus der Zoolog. Station zu Neapel*, II. pp. 197–221, Taf. X. 1880.

(Includes notice of larva of *Squilla* just hatched from the egg, p. 219.)

**Mecznikow.** See **Metschnikoff.**

**Meinert, Fr.** See **Schiödte, Jörgen C.**

**Meissner, Georg.**

Beobachtungen über das Eindringen der Samenelemente in den Dotter, Nro. II. *Zeitschr. f. wissenschaft. Zool.*, VI. pp. 272–295, Taf. IX. 1855.

(Micropyle in egg of *Gammarus*, pp. 284, 285, 293, 294, fig. 9.)

**Méneville.** See **Guérin-Méneville.**

**Metschnikoff, Elias.**

Istoriya Razvitiya Nebalia. Sravnitelno-embriologitshesky Otsherk. [History of the Development of *Nebalia*. A Comparative Embryological Essay.] *Zapiski Imp. Akad. Nauk*, XIII, 1868. [*Mem. Imper. Acad. of Sciences*, XIII. St. Petersburg, 1868.] 48 pp., 2 pl.

Noticed in *Rec. Zoölog. Lit.*, VI. (1869), p. 617. 1870.

Ueber ein Larvenstadium von *Euphausia*. *Zeitschr. f. wissenschaft. Zool.*, XIX. pp. 479–481, Taf. XXXVI. 1869.

Ueber den Naupliuszustand von *Euphausia*. *Zeitschr. f. wissenschaft. Zool.*, XXI. pp. 397–401, Taf. XXXIV. 1871.

**Metzger, A.**

Ueber das Männchen und Weibchen der Gattung *Lernaea* vor dem Eintritt der sogen. rückschreitenden Metamorphose. *Arch. f. Naturgesch.* 1868, 1, pp. 106–110. \**Nachrichten Kön. Gesell. Wissensch. Göttingen*, 1868, pp. 31–36.

Trans. by W. S. DALLAS, *Ann. Mag. Nat. Hist.* [4], III. pp. 154–157. 1869.

**Milne Edwards, Henri.**

Description des Genres Glaucothoë, Sicyonie, Sergeste et Acète, de l'Ordre des Crustacés Décapodes. *Ann. Sci. Nat.*, XIX. pp. 333-352, Pl. VIII.-XI. 1830.

(A young stage of a Pagurid made the type of a new genus, *Glaucothoë*, pp. 334-339, Pl. VIII.)

Histoire Naturelle des Crustacés, comprenant l'Anatomie, la Physiologie et la Classification de ces Animaux. Paris, 1834, 1837, 1840. 3 vols. and Atlas, 1638 pp., 44 pl. (Suites à Buffon.)

(Remarks on development, *passim*; especially Vol. I. pp. 175-200, Vol. II. pp. 260-264 (*Megalops*, *Monolepis*), pp. 431-438 (*Zoëa*.)

Observations sur les Changements de Forme que divers Crustacés éprouvent dans le jeune Âge. *Ann. Sci. Nat.* [2], Zool., III. pp. 321-334, Pl. XIV. 1835. *Arch. f. Naturgesch.*, 1836, 2. pp. 225-227.

(*Cymoethoë*, *Anilocra*, *Cyamus*, *Phronima*, *Amphithoë*, *Nazia*.)

Rapport sur un Travail de M. Hesse, relatif aux Métamorphoses des Ancées et des Caliges, fait à l'Académie des Sciences, le 28 Juin 1858. *Ann. Sci. Nat.* [4], Zool., IX. pp. 89-92. 1858. *Comptes Rendus de l'Acad. des Sci.*, Paris, XLVI. pp. 1256-1259. 1858.

**Montagu, George.**

Description of several Marine Animals found on the South Coast of Devonshire. *Trans. Linn. Soc. London*, VII. pp. 61-85, Pl. VI., VII. 1804. (Read December 7, 1802.)

(" *Cancer rhomboidalis*," p. 65, Tab. VI. fig. 1, is a megalopa. Observed the young of " *Cancer Phasma* " [*Caprella*] crawl from abdominal pouch of parent, "all perfectly formed," p. 67.)

**Müller, Fritz.**

Die Rhizocephalen, eine neue Gruppe schmarotzender Kruster. *Arch. f. Naturgesch.*, 1862, 1, pp. 1-9, Taf. I.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], X. pp. 44-50, Pl. II. figs. 1-7. 1862.

(Describes larva of *Lernæodiscus* and *Sacculina*.)

*Entoniscus Porcellanae*, eine neue Schmarotzerassel. *Arch. f. Naturgesch.*, 1862, 1, pp. 10-18, Taf. II.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], X. pp. 87-93, Pl. II. figs. 8-16. 1862.

(Larva described and figured.)

Die Verwandlung der Porcellanen. Vorläufige Mittheilung. *Arch. f. Naturgesch.*, 1862, 1, pp. 194-199, Taf. VII.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], XI. pp. 47-50, Pl. I. 1863.

Bruchstück zur Entwicklungsgeschichte der Maulfüßer. *Arch. f. Naturgesch.*, XXVIII. pp. 352-361, Taf. XIII. 1862.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], XII. pp. 13-19, Pl. II. 1863.

Ein zweites Bruchstück aus der Entwicklungsgeschichte der Maulfüßer. *Arch. f. Naturgesch.*, XXIX. pp. 1-7, Taf. I. 1863.

Die Verwandlung der Garneelen. Erster Beitrag. *Arch. f. Naturgesch.*, XXIX. pp. 8-23, Taf. II. 1863.

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], XIV. pp. 104-115, Pl. IV. 1864.

Reviewed by C. SPENCE BATE in *Rec. Zoölog. Lit.*, I. (1864), pp. 280-285. 1865.

(*Peneus.*)

Die zweite Entwicklungsstufe der Wurzelkrebse (*Rhizocephala*). *Arch. f. Naturgesch.*, XXIX. pp. 24-33, Taf. III. figs. 1-7. 1863.

Für Darwin. Leipzig, 1864. 91 pp., 67 cuts.

English transl. by W. S. DALLAS: Facts and Arguments for Darwin. With Additions by the Author. London, 1869. 144 pp., 67 cuts.

Reviewed by C. SPENCE BATE in *Rec. Zoölog. Lit.*, I. (1864), pp. 261-270. 1865.

(General work on development of Crustacea, with many original observations.)

Bruchstücke zur Naturgeschichte der Bopyriden. *Jenaische Zeitschr.*, VI. pp. 53-72, Taf. III., IV. 1871. [1869?]

(Includes observations on development.)

Ueber die Naupliusbrut der Garneelen. *Zeitschr. f. wissenschaft. Zool.*, XXX. pp. 163-166. 1878.

Trans. in *Ann. Mag. Nat. Hist.* [5], I. pp. 481-485. 1878.

Wasserthiere in Baumwipfeln. *Elpidium Bromeliarum*. *Kosmos*, VI. pp. 386-388, 15 figs. Feb. 1880.

Translated with title: An Entomostracoon living in Tree-tops, in *Nature*, XXII. pp. 55, 56. May 20, 1880.

(Egg and young figured. *Ostracoda.*)

*Palaemon Potiuna*. Ein Beispiel abgekürzter Verwandlung. *Zoolog. Anzeig.*, III. pp. 152-157, April 5, 1880; p. 233, May 10, 1880.

Die Putzfüße der Kruster. *Kosmos*, VII. pp. 148-152, 15 figs. May, 1880.  
(*Trichodactylus* leaves the egg in the perfect form, p. 152.)

See also Bate, C. Spence.

#### Müller, Otho Fredericus.

\*Entomostraca, seu Insecta testacea quæ in Aquis Daniæ et Norvegiæ reperit, descripsit et Iconibus illustravit. Lipsiæ et Hafniæ, 1785.

(Many larvæ represented. *Nauplius*. See reproduction of figures in *Encyclopédie Méthodique*, Pl. CCLXIV.-CCLXVIII.)



Zoologia Danica seu Animalium Daniæ et Norvegiæ rariorum ac minus notorum Descriptiones et Historia. Hafniæ, 1788, 1789, 1806. 4 vols., 225 pp., 160 pl.

(Young *Mysis*, II., Tab. LXVI. fig. 9, 1788. "*Cancer Faeroensis*," III. p. 56, Tab. CXIV., 1789, = megalopa.)

**Müller, P. E.**

Bidrag til Cladocerernes Forplantningshistorie. *Naturhistorisk Tidsskr.* [3], V. pp. 295-354, Tab. XIII. 1868. *Forhandl. Skand. Naturforsk.*, X. (1868), pp. 530-540. 1869. *Arch. Sci. Phys. Nat.*, XXXVII. pp. 357-372. 1870.

Noticed by GERSTAECKER in *Arch. f. Naturgesch.*, 1869, 2, pp. 190-192.

**Müller, Wilhelm.**

Beitrag zur Kenntniss der Fortpflanzung und der Geschlechtsverhältnisse der Ostracoden nebst Beschreibung einer neuen Species der Gattung *Cypris*. *Zeitschr. gesamt. Naturwissen.* [3], V. pp. 221-246, Taf. IV., V. 1880. (On parthenogenesis in *Ostracoda*. First stage of *Cythere lutea*, Taf. V. fig. 2.)

**Münter (Jul.) and Buchholz (Reinh.).**

\*Ueber *Balanus improvisus* Darw. var. *gryphicus* Münter. *Mitth. naturwissensch. Vereins v. Neu-Vorpommern. u. Rügen*, I. pp. 1-40, 2 pl. 1869. *Zeitschr. gesamt. Naturwissen.*, XXXVI. pp. 529, 530. 1870.

(Contains observations on development.)

**Noll, F. C.**

*Kochlorine hamata* N., ein bohrender Cirripede. (Vorläufige Mittheilung.) *Bericht über d. Senckenbergische naturforsch. Gesell. Frankfurt am Main*, 1872-73, pp. 50-58. \**Tageblatt d. 46. Versammlung deutsch. Naturforsch. u. Aerzte, Wiesbaden*, p. 131. 1873.

*Kochlorine hamata* N., ein bohrendes Cirriped. *Zeitschr. f. wissenschaft. Zool.*, XXV. pp. 114-128, Taf. VI. 20 Nov. 1874.

(Larvæ described and figured.)

**Nordmann, Alexander v.**

Mikrographische Beiträge zur Naturgeschichte der wirbellosen Thiere. Zweites Heft. Berlin, 1832. xviii. + 150 pp., 10 pl.

(Development of *Ergasilus*, pp. 11-15, Pl. II. figs. 7-9; of *Achtheres*, pp. 76-85, Pl. IV. figs. 5-12; of *Tracheliastes*, p. 99, Pl. VII. figs. 7, 8; of *Lernæocera*, pp. 127-130, Pl. VI. figs. 5-7.)

Neue Beiträge zur Kenntniss parasitischer Copepoden. Erster Beitrag. *Bull. Soc. Impér. des Nat. Moscou*, XXXVII. Pt. II., pp. 461-520, Pl. V.-VIII. 1864.

(Larvæ of *Lernanthropus Krøyeri*, Pl. VII. figs. 7, 8.)

**Olivier [Ant. Gu.].**

Encyclopédie Méthodique, Hist. Nat., VI. Paris, 1791.

(Observations on young *Gammarus*, p. 183.)

**Packard, A. S., Jr.**

Life Histories of the Crustacea and Insects. *Amer. Naturalist*, IX. pp. 533-622. Nov. 1875.

(General account of the development of Crustacea, pp. 533-605. Original observations on development of *Gelasimus pugnax*, p. 603.)

Appears also in the author's *Life Histories of Animals including Man or Outlines of Comparative Embryology*, pp. 167-189. New York, 1876.

Notes on the Early Larval Stages of the Fiddler Crab, and of *Alpheus*. *Amer. Naturalist*, XV. pp. 784-789, figs. Oct. 1881.

(*Gelasimus pugnax*, *Alpheus heterochelis*.)

**Pagenstecher, H. Alex.**

Untersuchungen über niedere Seethiere aus Cette. II. Abtheilung. IX. Beitrag zur Anatomie und Entwicklungsgeschichte von *Lepas pectinata*. *Zeitschr. f. wissensch. Zool.*, XIII. pp. 86-106, Taf. V., VI. 1863.

**Panceri, Paolo. See Cornalia, Emilio.****Philippi, R. A.**

Zoologische Bemerkungen (Fortsetzung). *Arch. f. Naturgesch.*, VI. 1, pp. 181-195, Taf. III., IV. 1840.

Trans. in *Ann. Mag. Nat. Hist.*, VI. pp. 89-101, Pl. III., IV. 1841.

(Zoëa of *Pagurus*, pp. 184-186, Taf. III. figs. 7, 8.)

Kurze Beschreibung einiger neuen Crustaceen. *Arch. f. Naturgesch.*, 1857, 1, pp. 319-329, Taf. XIV.

(*Thysanopus*, *Hoplites* [schizopod stage of *Caridea*], *Lucifer*, *Alima*, *Euacanthus* [zoëa of *Porcellana*], *Megalopa* [*Cancer*? see Gerstaecker, *Arch. f. Naturgesch.*, 1858, 2, p. 455].)

**Plateau, Félix.**

Recherches sur les Crustacés d'Eau douce de Belgique.

1<sup>e</sup> Partie. Genres *Gammarus*, *Linceus* et *Cypris*. *Mém. Cour. Acad. Roy. Belgique*, XXXIV. 1868. 66 pp., 1 pl.

2<sup>e</sup> et 3<sup>e</sup> Parties. Genres *Daphnia*, *Bosmina*, *Polyphemus*, *Cyclopsina*, *Canthocamptus* et *Cyclops*. *Ibid.* XXXV. 1870. 92 pp., 3 pl.

(Development, pp. 75-82.)

**Power, Wilmot Henry. See Bate, C. Spence.****Prevost, Bénédict.**

\*Histoire d'un Insecte (ou d'un Crustacé) qui l'Auteur a cru devoir appeler Chirocéphale diaphane (*Branchiopode* Lam., *Cancer stagnalis* L., *Gammarus stagn.* Fabr.). *Journ. de Physique*, LVII. pp. 37-54, 89-106, Pl. I. 1803.

Appears, in substance, in JURINE's *Histoire des Monocles*, pp. 201-244, 1820.

Mémoire sur le Chirocéphale. In JURINE's *Histoire des Monocles*, pp. 201-244, Pl. XX.-XXII. 1820.

(Young, pp. 214-220, Pl. XX., XXI.)

**Rasch.**

\*Om Forsog med kunstig Udklaekning af Hummer. *Nordisk Tidsskrift for Fiskeri*, ny Række, 2en Aargang, pp. 184, 188. 1875.

Translated in *United States Commission of Fish and Fisheries*. Part III. *Report of the Commissioner for 1873-74 and 1874-75*, pp. 267-269. Washington, 1876.

(Observations of Professor RASCH on young *Homarus*, pp. 268, 269.)

**Rathke, Heinrich.**

Flusskrebs. *Isis*, 1825, 2, col. 1093-1099.

(Prodromus of complete memoir published in 1829).

See also account of the development of *Astacus*, by RATHKE, in BURDACH'S *Physiologie*, II. pp. 191-200, Leipzig, 1828, and *Isis*, 1829, col. 429, 430.

Untersuchungen über die Bildung und Entwicklung des Flusskrebses. Leipzig, 1829. 97 pp., 5 pl.

Abstract in *Ann. Sci. Nat.*, XX. pp. 442-469, Pl. V.-VIII. 1830. *Zoölog. Journ.*, V. pp. 241-255. 1830. Milne Edwards's *Hist. Nat. des Crustacés*, I. pp. 175-195, Pl. XIV. Paris, 1834.

Abhandlungen zur Bildungs- und Entwicklungs-Geschichte des Menschen und der Thiere. Leipzig, 1832-33. 216 pp., 14 pl.

1<sup>er</sup> Th. 1<sup>e</sup> Abh. Untersuchungen über die Bildung und Entwicklung der Wasser-Assel oder des *Oniscus aquaticus*. Pp. 1-20, Pl. I. 1832.

Also in *Ann. Sci. Nat.* [2], Zool., II. pp. 139-157, Pl. II. C. 1834.

2<sup>er</sup> Th. 2<sup>e</sup> Abh. Bildungs- und Entwicklungs-Geschichte des *Oniscus asellus* oder der Kellar-Assel. Pp. 69-84, Pl. VI. 1833.

2<sup>er</sup> Th. 3<sup>te</sup> Abh. Bildungs- und Entwicklungs-Geschichte einiger Entomostraken (*Daphnia Pulex*, *Lynceus sphaericus*, *Cyclops quadricornis*). Pp. 85-94, Pl. VII. figs. 1-5. 1833.

Ueber die Entwicklung der Decapoden. *Arch. f. Anat. Physiol. und wissensch. Medicin (Müller's)*, 1836, pp. 187-192.

Trans. in *Edinburgh New Philosoph. Journ.*, XXII. pp. 364-366. 1837.

(This is a preliminary notice of the observations published in *Zur Morphologie, &c.*)

Zur Morphologie, Reisebemerkungen aus Taurien. Riga u. Leipzig, 1837. 192 pp., 5 pl.

Dritte Abhandlung. Zur Entwicklungsgeschichte der Crustaceen. Pp. 35-151, 179-184, Tab. I. figs. 13-15, II.-IV.

(*Lernaeopoda*, *Bopyrus*, *Idothea*, *Ligia*, *Janira*, *Amphithoë*, *Gammarus*, *Crangon*, *Palæmon*, *Eriphia*, *Carcinus*.)

Beobachtungen und Betrachtungen über die Entwicklung der *Mysis vulgaris*. *Arch. f. Naturgesch.*, 1839, 1, pp. 195-210, Taf. VI.

Zur Entwicklungsgeschichte der Dekapoden. *Arch. f. Naturgesch.*, VI. 1, pp. 241-249. 1840.

Trans. by W. FRANCIS in *Ann. Mag. Nat. Hist.*, VI. pp. 263-269. 1841.

(*Astacus* [*Homarus*] *marinus*, *Pagurus Bernhardus*, *Galatea rugosa*, *Hyas araneus*.)

(This is an abstract of the observations published in *Reisebemerkungen aus Skandinavien, &c.*)

Beiträge zur vergleichenden Anatomie und Physiologie, Reisebemerkungen aus Skandinavien, nebst einem Anhang über die rückschreitende Metamorphose der Thiere. *Neueste Schriften der naturforschenden Gesellschaft in Danzig*, III. Heft 4, 1842. 162 pp., 6 pl.

II. Zur Entwicklungs-Geschichte der Dekapoden. Pp. 23-55, Tab. II. figs. 11-21, III., IV.

(*Homarus, Pagurus, Galatea, Hyas*.)

Beiträge zur Fauna Norwegens. *Nov. Act. Acad. Cæs. Leop.-Car. Nat. Cur.*, XX. pp. 1-264 c, Tab. I.-XII. 1843.

(Development of *Phryxus*, pp. 49-56, Taf. I. figs. 16, 17; *Nicothoë*, pp. 109-116, Taf. V. figs. 7-10.)

#### Reichenbach, Heinrich.

Die Embryonalanlage und erste Entwicklung des Flusskrebse. *Zeitschr. f. wissenschaft. Zool.*, XXIX. 123-196, 263-266, Taf. X.-XII. 1877.

(Vorläufige Mittheilung appeared in *\*Centralblatt für die medicin. Wissenschaften*, 1876, No. 41.)

Abstr. by P. MAYER in *Jahresber. üb. Fortschr. Anat. u. Physiol.*, VI. (1877), 2<sup>o</sup> Abth. pp. 162-164. 1878.

Eng. Abstr. by T. JEFFERY PARKER in *Quart. Journ. Microscop. Sci.* [2], XVIII. pp. 84-94. 1878.

#### Richiardi, S.

Sulle Sacculine. *Atti della Soc. Toscana di Scienze Nat.*, I. fasc. 2<sup>o</sup>. 1875.

(Contains observations on development.)

Descrizione di cinque Specie Nuove del Genere *Philichthys* ed una di *Sphærifer*. *Atti della Soc. Toscana di Scienze Nat.*, III. Tav. VI. 1877.

(Nauplius of *Sphærifer Leydigi*, fig. 8.)

Descrizione di due Specie Nuove di *Lernænicus* Les., con Osservazioni intorno a questo ed ai Generi *Lernæocera* Bl., e *Lernæonema* M. Edw. *Atti della Soc. Toscana di Scienze Nat.*, III. Tav. VII. 1877.

(Describes and figures young forms of *Lernænicus*.)

#### Richters, Ferd.

Die Phyllosomen. Ein Beitrag zur Entwicklungsgeschichte der Loricaten. *Zeitschr. f. wissenschaft. Zool.*, XXIII. pp. 623-646, Taf. XXXI.-XXXIV. 1873.

**Rösel von Rosenhof, August Johann.**

Der monatlich-herausgegebenen Insecten-Belustigung Dritter Theil. Nürnberg, 1755. 624 pp., 101 pl.

(Young of *Astacus*, p. 337; *Gammarus*, p. 353.)

**Rougemont, Ph. de.**

Étude de la Faune des Eaux privées de Lumière. Histoire Naturelle du *Gammarus puteanus* Koch. Description de l'*Asellus Sieboldii*. Observations anatomiques sur l'*Hydrobia* de Munich. Paris, 1876. 49 pp., 5 pl.

(Describes six forms of *Gammarus puteanus*, pp. 28-31, Pl. I.-III.)

Sur l'Anatomie des Organes génitaux de l'Écrevisse de Rivière (*Astacus fluviatilis* Rond.) et sur la Physiologie de la Génération de ces Crustacés.

*Bull. Soc. Sci. Nat. Neuchatel*, XI. pp. 400-402. 1879.

(Observations on young.)

**Saint George.** See La Valette St. George.

**Saint-Hilaire.** See Geoffroy Saint-Hilaire.

**Salensky, W.**

*Sphaeronalla Leuckarti*, ein neuer Schmarotzerkrebs. *Arch. f. Naturgesch.* 1868, 1, pp. 301-322, Taf. X.

(Gives account of development. Parasitic Copepod.)

**Sars, Georg Ossian.**

Norges Ferskvandskrebsdyr. Første Afsnit *Branchiopoda*. I. *Cladocera Ctenopoda* (Fam. *Sididae* & *Holopedidae*). (Prisbelønnet Afhandling.) Christiania, 1865. viii. + 71 pp., 4 pl.

(Young of *Sida crystallina*, Tab. I. figs. 3-7.)

Histoire Naturelle des Crustacés d'Eau douce de Norvège. 1<sup>o</sup> Livraison. Les Malacostracés. Christiania, 1867. 146 pp., 10 pl.

(Development of *Gammarus neglectus*, pp. 64, 66, Pl. VI. figs. 10-19; *Asellus aquaticus*, pp. 116-122, Pl. X. figs. 23-40.)

Carcinologiske Bidrag til Norges Fauna. I. Monographi over de ved Norges Kyster forekommende Mysider. Første Hefte. Christiania, 1870. 64 pp., 5 pl.

(Embryo of *Pseudomma roseum*, Tab. IV. fig. 23.)

Om en dimorph Udvikling samt Generationsvexel hos *Leptodora*. *Forhandl. Vidensk.-Selsk. Christiania*, Aar 1873, pp. 1-15, Tab. I. 1873.

Notice of, by S. I. SMITH, in *Amer. Journ. Sci. & Arts* [3], IX. pp. 230, 231. Mar. 1875.

Om Hummerens postembryonale Udvikling. *Forhandl. Vidensk.-Selsk. Christiania*, Aar 1874, pp. 1-27, Tab. I., II. 1875.

Abstr. in *Gervais's Journ. de Zool.*, IV. pp. 362, 363. 1875.

Notice of, by S. I. SMITH, in *Amer. Journ. Sci. & Arts* [3], IX. p. 231. Mar. 1875.

(Three larval stages of *Homarus vulgaris*.)

**Sars, Michael.**

Beskrivelse over *Lophogaster typicus*, en mærkværdig Form af de lavere tilfødde Krebsdyr. *Kongl. Norske Universitetsprogram for andet Halvaar* 1862. Christiania, 1862. iv. + 37 pp., 3 pl.

Abstr. in *Bibliothèque Univ., Arch. Sci. Phys. Nat.*, XXI. pp. 87, 88. 1864. *Ann. Mag. Nat. Hist.* [3], XIV. pp. 461, 462. 1864.

(Development, pp. iv, 21-25, Tab. III. figs. 57-65.)

Bidrag til Kundskab om Christianiafjordens Fauna. Christiania, [I.] 1868; II. 1870. 218 pp., 13 pl.

(Young of *Munnopsis typica* [I.], Pl. VII. figs. 137, 138; nauplius of *Melinnacheres ergasiloides*, II. p. 14, Pl. VIII. fig. 7; embryo and nauplius of *Anteatheres Duebenii*, pp. 26-28, Pl. X. figs. 35-37.)

**Say, Thomas.**

An Account of the Crustacea of the United States. *Journ. Acad. Nat. Sci. Phila.*, I. pp. 155-169. 1817.

(The megalopa of *Ocypoda* described as a Macrouran genus under the name of *Monolepis*, pp. 155-160.)

**Schäffer, Jacob Christian.**

Die grünen Armpolypen, die geschwänzten und ungeschwänzten zackigen Wasserflöhe, und eine besondere Art kleiner Wasseraale. Regensburg, 1755. 94 pp. 3 pl.

Trans. in JURINE'S *Histoire des Monocles*, pp. 196, 197. Genève, 1820.

(Development of *Daphnia*, pp. 56 et seq., Pl. I. figs. 2, 3.)

\*Der Krebsartige Kiefenfuss mit der kurzen und langen Schwanzklappe. Regensburg, 1756.

(Parthenogenesis in *Apus cancriformis* and *A. productus*.)

**Schiödte (Jörgen C.) [and Meinert (Fr.)].**

Sur la Propagation et les Métamorphoses des Crustacés suceurs de la Famille des Cymothoadiens. *Comptes Rendus de l'Acad. des Sci., Paris*, LXXXVII. pp. 52-55. 1878.

Trans. in *Ann. Mag. Nat. Hist.* [5], II. pp. 195-197. 1878.

**Schmankewitsch, Wladimir.**

\*[On some Crustacea from Salt Lakes and Fresh Waters, and their Relation to the surrounding Element.] *Zapiski Novoross. Obshtch. Yestestvoisp. [Mem. New-Russian Soc. of Naturalists]*, III. 2. 1875. (In Russian.)

Ueber das Verhältniss der *Artemia salina* Miln. Edw. zur *Artemia Mühlhausenii* Miln. Edw. und dem Genus *Branchipus* Schaeff. *Zeitschr. f. wissenschaft. Zool.*, Supplem. XXV. pp. 103-116, Taf. VI. 1875.

Trans. in *Ann. Mag. Nat. Hist.* [4], XVII. pp. 256-258. 1876.

Zur Kenntniss des Einflusses der äusseren Lebensbedingungen auf die Organisation der Thiere. *Zeitschr. f. wissenschaft. Zool.*, XXIX. pp. 429-494. 1877.

\* (On the influence of salt and fresh waters on the development of Crustacea.)

**Schmidt, Oscar.**

Zoologische Mittheilungen. *Zeitschr. gesamt. Naturwissen.*, II. p. 101, 1853.

\**Hand-Atlas d. vergl. Anat.*, Taf. X. fig. 7. 1853. \**Das Weltall*, No. 3, p. 19. 1854.

(*Pellogaster* shown to be a parasitic Crustacean from its development.)

**Schöbl, Jos.**

Ueber die Fortpflanzung isopoder Crustaceen. *Arch. f. Mikroskop. Anat.*, XVII.

pp. 125-140, Taf. IX., X. 1879. \**Sitzungsber. böhm. Gesell. Wissensch.* 1879, pp. 339-350.

**Schulze, Max.**

Zoologische Skizzen. *Zeitschr. f. wissenschaft. Zool.*, IV. pp. 178-195. 1852.

(Development of *Balanidæ*, pp. 190-192.)

**Semper, Carl.**

Reisebericht von Herrn Dr. Carl Semper. Briefliche Mittheilung an A. Kölliker.

*Zeitschr. f. wissenschaft. Zool.*, XIII. pp. 558-570, Taf. XXXVIII., XXXIX. 1863.

(Larva of *Sacculina*, p. 560, Taf. XXXVIII. figs. 3<sup>a</sup>, 3<sup>b</sup>.)

On the Embryogeny of the *Rhizocephala*. *Ann. Mag. Nat. Hist.* [4], XV.

pp. 83, 84. 1875. *Arch. Zool. Expér.*, IV. pp. viii., ix. 1875.

(Reply to GIARD.)

\*Die natürlichen Existenzbedingungen der Thiere. Leipzig, 1880 [Ausgegeben, 1879]. 2 vols., 299 + 296 pp. (Internat. wissenschaft. Bibliothek.)

English trans.: Animal Life as affected by the Natural Conditions of Existence. London and New York, 1881. 472 pp., 106 cuts. (International Scientific Series.)

(*Zoëa* of *Pinnotheres holothuriæ*, p. 81, fig. 22. Influence of temperature and desiccation on development of eggs of *Apus*, *Branchipus*, *Cypris*, pp. 129, 175, 176.)

**Shaw, George.**

Description of the *Cancer stagnalis* of Linnæus. *Trans. Linn. Soc. London*, I.

pp. 103-110, Pl. IX. 1791.

(*Branchipus*. Describes eggs and young.)

**Siebold, C. Th. E. v.**

Beiträge zur Parthenogenesis der Arthropoden. Leipzig, 1871. 238 pp., 2 pl.

VI. Ueber die parthenogenetische Fortpflanzung bei *Apus* und verwandten Crustaceen. Pp. 160-222, Taf. II.

(*Apus cancriformis*, *Apus productus*, *Artemia salina*, *Limnadia Hermannii*.)

Ueber Parthenogenesis der *Artemia salina*. *Sitzungsber. d. Königl. Akad. d.*

*Wissensch. zu München*, III. pp. 168-196. 1873.

**Slabber, Mart.**

\*Natuurkundige Verlostingen, behelzende microscopische Waarnemingen van in- en uit- landische Water- en Land-Dieren. Haarlem, 1769-78. •

\*German trans. by P. L. ST. MÜLLER: *Physikalische Belustigungen, oder microscopische Wahrnehmungen in- und ausländischer Wasser- und Land-Thieren.* Nürnberg, 1775-81.

(Cirriped larva, zoëa of *Brachyura*, &c. See BELL's *Hist. Brit. Stalk-eyed Crustacea*, *Intro.*, pp. xxxix. et seqq.; J. V. THOMPSON'S *Zoölog. Res.*, Mem. I., and copy of figs. in *Encyc. Méth.*, Pl. CCLXVII., CCCXXXIII.; LATREILLE'S *Hist. Nat. gen. et partic. des Crustacés et des Insectes*, IV., Pl. XXXV., &c.)

### Smith, Sidney I.

The Early Stages of the American Lobster (*Homarus Americanus* Edwards). *Amer. Journ. Sci. & Arts*, [3], III. pp. 401-406, Pl. IX. 1872.

(Abstract of later paper in *Trans. Conn. Acad.*)

The Early Stages of the American Lobster (*Homarus Americanus* Edwards). *Trans. Conn. Acad.*, II. pp. 351-381, Pl. XIV.-XVIII. 1873.

(Includes description of larva of *Palæmonetes vulgaris*, p. 377, foot-note.)

The Metamorphoses of the Lobster and other Crustacea. *Invert. Animals of Vineyard Sound, etc.* (VERRILL and SMITH), pp. 228-243, Pl. VIII., IX. *Rep. U. S. Fish Comm.* 1871-72, pp. 522-537. Washington, 1873.

(*Homarus*, *Crangon*, *Palæmonetes*, *Virbius*, *Gebia*, *Callinassa*, *Eupagurus*, *Hippa*, *Cancer*, *Platyonychus*, *Cyllene*, *Ocyпода*, *Gelasinus?*, *Squilla*, &c., noticed.)

The Megalops Stage of *Ocyпода*. *Amer. Journ. Sci. & Arts* [3], VI. pp. 67, 68. 1873.

(*Monolepis inermis* Say is the megalopa of *Ocyпода arenaria*.)

The Early Stages of *Hippa talpoida*, with a Note on the Structure of the Mandibles and Maxillæ in *Hippa* and *Remipes*. *Trans. Conn. Acad.*, III. pp. 311-342, Pl. XLV.-XLVIII. 1877.

The Stalk-eyed Crustaceans of the Atlantic Coast of North America north of Cape Cod. *Trans. Conn. Acad.*, V. pp. 27-136, Pl. VIII.-XII. 1879.

(Observations on larval stages of *Thysanopoda*, pp. 90, 91.)

On the Species of *Pinnixa* inhabiting the New England Coast, with Remarks on their Early Stages. *Trans. Conn. Acad.*, IV. pp. 247-253. July, 1880.

Occasional Occurrence of Tropical and Sub-tropical Species of Decapod Crustacea on the Coast of New England. *Trans. Conn. Acad.*, IV. pp. 254-267. July, 1880.

(Describes megalopa stage of *Calappa marmorata*, &c.)

### Soubeiran, Léon.

Sur l'Histoire Naturelle et l'Éducation des Écrevisses. *Comptes Rendus de l'Acad. des Sci.*, Paris, LX. pp. 1249, 1250. 1865.

### Spangenberg, Friedrich.

Zur Kenntniss von *Branchipus stagnalis*. *Zeitschr. f. wissensch. Zool.*, Suppl. XXV. pp. 1-64, Taf. I.-III. 1875.

(Contains observations on development.)



**Steenstrup [Joh. Japetus Smith].**

Bemærkninger om Slægterne *Pachybdella* Dies. og *Peltogaster* Rathk. Overs. *K. Danske Vidensk. Selsk. Forhandl.* 1854, pp. 145-158, 214.

Trans. by CREPLIN in *Arch. f. Naturgesch.* 1855, 1, pp. 15-29, 62.

English trans. in *Ann. Mag. Nat. Hist.* [2], XVI. pp. 153-162. 1855.

[On *Liriopse* and *Peltogaster*.] *Forhandl. Skand. Naturforsk.*, VIII. (1860), pp. 684, 685. Kiöbenhavn, 1861.

**Steffenberg, Adalrik.**

\*Bidrag til Kännedomen om Flodkräftans Naturalhistoria. Falun, 1872. 72 pp. (Akadem. Afhandl.)

Noticed by EDUARD VON MARTENS in *Zoölog. Rec.* (1872), IX. p. 193. 1874.

(Young of *Astacus fluviatilis*.)

**St. George. See La Valette St. George.****Straus-Durckheim, Hercule Eug.**

Mémoire sur les *Daphnia*, de la Classe des Crustacés. *Mém. du Mus. d'Hist. Nat.*, V. pp. 380-425, Pl. XXIX., 1819; VI. pp. 149-162, 1820.

(Contains observations on development.)

Mémoire sur les *Cypris*, de la Classe des Crustacés. *Mém. du Mus. d'Hist. Nat.*, VII. pp. 33-61, Pl. I. 1821.

(Young, p. 54.)

**Stuxberg, Anton.**

Karcinologiska Iakttagelser. *Öfvers. K. Svenska Vetensk.-Akad. Förhandl.*, XXX. (1873), No. 9, pp. 3-23, Taf. XIV. 1874.

(*Stenorhynchus rostratus*, *Carcinus Mænas*, *Portunus depurator*, *Galatea intermedia*, *Hippolyte varians*, *Palæmon squilla*, *Pachybdella carcini*.)

**Suhm. See Willemoes-Suhm.****Targioni Tozzetti, Ad.**

Di una Specie nuova in un nuovo Genere di Cirripedi Lepadidei ospitante sulle Penne abdominali del *Priofusus cinereus* dell' Atlantico Australe e dell' Oceano Indiano raccolta nel Viaggio intorno al Mondo della Fregata Italiana *La Magenta* dai Professori F. De Filippi ed E. Giglioli. *Bull. Soc. Entomolog. Italiana*, IV. pp. 84-96, Tav. I. figs. 2-13. 1872.

(*Ornitholepas australis*, young stage according to A. GERSTAECKER, *Sitzungs-Ber. Gesell. naturforsch. Freunde Berlin*, 1875, pp. 113-115.)

**Thompson, John V.**

Zoölogical Researches and Illustrations; or Natural History of nondescript or imperfectly known Animals, in a Series of Memoirs. Illustrated by Numerous Figures. Cork, 1828-34. 110 pp., 20 pl.

Memoir I. On the Metamorphoses of the Crustacea, and on Zoëa, exposing their singular Structure and demonstrating that they are not, as has

been supposed, a peculiar Genus, but the Larva of Crustacea. Pp. 1-11, Pl. I., II. Addenda, pp. 63-65, Pl. VIII. fig. 1.

Analyt. notice in *Zoölog. Journ.*, IV. pp. 248-250. 1828.

(*Cancer pagurus*, &c.)

Memoir II. On the Genus *Mysis* or Opossum Shrimp. Pp. 13-31, Pl. III., IV. Addendum, p. 66.

(Contains observations on development.)

Memoir IV. On the Cirripedes or Barnacles; demonstrating their deceptive Character; the extraordinary Metamorphosis they undergo, and the Class of Animals to which they indisputably belong. Pp. 69-82, Pl. IX., X.

(*Balanus*.)

Memoir VI. Development of *Artemis salinus* or Brine Shrimp; demonstrative of its Relationship to *Branchipus* and the other Crustaceous *Phyllopora*, and to those enigmatical Fossils, the apparently eyeless Trilobites . . . with a new Species of *Artemis* and of *Apus*. Pp. 103-110, Pl. I.-VI.

[Letter to the Editor of the Zoölogical Journal, dated "Cork, Dec. 16, 1830."]  
*Zoölog. Journ.*, V. pp. 383, 384, Pl. XV. fig. 13. 1831.

(Metamorphosis of *Homarus*.)

Discovery of the Metamorphosis in the Second Type of the Cirripedes, viz., the *Lepadæ*, completing the Natural History of these singular Animals, and confirming their Affinity with the Crustacea. *Phil. Trans. Roy. Soc. London*, 1835, pp. 355-358, Pl. VI.

On the Double Metamorphosis in the Decapodous Crustacea, exemplified in *Cancer Mænas* Linn. *Phil. Trans. Roy. Soc. London*, 1835, pp. 359-362, Pl. V.

Memoir on the Metamorphosis and Natural History of the *Pinnotheres* or Pea-Crabs. *Entomolog. Mag.*, III. pp. 85-90, figs. 1-3. April, 1835.

Memoir on the Metamorphosis in *Porcellana* and *Portunus*. *Entomolog. Mag.*, III. pp. 275-280, figs. 1-3. October, 1835.

Of the Double Metamorphosis in *Macropodia phalangium* or Spider-Crab, with Proofs of the Larvæ being Zoëa in *Gecarcinus hydrodomus*, *Telphusa erythropus*, *Eriphia Caribbæa*, and *Grapsus pelagicus*. *Entomolog. Mag.*, III. pp. 370-375, figs. 1-6. January, 1836.

Natural History and Metamorphosis of an anomalous Crustaceous Parasite of *Carcinus Mænas*, the *Sacculina carcini*. *Entomolog. Mag.*, III. pp. 452-456, figs. 1-6. April, 1836.

Notice of, in *Arch. f. Naturgesch.*, 1837, 2, p. 248.

Memoir on the Metamorphosis in the *Macroura* or Long-tailed Crustacea, exemplified in the Prawn (*Palæmon serratus*). *Edinburgh New Philosoph. Journ.*, XXI. pp. 221-223, Pl. I. 1836.

Abstract in *Proc. Roy. Soc.*, III. p. 371. 1836.

**Thompson, William.**

Description of a Young Lobster measuring only Nine Lines. *The Zoölogist*, XI. p. 3765. 1853.

**Thorell, T.**

Bidrag till Kännedomen om Krustaceer, som lefva i Arter af Släktet *Ascidia* L. 84 pp., 14 pl. *K. Svenska Vetensk.-Akad. Handl.*, III. No. 8. 1859-60.

\**Zeitschr. gesammt. Naturwissen.*, XV. pp. 114-143. 1860.

(Copepoda. Young, *passim*.)

Till Kännedomen om Vissa parasitiskt lefvande Entomotraceer. *Öfvers. K. Svenska Vetensk.-Akad. Förhandl.*, XVI. (1859), pp. 335-362. 1860.

(Includes account of development.)

**Tozzetti. See Targioni Tozzetti.****Travis.**

[Letter to Pennant, dated "Scarborough, 25th Oct. 1768."] PENNANT'S *British Zoölogy*, IV. pp. 11-15. London, 1777.

(Describes the eggs of *Homarus*. Young have "the appearance of tadpoles.")

**Tscherniawsky, W.**

\*Materialia ad Zoographiam Ponticam comparatam, Basis Genealogiæ Crustaceorum. Oct. 1868. 120 pp., 8 pl. (In Russian.)

Noticed by GERSTAECKER in *Arch. f. Naturgesch.*, 1869, 2, p. 168.

(Larva of *Balanus*, and three zoëæ.)

\*[The Megalopa Larvæ of *Brachyura*.] *Trudy Russkoye Entomolog. Obshtchest.* [*Trans. Russian Entomolog. Soc.*], XI. No. 2, pp. 51-96, 2 pl. 1878. (In Russian.)

See *Zoolog. Anzeig.*, II. p. 219. 1879. *Zoölog. Rec.* (1878), XV., Crust., pp. 15, 16. 1880.

Notice of, by PAUL MAYER, in *Zoolog. Jahresber.* 1880, II. Abth., pp. 41, 42. 1881.

Ueber die Genealogie der Mysiden. *Zoolog. Anzeig.*, III. pp. 213, 214. 1880.

(*Verhandl. d. zool. Sect. d. VI. Versamml. russisch. Naturf. u. Aerzte.*)

Eng. abstr. in *Journ. Roy. Microscop. Soc.*, III. pp. 944, 945. 1880.

**Turner (Wm.) and Wilson (H. S.).**

On the Structure of the *Chondracanthus lophii*, with Observations on its Larval Form. *Trans. Roy. Soc. Edinburgh*, XXIII. pp. 67-76, Pl. III. 1861.

Abstr. in *Proc. Roy. Soc. Edinburgh*, IV. pp. 525-527. 1862.

(Larva, pp. 74, 75, Pl. III. figs. 15, 16.)

On the Structure of *Lernæopoda Dalmani*, with Observations on its Larval Form. *Trans. Roy. Soc. Edinburgh*, XXIII. pp. 77-87, Pl. IV. 1861.

Abstr. in *Proc. Roy. Soc. Edinburgh*, IV. pp. 569, 570. 1862.

(Larva, pp. 84, 85, figs. 13-16.)

**Uljanin, B.**

Untersuchungen über Blastoderm- und Keimblätterbildung bei *Orchestia Montagu* und *mediterranea*. *Zoolog. Anzeig.*, III. pp. 163-165. 1880. (*Verhandl. d. zoolog. Sect. d. VI. Versamml. russisch. Naturf. u. Aerzte.*)

Notice of, by P. MAYER, in *Zoolog. Jahresber.* (1880), II. Abt., pp. 53, 54. 1880.

Zur Entwicklungsgeschichte der Amphipoden. *Zeitschr. f. wissenschaft. Zool.*, XXXV. pp. 440-460, Taf. XXIV. 1881.

Abstr. in *Journ. Roy. Microscop. Soc.* [2], I. pp. 599, 600. Aug. 1881.

**Valenciennes, A.**

Note sur la Reproduction des Homards. *Comptes Rendus de l'Acad. des Sci., Paris*, XLVI. pp. 603-606. 1858.

**Valette St. George. See La Valette St. George.****Van Beneden, Édouard.**

Sur le Mode de Formation de l'Œuf et le Développement embryonnaire des Sacculines. *Comptes Rendus de l'Acad. des Sci., Paris*, LXIX. pp. 1146-1151. 29 Nov. 1869.

Trans. in *Ann. Mag. Nat. Hist.* [4], V. pp. 140-144. 1870.

Recherches sur l'Embryogénie des Crustacés. I. Observations sur le Développement de l'*Asellus aquaticus*. *Bull. Acad. Roy. de Belgique* [2], XXVIII. pp. 54-87, 2 pl. 1869.

Recherches sur l'Embryogénie des Crustacés. II. Développement des *Mysis*. *Bull. Acad. Roy. de Belgique* [2], XXVIII. pp. 232-249, 1 pl. 1869.

Recherches sur l'Embryogénie des Crustacés. III. Développement de l'Œuf et de l'Embryon des Sacculines (*Sacculina carcini*, Thomps.). *Bull. Acad. Roy. de Belgique* [2], XXIX. pp. 99-112, 1 pl. 1870.

Recherches sur l'Embryogénie des Crustacés. IV. Développement des Genres *Anchorella*, *Lernæopoda*, *Brachiella* et *Hessia*. *Bull. Acad. Roy. de Belgique* [2], XXIX. pp. 223-254, 1 pl. 1870.

Réponse à quelques-unes des Observations de M. Balbiani sur l'Œuf des Sacculines. *Comptes Rendus de l'Acad. des Sci., Paris*, LXX. pp. 197-200. 1870.

Recherches sur la Composition et la Signification de l'Œuf, basées sur l'Étude de son Mode de Formation et des premières Phénomènes embryonnaires (Mammifères, Oiseaux, Crustacés, Vers). *Mém. Cour. Acad. Roy. de Belgique*, XXXIV. 1870 [1869?]. 283 pp., 12 pl.

(Crustacea, pp. 107-143, Pl. VII.-X.)

**Van Beneden (Édouard) et Bessels (Émile).**

Mémoire sur la Formation du Blastoderme chez les Amphipodes, les Lernéens et les Copépodes. *Mém. Cour. Acad. Roy. de Belgique*, XXXIV. 1870 [1868?]. 59 pp., 5 pl.

Résumé in *Bull. Acad. Roy. de Belgique* [2], XXV. pp. 434-448. 1868. *Monthly Microscop. Journ.*, I. pp. 41-45. Jan. 1869.

See also Report by SCHWANN, GLUGE, and POELMAN, *Bull. Acad. Roy. de Belgique* [2], XXVI. pp. 252-259. 1868.

**Van Beneden, P.-J.**

Résumé d'un Mémoire sur le Développement et l'Organisation des Nicthoés. *Bull. Acad. Roy. de Belgique*, XV. 2<sup>me</sup> Partie, pp. 386-390. 1848. *Schleiden u. Froriep's Notizen* [3], IX. col. 165-167. 1849.

Mémoire sur le Développement et l'Organisation des Nicthoés. *Mém. Acad. Roy. de Belgique*, XXIV. 1850. 28 pp., 1 pl. *Ann. Sci. Nat.* [3], Zool., XIII. pp. 354-377, Pl. I. figs. 13-29. 1850.

Recherches sur quelques Crustacés inférieurs. *Ann. Sci. Nat.* [3], Zool., XVI. pp. 71-131, Pl. II.-VI. 1851.

(Parasitic Copepoda, *Lernæans*.)

Note sur un nouveau Genre de Crustacé parasite, *Eudactylina*. *Bull. Acad. Roy. de Belgique*, XX. Pt. I. pp. 235-238, 1 pl. 1853.

(Larvæ, figs. 5, 6.)

Histoire naturelle d'un Animal nouveau, désigné sous le Nom d'*Histriobdella*. *Bull. Acad. Roy. de Belgique*, 1858, pp. 263-296.

(Development of *Homarus*, pp. 263, 264.)

Un nouveau Genre de Crustacé Lernéen. *Bull. Acad. Roy. de Belgique*, 1860, pp. 137-146, 1 pl.

(*Enterocola fulgens* P. J. Van Ben. Larva, figs. 6, 7.)

Recherches sur les Crustacés du Littoral de Belgique. *Mém. Acad. Roy. de Belgique*, XXXIII. 1861 [1860?]. 174 pp., 21 pl.

Also printed separately with the following title: Recherches sur la Faune littorale de Belgique. Crustacés. Bruxelles, 1861. 174 pp., 21 pl.

See Rev. by FRITZ MÜLLER, *Ueber Cumaceen*. *Arch. f. Naturgesch.*, 1865, 1, pp. 311-323.

(Development of *Mysis*, pp. 52-69, Pl. VI. figs. 9-12, VIII.-XI.; *Homarus*, p. 53; *Cuma*, pp. 75, 87; *Cyamus*, p. 95; *Anceus*, p. 102, Pl. XVI.; *Peltogaster*, p. 118, Pl. XXI. figs. 5-7; *Sacculina*, Pl. XX. figs. 8, 9, Pl. XXI. figs. 8, 9; *Lernæa*, p. 131, Pl. XIX. figs. 9-13.)

**Vejdovský, Franz.**

Untersuchungen über die Anatomie und Metamorphose von *Tracheliastes polycolpus* Nordm. *Zeitschr. f. wissensch. Zool.*, XXIX. pp. 15-46, Taf. II.-IV. 1877.

(Development, pp. 34-43, Taf. III., IV.)

**Vogt, Carl.**

Recherches Cotières. Genève, 1877. 104 pp., 6 pl. *Mém. Inst. Genève*, XIII.

1<sup>er</sup> Mém. De la Famille des Philichthydes et en particulier du Léposphile des Labres (*Leposphilus labrei* Hesse). Pp. 1-41, Pl. I., II.

(Nauplius, p. 26, Pl. I. fig. 10.)

2<sup>d</sup> Mém. Sur quelques Copépodes Parasites à Males Pygmées habitant les Poissons. Pp. 43-104, Pl. III.-VI.

(Nauplius of *Brachiella*, p. 56, Pl. III. fig. 8; *Chondracanthus*, pp. 86-88, Pl. V.)

Also in *Arch. Zool. Expér.*, VI. 385-456. 1877.

Recherches Cotières faites a Roskoff. Crustacés Parasites des Poissons. Genève, 1879. 104 pp., 6 pl.

1<sup>er</sup> Mém. Leposphile des Labres, Famille des Philichthydes.

2<sup>d</sup> Mém. Familles des Lernæopodides et des Chondracanthides.

(Nauplius of *Leposphilus*, *Brachiella*, *Chondracanthus*.)

Same as the preceding.

L'Adaptation des Crustacés Copépodes au Parasitisme. *Actes de la Soc. Helvétique des Sci. Nat.*, 60<sup>e</sup> Sess., pp. 121-139. 1878.

(Contains remarks on larvæ.)

#### Wagner, Nicolas.

Observations sur l'Organisation et le Développement des Ancées. *Bull. Acad. Impér. des Sci., de St.-Petersbourg*, X. pp. 498-502 (*Mélanges Biologiques*, VI. pp. 27-34). 1866.

\*In *Arbeit. d. ersten Sitzung Russischer Naturforscher in St. Petersburg*, 1868, pp. 218-237, Taf. I.-IV.

(Development of *Hyalosoma* [*Leptodora*], according to Gerstaecker, *Arch. f. Naturgesch.*, 1871, I, p. 351.)

#### Wagner, Rudolphus.

Prodromus Historiæ Generationis Hominis atque Animalium. Lipsiæ, 1836. 15 pp., 2 pl.

(Eggs of *Porcellio*, *Cypris*, *Balanus*, *Gammarus*, *Astacus*, *Carcinus*, p. 8, Pl. I. figs. 12-17.)

#### Weismann, August.

Ueber Bau und Lebenserscheinungen von *Leptodora hyalina* Lilljeborg. *Zeitschr. f. wissensch. Zool.*, XXIV. pp. 349-418, Taf. XXXIII.-XXXVIII. 1874.

Zur Naturgeschichte der Daphniden. I. Ueber die Bildung von Wintereiern bei *Leptodora hyalina*. *Zeitschr. f. wissensch. Zool.*, XXVII. pp. 51-112, Taf. V.-VII. May, 1876.

Beiträge zur Naturgeschichte der Daphniden. Theil II., III., u. IV. *Zeitschr. f. wissensch. Zool.*, XXVIII. pp. 93-254, Taf. VII.-XI. Jan. 1877.

II. Die Eibildung bei den Daphniden. Pp. 95-175.

III. Die Abhängigkeit der Embryonal-Entwicklung vom Fruchtwasser der Mutter. Pp. 176-211.

IV. Ueber den Einfluss der Begattung auf die Erzeugung von Winteriern. Pp. 212-240.

Beiträge zur Naturgeschichte der Daphnoiden. VII. Die Entstehung der cyclischen Fortpflanzung bei den Daphnoiden. *Zeitschr. f. wissenschaft. Zool.*, XXXIII. pp. 111-264. Oct. 1879.

Parthenogenese bei den Ostracoden. *Zoolog. Anzeig.*, III. pp. 82-84. 23 Feb. 1880. *Journ. Roy. Microscop. Soc.*, III. Pt. I. pp. 431, 432. 1880.

#### Wendt.

Ueber das Ansetzen der Cirripeden an eisernen Schiffen. *Verhandl. d. Vereins f. naturwissenschaft. Unterhalt. zu Hamburg*, III. (1876), pp. 31, 32. 1878.

#### Westwood, J. O.

Extrait des Recherches sur les Crustacés du Genre *Pranize* de Leach. *Ann. Sci. Nat.*, XXVII. pp. 316-332, Pl. VI. 1832.

On the Transformations of the Crustacea. *Rep. Brit. Assoc. Adv. Sci. for 1834*, pp. 608, 609. 1835.

(Abstract of the following paper.)

On the supposed Existence of Metamorphoses in the Crustacea. *Phil. Trans. Roy. Soc. London*, 1835, pp. 311-328, Pl. IV.

Abstract in *Proc. Roy. Soc. London*, III. pp. 341, 342. 1835. *London and Edinburgh Philosoph. Mag.* [3], VII. pp. 210, 211. 1835. *Froriep's Notizen*, XLVI. pp. 230, 231. 1835.

(*Gecarcinus*, with direct development.)

See also Bate (C. Spence) and Hailstone (S.).

#### Willemoes-Suhm, Rudolf von.

On a new Genus of Amphipod Crustaceans. *Proc. Roy. Soc. London*, XXI. pp. 206-208. 1873. *Ann. Mag. Nat. Hist.* [4], XI. pp. 389-391. 1873.

(*Thaumops pellucida* W.-S. [*Cystisoma Neptuni* Guér.-Mén.] undergoes no metamorphosis after leaving the egg, pp. 207, 208.)

Von der Challenger-Expedition. Briefe an C. Th. E. v. Siebold von R. v. Willemoes-Suhm. I. *Zeitschr. f. wissenschaft. Zool.*, XXIII. pp. i.-vii. May, 1873.

(Embryo of *Thaumops pellucida* W.-S. [*Cystisoma Neptuni* Guér.-Mén., Amphipod] undergoes no metamorphosis, p. vi.)

Von der Challenger-Expedition. Briefe an C. Th. E. v. Siebold von R. v. Willemoes-Suhm. II. *Zeitschr. f. wissenschaft. Zool.*, XXIV. pp. ix.-xxiii. Oct. 1874.

(Young *Isopoda* and *Amphipoda* of Antarctic Islands developed in sacs of parent. Larval stages of the higher Crustacea not found on the surface at Kerguelen's Is., excepting one small zoëa.)

Von der Challenger-Expedition. Briefe von R. v. Willemoes-Suhm an C. Th. E. v. Siebold. V. *Zeitschr. f. wissensch. Zool.*, XXVI. pp. lix.-lxxv. Dec. 1875.

(According to a very intelligent fisherman, Menancio Perez, the young *Birgus* on hatching is like the parent in form, p. lxxiii.)

On some Atlantic Crustacea from the "Challenger" Expedition. V. On the Development of a Land Crab. *Trans. Linn. Soc. London* [2], Zool., I. pp. 46-48, Pl. XI. figs. 1-3. 1875.

(Zoëa of *Cardisoma* from Cape-Verd Isl. Direct development of *Telphusa fluviatilis* from Italy.)

On the Development of *Lepas fascicularis* and the "Archizoëa" of *Cirripedia*. *Phil. Trans. Roy. Soc. London*, CLXVI. pp. 131-154, Pl. X.-XV. 1876.

Abstract in *Proc. Roy. Soc. London*, XXIV. pp. 129-132. Dec. 1875. *Ann. Mag. Nat. Hist.* [4], XVII. pp. 158-161. 1876.

Preliminary Remarks on the Development of some Pelagic Decapods. *Proc. Roy. Soc. London*, XXIV. pp. 132-134. 1875. Also in *Ann. Mag. Nat. Hist.* [4], XVII. pp. 162, 163. 1876.

(*Amphion*, *Sergestes*, *Lucifer*.)

Preliminary Report to Professor Wyville Thomson, F. R. S., Director of the Civilian Scientific Staff, on Observations made during the earlier Part of the Voyage of H. M. S. "Challenger." *Proc. Roy. Soc. London*, XXIV. pp. 569-585. 1876.

(Blind megalopa from 1675 fms.; p. 577; *Cardisoma* zoëa, p. 582.)

Von der Challenger-Expedition. Briefe von R. v. Willemoes-Suhm an C. Th. E. v. Siebold. VII. *Zeitschr. f. wissensch. Zool.*, XXVII. pp. xcvii.-cviii. May, 1876.

(*Sergestes*, *Lucifer*, *Lepas*, pp. cvi.-cviii. Same observations as those recorded in *Preliminary Remarks*, &c., and *On the Development of Lepas fascicularis*, &c.)

Wilson, E. B. See Brooks, W. K.

Wilson, H. S. See Turner, Wm.

Woodward, Henry.

Art. *Crustacea* in *Encyclopædia Britannica* (9th ed.), VI. pp. 632-666. 1877.

(General account of development, pp. 643-652. Australian *Dromia*, with direct development, p. 644.)

Zaddach, Ernestus Gustavus.

De Apodis cancriformis Schaeff. *Anatome et Historia Evolutionis*. Bonnæ, 1841. 72 pp., 4 pl.

(Development, pp. 55-64, Pl. IV.)



**Zenker, Jonathan Carolus.**

De Gammari pulicis Fabr. Historia Naturali atque Sanguinis Circuita Commentatio. Jenæ, 1832. viii. + 28 pp., 1 pl.

(Remarks on development, p. 17.)

**Zenker [Wilhelm].**

Monographie der Ostracoden. *Arch. f. Naturgesch.* 1854, 1, pp. 1-87, Taf. I.-VI. figs. 1, 2.

(Development, pp. 57-60.)

Also published as \**Anatomisch-systematische Studien über die Krebsthiere (Crustacea)*. Berlin, 1854. 115 pp., 6 pl.

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[Notice of *Phyllosoma* hatched from Eggs of *Palinurus vulgaris* at Brighton Aquarium.] *Nature*, VIII. p. 231. 1873. *Amer. Journ. Sci. & Arts* [3], VI. p. 229. 1873.

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**ADDENDA.**

**Claus, Carl.**

Untersuchungen über die Organisation und Verwandtschaft der Copepoden.

(In Auszuge zusammengestellt.) *Würzburg. naturwiss. Zeitschr.*, III. pp. 51-103. 1862.

(Development, pp. 78-82.)

**Dohrn, Anton.**

\*Studien zur Embryologie der Arthropoden. 1868. (Habilitationsschrift.)

**Hartog, Marcus.**

On the Anal Respiration of the *Copepoda*. *Quart. Journ. Microscop. Sci.* [2], XX. pp. 244, 245. April, 1880. *Journ. Roy. Microscop. Soc.*, III. Pt. 2, pp. 632, 632. 1880.

(Anal respiration in nauplius of *Cyclops* and *Diaptomus*, p. 245.)

On the Respiration of the Crustacea. *Quart. Journ. Microscop. Sci.* [2], XX. p. 485. Oct. 1880. *Journ. Roy. Microscop. Soc.*, III. Pt. 2, p. 944. 1880.

(Anal respiration in zoëæ.)

**Kossmann, Robby.**

Die Entonisciden. *Mittheil. aus der zoolog. Station zu Neapel*, III. pp. 149-169, Taf. VIII., IX. Dec. 9, 1881

(Development, pp. 166-168, Taf. VIII., fig. 6.)

Studien über Bopyriden. III. *Jone thoracica* und *Cepon portuni*. *Mittheil. aus der zoolog. Station zu Neapel*, III. pp. 170-183, Taf. X., XI. Dec. 9, 1881.

(Young stages described and figured.)

XIPHOSURA (*Limulus*).**Agassiz, Alexander.**

Note on the Habits of young *Limulus*. *Amer. Journ. Sci. & Arts* [3], XV. pp. 75, 76. 1878. *Ann. Mag. Nat. Hist.* [5], I. pp. 183, 184. 1878.

(Swim, feed, and rest on their backs.)

**Beneden. See Van Beneden.****Dohrn, Anton.**

Untersuchungen über Bau und Entwicklung der Arthropoden. 19. Zur Embryologie und Morphologie des *Limulus Polyphemus*. *Jenaische Zeitschr.*, VI. pp. 580-640, Taf. XIV., XV. 1871.

**Edwards. See Milne Edwards.****Gegenbaur, C.**

Anatomische Untersuchung eine *Limulus*, mit besonderer Berücksichtigung der Gewebe. *Abhandl. Naturforsch. Gesell. Halle*, IV. pp. 229-250, 1 pl. 1858.

(Structure of egg, pp. 247-249, fig. 9.)

**Lockwood, S.**

The Horse-Foot Crab. *Amer. Naturalist*, IV. pp. 257-274, Pl. III. July, 1870.

(Development of *Limulus Polyphemus*.)

**Milne Edwards, Henri.**

Recherches relatives au Développement des Limules. \**Soc. Philomath. Paris, Extr. des Procès-Verbaux des Séances*, 1838, pp. 125, 126. \**L'Institut*, VI. No. 258, p. 397. 1838. Disciples' Ed. CUVIER'S *Règne Animal*, Crustacés, Pl. LXXVI. fig. 2 h, 2 i. *Hist. Nat. des Crustacés*, III. p. 546. 1840.

(Young *Limulus* at time of hatching.)

Notice of, in VAN DER HOEVEN'S *Recherches sur l'Histoire Naturelle et l'Anatomie des Limules*, p. 44. Leyde, 1838.

**Packard, A. S., Jr.**

On the Embryology of *Limulus Polyphemus*. *Amer. Naturalist*, IV. pp. 498-502, figs. 95-100. Oct. 1870. *Proc. Boston Soc. Nat. Hist.*, XIV. p. 60. Nov. 16, 1870. *Proc. Amer. Assoc. Adv. Sci.*, 19th Meeting (1870), pp. 247-255, 9 figs. 1871. *Quart. Journ. Microscop. Sci.* [2], XI. pp. 263-267. 1871.

(Notice of observations given in full in *Mem. Boston Soc. Nat. Hist.*, II. pp. 155-202. 1872.)

Morphology and Ancestry of the King Crabs. *Amer. Naturalist*, IV. pp. 754-756. Feb. 1871.

(Abstract of some of the conclusions stated in *Mem. Boston Soc. Nat. Hist.*, II. pp. 155-202. 1872.)

The Development of *Limulus Polyphemus*. *Mem. Boston Soc. Nat. Hist.*, II. pp. 155-202, Pl. III.-V. March, 1872.

Abstract by the author in *Life Histories of the Crustacea and Insects*, *Amer. Nat.*, IX. pp. 589-592, figs. 239-246, Nov. 1875; *Life Histories of Animals including Man, or Outlines of Comparative Embryology*, New York, 1876; and in *Zoölogy for Students and General Readers*, pp. 320-323, New York, 1879.

See also HENRY WOODWARD'S *Monograph of the British Fossil Crustacea of the Order Merostomata*, pp. 214-221. London, 1878.

Farther Observations on the Embryology of *Limulus*, with Notes on its Affinities. *Amer. Naturalist*, VII. pp. 675-678. Nov. 1873. *Proc. Amer. Assoc. Adv. Sci.*, 22d Meeting (1873), Pt. II. pp. 30-32. 1874.

On the Development of the Nervous System in *Limulus*. *Amer. Naturalist*, IX. pp. 422-424. July, 1875.

The Anatomy, Histology, and Embryology of *Limulus Polyphemus*. *Annivers. Mem. Boston Soc. Nat. Hist.* 1880. 45 pp., 7 pl.

(Embryology, pp. 36-40, Pl. I., III., IV.)

**Suhm.** See Willemoes-Suhm.

**Van Beneden, Édouard.**

De la Place que les Limules doivent occuper dans la Classification des Arthropodes d'après leur Développement embryonnaire. *Ann. Soc. Entomol. Belgique*, XV. *Comptes Rendus*, pp. x., xi. 14 Oct. 1871. *Gervais's Journ. de Zoologie*, I. pp. 41-44. 1872. *Ann. Mag. Nat. Hist.* [4], IX. pp. 98, 99. Jan. 1872.

\*[Observations on the first Stages of embryonic Development in *Limulus*.] *Tageblatt d. 46<sup>er</sup> Versamml. deutsch. Naturforsch. u. Aertze in Wiesbaden*, 1873, p. 58.

**Willemoes-Suhm, Rudolf von.**

Von der Challenger-Expedition. Nachträge zu den Briefen an C. Th. E. v. Siebold von R. v. Willemoes-Suhm. VIII. *Zeitschr. f. wissenschaft. Zool.*, XXIX. pp. cix.-cxxxvi. June, 1877.

(*Limulus* from the Philippine Islands has a free-swimming nauplius larva, p. cxxxii.)

Challenger-Briefe von Rudolf v. Willemoes-Suhm Dr. Phil. 1872-1875. Nach dem Tode des Verfassers herausgegeben von seiner Mutter. Leipzig, 1877. 180 pp.

(*Limulus rotundicaudatus* does not have a direct development like *L. Polyphemus* but has a nauplius larva, pp. 157, 158. [Letter to Professor Kupffer.]

## TRILOBITA.

## Barrande, Joachim.

Système Silurien du Centre de la Bohême. Prague et Paris.

Métamorphoses des Trilobites, I. pp. 257-278, Pl. VII., XLIX., &c. 1852. I. Suppl., pp. 182-189, Pl. *passim*. 1872.

*Cf.* A. GERSTÄECKER in BRONN'S *Klassen und Ordnungen des Thier-Reichs*, V. (Arthropoda), I. Abt., I. Hälfte, pp. 1200-1208, Taf. XLIII., XLVI. Leipzig und Heidelberg, 1879.

## Ford, S. W.

On some Embryonic Forms of Trilobites from the Primordial Rocks at Troy, N. Y. *Amer. Journ. Sci. & Arts* [3], XIII. pp. 265-273, 1 pl. 1877.

On additional Embryonic Forms of Trilobites from the Primordial Rocks of Troy, N. Y., with Observations on the Genera *Olenellus*, *Paradoxides*, and *Hydrocephalus*. *Amer. Journ. Sci.*, XXII. pp. 250-259, 13 cuts. 1881.

## Walcott, C. D.

Note upon the Eggs of the Trilobite. *31st Ann. Rep. N. Y. State Mus. Nat. Hist.*, pp. 66, 67. Albany, 1879. (Published and distributed in advance of Report, Sept. 20, 1877.) *Bull. Mus. Comp. Zool., at Harvard Coll., in Cambridge*, VIII. p. 216, Pl. IV. figs. 8, 8a. 1881.

Fossils of the Utica Slate. *Trans. Albany Inst.*, X. (Printed in advance, June, 1879.)

Metamorphoses of *Triarthrus Becki*, pp. 24-33, Pl. II. figs. 1-15.

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 PYCNOGONIDA.

## Allman [George James].

On a Remarkable Form of Parasitism among the *Pycnogonidæ*. *Rep. Brit. Assoc. Adv. Sci. for 1859*, Trans. of Sect., p. 143. 1860.

(Young *Ammothea*? parasitic in *Coryne*.)

## Böhm, R.

Zwei neue, von Herrn Dr. Hilgendorf in Japan gesammelte Pycnogoniden. *Sitzungs-Ber. Gesell. naturforsch. Freunde zu Berlin*, 1879, pp. 53-60, 140-142.

(On some structural characters of the young, pp. 55, 140, 141.)

## Claparède, A. René Edouard.

Beobachtungen über Anatomie und Entwicklungsgeschichte wirbelloser Thiere an der Küste von Normandie angestellt. Leipzig, 1863. viii+120 pp., 18 pl.

(Development of *Phozichilidium*, pp. 104, 105, Pl. XVIII. figs. 13, 14.)

**Couch, R. Q.**

On the Metamorphosis of the Crustaceans, including the *Decapoda*, *Entomostraca*, and *Pycnogonidæ*. *Twelfth Ann. Rep. Roy. Cornwall Polytechnic Soc.*, pp. 17-46, Pl. I. Falmouth, 1844.

(Young of *Orithyia coccinea* and *Nymphon gracile*, pp. 36, 37. First stage of *Orithyia coccinea*, fig. 13.)

**Dohrn, Anton.**

Untersuchungen über Bau und Entwicklung der Arthropoden. 2. Ueber Entwicklung und Bau der Pycnogoniden. *Jenaische Zeitschr.*, V. pp. 138-157, Taf. V., VI. 1870.

(According to Dohrn, the *Pycnogonida* are neither *Arachnida* nor *Crustacea*.)

Neue Untersuchungen über Pycnogoniden. *Mittheil. aus der Zoolog. Station zu Neapel*, I. pp. 28-39. 1878.

Die Pantopoden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Eine Monographie. Herausgegeben von der Zoologischen Station zu Neapel. Leipzig, 1881. 252 pp., 17 pl. (Fauna und Flora des Golfes von Neapel, III. Monographie.)

(Development, pp. 69 et seqq. *Phoxichilidium*, *Pallene*.)

**Gegenbaur, Carl.**

Zur Lehre vom Generationswechsel und der Fortpflanzung bei Medusen und Polypen. Würzburg, 1854. 68 pp., 2 pl.

(*Pycnogonum* developing as a parasite in *Eudendrium*, p. 38, foot-note.)

**Gerbe, Z.**

Appareils vasculaire et nerveux des Larves des Crustacés marins. *Comptes Rendus de l'Acad. des Sci., Paris*, LXII. pp. 932-937. 23 Apr. 1866.

(Larva of *Nymphon*, pp. 932, 933, foot-note.)

Trans. by W. S. DALLAS in *Ann. Mag. Nat. Hist.* [3], XVIII. pp. 7-12. 1866.

**Hesse [Eugène].**

Mémoire sur des Crustacés rares ou nouveaux des Côtes de France. 24<sup>e</sup> Art. Description d'un nouveau Crustacé appartenant à l'Ordre des *Pycnogonidiens* et formant le Genre Oomère, Nob. *Ann. Sci. Nat.* [5], Zool., XX. Art. 5. 18 pp., Pl. VIII. 1874.

(Contains observations on the larvæ of *Phoxichilidium femoratum* Rathke, and *Nymphon grossipes*.)

**Hodge, George.**

Observations on a Species of Pycnogon (*Phoxichilidium coccineum* Johnston), with an Attempt to explain the Order of its Development. *Ann. Mag. Nat. Hist.* [3], IX. pp. 33-43, Pl. IV., V. 1862.

(Development of *Phoxichilidium* in *Coryne*.)

**Hoek, P. P. C.**

Ueber Pycnogoniden. *Niederländisches Arch. f. Zool.*, III. pp. 235-254, Taf. XV., XVI. 1877.

(Development of *Pallene*, pp. 239, 240, Taf. XVI. figs. 21, 22.)

Report on the *Pycnogonida* dredged by H. M. S. "Challenger," during the Years 1873-76. 167 pp., 21 pl. Appendix II. Contributions to the Anatomy and Embryology of the *Pycnogonida*. Pp. 100-144, Pl. XIX., XX. *Rep. Sci. Results of the Voyage of H. M. S. "Challenger," during the Years 1873-76*, Zool., III. London, Edinburgh, and Dublin, 1881.

**Kölliker, A.**

Beiträge zur Entwicklungsgeschichte wirbelloser Thiere. 1. Ueber die ersten Vorgänge im befruchteten Ei. *Arch. f. Anat., Physiol. u. wissenschaft. Med.* 1843, pp. 68-141, Taf. VI., VII.

(Cleavage of egg of *Pycnogonon total*, p. 136.)

**Krohn, A.**

Notiz über die Eierstöcke der Pycnogoniden. *Schleiden u. Froriep's Notizen*, [3], IX. col. 225, 226. May, 1849.

(Structure of ovarian egg, col. 226.)

**Krøyer, Henrik.**

Om Pyknogonidernes Forvandlinger. *Naturhistorisk Tidsskr.*, III. pp. 299-306, Tab. III. 1840. *Isis*, 1841, col. 713-717, Taf. III. *Ann. Sci. Nat.* [2], Zool., XVII. pp. 288-292, Pl. IX. B. 1842. (Trans. by LEREBOLLET.)

In GAIMARD'S *Voyages de Commission Scientifique du Nord en Scandinavie, en Laponie au Spitzberg et aux Féroë pendant les Années 1838, 1839 et 1840, sur la Corvette "La Recherche."* Paris, 1842-45. Zoologie. Crustacés.

(Young *Pycnogonida*, Pl. XXXIX.)

**Lewes, George Henry.**

Sea-Side Studies at Ilfracombe, Tenby, the Scilly Isles, and Jersey. Edinburgh and London, 1858. 414 pp., 7 pl.

(Larva of *Nymphon gracile*, p. 203, Pl. V. fig. 4.)

**Semper, Carl.**

Ueber Pycnogoniden und ihre in Hydroiden schmarotzenden Larvenformen. *Arbeit. aus dem zoolog.-zootom. Inst. in Würzburg*, I. pp. 264-286, Taf. XVI., XVII. 1874. *Verhandl. d. physikal.-medicin. Gesell. in Würzburg*, [2], VII. pp. 257-279, Taf. IV., V. 1874.

**Wilson, Edmund B.**

Synopsis of the *Pycnogonida* of New England. *Trans. Conn. Acad.*, V. pp. 1-26, Pl. I.-VII. 1878.

(Young of *Achelia spinosa*, p. 8, Pl. II. fig. 1g; of *Nymphon hirtum*, p. 23, Pl. VI. figs. 2i, 2j.)

Report on the *Pycnogonida* of New England and Adjacent Waters. In *Rep. U. S. Commissioner of Fish and Fisheries for 1878*, pp. 463-506, 7 pl. Washington, 1880.

(Young of *Achelia spinosa*, p. 474; of *Nymphon hirtum*, p. 496, Pl. VII. fig. 41, as before.)

Reports on the Results of Dredging, under the Supervision of Alexander Agassiz, along the East Coast of the United States, during the Summer of 1880, by the U. S. Coast Survey Steamer "Blake," Commander J. R. Bartlett, U. S. N., commanding. XIII. Report on the *Pycnogonida*. *Bull. Mus. Comp. Zool., at Harvard Coll., in Cambridge*, VIII. pp. 239-256, 5 pl. 1881.

(Development of *Pallene* shows that Zenker's account of the innervation of the three anterior pairs of appendages of *Pycnogonida* is incorrect, p. 241, footnote.)

**Wright, T. Strehill.**

Observations on British Zoöphytes. 9. On the Development of Pycnogon Larvæ within the Polyps of *Hydractinia echinata*. *Quart. Journ. Microscop. Sci.* [2], III. pp. 51, 52. 1863.

monary chamber, as well as in the body cavity. Here the embryo undergoes a metamorphosis, becoming elliptical in shape. It becomes a mere blood-sac, in which the next generation is produced. The germs increase in size and each becomes a *redia*, as the nurse-form, provided with pharynx and intestine, is called. When the *redia* is ready to come forth, it breaks through the walls of the brood-sac (sporocyst), increases in size, finally becoming one-twentieth of an inch in length. Within them develop from minute cells germs of which form Cercariæ, each with a sucker at the anterior end and another in the middle beneath. They have, also, the anterior part of the body covered with exceedingly minute spines, and this form is believed by Thomas to become the fluke-worm. Similar forms in the same species of snails were at about the same time reared independently by Professor Leuckart, in Germany, whose statements confirm those of Mr. Thomas in the *Zoölogischer Anzeiger*. Mr. Thomas' final paper appears in the *Quarterly Journal of Microscopical Science* for January, and is illustrated with several plates.

CHROMATOPHORES IN CRUSTACEANS.—Dr. Max Weber has described the structure of *Haplophthalmus* and *Trichoniscus*, genera belonging to the exceptional Isopod sub-family of Trichoniscidæ. The structure of *Trichoniscus*, save in regard to externals, had not before been investigated. The copious details which such an essay contains must necessarily be studied in the original. Points of general interest, affecting other isopods, are duly indicated.

Dr. Weber makes a digression on the subject of chromatophores. Leydig first showed that in the same situations as chromatophores are found cells without pigment, but otherwise similar, the whole forming one common system. Also animals of constant tint possess non-contractile cells, presumably homologous with chromatophores. These are unquestionably distributed to the chromatophores. By means of gold chloride Dr. Weber has proved this connection in the case of a common isopod (a young *Philoscia*). Anger, fear, love and other emotions undoubtedly cause animals with chromatophores to change color; yet it is usually assumed that the play of the chromatophores serves to hide their possessor, and perhaps in some cases for protection. But Leydig saw tree-frogs amid their natural surroundings, change spontaneously their beautiful green for a dirty gray tint, just as they are known to do in captivity, especially during murky weather. The inference follows that a depressed temperature here acts on the chromatophores, particularly when we consider that these organs are an appanage of pœcilothermous animals. We learn from v. Platen, Moleschott and Tubini, that light acting directly on the skin (apart from what is termed the chromatic function, or the indirect influence of light through the eyes) enhances the metamorphosis of tissue. Dr. Weber concludes that one use at



least of the chromatophores is to diminish the transparency of the skin and thus to lower the action of even moderate light when it begins to affect injuriously the organism.

THE METAMORPHOSIS OF PENEUS.—Dr. W. K. Brooks, in his account of the metamorphosis of Peneus (Johns Hopkins University Circulars, Nov., 1882), noticed in the January number of the NATURALIST (p. 90), says :

“Those familiar with the literature of the subject will recollect that Fritz Müller kept under observation until it changed into a protozoëa, a nauplius which he captured at the surface of the ocean. He also secured, in the ocean, a very complete series of larvæ, through which he identified his protozoëa with a young Macrouran with the characteristics of the genus Peneus. He did not rear the nauplius from the Peneus egg, nor did he actually observe the transformation into the young Peneus. Certain over-cautious naturalists have therefore refused to accept his conclusions until more conclusive proof should be furnished.”

Dr. Brooks then proceeds to state that he has captured the protozoëa of Peneus and reared it in confinement, witnessing every one of the five molts between the youngest protozoëa and the young Peneus. “The whole metamorphosis of Peneus has therefore been actually witnessed and there is no longer any room for criticism.”

If Dr. Brooks will read Fritz Müller's two papers on the subject (Arch. Naturgesch., Bd. xxix., Zeitschr. wissensch. Zoöl., Bd. xxx), he will learn that Müller did *not* keep the nauplius under observation until it changed into a protozoëa, but that he captured the protozoëa in the sea and inferred its relation with the nauplius from its likeness in movements, color and structure. This assumed relation between the protozoëa and the nauplius “certain over-cautious naturalists” wished to see proved either by hatching the nauplius from the egg of Peneus, witnessing the transformation of the nauplius into the protozoëa, or discovering intermediate stages between the nauplius and the protozoëa. Brooks' observations have no bearing on the question whatever. He 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 protozoëa is an older stage than the youngest protozoëa secured by Müller. He has riveted the links in Müller's chain that were closely joined before, but has not touched the weak spot !

From the complete disappearance of the exopodites from the five pairs of legs and the simplicity of the abdominal appendages in the oldest stage observed, it would appear that Brooks' larva belongs to the genus *Sycionia* rather than to Peneus.

The larval stages of the Peneidæ seem to be not uncommon in the warmer seas. Besides the published figures of Müller

and Claus, I have seen drawings of the developmental stages, from the protozoëa onward, 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 re-discovered Müller's nauplius; yet in the light of our knowledge of the development of Mysis, Euphausia and Lucifer, I see no good ground for refusing to accept Müller's reasons for believing his nauplius and zoëa stages to be parts of one life-history.—*Walter Faxon, Cambridge, Mass., March 9, 1883.*

DISCOVERY OF EURYPAUROPUS IN EUROPE.—Dr. R. Latzel, of Vienna, writes us under date of February 23, that last summer he discovered in Austria the genus Eurypauropus of Ryder. It is there represented by two species, the rarer one of which is very similar to *Eurypauropus spinosus* Ryder. He has also detected *Pauropus huxleyi* of Lubbock. We believe this is the first time Pauropus has been detected on the continent.

REPUGNATORIAL PORES IN THE LYSIOPETALIDÆ.—Having received, through the kindness of Dr. Latzel, specimens of *Lysioptalum carinatum* Brandt, from Dalmatia, which is a very large species, I have been able to examine the repugnatorial pores, which are very distinct, their crateriform openings being situated each between two ridges on the anterior edge of the raised portion of the scute. In *L. illyricum* Latzel, from Austria, they are with difficulty perceived, the area in which they are situated not being discolored with yellow; but they can be detected with a half-inch objective. The two European species mentioned are provided with setæ, while our *L. lactarium* is naked. In the latter species the repugnatorial pores are situated in the middle of the yellow lateral spot, between two carinæ, which are higher and closer together than any of the others. They can be seen with a Tolles triplet.

Reëxamining the cave Lysiopetalid, *Pseudotremia cavernarum* Cope, from Wyandotte cave, and a variety *carterensis* which inhabits the Carter caves, Ky., I cannot with certainty discover their site, as they are nearly, if not quite, obsolete. It is possible that in cave species, where there are apparently no enemies of these Myriopods, their pores become at least externally obsolete.—*A. S. Packard, Jr.*

POISON-APPARATUS OF SCORPIONS.—M. Joyeux-Laffuie finds that the poison organ of the scorpion (*S. occitanus*) is formed by the last abdominal segment, where two small oval orifices serve for the exit of the poison; there are two glands, equal in size, and symmetrically arranged; each occupies a space, covered externally by the chitinous skeleton, and having internally an interior and posterior membrane, formed by striated muscular fibres, which are inserted into the chitinous skeleton. By their contraction the poison is forced outwards. The wall of the gland consists of a

delicate layer, formed by cellular tissues and smooth muscular fibres; on its internal surface there are projecting lamellæ, which increase the extent of the secreting surface; below this, is a layer of prismatic cells, which are filled with protoplasm, containing in suspension, and in abundance, fine rounded granulations, which are characteristic of the poison of the scorpion, and hide the nuclei, which only become apparent on the addition of acetic acid; these are the cells which elaborate the poison, and from which it escapes, by the rupture of the cells, into the central cavity of the organ.

Physiologically, this poison is very active, and that in direct relation to the quantity introduced; one drop is soon fatal to a rabbit and still more active on a bird; seven to eight frogs may be killed by one drop, and the hundredth part of one is fatal to an ant of large size. It would appear to affect the nervous system, and has undoubtedly a marked action on striated muscle, suppressing spontaneous and reflex movement.—*Journal of the Royal Microscopical Society.*

THE HABITS OF THE SNAKE BIRD.—The mechanism of the neck in the darters (*Plotus*) is treated by W. A. Forbes in the Proceedings of the London Zoölogical Society. The darters feed entirely, so far as Mr. Forbes had been able to observe, under water. "Swimming with its wings half expanded, though locomotion is effected entirely by the feet, the bird pursues his prey (small fishes) with a peculiar darting or jerking action of the head and neck, which may be compared to that of a man poising a spear or harpoon before throwing it. Arrived within striking distance, the darter suddenly tranfixes, in fact, bayonets, the fish on the tip of its beak with marvelous dexterity, and then immediately comes to the surface, where the fish is shaken off the beak by jerking of the head and neck (repeated until successful), thrown upward, and swallowed, usually head first." A study of the neck in the recently dead bird leaves little doubt as to the mechanism by which this peculiar impaling of the prey is effected. The eighth cervical vertebra is articulated with the seventh in such a way that the two cannot naturally be got to lie in the same line, but form an angle, open forwards, of about  $145^{\circ}$ , when the two bones are stretched as far as possible in that direction. After further describing the mechanism, Mr. Forbes thus concludes his paper: "It is obvious that considerable advantage is gained by the action in question, the rapid protrusion of the narrow neck and head over a small space by this mechanism necessitating a less amount of exertion than would a similar movement of the whole bird over the same space, and being equally efficacious in striking the prey. The whole mechanism, it may be observed, exists in a less developed form in the neck of the herons, cormorants, etc.; and it requires but a slight modification of the arrangement of these parts in those birds—none of which, so far as I know, impale their prey like

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[FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. XXVII, JANUARY, 1884.]



ART. VIII. — *On the so-called Dimorphism in the Genus Cambarus*; by WALTER FAXON.

THE existence of two forms of the adult male in all the species of the genus *Cambarus* was discovered by Louis Agassiz and Henry James Clark. The differences between the two forms affect more especially the first pair of abdominal appendages, organs concerned in the act of coition, but also extend to the general form and sculpture of the body. In one form (unhappily called by Dr. Hagen the "second form"), the first pair of abdominal appendages have a structure nearly like that seen in all *young* males. The hooks on the third joint of the third (in some species of the third and fourth) pair of legs are small, and in the sculpture of the shell and shape of the claws, this form approaches the female. In the other form (Hagen's "first form"), the articulation near the base of the first pair of abdominal appendages is gone and the whole member is much more highly specialized, the terminal hooks being horny, more widely separated and in every way more highly developed; in

those species with bifid tips to these appendages, the branches are longer, slenderer, more widely separated and stiffer; the hooks on the thoracic legs are longer and more perfectly finished; the sculpture of the whole body is more pronounced and the claws are larger and more powerful. No intermediate conditions are found, and there is no relation between these forms and the size of the individual, the "second form" being large and the "first form" small, or *vice versa*. Hence we are forbidden to interpret the two forms as stages in ordinary development. Dr. Hagen has shown that in individuals of the "second form" the internal generative organs are smaller than in the "first form," but having only alcoholic material he was unable to determine anything concerning the presence or absence of spermatozoa. He interprets the facts as a case of dimorphism and surmises that the "second form" males are sterile individuals.

In the autumn of 1875, I received a lot of living *Cambarus rusticus* Girard, from Kentucky, males of the "first form" and females, which bred freely in confinement. After pairing, three of the males moulted and were thrown, while in the soft-shelled state, into alcohol together with their exuviae. An examination of these specimens now reveals the fact that the soft-shelled specimens are all of the "second form," their exuviae of the "first form!" After attaining the "first form" and after pairing, the same individual has reverted to the "second form." It is now clear that we are not dealing with a case of true dimorphism such as is well known among insects and plants, but it appears probable that the two forms of the crayfish are alternating periods in the life of the individual, the "first form" being assumed during the pairing season, the "second form" during the intervals between the pairing seasons. It is to be inferred that before the animal is again capable of reproduction, another moult will bring it again into the "first form."

The fact that large collections, made at one time and place, often contain only one or a great preponderance of one, form of the male, is now explained.

I have also before me a male specimen of *Cambarus propinquus* Girard, from Wisconsin, belonging to the Peabody Museum of Yale College, which was taken in the act of moulting. The old shell is "first form," the soft shell emerging from it is "second form."

It is remarkable that two forms of the male have not been detected in any other genus of crayfishes.

Fritz Müller (Für Darwin) has pointed out the existence of two forms of the male in the genera *Tanais* and *Orchestia* which he considers as truly dimorphic forms. It is possible that these are to be explained in the same way as the two forms of the male *Cambarus*.

Such a change as this connected with the reproductive periods is unparalleled, so far as I know, among the Invertebrata; and even among the Vertebrata, the cases of partial atrophy of the generative organs or shedding of antlers (as in the stag) after the rut is over are hardly comparable.

At the time I had the specimens alive my attention had not been drawn to the questions relating to the two forms of the males, so that I failed to make anatomical examination, and the specimens have now lain too long in alcohol to be serviceable for internal dissection. I hope, however, that naturalists who are more favorably situated will be able to throw more light on this subject.

I will add that the males of extraordinary size which I have seen, are all of the "first form." Do these very old individuals cease to moult? Do they become permanently capable of reproduction?

Museum of Comparative Zoölogy, Cambridge, Mass., Nov. 12, 1883.

M. J. Rathbun

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CONTRIBUTIONS FROM THE  
ZOOLOGICAL LABORATORY OF THE MUSEUM OF COMPARATIVE ZOOLOGY  
AT HARVARD COLLEGE.

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DESCRIPTIONS

OF

NEW SPECIES OF CAMBARUS;

TO WHICH IS ADDED

A SYNONYMICAL LIST OF THE KNOWN SPECIES  
OF CAMBARUS AND ASTACUS.

BY WALTER FAXON.

[REPRINTED FROM THE PROCEEDINGS OF THE AMERICAN ACADEMY  
OF ARTS AND SCIENCES, VOL. XX.]

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DECEMBER, 1884.

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## VII.

CONTRIBUTIONS FROM THE ZOÖLOGICAL LABORATORY  
OF THE MUSEUM OF COMPARATIVE ZOÖLOGY  
AT HARVARD COLLEGE.

No. VII.—DESCRIPTIONS OF NEW SPECIES OF *CAMBARUS*;  
TO WHICH IS ADDED A SYNONYMICAL LIST OF THE KNOWN SPECIES OF *CAMBARUS*  
AND *ASTACUS*.

By WALTER FAXON.

Communicated November 12th, 1884.

SIXTEEN years have elapsed since the North American Crayfishes were revised by Dr. Hagen.\* In the mean while a large amount of new material has accumulated in the Museum of Comparative Zoölogy. On examination, this material revealed so many new forms, and shed so much light on the variability and geographical distribution of these animals, that it seemed desirable to subject the group anew to a critical revision. With this in view I have examined all the collections accessible, including those belonging to the Museum of Comparative Zoölogy, the Boston Society of Natural History, the Peabody Academy of Science at Salem, Mass., the Academy of Natural Sciences of Philadelphia, the United States National Museum at Washington, D. C., Yale College, New Haven, Conn., Bowdoin College, Brunswick, Me., and Butler University, Irvington, Ind., together with the private collections of Mr. P. R. Uhler of Baltimore, Md., Prof. O. P. Hay of Irvington, Ind., Prof. L. A. Lee of Brunswick, Me., Prof. A. S. Packard of Providence, R. I., Prof. D. S. Jordan of Washington, D. C., Mr. R. S. Tarr of Gloucester, Mass., Dr. C. Hart Merriam of Locust Grove, N. Y., and Prof. B. F. Koons of Mansfield, Conn. Only through the kind offices of the curators of these collections was a thorough revision of this difficult group possible. I have now ready for the press the first part of a revision of the *Astacina*, embracing

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\* Ill. Cat. Mus. Comp. Zoöl., No. III. This monograph was finished in 1868, although not published until 1870.

all the Crayfishes found in the Northern hemisphere, viz. the family *Potamobiidae* of Huxley. Owing to unavoidable delay in the publication of the full Revision in the Memoirs of the Museum of Comparative Zoölogy, illustrated by quarto lithographic plates, it is thought advisable to publish the following descriptions of the new species. All of them will be figured in the final Memoir.

#### GENUS CAMBARUS.

§ 1. *Third and fourth pairs of legs of male furnished with hooks on the third segment. First abdominal appendages of the male with outer part truncate at the tip and furnished with one to three small recurved teeth, inner part ending in an acute spine which is generally directed outwards.*

a. *Rostrum with ante-apical lateral spines.*

##### 1. C. HAYI, sp. nov.

Male, form I. Rostrum broad, triangular, excavated, sparsely pubescent above, acumen short, lateral spines moderate. Carapace punctate above, granulated on the sides, the granules ciliate. Lateral spines slightly developed in fully-grown individuals, more prominent in the young. Areola narrow. Abdomen broad, shorter than the cephalo-thorax. Pleural angles rounded. Proximal segment of telson with two spines on each side of the distal border. Hind margin of telson slightly concave. Anterior process of epistoma broadly triangular. Antennæ shorter than the body. Antennal scale a little shorter than the peduncle, equal to the rostrum, broad, broadest at the middle. Chelipeds slender, chela long, inner and outer margins parallel, squamoso-tuberculate, tubercles ciliate, those along the inner margin of the hand blunt spiniform. Fingers longer than the hand. Opposed margins of fingers ciliate, with one or two small spinous teeth. Carpus long triangular, smooth without, tuberculate and spinous within. Meros with scattered puncta without, tuberculate on the upper margin, one or two spines at the anterior end of upper margin, two rows of spines beneath. Third and fourth pairs of legs hooked on third segments. Anterior abdominal legs of moderate length, deeply excavated on the outer side near the tip. A beard-like tuft of cilia from the protuberance behind the excavation. Tip bears three flattened horny teeth. Inner part ciliate, with a long spine directed outwards and forwards.

The second form of the male has shorter chelipeds, smaller hooks

on the second and third pairs of legs, the terminal teeth of the first pair of abdominal legs smaller and not corneous.

In the female the chelipeds are short, the chelæ broad. Sternum bituberculate between the fourth pair of legs. Annulus ventralis umbilicoid, with a tubercle in the median depression.

Length, 100 mm. Rostrum, 15 mm.; acumen, 3 mm. Length of carapace, 51 mm. From cervical groove to posterior margin of carapace, 18.5 mm. Abdomen, 50 mm. Width of areola, 1.5 mm. Chelipeds, 92 mm. Chela, 43 mm.

Known localities. Mississippi: Macon, Artesia.

Closely related to *Cambarus Blandingii*, but easily distinguished by the first pair of abdominal legs of the male, which are characteristic even in very small specimens. Over a dozen specimens of this species (including males of the first form, males of the second form with first pair of abdominal appendages articulated near the base, and unarticulated, and females) were collected by Prof. O. P. Hay in Eastern Mississippi. One lot has a particular locality specified, Macon. Macon is situated on the Noxubee, an affluent of the Tombigbee River. Another lot was collected at Artesia, a town about twenty miles north of Macon.

## 2. C. PUBESCENS, sp. nov.

Male, form II. Rostrum long, triangular, sides sub-parallel at the base, then converging towards the lateral spines, which are evident; slightly depressed above at the base, subplane, with raised margins; ciliated especially on the acumen; acumen long, pointed. Post-orbital ridges with anterior spines. Carapace cylindrical, fore border angulated behind the antennæ, punctate above, slightly granulated on the sides, with one lateral spine on each side. Cervical groove ciliated. Cardiac region short (much less than one third as long as the anterior part of the carapace). Areola broad. Sternum covered with a dense growth of coarse setæ. Abdomen longer than the cephalo-thorax. Proximal segment of telson armed on each side with four spines. Anterior process of epistoma broad triangular with ciliated margin. Basal segment of antennule with a sharp spine below near the inner margin of the middle of its length. Antennæ shorter than the body. Second and third segments with acute external spine; scale a little longer than peduncle of antennæ and rostrum, moderately broad, broadest below the middle. Third maxillipeds hairy within and below. Chela moderately broad, covered with inconspicuous ciliate squamous tubercles, internal margin nearly straight.

Fingers as long as the hand, densely ciliated. Carpus tuberculate, a prominent spine within, and one near each point of articulation with the chela. Merois smooth outside and inside, tuberculate and spinous above, biserially spinous and ciliate beneath. Third and fourth pairs of legs toothed on the third segment. Fifth pair of legs with a hook on the basal segment. Anterior abdominal appendages of moderate length, articulated at the base, internal part with an articulated spine obliquely placed, external part terminating in a rounded head with two short, blunt teeth.

Female. Differs from the male in its shorter and smaller claws. The sternum is densely ciliated as in the male. The annulus ventralis conical with sigmoid longitudinal fissure; movable.

Length, 54 mm. Carapace, 26 mm. Abdomen, 29 mm. Distance from tip of rostrum to cervical groove, 19 mm; from cervical groove to posterior border of carapace, 7 mm. Width of areola, 3 mm. Length of chela, 15.5 mm.; breadth, 4 mm. (In the female, which is 59 mm. long, the chela is 12 mm. long by 4 mm. wide.)

Two specimens, one male of the second form and one female, in the U. S. National Museum (No. 3181), collected by A. Graves in McBean Creek, a tributary of the Savannah River a little south of Augusta, Georgia, are the types of this species. There are two young female specimens from the same region, Richmond Co., in the Museum of Comparative Zoölogy.

Differs from *C. Lecontei* and *C. angustatus* by its broader areola, subplane rostrum, and the pubescence of rostrum and cervical groove. The male appendages also differ, as shown in the description.

b. *Rostrum without ante-apical lateral spines (at least in full-grown specimens).*

### 3. *C. ALLENI*, sp. nov.

Male, form I. Rostrum broad, triangular, somewhat deflexed, smooth, excavated above, margins raised into sharp crests and gradually converging to near the tip, where they suddenly approximate each other to form the short, sharp acumen; no lateral spines. Post-orbital ridges without spines. Carapace cylindrical, somewhat compressed laterally, fore border angulated behind the antennæ, punctate above, granulated on the sides. Cervical groove deeply sulcated, without lateral spines. Cardiac region more than one third as long as the distance from the tip of rostrum to hind border of carapace. Areola narrow. Abdomen broad, longer than cephalo-thorax. Angles of pleura rounded. Three or four spines on each side of posterior border

of basal segment of the telson. Terminal segment of telson shorter than basal part, one third broader than long, hind margin concave. Anterior process of epistoma subquadrangular. Basal segment of antennules with a sharp spine below near the inner margin, half-way towards the end of the segment. Antennæ shorter than the body, second and third segments with an external sharp tooth. Antennal scale equal to peduncle, slightly surpassing the rostrum, broad, broadest at the middle, rounded at apex, terminating in a short spine, external margin inflated. Third maxillipeds hairy within and below. Chelipeds slender, chela long, subcylindrical, squamoso-tuberculate, tubercles ciliate anteriorly, internal border straight, serrate. Fingers as long as the hand, with alternate longitudinal ribs and lines of ciliate impressed dots. Opposed margins of fingers straight, unidentate. Carpus squamoso-tuberculate within, obsoletely so without, with one prominent spine on inner border. Meros punctate outside, ciliato-tuberculate within and on upper margin, which has two ante-apical spines obliquely placed; two rows of spines beneath. Third and fourth pairs of legs hooked on third segments, hooks of fourth pair bituberculate. Fifth pair of legs with a flattened laminate tubercle on basal joint. Anterior abdominal appendages of moderate length, bifid at apex, outer part forming a broad flattened plate whose anterior margin is furnished with hairs and one strong seta, the posterior margin of the plate produced anteriorly into a blunt tooth-like process. Inner part bearded within, and produced into a long erect spine, which much exceeds in length the outer part of the appendage.

Length, 62 mm. Rostrum, 6 mm. Carapace, 30 mm. From tip of rostrum to cervical groove, 19.5 mm. From cervical groove to posterior border of carapace, 10.5 mm. Abdomen, 32 mm. Width of areola, 7 mm. Antennæ, 47 mm. Chelipeds, 49 mm. Chela, 23 mm. Width of chela, 6 mm.

St. John's River, Hawkinsville, Orange Co., Fla.: J. A. Allen.

A well-marked species with toothless excavated rostrum (younger specimens probably have marginal rostral teeth), narrow areola, long, subcylindrical chelipeds covered with ciliated squamous tubercles. The first abdominal legs are not jointed, the hooks on the third and fourth pairs of thoracic legs are large and well-finished, so that I consider the single specimen examined to be the first form.

In the collection of the Academy of Natural Sciences of Philadelphia there is a specimen from Hernando Co., Fla., Jos. W. Wilcox, which is probably the second form of the male of this species. The sexual appendages are not articulated at the base. The hooks on the

third and fourth pairs of legs are small tooth-like processes merely. Besides the differences in these hooks and in the sexual appendages the following may be pointed out: the rostrum has small lateral teeth near the tip, the post-orbital ridges have a sharp spine at their anterior end, the basal segment of the fifth pair of legs is armed with a sharp hooked tooth in place of a flattened tubercle, and the hind segment of the telson is longer in proportion to its width.

§ 2. *Third pair of legs of male hooked. First pair of abdominal appendages of male as in § 1.*

4. C. SIMULANS, sp. nov.

Male, form I. Rostrum broad, deeply excavated; margins raised into sharp crests which overhang the base of the sides of the rostrum, converging, sinuated before the tip to form the short acumen; no lateral spines; the acumen is barely margined. Post-orbital ridges subacute in front, divergent and ending in slight callosities behind. Carapace ovate, narrowing in front, gastric area smooth, cardiac area lightly punctate, sides granulate; anterior border notched behind the antennæ; cervical groove sinuate, split on the sides, with a minute terminal branchiostegian spine; no lateral spine; areola more than one half as long as the distance from the point of the rostrum to cervical groove, narrow, carinate, expanding into an anterior and a posterior triangular field; two longitudinal dotted lines run along the areola from the anterior triangle to the posterior triangle, which is irregularly and sparsely dotted. Abdomen broad, shorter than carapace, punctate, posterior margins of pleura obliquely convex; hind margin of anterior segment of telson bi- to multi-denticulate on each side, posterior segment short, hind border almost straight; median rib of inner plate of swimmeret ends inside of the margin. Basal segment of antennule with a spine below. Antennæ shorter than body, second and third segments furnished with minute blunt spinules, scale a trifle longer than the rostrum, very broad, broadest in the middle, truncate at apex, external terminal spine minute. Anterior process of the epistoma triangular, antero-lateral borders convex, rimmed, anterior angle truncate or notched in old specimens, with a projecting median spine. Third maxillipeds densely hairy within and beneath. Chela long, slender, squamoso-tuberculate, internal margin long, straight, strongly dentate; fingers long, punctate, external border of movable finger tuberculate, inner border of both fingers toothed, a prominent tubercle near the base of external finger opposite a more or less clearly marked incision

in the base of the thumb. Carpus triangular, obliquely truncate, inner margin armed with a stout spine and some low, scattered tubercles, lower side with two or three teeth and numerous small tubercles. Superior margin of meros with short spines, which are sometimes obsolescent except the distal ones; below, the biserial spines are well developed. Sternum hairy. Third pair of legs hooked. First pair of abdominal appendages strong, straight, internal part with a very small, straight apical spine, which does not reach the end of the external part; external part with two horny terminal teeth, one of which is flat and disc-shaped, the other slender and somewhat curved.

Length, 97 mm. Breadth, 27 mm. Length of carapace, 51 mm. Length of areola, 18 mm. Width of areola, 1.3 mm. Length of rostrum, 11.5 mm. Length of chela, 50.5 mm.

Male, form II. Chelipeds smaller, hooks on the third pair of legs smaller, first abdominal appendages without horny teeth at apex.

Female. Chelæ smaller and shorter-fingered than in the male; annulus ventralis bituberculate in front, each tubercle denticulate.

Known localities. Texas: Dallas; east of Canadian River (Coll. U. S. Nat. Mus.). Kansas: Fort Hays.

This species is remarkable in having the general form of body and claw of the *C. Blandingii* group of species, while the fact that only the third pair of legs are hooked places it in the *C. advena* group. The male appendages and the female annulus are very near to those of *C. gracilis*. In the shape of the body, areola, antennal scale, and claw, it resembles *C. Blandingii*, var. *acuta*, but the rostrum is deeply excavated, and toothless even in small specimens. The full cephalo-thorax and large abdomen seem to indicate that it is not a pre-eminently burrowing species, like its allies, *C. gracilis*, *C. advena*, &c.

There are specimens in the United States National Museum collected by the United States Exploring Expedition West of the Hundredth Meridian in pools east of the Canadian River. This locality, I presume, is within the limits of the State of Texas.

§ 3. *Third pair of legs of male hooked. First pair of abdominal appendages of male thick, terminating in two short, recurved teeth.*

a. *Rostrum devoid of lateral teeth.*

5. *C. ACUMINATUS*, sp. nov.

Rostrum long, tapering, ending in a long, sharp acumen, without lateral spines; upper surface smooth, somewhat hollowed out, margins punctate, ciliate, raised into low sharp crests. Post-orbital ridges with



sharp anterior spines. Carapace smooth, punctate, granulated on the sides, cervical groove sulcate, sinuate; a sharp lateral and branchiostegian spine; sub-orbital angle rounded; an irregular indentation on the side of the carapace, below the lateral spine, on the hepatic region and anterior part of the branchial region; areola broad, smooth, punctate, less than one half as long as the distance from the tip of the rostrum to the cervical groove. Telson bispinose on each side. Epistoma triangular, angles rounded. Second and third segment of the antennæ with a strong sharp spine; scale of moderate length, rather broad, inner margin rounded, outer margin thick, turned outwards at the tip. Third maxillipeds hairy within. Chela moderate, punctate, serrato-tuberculate on internal border, fingers setose on their inner margins, external border of outer finger submarginate. Carpus armed with a strong internal spine and smaller inferior median and external spines. Meros with well-developed biserial spines below and two obliquely placed near the distal end of the superior border. In some specimens one of the superior pair is obsolete. Third pair of legs hooked. First pair of abdominal appendages as in *C. Bartonii*.

Length, 48 mm. Carapace, 23 mm. Rostrum, 6 mm. Areola, 7 mm. Breadth of areola, 2 mm.

Saluda River, west of Greenville, S. C. Collected by Prof. D. S. Jordan. Three specimens, one male of the second form, two females. For the opportunity to examine these I am indebted to Prof. O. P. Hay of Butler University, Irvington, Ind. Differs from the other species of the *C. Bartonii* group by its long, gradually tapering rostrum, short metacarapace, strongly developed spines of carapace, antennæ, and meros. The acumen of the rostrum is scarcely upturned at the tip.

Specimens from North Carolina, Old Fort, McDowell Co., and French Broad River, (in Mus. Comp. Zool. and Acad. Nat. Sci. Phila.), differ from the above in having the rostrum flatter and less attenuated at the tip, a shorter antennal scale, sub-orbital angle produced into a sharp spine. These may prove to be a distinct species from the Saluda River specimens. They approach *C. robustus*, but may be distinguished from that species by the longer-pointed rostrum, shorter metacarapace, better-developed spines, etc.

#### 6. *C. DUBIUS*, sp. nov.

Rostrum short, broad, sides sub-parallel from the base to near the tip, when they suddenly converge to form the short, broadly triangular acumen; the rostrum is angulated but not toothed at the base of the

acumen; upper surface of rostrum concave, sides thickened, punctate-lined. Post-orbital ridges without spines, slightly swollen at the posterior end. Carapace longer than the abdomen, oval, punctate, granulated on sides, posterior dorsal margin depressed, cervical groove hardly sinuate, crossing the median line of the back half-way between the base of the rostrum and the posterior margin of the carapace; lateral and branchiostegian spines obsolete; sub-orbital angle little developed, obtuse; areola narrow, with two irregular longitudinal rows of dots. Epistoma subquadrangular. Abdomen small, short; anterior segment of telson bispinose on each side, posterior segment rounded behind. Antennæ shorter than the body, second and third segments without spines, scale small. External maxillipeds hairy within. Chela punctate, inner margin of hand serrato-tuberculate, outer margin thickened, serrate; fingers somewhat down-curved, slightly gaping, toothed on their opposed margins. Carpus with a strong tooth on the inner side, teeth of the lower side obsolescent. Superior border of meros serrate, lower side armed with two rows of spines. Third pair of legs hooked. First pair of abdominal legs of the first form of the male short, thick, twisted, internal part cylindrical, recurved, with pointed apex; external part broader, plane within, apex recurved, compressed, external margin corneous, striated.

Length, 62 mm. Length of carapace, 33.5 mm. Length of abdomen, 28.5 mm. Length of rostrum, 5 mm. Metacarapace, 15 mm. Width of areola, 1.5 mm.

Known localities. West Virginia: Cranberry Summit, Preston Co. Virginia: Pennington's Gap, Lee Co. Tennessee: Cumberland Gap.

This species has the general appearance of *C. Diogenes*, but the rostrum is short, as in *C. Bartonii*, and the areola is not obliterated in the middle by the apposition of the branchio-cardiac lines. The few (four) specimens which I have seen come from the Appalachian Mountain region of Virginia and West Virginia. According to Mr. Uhler, it makes mud chimneys like *C. Diogenes*, which it seems to represent in the mountain regions, *C. Diogenes* belonging to the lowlands.

#### 7. *C. ARGILLICOLA*, sp. nov.

Rostrum short, broad, down-curved, excavated, with a deep foveola at base; acumen short, broadly triangular, acute, no lateral spines. Post-orbital ridges without anterior spines, swollen behind. Cephalothorax laterally compressed, carapace punctate, anterior border not angulated, cervical groove sinuate, no lateral or branchiostegian spine.

Areola linear in the middle, with an anterior and posterior triangular space, the latter the larger. Abdomen broad, but narrow at the base, longer than the cephalo-thorax. Telson uni- or bi-spinose on each side. Epistoma rounded in front. Antennal scale small, rounded within. Third maxillipeds heavily bearded within, lightly so beneath. Chela large, hand swollen, denticulate on inner border, irregularly punctate, fingers flattened laterally, punctate and costate; the movable finger has a single row of tubercles on external border and a very prominent rib on its upper face, its internal, cutting edge is toothed and excised at the base. The outer finger is sharply marginate on its external border, inner border toothed and heavily bearded at the base. Carpus armed with a sharp spine and a few minute tubercles within; beneath them is a sharp median anterior spine, and a minute spiniform tubercle between this and the spine of the internal border. Meros furnished with one or two small sub-apical teeth on the superior border, and two rows of teeth below. Second pair of legs ciliate near the end. Third pair of legs of male hooked. First abdominal appendages of male and annulus of female as in *C. Diogenes*.

Length, 76 mm.

Known localities. Dominion of Canada: Toronto, Prov. Ontario. Michigan: Detroit, East Saginaw (Coll. Peabody Mus. Yale Coll.). Indiana: New Albany. Louisiana: New Orleans (Coll. U. S. Nat. Mus.). North Carolina: Kinston.

Closely related to *C. Diogenes*, but at once distinguished by the sharply compressed fingers bearded at the base, excised thumb with a single row of tubercles on external margin, non-angulated anterior border of carapace, etc. The types of this species were dug out of burrows in solid blue clay in Detroit, Mich., by Mr. H. G. Hubbard, in August, 1873. The burrows were three to five feet deep. At the bottom of each burrow was a pocket in a layer of loose gravel and clay, holding water. Just above the water-line an enlargement in the burrow formed a shelf on which the animal rested.

Specimens from Kinston, N. C., and New Orleans, La., which I have referred to this species, are not adult, and cannot be determined with absolute certainty.

#### 8. *C. UHLERI*, sp. nov.

Male, form I. Rostrum of moderate length, sides nearly parallel to base of acumen, which is broadly triangular, acute; no lateral spines; upper surface of rostrum plane, punctate, lightly foveolate at base, margins raised into a low, sharp crest, punctate-lineate; there is

a faint trace of a median longitudinal carina. Post-orbital ridges without anterior spines, swollen posteriorly. Carapace oval, punctate, granular on sides. Antero-lateral border not angulate or notched. No lateral or branchiostegian spines. Cervical groove sub-sinuate. Areola none. Abdomen longer than cephalo-thorax. Anterior segment of telson bispinose on each side, posterior segment round behind. Epistoma triangular. Antennæ short, with very small spines on the second and third segments, scale short, broad, inner margin rounded. Third maxillipeds hairy within and beneath. Chela moderate, hand inflated, punctate, ciliate, inner margin ornamented with a row of sharp dentiform tubercles, outside of which is a row of smaller tubercles. Fingers compressed, punctate and costate, movable finger with a single row of tubercles on the outer edge, a prominent rib running along the middle of the upper surface, inner margin excised at base and furnished with tuberculiform teeth. External finger toothed within, hairy at base, outer border marginate. Carpus armed with a strong tooth and a few small scattered tubercles on the inner side, a stout median anterior spine beneath, and two or three smaller ones between the median and internal spine. Superior border of meros serrate, inferior surface with two longitudinal rows of spines. Second pair of legs densely ciliate on the inner side near the tip. Third pair of legs hooked. First pair of abdominal appendages of male and annulus of female as in *C. Diogenes*.

Length, 65 mm. Carapace, 30.5 mm. Rostrum, 6.5 mm.

Known localities. Maryland: Carolina Co. (Coll. P. R. Uhler); Dorchester Co.; Talbot Co. (Coll. P. R. Uhler); St. Mary's Co. (Coll. P. R. Uhler); Wicomico Co. (Coll. P. R. Uhler); Somerset Co.; Worcester Co.

This species was discovered by Mr. P. R. Uhler, of Baltimore, in the counties of Maryland enumerated above, on the Chesapeake and Atlantic coasts of Maryland. It is found in salt marshes, covered twice daily by the tides, and also in brackish and fresh-water ditches in company with *C. Blandingii*. In Dorchester County it is found far back in the lowlands in the neighborhood of Vienna.

*C. Uhleri* is easily distinguished from *C. Diogenes* and *C. argillicola* by its plane rostrum, shape of the hand, etc.

b. *Rostrum with small lateral teeth.*

9. *C. GIRARDIANUS*, sp. nov.

Male, form II. Rostrum broad, excavated, margins with a line of puncta, slightly convergent; acumen long, ending in a brown corneous

upturned tip; a pair of minute, brown horny teeth at base of the acumen. Post-orbital ridges depressed, with sharp anterior spines. Cephalo-thorax as long as the abdomen. Carapace flattened above, densely and finely punctate, slightly granulated and finely ciliated on the branchial and hepatic regions. Cervical groove sulcate, sinuate, with minute lateral spine and terminating with a small branchiostegian spine; external angle of the orbit very prominent, ending in a spinule. Areola long and wide, plane, punctate, in length more than one half the distance between the tip of rostrum and posterior margin of the carapace; sides nearly parallel to within a short distance of the posterior margin, where they diverge. Telson bispinous on each side. Anterior process of epistoma broad. Antennæ longer than the body, scale moderately broad, ending in long, acute apical spine. Third pair of maxillipeds hairy within. Chelipeds moderate; chela large, densely punctate, inner margin short, lightly serrate; fingers long, with parallel rows of puncta, toothed within, outer one bearded within at base. Carpus broad, obliquely truncated, punctate above, with a strong median spine on the inner side and a small double one at the base; below the carpus is armed with a spine on the anterior border. Meros smooth, with a single ante-apical spine on the upper edge and the usual biserial ones beneath; of the latter, only two or three at the proximal end are developed. Thoracic sterna naked. Third pair of legs hooked on the third segment. Fourth pair of legs with a small ovate basal tubercle. First pair of abdominal appendages articulated near the proximal end, stout, short, swollen in the middle. External part with the compressed apex in the form of a strong, obtuse, recurved tooth, double within; internal part recurved, cylindrical, short, acute.

Female. Annulus ventralis transverse, with a sigmoid sulcus.

Measurements of an individual:—

Length of body . . . . .	60 mm.
“ “ cephalo-thorax . . . . .	31 “
“ “ abdomen . . . . .	29 “
From tip of rostrum to cervical groove . . . . .	20 “
From cervical groove to hind margin of carapace . . . . .	11 “
Width of areola . . . . .	3.5 “
Length of rostrum . . . . .	7.5 “
“ “ acumen of rostrum . . . . .	2.5 “
“ “ chela . . . . .	20 “
“ “ inner margin of hand . . . . .	7 “
“ “ fingers . . . . .	13 “
“ “ antennæ . . . . .	58 “

Cyprus Creek, Lauderdale Co., Ala.

This species is near *C. extraneus*, but differs in its longer and narrower areola, in the short hand and long fingers, the single superior ante-apical spine on the meros, naked thoracic sterna (in *C. extraneus* they are setiferous), the greater smoothness of the body altogether, and the fineness of the punctation of the carapace; the sub-orbital angle is very much more projecting than in *C. extraneus*.

This species was discovered by Mr. C. L. Herrick in Cypress Creek, Lauderdale Co., Ala., when collecting under the auspices of the U. S. National Museum, in October, 1882. The specimens obtained were two males, form II., and three females.

#### 10. *C. JORDANI*, sp. nov.

Male, form II. Rostrum broad, subplane, sides nearly parallel, acumen long, with minute lateral teeth at base. Post-orbital ridges provided with sharp anterior spines. Carapace punctate (sparsely so on the gastric region), slightly granulated on the sides. A single acute spine on each side of the carapace behind the cervical groove, and a branchiostegian spine on the anterior border. Sub-orbital angle prominent. Areola long, narrow, widening gradually anteriorly, suddenly posteriorly, smooth, with but few puncta irregularly disposed in its field. Abdomen longer than the cephalo-thorax; proximal segment of the telson bispinous, distal segment rounded posteriorly. Epistoma triangular. Antennæ equal in length to the body minus the telson, scale broad, greatest width toward the distal end, which is subtruncate and furnished with a sharp external spine. Third pair of maxillipeds hairy within. Chela punctate, ciliate; inner margin of hand short, serrate; fingers long, costate, outer border of movable one serrato-tuberculate. Carpus with a strong, acute, median spine, and a small basal spine on inner border; a small spine at each articulation with the chela. Meros smooth on the external surface, two ante-apical spines obliquely placed on the upper edge. First pair of abdominal appendages short, thick, articulated near the base, terminating in two blunt, recurved teeth.

Length of body . . . . .	47 mm.
“ “ carapace . . . . .	23 “
“ “ abdomen . . . . .	24 “
“ “ rostrum . . . . .	6 “
“ “ acumen of rostrum . . . . .	2 “
Length from point of rostrum to cervical groove . . . . .	15 “
“ “ cervical groove to hind margin of carapace . . . . .	8 “
Width of areola . . . . .	1.8 “
Length of antennæ . . . . .	44 “

Of this species I have seen but one specimen, a male of the second form, collected by Prof. D. S. Jordan in the Etowah River near Rome, Georgia, communicated by Mr. P. R. Uhler of Baltimore. It has a toothed rostrum and first abdominal appendages like *C. Bartoni*. It is distinguished from the other allied species by its flat rostrum and narrow areola.

#### 11. *C. CORNUTUS*, sp. nov.

Male, form I. Rostrum long, narrow, excavated above; margins divergent at the base, thickened, concave, costate; acumen long, with upturned horny tip; lateral teeth at base of acumen upright, stout, blunt, horny. Post-orbital ridges sulcate on the outer side, with well-developed horny-tipped anterior spines. Carapace flat, smooth, and punctate above, granulated on the sides; a depression on each side just outside the orbital ridges; no sub-orbital angle nor spine; cervical groove sulcated, sinuate, with a strong, sharp lateral spine; no branchiostegal spine; areola long, of moderate width, plane, punctate, widening at the posterior end of the carapace. The length of the areola is equal to the distance from the cervical groove to the base of the rostrum. Abdomen broad, as long as the cephalo-thorax without the acumen of the rostrum, pleura triangular, with sharp lateral angles. Terminal segment of telson broader than long, posterior border rounded; anterior segment of telson bispinous on each side. Anterior process of epistoma very broad, short, triangular; apex not truncated nor notched. Thoracic sterna ciliated. Basal segment of antennule with a spine on lower side on the distal half of the segment. Antennæ longer than the body, flagellum very large, composed of annulations flattened in the vertical direction, conspicuously bearded along the inner margin. Antennal scale oblique to the horizontal plane of the body, a little longer than the rostrum, inner margin straight and parallel with the outer margin, sub-truncate at the tip, apical spine strong, long and acute; second segment of antenna with a large external spine at base of the scale; another small but well-formed external spine on the following segment below. Chelipeds large. Chela of moderate size; hand smooth, punctate, internal margin serrate; fingers of moderate length, curved slightly downwards, ribbed and punctate above, tips incurved, horny; external finger serrate on outer margin, impressed above and below at base; inner borders of fingers tuberculate and ciliated especially at their bases. Carpus smooth, lightly punctate above, with a strong median internal spine and a small basal internal spine; a sharp, prominent median anterior spine beneath. Meros smooth, a

single acute ante-apical spine on the superior margin, only one or two distal spines in the outer row of biserial spines beneath. Third joint of third pair of legs hooked. Fourth pair of legs with a conical tubercle on the first segment. First pair of abdominal appendages short, stout, twisted, distal half bent in towards the median line of the body; internal part truncate at apex, with a small spine directed backward and outward; external part longer, ending in a short, recurved, blunt, laterally compressed, horny tooth.

Measurements:—

Length of body . . . . .	81 mm.
“ “ cephalo-thorax . . . . .	43.5 “
“ “ abdomen . . . . .	37.5 “
Length from tip of rostrum to cervical groove . . . . .	27 “
From cervical groove to posterior border of carapace . . . . .	16 “
Length of rostrum . . . . .	11 “
“ “ acumen of rostrum . . . . .	5 “
Width of base of acumen of rostrum . . . . .	3 “
“ “ areola . . . . .	3 “
Length of antennæ . . . . .	91 “
“ “ chela . . . . .	36 “
Width of chela . . . . .	15 “
Length of movable finger . . . . .	22 “

One specimen, collected by Mr. F. W. Putnam in Green River near the Mammoth Cave, Kentucky, November 3, 1874.

This species is very distinct from every other known Crayfish. In its general appearance it approaches those species included in the group typified by *C. Bartonii*. The rostrum, however, is more after the fashion of *C. rusticus*, but the lateral spines are much larger and stand erect. The impressed external finger recalls *C. robustus*. The sexual appendages are formed nearly as in *C. Bartonii*. The development of the antennæ is extraordinary.

§ 4. *Third pair of legs of male hooked. First pair of abdominal appendages of male terminating in two elongated, straight tips.*

a. *Rostrum without lateral teeth.*

#### 12. *C. MEDIUS*, sp. nov.

Male, form I. Rostrum of moderate length, excavated, slightly carinated at the tip; margins thickened, converging, sinuated near the tip to form the short triangular acumen; no lateral spines. Post-orbital ridges depressed, sulcated on external face, subacute anteriorly. Cara-



pace subcylindrical, somewhat flattened above, punctate, granulated on the sides; cervical groove sinuate, no lateral nor branchiostegian spine; sub-orbital angle rounded; areola long (much more than one half as long as the distance from the cervical groove to the tip of the rostrum), of moderate width, punctate, widening posteriorly. Abdomen as long as the cephalo-thorax; telson rounded behind, basal segment bispinous on each side of the posterior border. Basal segment of antennule with an interior median spine. Second and third segments of antennæ not spiniferous (flagellum of antennæ broken off in the specimen examined, probably much shorter than the body). Antennal scale short, of moderate width, terminating in a short, acute spine. Anterior process of epistoma triangular, apex pointed, sides convex. Third maxillipeds bearded within. Chelipeds of moderate length, stout; chela broad, inflated, coarsely punctate above and below, external margin rounded; internal margin of hand with a double row of obsolescent tubercles; fingers stout, gaping at base, costate, heavily dotted-lined, internal margins furnished with rounded tubercles. Carpus sparsely punctate, armed with a moderate median and a smaller basal internal spine; below, there are no spines developed. Meros furnished with two nearly obsolete obliquely-placed tubercles near the distal extremity of superior border, and with a double row of tubercles below. Second pair of legs provided with long cilia towards their distal extremity. Third segment of third pair of legs hooked. First pair of abdominal legs long (reaching to base of chelipeds), deeply bifid, rami slender, straight, the outer one a little recurved at the tip, aciculate, the inner one slightly dilated near the tip, blunt pointed; a projecting angle or shoulder at base of rami on anterior margin.

Female. Hand small, fingers not gaping, ciliated within; sternum between fourth pair of legs plane; annulus ventralis bilaterally symmetrical, anterior border bituberculate, posterior border unituberculate, transverse fossa deep, recurved at each end.

Measurements of male, form I.:—Length of body, 49 mm. Length of carapace, 25 mm. Length of rostrum, 6 mm. Length from end of rostrum to cervical groove, 15.5 mm. Length from cervical groove to hind border of carapace, 9.5 mm. Width of areola, 2 mm. Length of abdomen, 25 mm. Length of chela, 23.5 mm. Length of internal margin of hand, 9.5 mm. Breadth of chela, 11.5 mm. Length of movable finger, 14 mm.

Two specimens, first form of male and female, in the Museum of Comparative Zoölogy, from Irondale, Mo.

This species has the general form of body, rostrum, and chelæ of

the *C. Bartonii* group, together with the male abdominal appendages of the *C. affinis* group. These appendages have a projecting shoulder at the base of the rami, on the anterior edge, as in *C. rusticus*, *C. Putnami*, etc. *C. immunis* and *C. Mississippiensis*, belonging to the *C. affinis* group, also have the rostrum devoid of lateral spines, but in general habit of body they do not resemble *C. Bartonii* and its allies, as is the case with the present species.

### 13. *C. MISSISSIPPIENSIS*, sp. nov.

Male, form I. Rostrum broad, twice as long as broad, sub-excavated above, smooth, foveolate at base, margins raised, converging anteriorly, sinuate at apex; acumen short, triangular, acute, no lateral teeth. Post-orbital ridges sulcate on outer side, with short, blunt anterior spines. Carapace densely punctate, sides lightly granulate, front lateral border not angulated. Cervical groove sinuate, with small lateral and branchiostegian spines. Areola linear anteriorly to the middle, with a small anterior and a larger posterior, triangular field. Length of areola equal to half the distance from tip of rostrum to cervical groove. Abdomen as long as the carapace. Terminal segment of the telson shorter than the basal segment, hind border slightly concave at the centre; basal segment bispinose on each side. Anterior angle of epistoma notched. Sternum between the legs densely ciliated. Antennal scale very broad, apical spine short. Third maxillipeds hairy without and beneath. Chelæ large, punctate, smooth below, margined without; inner margin of hand short, furnished with dentiform tubercles irregularly disposed in a double series; a little distance from these is another line of smaller ciliated tubercles on the upper surface of the hand on a line with the middle of the base of the movable finger. Fingers long, gaping at base, each with a punctate impressed line parallel with inner margin, and furnished with rounded tubercles on inner margin. Movable finger tuberculate on outer margin. Outer finger bearded below at base. Carpus broad, obliquely truncate on the external side, punctate and tuberculate above, a strong median internal spine, two small spines near on the base and one at the anterior end near the articulation; multispinous beneath, the two anterior spines the largest. Meros smooth, two ante-apical spines obliquely placed on upper margin, lower face with blunt biserial spines. Second pair of legs with long setæ near the end on inner side, not tufted as in *C. immunis*. Third pair of legs hooked. First pair of abdominal appendages long, deeply bifid, rami recurved at tip, parallel, internal ramus sub-cylindrical, dilated and grooved at tip,

external ramus a little longer than the internal, laterally flattened, ending in a slender, sharp point.

Male, form II. Rostrum with small lateral teeth; hand smaller, with smaller tubercles; hooks on third legs smaller; third pair of abdominal appendages stouter, cleft for only a short distance from the tip, tips blunt, no articulation at the base in the one specimen examined.

Female. Rostrum as in the second form of the male. Hand shorter and broader, annulus ventralis with a very deeply excavated fossa.

Measurements of male, form I.:—Length, 73 mm. Length of rostrum, 9 mm. Breadth of rostrum at base, 5 mm. Length of areola, 11 mm. From tip of rostrum to cervical groove, 25 mm. Length of chela, 35 mm. Breadth of chela, 14 mm. Length of inner finger, 24 mm. Length of internal margin of hand, 11 mm.

Five specimens, one male, form I., one male, form II., and three females, were collected by Prof. O. P. Hay in Eastern Mississippi. Two of them are labelled "Macon, Miss."

Differs from *C. immunis* in its linear areola, flatter rostrum, differently shaped chela, and male appendages, the rami of which are longer and less strongly recurved. *C. Palmeri* differs from it in its quadrangular rostrum, which has a longer acumen and more prominent lateral spines, narrower and long-spined antennal scale, longer areola; the rami of the male appendages (form II.) are a little longer and more widely separated. *C. Alabamensis* differs by its wide areola, toothed and carinated rostrum, etc.; *C. compressus*, by its laterally compressed carapace, wide areola, narrow carinated rostrum, etc.

b. *Rostrum with lateral teeth.*

14. *C. PALMERI*, sp. nov.

Male, form II. Rostrum broad, sub-excavated, margins nearly parallel from base to lateral spines, which are small and sharp; acumen long. Post-orbital ridge with sharp anterior spine. Carapace smooth and punctate above, granulate on sides, lateral spine of moderate size, anterior lateral border notched just below the sub-orbital angle, which is not prominent. Areola linear for a short distance anterior to the centre, with a small anterior and a larger posterior triangular field. The length of the areola is one half the distance from cervical groove to tip of rostrum. Abdomen as long as the cephalothorax. Proximal segment of telson bispinose on each side. Antennae nearly as long as the body. Lamina a trifle longer than rostrum,

broad, greatest width at the middle, thence tapering to the long spine at apex. Third maxillipeds hairy within and below. Anterior process of epistoma truncate at apex. Chela broad, depressed, smooth and punctate below, ciliate-punctate above, margined on the outer edge. Inner margin of hand short, with a double row of small ciliated tubercles. Fingers of moderate length, straight, corneous and incurved at tip, costate and punctato-ciliate above. Movable finger with outer edge furnished with a double row of ciliated tubercles on basal half. Outer finger hairy below at base of inner side. Carpus tuberculate above, with a strong and acute internal median spine, and a minute one at the base; smooth below, with two prominent anterior spines. Third pair of legs hooked. First pair of abdominal appendages articulated near the base, long, stout, strongly curved, bifid for a short distance from tip, rami divergent, outer one the longer.

Female. Annulus ventralis triangular, rounded anteriorly, posterior wall with a longitudinal sigmoid fissure. Sternum between fourth pair of legs smooth.

Length, 61 mm. Antennæ, 52 mm.

Twenty-five specimens of this species were collected for the U. S. National Museum by Mr. Edward Palmer, in a brook running into the eastern side of Red Foot Lake, near Idlewild Hotel, Obion Co., Tenn., May 30, 1882. The lot contains males of the second form, and females. The rostrum, chelæ, and antennal scale are similar to those of *C. virilis*. It differs from that species in its linear shorter areola and male appendages, which are more strongly curved and formed more on the pattern of the same parts in *C. immunitis*. In the latter species, however, these appendages are still more strongly curved, the areola is not linear in any part, the rostrum is more deeply excavated, longer, and (usually) toothless, the antennal scale is subtruncate at the end, and the hand different. Its closest relative is *C. Mississippiensis*. See description of that species.

Some of the specimens still show spots of dark color (purplish) on the chelæ, carpus, and branchial regions of the carapace. In a few specimens there is a very faint indication of a median carina on the rostrum.

#### 15. *C. ALABAMENSIS*, sp. nov.

Male, form I. Rostrum broad, punctate, sub-excavated above at base, with a broad, rounded, slightly elevated median carina near the tip, sides sub-parallel, punctato-ciliate; acumen long, triangular, marginal spines slightly developed. Anterior spine of post-orbital ridge

hardly developed. Carapace smooth, punctate, cervical groove sinuate, with minute lateral and branchiostegal spines; anterior margin notched at base of antennæ; areola wide, short (less than one half as long as the distance from cervical groove to the lateral rostral spines), thickly punctate. Abdomen longer than the cephalo-thorax by the length of the terminal segment of telson. Telson rounded behind, basal segment bispinous. Epistoma triangular. Antennæ nearly as long as the body, slender; scale moderately broad, broadest in middle, thence tapering to the apical spine. Third maxillipeds hairy within and below. Chelipeds of moderate length, strong. Chela broad, thick, hand punctate, inner margin of moderate length, scarcely serrate; fingers of moderate length, costate, ciliate-punctate, usually meeting only through their distal third. Immobile finger heavily bearded at base within, both above and below. Carpus smooth, punctate above; on the internal border there is a strong median spine, in front of this near the articulation is a minute spine, and behind it are one or two faint ones near the base; below, the carpus has a single small spine near the external articular point of the hand. Meros smooth, punctate, two obliquely-disposed spines near the anterior end of superior border; of the biserial spines beneath, only the distal one or two of the outer row are developed. Third pair of legs hooked at base. First pair of abdominal appendages long, deeply bifid, rami slender, recurved, parallel, inner ramus spoon-shaped at tip, outer ramus a little longer than the inner, compressed laterally, tapering to a fine point at tip.

Male, form II. Lateral rostral spines a little more prominent, hand smaller, hooks on third legs less strongly developed, first abdominal appendages thicker, bifid for only a short distance from the tip, rami laterally compressed, blunt-pointed.

Female. Rostrum as in the second form of the male, hand shorter and wider. Annulus ventralis with well-marked transverse fossa.

Measurements of a male, form I.:—Length, 55 mm. Carapace, 25 mm. Abdomen, 30 mm. Length of antennæ, 50 mm. Length of areola, 7 mm. Breadth of areola, 2.5 mm. Length of chela, 21 mm. Breadth of chela, 9 mm. Length of movable finger, 12.5 mm.

A female of the same size has the areola 3 mm. in width, 7 mm. in length.

Forty specimens, including both forms of the male and the female, were collected by C. L. Herrick in Second Creek, Waterloo, Lauderdale Co., Ala., for the U. S. National Museum. The male appendages are very like those of *C. Mississipiensis*, the rami being longer and less strongly recurved than in *C. immutis*. It is at once distinguished by

its broad and short areola from the other species in which the first abdominal appendages are formed after the pattern of those of *C. immunis*. The section of the carapace behind the cervical groove is very short in this species, and the dense beard at base of the external finger is very characteristic. In *C. compressus* the areola, although broad, is long, and the strong lateral compression of the body, different form of the chela, &c., distinguish it at a glance from this species.

16. *C. COMPRESSUS*, sp. nov.

Male, form I. Rostrum narrow, excavated, curved downwards, with a longitudinal median carina; margins thickened, converging, with a line of ciliated dots; acumen long, triangular, with acute lateral spines at base which are obsolescent in the largest specimens. Cephalothorax strongly compressed laterally. Post-orbital ridges armed with acute anterior spines. Carapace punctate on both the back and sides; on the gastric region the punctation is very coarse, assuming the form of reticulation; cervical groove sinuate; no lateral or branchiostegian spines; anterior lateral margins notched behind the antennæ; areola broad, heavily punctated. Abdomen about the length of the thorax. Telson long, proximal segment bispinose on each side. Antennæ slender, shorter than the body by the length of the telson. Antennal scale of moderate width, terminal spine very long, reaching beyond the tip of the rostrum. Epistoma triangular. External maxillipeds hairy within and below. Chelipeds short, stout; chelæ very large, broad, non-tuberculate, hand convex above and below, punctate, internal margin entire; fingers short, thick, with lines of ciliated dots. Carpus punctate above, with one internal median spine. Upper border of meros with one or two ante-apical spines; the biserial spines below are not developed, except the distal one of each row, and even these are minute. Third segment of third pair of legs hooked. First pair of abdominal appendages reach the base of the second pair of legs. They are deeply bifid, the rami recurved; the outer ramus is aciculate, the inner is enlarged at base and at tip, and the tip is furthermore grooved in front and rounded off at the end.

Male, form II. Hand smaller, fingers gaping at base, external finger ciliated at base within, hook on third segment of third legs very small; first pair of abdominal appendages articulated near the base, thick, inner and outer parts separated for only a very small distance from apex, compressed from side to side, tips a little recurved, blunt-pointed.

Female. Chelæ somewhat smaller than in the first form of the male, fingers less widely separated at base, external finger ciliated at base within. Anterior border of annulus ventralis nearly obliterated in the median line, lateral borders raised into prominent tubercles, transverse fossa wide.

Length of body (male, form I.), 45 mm. Length of carapace, 22.5 mm. Length of areola, 8 mm. Breadth of areola, 2 mm.

In the largest specimen seen, the dimensions of which are given above, the lateral spines of the rostrum are obsolete, the margins simply notched at base of the acumen; in the other specimens the lateral rostral spines, though small, are evident; the antennæ in the larger specimens are shorter in proportion to the length of the body.

Thirty-nine specimens (eighteen males, form I., two males, form II., and nineteen females) were collected by C. L. Herrick for the U. S. National Museum in Second Creek, Waterloo, and in Cyprus Creek, Lauderdale Co., Ala., October, 1882.

A small species with first abdominal appendages of the male similar to those of *C. immunis*. It is readily distinguished from all the other species with similar male appendages by the lateral compression of the cephalo-thorax, form of the chela, &c.

#### 17. *C. SANBORNII*, sp. nov.

Male, form I. Rostrum long, of moderate width, excavated, margins sub-parallel, lateral spine short, acute, brown-horny, acumen long, triangular, acute. Post-orbital ridges sulcate without, with acute anterior spines; carapace oval, flattened on the back, punctate, lightly granulate and ciliate on the sides; antero-lateral margin notched behind the antennæ; cervical groove sinuate, interrupted on the sides just above the small acute lateral spine; areola of moderate width, punctate, dilated anteriorly and posteriorly. Abdomen as long as the body; posterior border of telson rounded, posterior border of basal segment bispinose on each side. Basal segment of antennule armed with an acute spine on internal border of lower side, near the apex. Antennæ as long as the body, a small acute spine on the external side of second segment; scale a little longer than the rostrum, of moderate width, widest toward the middle, thence tapering to the acute terminal external spine. Anterior process of epistoma truncate in old specimens. Third pair of maxillipeds hairy within. Chelipeds short, chela broad, punctate above and below, inner margin with a double row of depressed squamous tubercles; all the puncta and tubercles of the hand give rise to pencils of fine downy cilia;

fingers costate, punctate and ciliate, outer margin of movable finger furnished with low ciliate tubercles. Carpus broad, obliquely truncate, punctate and ciliate above, with a median internal spine; beneath, the carpus has an acute median anterior and a small external spine. Superior border of meros armed with two obliquely placed ante-apical spines; beneath ciliate; of the outer row of biserial spines only the distal spine is developed. Third segment of third pair of legs hooked. First pair of abdominal appendages short, somewhat twisted, bifid at apex; rami short, thick, of nearly equal length, outer one sharp-pointed, brown-horny, inner one curved outwards and then inwards, flattened at apex.

Length, 69 mm.

Male, form II. First abdominal appendages articulated near the base, scarcely bifid, inner and outer parts thicker than in first form, tips blunt, not brown-horny.

Female. Annulus ventralis depressed, anterior wall not prominent, posterior wall projecting backwards, a sinuous longitudinal fissure, transverse fossa obliterated.

Smoky Creek, Carter Co., Ky., and Oberlin, O.

Very closely related to *C. propinquus*, but differs as follows: the rostrum is never carinate, the chela is pubescent, the inferior median anterior spine of the carpus is well developed; the first abdominal appendages, though very near those of *C. propinquus*, have the apical part shorter and less deeply bifid. These variations may perhaps be deemed of varietal rather than of specific value; but, aside from these specimens, I have seen so little variation in the very large number of *C. propinquus* examined, that I have decided to give the present form a special name.

I have examined many specimens, including the two forms of the male, females, and young, collected by the late F. G. Sanborn in Carter Co., Ky., and by Prof. B. F. Koons at Oberlin, O.

Small individuals closely resemble young specimens of *C. propinquus*, *C. affinis*, and more closely *C. Putnami*; but the young of the first may be distinguished by the carinated rostrum; of the second, by the longer rostral acumen, antennal scale, and anterior spine of post-orbital ridge, by the longer hand and internal carpal spine, and by the divergent tips of the first pair of abdominal appendages in the male; of the third, by the longer-spined antennal lamina, the long, deeply-cleft abdominal appendages of the male, and the annulus ventralis of the female, which has a transverse fossa and bituberculate anterior wall.



One small specimen presents an interesting hermaphroditic condition. With the first abdominal appendages of the male is combined a well-formed annulus ventralis of the female!

18. *C. HARRISONII*, sp. nov.

Male, form I. Rostrum long, narrow, deflexed, excavated; margins thickened, a little convergent; acumen of moderate length, triangular, acute; marginal spines short, obtuse, often obsolescent. Carapace flattened above, coarsely punctate, granulate on the sides; post-orbital ridges prominent, sulcate without, with acute anterior spine; antero-lateral margin notched at base of antenna; cervical suture not sinuate, interrupted on the side; lateral spine small, acute; branchiostegian spine obsolete; areola at least one half as long as the distance from the tip of the rostrum to the cervical groove, of moderate width, punctate, the dots tending to a biserial arrangement in the middle portion. Abdomen as long as the cephalo-thorax; telson long, posterior margin rounded, posterior margin of basal segment bispinous on each side. Basal segment of antennule with an internal, sub-apical, inferior spine. Antennae as long as the body; second segment armed with a short, acute, external spine; scale as long as the rostrum, of moderate width, widest near the middle, thence tapering to the acute external, apical spine. Anterior process of epistoma with convex sides, apex blunt or truncate. Third pair of maxillipeds hairy within. Chelipeds of moderate length, thick; chela large, broad, coarsely punctate above and below, inner margin of hand with two or three rows of depressed ciliate tubercles; fingers costate and punctato-lineate, gaping, inner margins with rounded tubercles; movable finger incurved; carpus punctate above, armed with an acute median internal spine and two inferior spines (a large median and a minute external). In some specimens there are one or two small antennal basal tubercles. Meros smooth without, two obliquely-disposed superior sub-apical spines; of the biserial inferior spines only a few of the distal ones in each row are developed. Distal end of second pair of legs ciliate. Third segment of third pair of legs hooked. First pair of abdominal appendages short, reaching to the base of third pair of legs, thick, split for a short distance from the tip; outer part longer than the inner; tips recurved, brown-horny.

Female. Fingers less widely gaping, outer one ciliate within at base. Abdomen broader. Sternum between fourth thoracic legs, smooth. Annulus ventralis a transverse ridge, thickest in the middle, where there is a rounded tubercle divided longitudinally by a sinuous

groove. Between the ridge and the sternal plates of the fourth pair of legs there is a deep transverse fossa.

Measurements of a male, form I.:— Length of body, 60 mm. Length of carapace, 30 mm. Length of abdomen, 30 mm. From end of rostrum to cervical suture, 20 mm. From cervical suture to posterior border of carapace, 10 mm. Length of rostrum, 10 mm. Breadth of rostrum at base, 4 mm. Length of rostral acumen, 3 mm. Width of areola, 1.5 mm. Length of antennæ, 60 mm. Length of chela, 25 mm. Breadth of chela, 12 mm. Length of movable finger, 17 mm. Internal border of hand, 7 mm.

In one specimen, a male, form I., the fingers are very much elongated, not gaping at base. The length of the internal border of the hand in this specimen is 7.5 mm.; the length of the movable finger, 21 mm.

Irondale, Mo. Collected by E. Harrison.

This species resembles *C. rusticus* in its general form. The male appendages, as well as the annulus ventralis of the female, however, are very different from those of any previously described species. The male appendages approach in form those of *C. propinquus* more nearly than any other, but in that species these appendages are more deeply bifid, and not recurved.

The second form of the male is unknown.

#### 19. *C. PUTNAMI*, sp. nov.

Male, form I. Rostrum broad, sub-excavated, margins nearly parallel, with a line of ciliated puncta; acumen long, equal in length to the width of base of rostrum, narrow, acute, with a black, horny tip and lateral spines. Post-orbital ridges sulcate on external side, inflated at posterior end, armed with a sharp, horny-tipped anterior spine. Carapace long-oval, slightly flattened above, heavily punctated, sides rough with ciliated granules; cervical groove deep, lightly sinuate, broken on the sides just above the small, acute lateral spine; branchiostegian spine slightly developed; anterior lateral margin angulated, but without sub-orbital spine. Posterior segment of carapace equal in length to one half the distance from tip of rostrum to cervical groove. Areola of moderate width, punctated. Abdomen as long as cephalo-thorax, pleuræ punctate, telson bispinose on each side. Anterior process of epistoma ciliated, triangular, sides convex, marginated. Basal segment of antennule armed below with an internal ante-apical spine. Antennæ slender, about as long as the body, scale as long as the rostrum, of moderate width, external border inflated,

ending in a sharp spine. Third maxillipeds hairy within and below. Chelipeds stout; chela large, external margin convex; hand ciliato-punctate above and below (the dots large), swollen above, internal border of moderate length and furnished with two or three rows of depressed ciliate tubercles; fingers gaping at base, at least in large individuals, costate and punctate-lined, external margin of movable finger with depressed ciliated tubercles irregularly disposed in two rows; tips of fingers incurved, horny. Carpus smooth or faintly tuberculate above, a large, acute median internal spine, and small proximal and distal internal spines; beneath, the carpus has a very minute or no median anterior spine, a short and acute external spine. Meropods with two superior, obliquely placed ante-apical spines; of the ordinary biserial inferior spines only the distal one or two of the outer row are developed. Third pair of legs hooked on third segment. Thoracic sterna hairy. First pair of abdominal appendages very long, reaching the base of the chelipeds when the abdomen is flexed, tuberculated on internal border at the base, deeply bifid, rami slender, acute, forming an acute angle with the basal part, the outer slightly recurved, the inner shorter, incurved, and a little dilated before the tip; a projecting angle or shoulder on the anterior border at base of rami.

Male, form II. Chela smaller, fingers not gaping, hook on third segment of third pair of legs smaller; first pair of abdominal appendages split only half as far down as in the first form, rami much thicker, no projecting angle on the anterior border; these appendages are as long as in the first form, reaching forward to the base of the chelipeds; they are articulated near the base.

Female. Chela shorter and wider, external finger bearded within at base; sternum between fourth pair of legs non-tuberculate, lightly ciliate. Annulus ventralis large, transverse fossa broad and deep, anterior border bituberculate.

Measurements of a male, form I.:—Length of body, 73 mm. Length of carapace, 36 mm. From tip of rostrum to cervical groove, 24 mm. From cervical groove to hind border of carapace, 12 mm. Length of rostrum, 11 mm. Breadth of rostrum at base, 4.5 mm. Length of acumen of rostrum, 4 mm. Width of areola, 2.5 mm. Length of abdomen, 37 mm. Length of chela, 34 mm. Breadth of chela, 14 mm. Length of movable finger, 22 mm.

Known localities. Kentucky: Grayson Springs, Grayson Co.; Green River, near Mammoth Cave; Cumberland Gap.

M. C. Z., Cat. No. 3574 (young female), from Knoxville, Tenn.,

Walter Faxon, and Cat. No. 3575 (male, form II.), from Bradford, Ind., A. S. Packard, Jr., probably belong to this species, but the specimens are too young to determine with confidence.

This species resembles *C. spinosus*, from which it is easily distinguished by the length of the posterior section of the carapace, and by the length of the male appendages. From *C. affinis* it may be separated by the different form of the male appendages and female annulus ventralis, and by the single lateral spine of the carapace. I have seen males of the first form only 34 mm. in length.

20. *C. FORCEPS*, sp. nov.

Male, form I. Rostrum narrow, excavated, faintly carinated in the middle; margins divergent at the base, thickened, dotted-lined; acumen long and narrow, horny tipped; lateral spines small. Post-orbital ridges not very prominent except anteriorly, where they terminate in a spine with a corneous tip. Carapace cylindroidal, punctate above, granulated on the sides, antero-lateral margins bluntly angulated; cervical groove sinuate; small and acute lateral spine: no branchiostegian spine; areola of moderate width, punctate. Abdomen as long as the cephalo-thorax: telson rounded behind, bispinose on each side. Epistoma smooth, anterior process triangular, in some specimens truncate. Thoracic sterna with silky setæ at bases of the legs. Antennæ slender, as long as the body; scale a little longer than the rostrum, of moderate width, sub-truncate at distal end, outer margin ending in a long, sharp, somewhat outwardly directed spine. Third pair of maxillipeds hairy within. Chelipeds short, stout; chelæ large, wide, with slender cylindrical, widely-gaping fingers, which are curved outward at the base and opposable only at their tips; hand thickly punctated above and below, inner margin obscurely serrate; fingers naked at base, with parallel rows of ciliated dots; a dark band around both the inner and outer fingers a little distance from the tip. Carpus punctate above, a strong, sharp internal median spine; below there is no anterior median spine, and only a very minute external one. Meros short; of the biserial inferior spines only the distal one in each row is usually developed to any extent; above there are commonly two obliquely placed ante-apical spines, in some specimens only one. Distal portion of the following pairs of legs furnished with long setæ, especially long on the second pair of legs. Third segment of third pair of legs hooked. First pair of abdominal appendages long, deeply bifid, rami slender, straight, parallel, the outer a little longer than the inner, and a little recurved at the tip. In some specimens the anterior border at the

base of the rami has a projecting angle or shoulder, but in most specimens this is not evident.

Female. Fingers straighter. Base of external finger has a dense beard on the inside; in a few of the specimens seen the fingers are longer, nearly straight, their opposed margins almost meeting throughout their length. Annulus ventralis bilaterally symmetrical, anterior margin bituberculate, posterior margin unituberculate, fossa transverse.

Dimensions of a male, form I.:— Length of body, 38 mm. Length of carapace, 19.5 mm. Length of abdomen, 18.5 mm. From tip of rostrum to cervical groove, 14 mm. From cervical groove to posterior border of carapace, 6 mm. Length of rostrum, 5 mm. Length of acumen of rostrum, 2 mm. Width of areola, 1 mm. Length of antenna, 36 mm. Length of chela, 16 mm. Breadth of chela, 7.5 mm. Length of movable finger, 10.5 mm.

The largest female specimen is 60 millimeters in length.

Cypress Creek, Lauderdale Co., Ala.

Nine specimens, four males of the first form and five females, collected by C. L. Herrick for the U. S. National Museum, October, 1882.

This is a small species with large hand, slender fingers widely separated at base and meeting only at the tips. In the female, there is a heavy beard at base of external finger on the inner side.

In the summer of 1872 I collected in a brook at Knoxville, Tenn., six specimens, three second form males and three females, which closely resemble those obtained by Mr. Herrick in Alabama, and belong, I think, to the same species. The external finger of the males is densely bearded within at the base, as in the females from Lauderdale Co., Ala., the first abdominal appendages reach forward to the base of the second pair of legs, are bifid at the tip, the internal and external parts are thick, blunt at the tip, the outer somewhat longer than the inner, and slightly recurved at the tip.

§ 5. *Second and third pairs of legs of male hooked.*

21. C. SHUFELDTII, sp. nov.

Male, form I. Rostrum plane above, margins a little convergent, raised into a slight rim from the base to the lateral spines, which are prominent and acute; acumen of moderate length, acute, pubescent. Post-orbital ridges with anterior spines. Carapace smooth, a sharp spine on the cervical groove on each side; sub-orbital angle prominent, branchiostegian spine present. Areola of moderate breadth. Telson bispinous on each side. Epistoma triangular. Antennal scale broad.

Hand smooth, cylindrical, inflated; fingers slender, incurved at the tips. Carpus smooth, armed with a single spine on the antero-inferior border. Meros provided with a single spine near the distal end of the superior margin and two or three below. Third segment of second and third pairs of legs hooked. First pair of abdominal appendages straight, bifid, inner part ending in a straight, acute tip, outer part split at the tip into two straight acute points.

In the second form of the male the hooks upon the thoracic legs are very slightly developed, and the first abdominal appendages are less deeply cleft, with blunter and less finished tips. The chela is shorter.

In the female the chela is much shorter, broader, and less cylindrical, the abdomen broader. Annulus ventralis a transverse curved ridge, the hind side of the ridge concave.

Length, 19 to 27 mm.

Locality. Near New Orleans, La.

Found with *C. Clarkii* in the collection made by Dr. R. W. Shufeldt, U. S. A., in 1883, now in the U. S. National Museum.

This is a minute species closely related to *C. Montezumæ* from Mexico. Like that species, it has the *second and third* pairs of legs hooked in the male, a condition which normally obtains in no other species known.\* *C. Shufeldtii* is distinguished from *C. Montezumæ* by the presence of a lateral spine on the carapace and by the form of the male appendages. In the latter species the tips of these appendages are recurved, the inner part flattened at the end into a spoon-shaped surface. In *C. Shufeldtii* the tips of these organs are straight, and each of the three points in which they terminate is acute.

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#### LIST OF THE KNOWN SPECIES OF CAMBARUS AND ASTACUS.

##### 1. CAMBARUS BLANDINGII.

*Astacus Blandingii*, Harlan, Trans. Amer. Philosoph. Soc., III. 464. 1830.—Med. and Phys. Res., p. 229, fig. 1. 1835.

*Astacus (Cambarus) Blandingii*, Erichson, Arch. Naturgesch., Jahrg. XII., Bd. I., 98. 1846.

? *Astacus Blandingii*, Le Conte, Proc. Acad. Nat. Sci. Phila., VII. 400. 1855.

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\* I have seen two or three abnormal specimens of *C. virilis* and *C. propinquus* with a like disposition of hooks on the legs.

*Cambarus Blandingii*, Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III. 43, Pl. I. figs. 63, 64, Pl. III. fig. 140. 1870.

*Cambarus acutus*, var. B, Hagen, *op. cit.*, p. 36, Pl. III. fig. 144. 1870.

*Cambarus acutus*, Abbott, Amer. Nat., VII. 80. 1873 (habits).

Hab. New Jersey, Maryland, Virginia, North Carolina, South Carolina, Georgia.

a. *Var. acuta.*

*Cambarus acutus*, Girard, Proc. Acad. Nat. Sci. Phila., VI. 91. 1852.

*Cambarus acutissimus*, Girard, *l. c.*

*Cambarus acutus*, Hagen, *op. cit.*, p. 35, Pl. I. figs. 1-5, Pl. II. figs. 106, 108, 110-114, 116, 118, 120-124, 126, 127, Pl. III. fig. 143. 1870.

*Cambarus acutus*, var. A, Hagen, *op. cit.*, p. 36, Pl. II. figs. 107, 109, 115, 117, 119, 125.

*Cambarus acutus*, Forbes, Bull. Ill. Mus. Nat. Hist., No. I. pp. 3, 18. 1876.

Hab. Louisiana, Mississippi, Alabama, South Carolina, Tennessee, Missouri, Illinois, Indiana, Iowa, Wisconsin.

2. CAMBARUS FALLAX.

*Cambarus fallax*, Hagen, *op. cit.*, p. 45, Pl. I. figs. 103-105. 1870.

Hab. Florida.

3. CAMBARUS HAYI.

*Cambarus Hayi*, Faxon, *supra*, p. 108.

Hab. Mississippi.

4. CAMBARUS CLARKII.

*Cambarus Clarkii*, Girard, *op. cit.*, p. 91. 1852.

*Cambarus Clarkii*, Hagen, *op. cit.*, p. 39, Pl. I. figs. 7-10, 99, 100, Pl. II. figs. 133, 134, Pl. III. fig. 142, Pl. IV. 1870.

Hab. Texas, Louisiana, Mississippi, Alabama, Florida.

5. CAMBARUS TROGLODYTES.

*Astacus troglodytes*, Le Conte, *op. cit.*, p. 400. 1855.

*Astacus fossarum*, Le Conte, *op. cit.*, p. 401. 1855.

*Cambarus troglodytes*, Hagen, *op. cit.*, p. 41, Pl. I. figs. 11-14, Pl. II. fig. 141. 1870.

Hab. Georgia, South Carolina.

NOTE.—Girard and Gibbes confounded this species with *C. Blandingii*. Gibbes distributed specimens of *C. troglodytes* under the name of *Astacus Blan-*

*dingii*, and the localities for *C. Blandingii* given by Girard and Gibbes probably appertain to *C. troglodytes*. The dry specimen in the Museum of Comparative Zoölogy (No. 3337) labelled "Rocky River, Olmsted, Ohio," determined as *C. troglodytes* by Hagen (*op. cit.*, p. 43), is *C. Clarkii*. The labels of dry specimens are easily transposed, and I believe this locality to be erroneous. There is an alcoholic specimen of *C. troglodytes* in the same Museum (No. 197) labelled "Lawn Ridge, Ill." No other specimens have been reported from the West, and I doubt the accuracy of the locality label of this specimen. Specimens from Richmond Co., Ga., lately received from Col. C. C. Jones, Jr., approach *C. Clarkii* in the shape of the male appendages, while in the form of the rostrum and other respects they agree with *C. troglodytes*. Judging from these specimens, I believe that further explorations will break down the specific distinctions between these two forms. But my material is not sufficient for a definite opinion.

6. CAMBARUS MANICULATUS.

*Astacus maniculatus*, Le Conte, *op. cit.*, p. 401. 1855.

*Cambarus maniculatus*, Hagen, *op. cit.*, p. 52. 1870 (after Le Conte).

Hab. Lower Georgia.

Known only through Le Conte's description, which perhaps was drawn up from an immature specimen of *C. troglodytes*.

7. CAMBARUS LECONTEI.

*Cambarus Lecontei*, Hagen, *op. cit.*, p. 47, Pl. I. figs. 15-18, Pl. III. fig. 145. 1870.

Hab. Georgia, Alabama.

The specimens from Beaufort, N. C., and Root Pond, Miss., referred to *C. Lecontei* by Hagen, are *C. Blandingii*. Three young specimens from Pensacola, Fla. (M. C. Z., No. 249), are also placed here by Hagen, but the justice of the determination seems doubtful. They do not agree well with the types from Mobile.

8. CAMBARUS ANGUSTATUS.

*Astacus angustatus*, Le Conte, *op. cit.*, p. 401: 1855.

*Cambarus angustatus*, Hagen, p. 50, Pl. I. figs. 65-67, Pl. III. fig. 146. 1870.

Hab. Lower Georgia.

Known only through a single type specimen in the Acad. Nat. Sci. Phila.

9. CAMBARUS PUBESCENS.

*Cambarus pubescens*, Faxon, *supra*, p. 109.

Hab. Georgia.



10. *CAMBARUS SPICULIFER.*  
*Astacus spiculifer*, Le Conte, *op. cit.*, p. 401. 1855.  
*Cambarus spiculifer*, Hagen, *op. cit.*, p. 48, Pl. I. figs. 59-62,  
 Pl. III. fig. 147. 1870.  
 Hab. Upper Georgia.
11. *CAMBARUS VERSUTUS.*  
*Cambarus versutus*, Hagen, *op. cit.*, p. 51, Pl. I. figs. 55-58,  
 Pl. III. fig. 150. 1870.  
 Hab. Neighborhood of Mobile, Ala. Cape Barrancas, Fla.
12. *CAMBARUS ALLENI.*  
*Cambarus Alleni*, Faxon, *supra*, p. 110.  
 Hab. Florida.
13. *CAMBARUS PENICILLATUS.*  
*Astacus penicillatus*, Le Conte, *op. cit.*, p. 401. 1855.  
*Cambarus penicillatus*, Hagen, *op. cit.*, p. 53, Pl. I. figs. 93, 94,  
 [95, 96?], Pl. III. fig. 149. 1870.  
 Hab. Georgia, Mississippi? South Carolina?  
 Two young female specimens from Charleston, S. C. (M. C. Z.,  
 No. 254), referred by Hagen to *C. penicillatus*, are *C. troglodytes*.  
 Two other females, and two second form males, also from Charles-  
 ton, in the same collection (No. 250), may be the female and  
 second form of the male of *C. penicillatus*, to which they are  
 referred by Hagen; but they differ in so many respects, that I  
 suspect they belong to another species. In the collection of  
 Prof. O. P. Hay of Butler University, Irvington, Ind., there is  
 a second form male from Eastern Mississippi, which with some  
 doubts I have referred to this species. More material must be  
 obtained before the specific characters can be accurately given.
14. *CAMBARUS WIEGMANNI.*  
*Astacus (Cambarus) Wiegmanni*, Erichson, *op. cit.*, p. 99.  
 1846.  
 ? *Cambarus Wiegmanni*, Hagen, *op. cit.*, p. 54, Pl. III. fig. 151.  
 1870.  
 Hab. Mexico.  
 The types of Erichson's two Mexican species of *Cambarus*,  
*C. Wiegmanni* and *C. Mexicanus*, could not be found in the  
 Berlin Museum, either by Hagen, who examined the collection in  
 September, 1870, or by Von Martens (Arch. Naturgesch., 1872,  
 p. 131). *C. Wiegmanni* alone of the known Mexican species  
 belongs to the *C. Blandingii* group, with hooks on the third and

fourth pairs of legs in the male. The female specimen in the Acad. Nat. Sci. Phila. (No. 170, Mr. Pease), fully described by Hagen, is probably correctly referred to this species by him, although in the absence of male specimens there is some uncertainty. I have seen but one specimen of *C. Mexicanus*, a male. In this the chelæ are more cylindrical, and are covered with smaller, more closely set, granular tubercles. In the collection of Acad. Nat. Sci. Phila., I find another alcoholic female from Jalapa, Mexico, which agrees well with Mr. Pease's specimen. A mutilated female in the U. S. Nat. Mus. (No. 3288), collected by Sumichrast at the Isthmus of Tehuantepec, seems also to belong here.

15. *CAMBARUS PELLUCIDUS*.

*Astacus pellucidus*, Tellkampf, Arch. Anat. Physiol. u. wissenschaft. Med., 1844, p. 383.

*Astacus (Cambarus) pellucidus*, Erichson, *op. cit.*, p. 95. 1846.

*Cambarus pellucidus*, Girard, *op. cit.*, p. 87. 1852.

*Cambarus pellucidus*, Hagen, *op. cit.*, p. 55, Pl. I. figs. 68-71, Pl. III. fig. 148, Pl. VI. 1870.

*Orconectes pellucidus*, Cope, Amer. Nat., VI. 410, 419. 1872. — 3d and 4th Ann. Rep. Geolog. Surv. Ind., pp. 162, 173. 1872.

*Orconectes inermis*, Cope, Amer. Nat., VI. 410, 419. 1872. — 3d and 4th Ann. Rep. Geolog. Surv. Ind., pp. 162, 173. 1872.

Hab. Mammoth Cave and other caves in Edmonson Co., Ky., Wyandot Cave, Ind., and cave in Bradford, Harrison Co., Ind.

The Indiana specimens do not differ enough from the typical form from Mammoth Cave to be considered a distinct species, as Cope would have us believe. I have seen the same form from Mammoth Cave.

In the Berliner Entomologische Zeitschrift, XXVI. 12-14, April, 1882, Gustav Joseph imperfectly describes under the name *CAMBARUS STYGIUS* a blind Crayfish, very closely related to *C. pellucidus*, said to have come from the caves of Carniola! In the earliest notice of this startling discovery in 57th Jahressber. Schles. Gesellsch. vaterländ. Cultur, 1879, p. 202, Breslau, 1880, the new species is called *Cambarus typhlobius*. In a paper published in December, 1881, in Berliner Entomol. Zeitschr., XXV., Joseph again mentions, without describing, the animal under the names *Cambarus cæcus* (p. 237) and *C. Stygius* (pp. 241, 249). Until a more satisfactory account of this discovery

is published, one may well hesitate to admit the Carniola *Cambarus* into the list.

CAMBARUS STYGIUS, Bundy, Bull. Ill. Mus. Nat. Hist., No. I. p. 3, 1876, Trans. Wis. Acad. Sci., V. 180, 1882, Geol. Wis., Surv. 1873-1879, I. 402, 1883, a species founded on mutilated specimens (the fourth thoracic legs of the males being lost), is indeterminate. It is said to be "closely related to *C. acutus*, but may be at once separated by the shorter hands, — similar to those of *C. propinquus*, — and the non-tuberculated annulus of the female." Shore of Lake Michigan, Racine, Wis.

16. CAMBARUS SIMULANS.

*Cambarus simulans*, Faxon, *supra*, p. 112.

Hab. Texas, Kansas.

17. CAMBARUS ADVENA.

*Astacus advena*, Le Conte, *op. cit.*, p. 402. 1855.

*Cambarus Carolinus*, Hagen, *op. cit.*, p. 87, Pl. I. figs. 51-54, Pl. III. fig. 165. 1870.

*Cambarus advena*, Hagen, *op. cit.*, Pl. III. fig. 164, Pl. VII. 1870.

ab. Georgia. >

The descriptions of *C. advena* and *C. Carolinus* in Hagen's monograph are accidentally transposed, so that they do not agree with Hagen's types in the Museum of Comparative Zoölogy. A full figure of Le Conte's species is given as *C. advena* on Plate VII,\* and the antennal scale, spine of the second segment of the antenna, and epistoma (from Le Conte's type in the Philadelphia Academy) on Pl. III. fig. 164. The male appendages, antennal scale, and epistoma are figured on Pl. I. figs. 51-54, Pl. III. fig. 165, as *C. Carolinus*.

18. CAMBARUS CAROLINUS.

? *Astacus (Cambarus) Carolinus*, Erichson, *op. cit.*, p. 96. 1846.

*Cambarus advena*, Hagen, *op. cit.*, p. 86, Pl. I. figs. 90-92. 1870.

*Cambarus Carolinus*, Hagen (as determined by examination of his type specimen!).

Hab. South Carolina.

For the transposition of the descriptions and part of the figures of *C. advena* and *C. Carolinus* in Hagen's Monograph, see above. Hagen's type of *C. Carolinus*, labelled, "*Cambarus Caro-*

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\* This figure represents a female (M. C. Z., No. 282), not male, as stated on the plate and in the text.

*linus* Er.," and described by him (p. 86) as *C. advena* Le Conte, is a first form male (M. C. Z., No. 232) from Charleston, S. C. The distinctions noted by Hagen, based on the presence or absence of spines on the lower side of the first segment of the antennule and at the end of the cervical groove, I do not find to hold good. The statement that "in the larger specimens the hand is more sulcated beneath at the inner margin, and the carpus more spinulose," probably refers to Le Conte's type of *C. advena* in the Philadelphia Academy. The female in the same jar with the male type above noticed differs from the male in so many respects that I doubt whether Hagen has correctly referred it to the same species. All the other specimens in the Museum determined as *C. Carolinus* by Hagen are small specimens. No. 3368, dry female from Georgia, L. Agassiz, is certainly *C. advena*. No. 3367 (1850 of Hagen), a young female, also from Georgia, resembles *C. advena* in most respects, but the antennal scale is too broad near the tip. No. 230, young female specimens from Mobile, Ala., and No. 275, a very young male from the same locality, appear to belong to some species allied to *C. Bartonii*, the tips of the male appendages being strongly recurved. Dr. Hagen examined Erichson's type, a male, form I., in Berlin, in 1870, and thought it was *C. Bartonii*. Erichson's description, nevertheless, fits the present species very well. The structure of the male appendages of Erichson's type would at once prove or disprove its identity with *C. Bartonii*. If it be really *C. Bartonii*, the species under consideration must receive a new name, *C. Hagenianus*.

19. CAMBARUS GRACILIS.

*Cambarus gracilis*, Bundy, Bull. Ill. Mus. Nat. Hist., No. I., p. 5. 1876. — Trans. Wis. Acad. Sci., V. 182. 1882. — Geol. Wis., Surv. 1873-1879, I. 403. 1883.

Hab. Wisconsin, Iowa, Illinois.

20. CAMBARUS MEXICANUS.

*Astacus (Cambarus) Mexicanus*, Erichson, *op. cit.*, p. 99. 1846.  
? *Cambarus Aztecus*, Saussure, Rev. et Mag. de Zool., 2<sup>e</sup> Sér., IX. 503. 1857. — Mém. Soc. Phys. Hist. Nat. Genève, XIV. 460, Pl. III. fig. 23. 1858.

*Cambarus Mexicanus*, Hagen, *op. cit.*, p. 84. 1870 (after Erichson).

Hab. Mexico.

I have seen one specimen (a male) in the Philadelphia Academy, which agrees with Erichson's description. It comes from

Mirador, Mexico. *C. Aztecus* Saussure has (according to the description) a shorter, flatter hand, and carpus spinous on internal border. Von Martens (Arch. Naturgesch., XXXVIII. 131) would separate it from *C. Mexicanus*. Dr. Hagen has kindly given me the following note on the types of Saussure in the Berlin Museum: "The first form of the male, and the female, from Mexico, seem to be *C. Mexicanus* Erichs., with nearly cylindrical hands. The second form, with more flattened hands, belongs alone, then, to Saussure's *C. Aztecus*. In the second form the antennal scale is more broadly truncate in front, and the rostrum is a little different, but the differences are not striking enough to preclude the identity." Erichson's types of *C. Mexicanus* were not found. Saussure's locality for *C. Aztecus* is near Tomatlan "dans les Terres-Chaudes." According to Von Martens there are specimens in the Berlin Museum from Puebla.

21. CAMBARUS CUBENSIS.

*Astacus (Cambarus) Cubensis*, Erichson, *op. cit.*, p. 100. 1846.

? *Cambarus consobrinus*, Saussure, Rev. et Mag. de Zool., 2<sup>e</sup> Sér., IX. 101. 1857. — Mém. Soc. Phys. Hist. Nat. Genève, XIV. 457, Pl. III. fig. 21. 1858.

*Cambarus Cubensis*, Hagen, *op. cit.*, p. 85. 1870 (after Erichson).

*Cambarus Cubensis*, Von Martens, Arch. Naturgeschichte, XXXVIII. 129. 1872.

Hab. Cuba.

Erichson's and Saussure's types are in the Berlin Museum, and have been examined by Hagen and Von Martens. Saussure's *C. consobrinus* are two dry female specimens. They differ in some unimportant regards from Erichson's *C. Cubensis*, and, as the male appendages of Saussure's species are not described, the identity of the two species is somewhat doubtful. According to Von Martens, specimens in the Berlin Museum indicate the presence of two species in Cuba. The examples of *C. Cubensis* in the Museum of Comparative Zoölogy were taken by Mr. Samuel Garman from creeks near Havana.

22. CAMBARUS BARTONII.

? *Astacus Bartonii*, Fabricius, Suppl. Entomolog. Syst., p. 407. 1798.

? *Astacus Bartonii*, Bosc, Hist. Nat. Crust., II. 62, Pl. XI. 1802.

*Astacus ciliaris*, Rafinesque, Amer. Monthly Mag., II. 42. Nov., 1817.

? *Astacus pusillus*, Rafinesque, *op. cit.*, p. 42.

*Astacus Bartonii*, Say, Journ. Acad. Nat. Sci. Phila., I. 167.  
Dec., 1817.

*Astacus Bartonii*, Harlan, Med. and Phys. Res., p. 230, fig. 3.  
1835.

? *Astacus affinis*, Milne Edwards, Hist. Nat. Crust., II. 332.  
1837.

*Astacus Bartonii*, Gould, Rep. Invert. Mass., p. 330. 1841.

*Astacus Bartonii*, Thompson, Hist. Vermont, Part I. p. 170.  
1842.

*Astacus Bartonii*, De Kay, Zoöl. N. Y., Part VI., Crustacea,  
p. 22, Pl. VIII. fig. 25. 1844.

*Cambarus Bartonii*, Girard, *op. cit.*, p. 88. 1852.

*Cambarus montanus*, Girard, *op. cit.*, p. 88.

? *Cambarus longulus*, Girard, *op. cit.*, p. 90.

? *Cambarus pusillus*, Girard, *op. cit.*, p. 90.

*Cambarus Bartonii*, Hagen, *op. cit.*, p. 75, Pl. I. figs. 47-50,  
Pl. II. figs. 135-139, Pl. III. fig. 166. 1870.

*Cambarus Bartonii*, Abbott, *op. cit.*, p. 80. 1873 (habits).

Hab. New Brunswick; Province of Quebec? Maine, Vermont, Massachusetts, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, Ohio, Indiana, Lake Superior, Kentucky, Tennessee.

In the Museum of Comparative Zoölogy are specimens of *C. Bartonii* labelled, "Osage River, G. Stolley" (No. 183); but this locality is marked by Dr. Hagen as being very doubtful. Another specimen (No. 3358) is ticketed, "Charleston, S. C.?" and three specimens (No. 1101) in the same jar with an *Alpheus* are marked, "Pico, Azores, Miss O. Dabney, May 23, 1860." The latter locality, at any rate, is doubtless erroneous. Hagen states that he has seen a specimen from Georgia, and I find in the collection of the Boston Society of Natural History this species in the same bottle with a *Pagurus* and *Hyas coarctatus*, labelled, "Savannah, Ga., Dr. H. Bryant." The presence of the marine forms, especially the Northern *Hyas*, casts doubt on the correctness of the label.

As might be expected of a species with such a wide geographical range, *C. Bartonii* presents many variations of form.

### 23. CAMBARUS ROBUSTUS.

*Cambarus robustus*, Girard, *op. cit.*, p. 90. 1852.

*Cambarus robustus*, Hagen, *op. cit.*, p. 80, Pl. III. fig. 167.  
1870.

Hab. Neighborhood of Toronto, Province of Ontario; New York, Maryland, Virginia, Illinois.

24. *CAMBARUS ACUMINATUS.*

*Cambarus acuminatus*, Faxon, *supra*, p. 113.

Hab. Saluda River, South Carolina; Western North Carolina.

25. *CAMBARUS LATIMANUS.*

? *Astacus* (*Cambarus*) *Bartonii*, Erichson, *op. cit.*, p. 97. 1846.

*Astacus latimanus*, Le Conte, *op. cit.*, p. 402. 1855.

*Cambarus latimanus*, Hagen, *op. cit.*, p. 83, Pl. I. figs. 43-46, Pl. III. fig. 162. 1870.

Hab. South Carolina, Georgia, Alabama, Mississippi, Tennessee (*var.*).

Erichson's types of *C. Bartonii* were examined by Dr. Hagen in 1870, and judged to be *C. latimanus*.

26. *CAMBARUS DIOGENES.*

*Cambarus Diogenes*, Girard, *op. cit.*, p. 88. 1852.

*Cambarus obesus*, Hagen, *op. cit.*, p. 81, Pl. I. figs. 39-42, Pl. III. fig. 163, Pl. IX. 1870.

Hab. New Jersey, Maryland, District of Columbia, Virginia, North Carolina, Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa, Missouri, Kansas, Colorado, Wyoming, Arkansas, Kentucky? Mississippi.

The labels of specimens, probably types, of *C. propinquus* and *C. Diogenes*, in the Philadelphia Academy, have been transposed.

*Var. Ludoviciana.*

Hab. Louisiana.

This variety, received from New Orleans, differs in having a narrower rostrum, with parallel margins, and more acute tip.

The burrowing habits of *C. Diogenes* are described by Girard, *l. c.*, and recently by R. S. Tarr in *Nature*, XXX. 127, and C. C. Abbott in *Amer. Nat.*, XVIII. 1157. The curious "chimneys" at the mouth of the burrows are figured by Audubon, *Birds of America*, Pl. 360, 370 (4to ed.).

27. *CAMBARUS ARGILLICOLA.*

*Cambarus argillicola*, Faxon, *supra*, p. 115.

Hab. Toronto, Province of Ontario; Michigan, Indiana, Louisiana? North Carolina?

28. **CAMBARUS DUBIUS.**  
*Cambarus dubius*, Faxon, *supra*, p. 114.  
 Hab. Mountain region of West Virginia, Virginia, and Tennessee.
29. **CAMBARUS NEBRASCENSIS.**  
*Cambarus Nebrascensis*, Girard, *op. cit.*, p. 91. 1852.  
*Cambarus Nebrascensis*, Hagen, *op. cit.*, p. 83. 1870 (after Girard).  
 Hab. Fort Pierre, Dakota.  
 This species is unknown to me. Possibly it is a form of *C. Diogenes*.
30. **CAMBARUS UHLERI.**  
*Cambarus Uhleri*, Faxon, *supra*, p. 116.  
 Hab. Lowlands of Maryland.
31. **CAMBARUS EXTRANEUS.**  
*Cambarus extraneus*, Hagen, *op. cit.*, p. 73, Pl. I. figs. 88, 89, Pl. III. fig. 156. 1870.  
 Hab. Tennessee River, near the border of Georgia; Etowah River, Rome, Georgia.  
 The larger female mentioned by Hagen, p. 74, is *C. spinosus* Bundy.
32. **CAMBARUS GIRARDIANUS.**  
*Cambarus Girardianus*, Faxon, *supra*, p. 117.  
 Hab. Cyprus Creek, Lauderdale Co., Alabama.
33. **CAMBARUS JORDANI.**  
*Cambarus Jordani*, Faxon, *supra*, p. 119.  
 Hab. Etowah River, Rome, Georgia.
34. **CAMBARUS CORNUTUS.**  
*Cambarus cornutus*, Faxon, *supra*, p. 120.  
 Hab. Green River, near Mammoth Cave, Kentucky.
35. **CAMBARUS HAMULATUS.**  
*Orconectes hamulatus*, Cope and Packard, Amer. Nat., XV. 881, Pl. VII. figs. 1, 1 *a*, 1 *b*. Nov., 1881.  
 Hab. Nickajack Cave, Tennessee.  
 I am indebted to Prof. A. S. Packard for the opportunity to examine six type specimens (four males, form II., and two females) of this interesting blind species.
36. **CAMBARUS MEDIUS.**  
*Cambarus medius*, Faxon, *supra*, p. 121.  
 Hab. Irondale, Missouri.



## 37. CAMBARUS IMMUNIS.

*Cambarus immunis*, Hagen, *op. cit.*, p. 71, Pl. I. figs. 101, 102, Pl. III. fig. 160, Pl. VIII. fig. b. 1870 (male, form I., and female).

*Cambarus immunis*, Forbes, *op. cit.*, pp. 4, 19. 1876 (male, form II., and young).

*Cambarus immunis*, Bundy, Proc. Acad. Nat. Sci. Phila., 1877, p. 171.

*Cambarus signifer*, Herrick, 10th Ann. Rep. Geolog. Surv. Minn., p. 253. 1882.

Hab. New York, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Wyoming, Alabama, and Orizaba, Mexico.

a. *Var. spinirostris.*

Hab. Obion Co., Tennessee.

In this form the rostrum possesses lateral spines at the base of the acumen.

## 38. CAMBARUS MISSISSIPPIENSIS.

*Cambarus Mississippiensis*, Faxon, *supra*, p. 123.

Hab. Eastern Mississippi.

## 39. CAMBARUS PALMERI.

*Cambarus Palmeri*, Faxon, *supra*, p. 124.

Hab. Obion Co., Tennessee.

## 40. CAMBARUS ALABAMENSIS.

*Cambarus Alabamensis*, Faxon, *supra*, p. 125.

Hab. Lauderdale Co., Alabama.

## 41. CAMBARUS COMPRESSUS.

*Cambarus compressus*, Faxon, *supra*, p. 127.

Hab. Lauderdale Co., Alabama.

## 42. CAMBARUS LANCIFER.

*Cambarus lancifer*, Hagen, *op. cit.*, p. 59, Pl. I. figs. 86, 87, Pl. III. fig. 159. 1870.

Hab. Mississippi.

Hagen's type remains unique.

## 43. CAMBARUS AFFINIS.

? *Astacus limosus*, Rafinesque, *op. cit.*, p. 42. Nov., 1817.

*Astacus affinis*, Say, *op. cit.*, p. 168. Dec., 1817.

*Astacus affinis*, Harlan, Med. and Phys. Res., p. 230, fig. 2. 1835.

*Astacus Bartonii*, Milne Edwards, *op. cit.*, II. 331. 1837.

- ? *Astacus (Cambarus) affinis*, Erichson, *op. cit.*, p. 96. 1846.  
*Cambarus affinis*, Girard, *op. cit.*, p. 87. 1852.  
*Cambarus Pealei*, Girard, *op. cit.*, p. 87. 1852.  
*Cambarus affinis*, Hagen, *op. cit.*, p. 60, Pl. I. figs. 19-22, 84,  
 85, Pl. III. fig. 152, Pl. V. 1870.

*Cambarus affinis*, Abbott, *op. cit.*, p. 80. 1873 (habits).

Hab. New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, Lake Erie, Lake Superior.

Erichson's type, a female, from South Carolina, near Greenville (Dr. Cabanis), is perhaps the closely allied *C. spinosus* Bundy. I have seen types of *C. Pealei* Girard in the Smithsonian Institution. They are large *C. affinis*, as Hagen suspected.

44. CAMBARUS SLOANII.

*Cambarus Sloanii*, Bundy, Bull. Ill. Mus. Nat. Hist., No. I. p. 24. 1876. — Proc. Acad. Nat. Sci. Phila., 1877, p. 172.

Hab. Indiana, Kentucky.

45. CAMBARUS PROPINQUUS.

*Cambarus propinquus*, Girard, *op. cit.*, p. 88. 1852.

*Cambarus propinquus*, Hagen, *op. cit.*, p. 67, Pl. I. figs. 34-38, Pl. III. fig. 153. 1870.

Hab. Toronto, Province of Ontario; Montreal, Province of Quebec; New York, Indiana, Illinois, Michigan, Lake Superior, Wisconsin, Iowa.

46. CAMBARUS SANBORNII.

*Cambarus Sanbornii*, Faxon, *supra*, p. 128.

Hab. Smoky Creek, Carter Co., Kentucky; Oberlin, Ohio.

47. CAMBARUS HARRISONII.

*Cambarus Harrisonii*, Faxon, *supra*, p. 130.

Hab. Irondale, Missouri.

48. CAMBARUS VIRILIS.

*Cambarus virilis*, Hagen, *op. cit.*, p. 63, Pl. I. figs. 23-28, Pl. II. figs. 128-132, Pl. III. fig. 155, Pl. VIII. 1870.

*Cambarus debilis*, Bundy, Bull. Ill. Mus. Nat. Hist., No. I. p. 24. 1876. — Trans. Wis. Acad. Sci., V. 181. 1882. — Geol. Wis., Surv. 1873-1879, I. 403. 1883 (male, form II.).

*Cambarus Couesi*, Streets, Bull. U. S. Geolog. Geograph. Surv. Terr., III. 803. 1877.

*Cambarus virilis*, Herrick, *op. cit.*, p. 253. 1882.

Hab. Lake Winnipeg, Saskatchewan River, Red River of the North, Toronto, and Montreal (?), Dominion of Canada; Da-

kota, Minnesota, Wisconsin, Iowa, Nebraska, Wyoming, Kansas, Missouri, Illinois, Indiana, Tennessee, Texas, New York?

I have examined the types of all the authors cited in the above synonymy.

49. CAMBARUS RUSTICUS.

*Cambarus rusticus*, Girard, *op. cit.*, p. 88. 1852.

*Cambarus rusticus*, Hagen, *op. cit.*, p. 71, Pl. I. figs. 80-83, Pl. III. fig. 161. 1870.

*Cambarus placidus*, Hagen, *op. cit.*, p. 65, Pl. I. figs. 76-79, Pl. III. fig. 158.

*Cambarus juvenilis*, Hagen, *op. cit.*, p. 66, Pl. I. figs. 29-33, Pl. III. fig. 157.

*Cambarus Wisconsinensis*, Bundy, Bull. Ill. Mus. Nat. Hist., No. I. p. 4. 1876.—Trans. Wis. Acad. Sci., V. 181. 1882.—Geol. Wis., Surv. 1873-1879, I. 402. 1883.

Hab. Pennsylvania, Ohio, Indiana, Illinois, Kentucky, Tennessee, Lake Superior, Wisconsin, Iowa, Missouri, Texas.

Among the large amount of material before me I find so many specimens that combine characters belonging to Hagen's three species, *C. rusticus*, *C. placidus*, and *C. juvenilis*, that I am led to consider them all as varieties or forms of *C. rusticus*. A type, male, form II., of *C. Wisconsinensis*, from Racine, Wis., received from Mr. Bundy, agrees pretty closely with the form *C. placidus*.

50. CAMBARUS SPINOSUS.

*Cambarus spinosus*, Bundy, Proc. Acad. Nat. Sci. Phila., 1877, p. 173.

Hab. Saluda River, South Carolina; neighborhood of Rome, Georgia; Tennessee River, near border of Georgia; Lauderdale Co., Alabama.

51. CAMBARUS PUTNAMI.

*Cambarus Putnami*, Faxon, *supra*, p. 131.

Hab. Kentucky, Tennessee, Indiana?

52. CAMBARUS OBSCURUS.

*Cambarus obscurus*, Hagen, *op. cit.*, p. 69, Pl. I. figs. 72-75, Pl. III. fig. 154. 1870.

Hab. Genesee River, Rochester, New York.

53. CAMBARUS FORCEPS.

*Cambarus forceps*, Faxon, *supra*, p. 133.

Hab. Lauderdale Co., Alabama; Knoxville, Tennessee?

## 54. CAMBARUS MONTEZUMÆ.

*Cambarus Montezumæ*, Saussure, Rev. Mag. de Zool., 2<sup>e</sup> Sér. IX. 102. 1857. — Mém. Soc. Phys. Hist. Nat. Genève, XIV. 459, Pl. III. fig. 22. 1858.

*Cambarus Montezumæ*, var. *tridens*, Von Martens, *op. cit.*, p. 130. 1872.

Hab. Mexico.

*C. Montezumæ* and *C. Shufeldtii* are small species, distinguished from all others by the presence of hooks on the third segment of the *second and third* pairs of legs in the male. Dr. Hagen has given me the following note on Saussure's types of *C. Montezumæ* in Berlin: "The types are in alcohol, male, form I., and female. In the male (young) the rostrum is nearly rounded in front. Another jar contains male, form II., and female, also from Saussure, with tridentate rostrum. The second and third pairs of legs are hooked, as is stated by Saussure." The majority of the specimens which I have seen, amounting to about seventy, have the lateral spines on the rostrum (Von Martens's var. *tridens*); but in some these spines are very small, and in others-reduced to a mere angle at the base of the acumen. Six specimens in the Museum of Comparative Zoölogy from near Parras, Cohahuila, have the section of the carapace behind the cervical groove shorter, the areola much broader. These may prove to be a distinct species. Five dry specimens in the same collection come from Mazatlan. It appears from these that the genus *Cambarus* extends in Mexico to the Pacific Ocean. Other localities are the neighborhood of the city of Mexico; \* Puebla; Lake San Roque, Trapuato.

## 55. CAMBARUS SHUFELDTII.

*Cambarus Shufeldtii*, Faxon, *supra*, p. 134.

Hab. Neighborhood of New Orleans, Louisiana.

## 56. ASTACUS (CAMBAROIDES) JAPONICUS.

*Astacus Japonicus*, De Haan, Crustacea of Siebold's Fauna Japonica, p. 164, Pl. XXXV. fig. 9. 1842.

*Astacus Japonicus*, Erichson, *op. cit.*, p. 94. 1846.

*Astacus Japonicus?* Kessler, Bull. Soc. Impér. Nat. Moscou, XLVIII. 364. 1874.

Hab. Japan.

The three species *A. Japonicus*, *A. Dauricus*, and *A. Schrenckii*, from Japan and the basin of the Amoor River, widely separated

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\* I have seen specimens from Lake Tezcoco, which is said to be salt.

from the rest of their family in geographical position, form a natural group of sub-generic value to which I have given the name *Cambaroides*. In them is found a combination of characters of *Astacus* and *Cambarus*. In the general appearance of the body, with its sub-cylindrical cephalo-thorax, and in the form of the rostrum and chelipeds, these Asiatic Astacines strikingly recall the *Cambari* of North America, and their affinity is made more evident through the hooked thoracic legs and tooth-tipped sexual appendages of the male. The hooks are situate, in all these species, on the third segment of the second and third pairs of legs, as in *Cambarus Montezumæ* and *Cambarus Shufeldtii*. In all the male examples of *Cambaroides* that I have seen (one *A. Dauricus*, three *A. Japonicus*) the first abdominal appendages are divided into two sections by a transverse suture, and furnished with short blunt teeth at the tip. I suspect the existence of two forms of the male here, as in *Cambarus*, for in the male specimen of *A. Dauricus* the hooks on the thoracic legs are strongly developed, and some of the teeth at the apex of the first abdominal appendages are brown and corneous, whilst in the three male *A. Japonicus* the hooks of the thoracic legs are weak, and the terminal teeth of the first abdominal appendages are smaller and not corneous. In *A. Schrenckii* there is a transverse tubercle behind the sternum of the penultimate thoracic somite, much as in *Astacus* proper. In *A. Dauricus* and *A. Japonicus* this transverse tubercle is hollowed out behind, but still remains closely soldered to the sternum. The first abdominal somite of the female is devoid of appendages. I have examined the branchiæ in *A. Japonicus*, and find them to agree in number and arrangement with those of *A. fluvialis*, there being one pleurobranchia (on each side) upon the last thoracic somite, and one simple branchial filament on each of the three antecedent somites. The structure of the branchiæ and coxopoditic setæ is the same as in the true *Astaci*.

Prof. C. O. Whitman, to whom the Museum of Comparative Zoölogy is indebted for four specimens of *A. Japonicus*, informs me that during his sojourn in Japan he could not learn of the occurrence of Crayfishes in Hondo, or Nippon, the main island of the empire, all the specimens known to him coming from the island of Yesso. Kessler's specimens came from the same locality as Whitman's, viz. Hakodadi, Yesso. In Whitman's specimens, as in those described by Kessler, the hind border of the telson

shows no trace of the deep notch described and figured by De Haan.

57. *ASTACUS* (*CAMBAROIDES*) *DAURICUS*.

*Astacus Dauricus*, Pallas, *Spicilegia Zoolog.*, Fasc. IX. p. 81. 1772.

*Daurische Krebs*, Herbst, *Versuch Naturgesch. Krabben u. Krebse*, II. 42. 1796.

*Astacus leptorrhinus*, Fischer, *Bull. Soc. Impér. Nat. Moscou*, IX. 467, Pl. V. fig. 1. 1836.

*Astacus Dauricus*, Erichson, *op. cit.*, p. 94. 1846.

*Astacus Davuricus*, Gerstfeldt, *Mém. Acad. Impér. Sci. St. Pétersbourg*, VIII. 292. 1859.

*Astacus Dauricus*, Kessler, *op. cit.*, p. 361. 1874.

Hab. Upper portion of the basin of the Amoor River.

58. *ASTACUS* (*CAMBAROIDES*) *SCHRENCKII*.

*Astacus Schrenckii*, Kessler, *op. cit.*, p. 363. 1874.

Hab. Lower portion of the basin of the Amoor River.

59. *ASTACUS* *KLAMATHENSIS*.

*Astacus Klamathensis*, Stimpson, *Proc. Bost. Soc. Nat. Hist.*, VI. 87. Feb., 1857. — *Journ. Bost. Soc. Nat. Hist.*, VI. 494. April, 1857.

*Astacus Klamathensis*, Hagen, *op. cit.*, p. 93, Pl. III. fig. 169. 1870.

Hab. Oregon, Washington Terr., British Columbia (Spence Bate); from the higher regions.

I have examined the branchiæ of *A. Klamathensis*, *A. nigrescens*, and *A. Gambelii*, of the American *Astaci*. In all of them the branchial formula is the same as in *A. fluviatilis*, there being three rudimentary branchiæ on each side of the thorax. In *A. nigrescens* the two anterior ones are short, but thick. They are more highly developed in *A. Gambelii* than in any other species of *Astacus* examined, presenting an interesting approach in structure to the perfectly developed branchia. Each of the rudimentary branchiæ is much larger than in any other species, and is jointed at a short distance from the base. At the joint there are, in the intermediate pair, two short lateral filaments; in the anterior and posterior pairs, the main stem bears one filament.

60. *ASTACUS* *LENIUSCULUS*.

*Astacus leniusculus*, Dana, *Crust. U. S. Explor. Exped.*, I. 524, Pl. XXXIII. fig. 1. 1852.

*Astacus leniusculus*, Stimpson, *Journ. Bost. Soc. Nat. Hist.*, VI. 493. 1857.

*Astacus leniusculus*, Hagen, *op. cit.*, p. 94 (after Dana and Stimpson).

Hab. Washington Terr. (lower part of Columbia River, Puget Sound).

One of Dana's types is in the Smithsonian Institution (No. 2019).

The type of *ASTACUS OREGANUS* Randall (Journ. Acad. Nat. Sci. Phila., VIII. 138, Pl. VII., 1839), from the Columbia River, was lost or destroyed while in the hands of the artist by whom the drawing was made, and no specimen answering to the figure or description has since been found. The figure is very faulty, as pointed out by Hagen. I am inclined to think, with Hagen, that Randall's specimen belonged to the species afterwards described by Dana as *A. leniusculus*.

61. *ASTACUS TROWBRIDGII*.

*Astacus Trowbridgii*, Stimpson, Proc. Bost. Soc. Nat. Hist., VI. 87. Feb., 1857. — Journ. Bost. Soc. Nat. Hist., VI. 493. April, 1857.

*Astacus Trowbridgii*, Hagen, *op. cit.*, p. 93, Pl. III. fig. 171, Pl. X. 1870.

Hab. Columbia River, near Astoria, Oregon; streams running into Shoalwater Bay, Washington Terr. (J. G. Cooper).

62. *ASTACUS NIGRESCENS*.

*Astacus nigrescens*, Stimpson, Proc. Bost. Soc. Nat. Hist., VI. 87. Feb., 1857. — Journ. Bost. Soc. Nat. Hist., VI. 492. April, 1857.

*Astacus nigrescens*, Hagen, *op. cit.*, p. 92, Pl. III. fig. 168. 1870.

*Astacus nigrescens*, Huxley, The Crayfish, p. 244, fig. 61, C, F, I, fig. 62, C, F. 1880.

Hab. San Francisco, California; Steilacoom, Washington Terr.

63. *ASTACUS GAMBELII*.

*Cambarus Gambelii*, Girard, *op. cit.*, p. 90. 1852.

*Astacus Gambelii*, Agassiz, Proc. Acad. Nat. Sci. Phila., VI. 375. 1853.

*Astacus Gambelii*, Stimpson, Journ. Bost. Soc. Nat. Hist., VI. 492. 1857.

*Astacus Gambelii*, Hagen, *op. cit.*, p. 90, Pl. I. figs. 97, 98, Pl. III. fig. 170, Pl. XI. 1870.

Hab. Utah, Idaho, Montana, Wyoming? California?

*A. Gambelii* has the most eastern range of any of the American *Astaci*. It is found in the Great Salt Lake Valley, and in the upper waters of the Snake River, Idaho. From this region it has passed over the divide into the Yellowstone Valley, and invaded the territory of the *Cambari* as far as the confluence of the Yellowstone and the Missouri. An examination of the physical geography of this region shows that the migration of a Western species into the Mississippi basin at this point is no difficult matter, the divide separating the waters of the Yellowstone from those of the Snake River being very low, hardly above the level of the ancient Yellowstone Lake.\* In the U. S. National Museum are two young specimens, labelled, "Willow Creek, Oct. 9, 1872. Dr. Curtis." An added ticket reads, "Wyoming Terr.?" Willow Creek in Wyoming Territory flows into the South Fork of the Platte, another affluent of the Missouri. Girard's types are said to have come from "California"; but whether this signifies California as now limited, I cannot say. In the U. S. National Museum are some specimens marked, "Found in bottle containing specimens from Santa Barbara. Dr. Webb." It is doubtful whether these were really collected at Santa Barbara. I have seen no authentic specimens from California.

64. *ASTACUS TORRENTIUM*.

*Cancer torrentium* (Steinkrebs), Schrank, Fauna Boica, III. 247. 1803.

*Astacus torrentium* (Steinkrebs), Wolf, Mag. neuesten Zustand Naturkunde (Voigt), XI. 42-45, Pl. I. figs. 1, 2. 1806.

*Astacus saxatilis*, Koch, Deutschlands Crust. Myriap. u. Arach., Heft 7, No. 1, with fig. (Panzer u. Herrich-Schäffer's Deutschlands Insecten, Heft 140, No. 1). 1835.

*Astacus tristis*, Koch, *op. cit.*, Heft 7 (140), No. 2, with fig. 1835.

*Astacus torrentium*, Koch, *op. cit.*, Heft 36 (186), No. 24, with fig. 1841.

*Astacus torrentium*, Erichson, † *op. cit.*, p. 92. 1846.

*Astacus saxatilis*, † Erichson, *op. cit.*, p. 92.

*Astacus tristis*, † Erichson, *op. cit.*, p. 93.

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\* See W. H. Holmes's Report on the Geology of the Yellowstone National Park, in 12th Ann. Rep. U. S. Geolog. Surv. of the Territories, for 1878, Part II. p. 56, 1883.

† Erichson had an opportunity to examine Koch's types of *A. torrentium*, *A. saxatilis*, and *A. tristis*, and notes their clear specific separation from *A. fluvi-*



*Steinkrebs*, Lereboullet, Comptes Rendus, XXXIII. 379. 1851.

*Astacus longicornis*, Lereboullet, Mém. Soc. Nat. Strasbourg, V. 2 (separate pagination), Pl. I. figs. 2-2<sup>d</sup>. 1858.

*Astacus torrentium* (Steinkrebs) (in part), Gerstfeldt, Mém. Acad. Impér. Sci. St. Pétersbourg, IX. 574, 579, 581, 584. 1859 (after Koch, Erichson, and Lereboullet).

*Astacus torrentium* (Steinkrebs), Klunzinger, Jahresh. Vereins vaterländ. Naturkunde Württemberg, XXXVIII. 340. 1882.

Hab. Central Europe (Bohemia, Bavaria, Württemberg, Alsace)\*.

The branchial formula of *A. torrentium* is the same as that of *A. pallipes*.

65. *ASTACUS PALLIPES*.

? *Astacus astacus*, Pennant, Brit. Zoöl., IV. 18, Pl. XV. fig. 27. 1777.

*Astacus fluviatilis* (in part), Milne Edwards, *op. cit.*, II. 330. 1837 (first "variety" noted on p. 331). — Cuvier's Règne Animal, Disciples' ed., Crust., Pl. XLIX. fig. 2.

*Duhlenkrebs*, † Lereboullet, Comptes Rendus, XXXIII. 376. 1851.

*Astacus fluviatilis*, Bell, Hist. Brit. Stalk-eyed Crust., p. 237, with cut. 1853.

*Astacus pallipes*, Lereboullet, Mém. Soc. Sci. Nat. Strasbourg, V. 7 (separate pagination), Pl. II., Pl. III. figs. 3-3<sup>d</sup>. 1858.

*Astacus pallipes*, var. *flavus*, Lereboullet, Mém. Soc. Sci. Nat. Strasbourg, V. 9. 1858.

*Astacus torrentium* (Steinkrebs) (in part), Gerstfeldt, *op. cit.*, p. 577. 1859.

*Astacus saxatilis*, Heller, Die Crust. südl. Europa, p. 217, Pl. VII. fig. 5. 1863.

? *Astacus fontinalis* (l'écrevisse à pieds blancs), Carbonnier, L'Écrevisse, p. 8. 1869.

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*atilis*, and their close affinity with each other. He shows that the dark color of *A. tristis* is due to a coat of adhesive mould, and dismisses the question of the specific value of the differences with the remark that the distinctions may have been more evident during life.

\* *A. torrentium*, *A. pallipes*, and *A. fluviatilis* have been so generally confounded by European authors that the data are insufficient for definitely fixing their geographical range.

† Here considered by Lereboullet but a variety of *A. fluviatilis*.

*Potamobius astacus*, G. B. Sowerby, Continuation of Leach's Malacostraca Podophthalma Britanniae, Nos. XVIII., XIX., Pl. XXXIV. fig. 1. 1875.

*Astacus fluviatilis*,\* Huxley, *op. cit.*, *passim*, and p. 230 in particular, frontispiece and figs. 1-60. 1880.

*Astacus torrentium*,\* Huxley, *op. cit.*, p. 296, fig. 61, A, D, G, fig. 62, A, D. 1880.

*Astacus pallipes* (der Dohlenkrebs), Klunzinger, *op. cit.*, p. 341. 1882.

Hab. Southern and Western Europe: Greece, Dalmatia, Islands of Cherso and Veglia, Trieste, Italy (Heller); France; Switzerland; Alsace (Lereboullet); Spain (Huxley); England, Ireland.

66. ASTACUS FLUVIATILIS.

? *Cammarus*, Belon, De Aquatil., p. 353, fig. on p. 355. 1553.

*Astacus fluviatilis*, Rondelet, Univ. Aquatil. Hist., Pars II. p. 210, with cut. 1555.

*Astacus fluviatilis*, Gesner, Hist. Animal., Lib. IV. p. 120, with cut. 1558 (in part: Edelkrebs, † p. 122).

*Cammarus*, Mattioli, Comment. Dioscor. de Med. Mat., Lib. II. p. 309, with fig. 1565.

*Cammarus, seu Astacus fluviatilis*, Aldrovandi, De Reliq. Animal. Exang.: Moll., etc., Cap. VI. p. 127, with cuts. 1606 (in part: Krebs, Edelkrebs, p. 129).

*Cammarus, seu Astacus fluviatilis*, Jonston, Hist. Nat. de Exang. Aquat., Lib. IV. p. 18, Pl. II. fig. 4, Pl. III. figs. 2, 3, 4, Pl. IV. fig. 1 (fig. 2 after Aldrovandi). 1650.

*Cancer macrourus; rostro supra serrato*, etc., Linne, Fauna Suecica, p. 358. 1746.

*Der Fluskrebs*, Rösel, Insekten-Belustigung, Th. III. p. 305, Pl. LIV. - LXI. 1755.

*Cancer astacus*, Linne, Syst. Nat., 10th ed., I. 631, 1758; 12th ed., I. 1051, 1767.

*Astacus fluviatilis*, Fabricius, Syst. Entomol., p. 413. 1775.

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\* Huxley leaves the question of the specific or the varietal value of the forms *A. nobilis* and *A. torrentium* (= *A. fluviatilis* and *A. pallipes*) undecided.

† Under the name *Astacus fluviatilis*, *Cammarus*, or *Gammarus*, the older authors included not only the *Edelkrebs*, or the species to which the name *A. fluviatilis* is now restricted, but also the *Steinkrebs* or *Thulkrebs*, a smaller form now known as *A. torrentium*. Indeed, it is probable that these authors confounded *A. torrentium* and *A. pallipes* under the name *Steinkrebs*.

—Spec. Insect., I. 509. 1781.—Mantissa Insect., I. 331. 1787.—Entomol. Syst. em. et aucta, II. 478. 1793.—Supplem. Entomol. Syst., p. 406. 1798.

*Astacus fluviatilis*, De Geer, Mém. Hist. Ins., VII., Pl. XX.—XXII. 1778.

*Cancer astacus*, Herbst, *op. cit.*, II. 38, Pl. XXIII. fig. 9. 1796 (in part: Edle Krebse, p. 41).

*Astacus fluviatilis*, Latreille, Hist. Nat. Crust. et Ins., I. 367, Pl. III. 1801; III. 33, 1801; V. 235, 1802.

*Astacus fluviatilis*, Bosc, Hist. Nat. Crust., II. 62, Pl. XI. fig. 2. 1802.

*Cancer nobilis* (Edelkrebs), Schrank, *op. cit.*, p. 246. 1803.

*Edelkrebs*, Wolf, *op. cit.*, Pl. I. fig. 3. 1806.

*Astacus fluviatilis*, Brandt and Ratzeburg, Med. Zoöl., II. 58, Pl. X., XI. 1833.

*Astacus fluviatilis* (in part), Milne Edwards, *op. cit.*, II. 330. 1837 (second "variety" noted on p. 331).

*Astacus fluviatilis*, Koch, *op. cit.*, Heft 36 (186), No. 23, with fig. 1841.

*Astacus fluviatilis*, Erichson, *op. cit.*, p. 90. 1846.

*Astacus fluviatilis*, Lereboullet, *op. cit.*, V., Pl. III. figs. 1–1<sup>a</sup>. 1858.

*Astacus fluviatilis communis*, Gerstfeldt, *op. cit.*, pp. 554, 584. 1859.

*Astacus fluviatilis*, Heller, *op. cit.*, p. 214, Pl. VII. figs. 3, 4. 1863.

*Astacus fluviatilis* (l'écrevisse à pieds rouges), Carbonnier, *op. cit.*, p. 8. 1869.

*Astacus fluviatilis*, Kessler, *op. cit.*, p. 257. 1874.

*Astacus nobilis*,\* Huxley, *op. cit.*, pp. 295, 296, fig. 61, B, E, H, fig. 62, B, E. 1880.

*Astacus fluviatilis* (Edelkrebs), Klunzinger, *op. cit.*, XXXVIII. 342. 1882.

Hab. Russia (Baltic water-shed and small streams of the upper part of the basin of the Dnieper), Austria, Germany, France, Italy? It is also found in Denmark according to Huxley, and in the Scandinavian peninsula. It appears to have been artificially introduced into the latter. It was scarcely known in Sweden before the time of John III. (1568–1592).† From Sweden

\* See first foot-note on preceding page. † Linne, Fauna Suecica, p. 358, 1746.

it has spread into Southeastern Norway.\* The *Astaci* of Spain are probably all *A. pallipes*, as well as those of England and Ireland.

67. *ASTACUS LEPTODACTYLUS*.

*Astacus leptodactylus*, Eschscholtz, Mém. Soc. Impér. Nat. Moscou, VI. 109, Pl. XVIII. 1823.

*Astacus leptodactylus*, Rathke, Mém. Acad. Impér. Sci. St. Pétersbourg, III. 359, Pl. IV. figs. 1, 2. 1837 (separate, 1836).

*Astacus leptodactylus*, var. *Caspia*, Eichwald, Bull. Soc. Impér. Nat. Moscou, 1838, p. 148. — Fauna Caspio-Caucasia, p. 179, Pl. XXXVI. fig. 1. 1841.

*Astacus leptodactylus*, var. *salinus*, Nordmann, Obs. sur la Faune Pontique, in Demidoff's Voy. dans la Russ. Mérid. et la Crimée, Atlas, Crust., Pl. I. (No date. †)

*Astacus leptodactylus*, Erichson, *op. cit.*, p. 90. 1846.

*Astacus fluviatilis*, var. *leptodactylus*, Gerstfeldt, *op. cit.*, pp. 558, 584. 1859.

*Astacus leptodactylus*, Heller, *op. cit.*, p. 215, Pl. VII. fig. 6. 1863.

*Astacus leptodactylus*, Kessler, *op. cit.*, p. 249. 1874.

Hab. Russia (rivers of the Ponto-Caspian basin on the north from the Danube to the Ural Mountains and the Muchojar Hills in Western Siberia, rivers and lakes draining into the Baltic and White Sea), Caspian Sea, Austria (basin of the Danube). Artificially introduced into affluents of the Tobol River, a tributary of the Irtish, Siberia, ‡ where it has rapidly multiplied.

a. *Var. angulosa*.

*Astacus angulosus*, Rathke, *op. cit.*, p. 364, Pl. IV. fig. 3. 1836.

*Astacus angulosus*, Erichson, *op. cit.*, p. 91. 1846 (after Rathke).

*Astacus fluviatilis*, var. *angulosus*, Gerstfeldt, *op. cit.*, pp. 563, 584. 1859.

*Astacus angulosus*, Heller, *op. cit.*, p. 216. 1863.

*Astacus leptodactylus*, var. *angulosus*, Kessler, *op. cit.*, p. 251. 1874.

Hab. Crimea and adjacent region.

\* G. O. Sars, Hist. Nat. Crust. d'Eau Douce de Norvège, p. 11, 1867.

† The text is dated 1840.

‡ Middendorf, Sibirische Reise, IV., Th. 2, p. 885, 1867. Kessler, *op. cit.*, p. 371.

There has lately appeared an insufficient preliminary notice, by Wladimir Schimkewitsch,\* of an *Astacus* from the neighborhood of the town of Toorkistan in the valley of the Jaxartes. It is closely related to *A. fluviatilis* and *A. leptodactylus*, perhaps not specifically distinct from one of these. Schimkewitsch affirms that intermediate forms connect *A. pachypus* with *A. leptodactylus* (Government of Riazan) and *A. leptodactylus* with *A. fluviatilis* (Governments of Toola and Moscow).

68. *ASTACUS PACHYPUS.*

*Astacus pachypus*, Rathke, *op. cit.*, p. 365. 1836.

*Astacus Caspius*, Eichwald, Bull. Soc. Impér. Nat. Moscou, 1838, p. 149.—Fauna Caspio-Caucasia, p. 181, Pl. XXXVI. fig. 2. 1841.

*Astacus pachypus*, Erichson, *op. cit.*, p. 91. 1846 (after Rathke).

*Astacus Caspius*, Erichson, *op. cit.*, p. 92 (after Eichwald).

*Astacus fluviatilis*, var. *pachypus et Caspius*, Gerstfeldt, *op. cit.*, pp. 566, 584. 1859.

*Astacus pachypus*, Heller, *op. cit.*, p. 217. 1863.

*Astacus pachypus*, Kessler, *op. cit.*, p. 254. 1874.

Hab. Brackish waters of the Caspian Sea and estuaries of rivers flowing into the Caspian and Black Seas.

69. *ASTACUS COLCHICUS.*

*Astacus Colchicus*, Kessler, Bull. Soc. Impér. Nat. Moscou, L. 2. 1876.

Hab. Upper portion of Rion River and tributaries, Asiatic Russia. It has been artificially introduced into some of the tributaries of the Upper Koor (anc. Cyrus). (Kessler.)

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\* Der turkestanische Flusskrebs. (Vorläufige Mittheilung.) Von Wladimir Schimkewitsch. Zoologischer Anzeiger, VII. 339, 23 Juni, 1884.

FAXON, WALTER.

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A LIST OF THE ASTACIDÆ IN THE U.S. NATIONAL  
MUSEUM.

∠ PROC. U.S. NAT. MUS., 1885.



ayon

W. B. Rathbun

- Ammodramus rostratus guttatus*. 195. *Passerculus guttatus*.
- Ammodramus savannarum passerinus*. 198. *Coturniculus passerinus*.
- Ammodramus savannarum perpallidus*. 198a. *Coturniculus passerinus perpallidus*.
- Junco cinereus dorsalis*. 221. *Junco dorsalis*.
- Melospiza georgiana* (Lath.). 233. *Melospiza palustris*.
- Icterus icterus* (Linn.). 265. *Icterus vulgaris* Daud.
- Corvus corax sinuatus* (Wagl.). 280. *Corvus corax carnivorus*.
- Pica pica hudsonica*. 286. *Pica rustica hudsonica*.
- Aphelocoma sieberii arizonæ*. 295. *Aphelocoma sordida arizonæ*.
- Dryobates villosus leucomelas*. 360a. *Picus villosus leucomelas*.
- Dryobates villosus audubonii* (Sw. & Rich.). *Picus audubonii* Sw. & Rich., F. B. A., ii, 1831, 306.
- Dryobates villosus harrisii*. 360b. *Picus villosus harrisii*.
- Dryobates pubescens gairdnerii*. 361a. *Picus pubescens gairdnerii*.
- Dryobates borealis* (Vieill.). 362. *Picus querulus*.
- Dryobates scalaris*. 363. *Picus scalaris*.
- Dryobates scalaris lucasanus*. 363a. *Picus scalaris lucasanus*.
- Dryobates nuttalli*. 364. *Picus nuttalli*.
- Dryobates stricklandi*. 365. *Picus stricklandi*.
- Picoides americanus alascensis* (Nels.). *Picoides tridactylus alascensis* Nelson, Auk, i, April, 1884, 165.
- Melanerpes aurifrons*. 373. *Centurus aurifrons*.
- Melanerpes uropygialis*. 374. *Centurus uropygialis*.
- Trochilus alleni*. 341. *Selasphorus alleni*.
- Megascops asio trichopsis*. 403. *Scops trichopsis*.
- Accipiter atricapillus striatulus*. 433a. *Astur atricapillus striatulus*.
- Zenaidura macroura* (Bonap.). 462. *Zenaidura amabilis*.
- Buteo butes*. [435.] *Buteo vulgaris*.
- Syrnium nebulosum alleni*. (*Strix nebulosa alleni*, Ridgw. Pr. U. S. Nat. Mus., iii, 1880, 8.)
- Zenaidura macroura* (Linn.). 460. *Zenaidura carolinensis* (Linn.).
- Dendragapus obscurus fuliginosus*. 471a. *Canace obscura fuliginosa*.
- Dendragapus obscurus richardsoni*. 471b. *Canace obscura richardsoni*.
- Dendragapus canadensis*. 472. *Canace canadensis*.
- Dendragapus franklini*. 472a. *Canace canadensis franklini*.
- Bonasa umbellus togata* (Linn.). (*Tetrao togatus*, Linn. S. N. ed. 12, I, 1766, 275.)
- Tympanuchus pinnatus* (Brewst.). 477. *Cupidonia cupido*. (*Cupidonia pinnata* Brewst., Auk, ii, Jan., 1885, 82.)
- Tympanuchus cupido* (Linn.). (Cf. Brewst., Auk, ii, Jan., 1885, pp. 80-84.)
- Tympanuchus pallidicinctus*. 477a. *Cupidonia cupido pallidicincta*.
- Callipepla californica vallicola*, Ridgw. 482. *Lophortyx californica*. (NOTE.—*L. californicus brunnescens*, Ridgw. Pr. Biol. Soc. Washington, II, 1885, 94, is a synonym of *Tetrao californicus*, Shaw. The birds of this species from the interior valleys of California differ decidedly from those found along the west side of the coast range, being much less brown above, with the inner edges of the tertials light buff or buffy whitish, instead of rusty ochraceous. The coast bird being the true *Californica*, it becomes necessary to give a new name to that of the interior valleys, and the one above given has been selected as seemingly appropriate.)
- Ardea tricolor ruficollis* (Gosse). 492. *Hydranassa tricolor ludoviciana*.
- Branta canadensis occidentalis*. 594c. *Bernicla canadensis occidentalis*.
- Branta canadensis minima*, Ridgw. 594b. *Bernicla canadensis leucopareia*. (*Bernida minima*, Ridgw. Pr. U. S. Nat. Mus., viii, Apr. 20, 1885, 22.)
- Netta rufina*. 616. *Fuligula rufina*.



- Aythya collaris*. 616. *Fulix collaris*.  
*Oceanodroma homochroa*. 725. *Cymochorea homochroa*.  
*Colymbus nigricollis californicus*. 733a. *Dytes nigricollis californicus*.  
*Xanthocephalus xanthocephalus* (Bp.). 260. *Xanthocephalus icterocephalus*.  
*Scolecophagus carolinus* (Müll.). 273. *Scolecophagus ferrugineus*.  
*Empidonax fulvifrons pygmaeus* (Coeus). 329. *Empidonax fulvifrons pallescens*.  
*Dendroica vigorsii* (Aud.). 111. *Dendroica pinus*.  
*Limosa limosa* (Linn.). [546.] *Limosa agocephala*.  
*Tryngites subruficollis* (Vieill.) 556. *Tryngites rufescens*.  
*Grus mexicana* (Müll.). 583. *Grus canadensis* (Linn.).  
*Tringa couesi*. 531. *Arquatella couesi*.  
*Sula sula* (Linn.). 652. *Sula leucogastra* (Bodd.).

## A LIST OF THE ASTACIDÆ IN THE UNITED STATES NATIONAL MUSEUM.

By WALTER FAXON.

(Corrected to July 1, 1885.)

1. *Astacus fluviatilis* Rond.  
 3229.\* Central Germany.  
 4137. Germany. 6 ♀.  
 4134. Bohemia. Dr. Hessel. 4 ♂.
2. *Astacus pallipes* Lereb.  
 10128. Montagny, Lake Neuchatel, Switzerland. Mus. Comp. Zoöl. 1 ♂, 1 ♀.
3. *Astacus torrentium* (Schrank) Wolf.  
 4861. Bohemia.
4. *Astacus Gambellii* Ag.  
 2536. Fort Hall, Idaho.  
 3251. Teton Basin, Idaho.  
 3227. Mouth of Yellowstone River.  
 3249. Mouth of Yellowstone River.  
 4396. Willow Creek [Wyoming Territory ?], Dr. Curtis, October 29, 1872.  
 Young.  
 4855. Santa Barbara, Cal. Dr. Webb. 6 ♂, 1 ♀.
5. *Astacus nigrescens* Stm.  
 4974. San Francisco, Cal. Mus. Comp. Zoöl. 1 ♀.  
 2267. California.  
 2526. Fort Steilacoom, Wash. (Differs from the typical form. See Faxon, Revision of the Astacidæ).  
 8954. Oonalaska, Alaska. W. H. Dall. 1 ♂.
6. *Astacus Trowbridgii* Stm.  
 2080. Astoria, Oreg. Lieutenant Trowbridge. Types. 2 ♂, 2 ♀.
7. *Astacus leniusculus* Dana.  
 2019. Columbia River. U. S. Explor. Exped. Type.  
 2161. Locality unknown.
8. *Astacus Klamathensis* Stm.  
 3881. Fort Walla Walla, Wash. Capt. Charles Bendire. 3 ♂, 2 ♀.  
 4037. Fort Walla Walla, Wash. Capt. Charles Bendire. 8 ♂, 12 ♀.

\* These numbers refer to the catalogue of Crustacea of the National Museum, in which the specimens are registered.

3899. Fort Walla Walla, Wash. 4 ♂.  
 3568. Fort Walla Walla, Wash., 3 ♂, 12 ♀.  
 3559. Fort Walla Walla, Wash. ♂, ♀. 12 +.  
 9428. Fort Walla Walla, Wash. 2 ♂, 1 ♀.  
 3166. Sikan Creek, Oreg.  
 6673. Des Chutes River, Oreg.  
 2072. Locality unknown. 1 ♂, 3 ♀.  
 4862. Locality unknown.  
 5042. Locality unknown.

**9. *Cambarus Blandingii* (Harlan) Erichs.**

3301. Kinston, N. C.  
 4148. Tarborough, N. C.  
 3220. Wilmington, N. C.  
 3572. Salmon Creek, N. C.  
 3381. Near Columbia, S. C. M. McDonald.

***Cambarus Blandingii* (Harlan) Erichs.?**

4888. Montgomery, Ala.  
 4132. Montgomery, Ala.

**10. *Cambarus Blandingii*, var. *acuta* Fax. (*C. acutus* Gir.)**

5617. New Orleans, La.  
 5505. Louisiana.  
 3252. Tickfaw, La.  
 3255. Tangipahoa River, Amite, La. P. Maxson, December 22, 1876.  
 9315. Jackson Barracks, La. 1 ♂.  
 4949. Mobile, Ala.  
 4950. Mobile, Ala.  
 4951. Blount Spring and Cullman, Sand Mountain, Ala.  
 4491. Near Bridgeport, Jackson County, Ala.  
 4875. South of Decatur, Ala.  
 4127. Montgomery, Ala. Kumblein & Bean. 1 ♂.  
 5499. Wheatland, Ind.  
 3382. Wheatland, Ind. Robert Ridgway, April, May, 1881.  
 3221. Aux Plains, Ill.? 1 ♂.  
 4131. Illinois. G. W. Milner, 1876. 1 ♀.  
 2164. Locality unknown. 25 +.

***Cambarus* sp.**

5619. New Orleans, La. Dr. Shufeldt.  
 9430. Arkadelphia, Ark. Jordan & Gilbert. 1 ♀.

**11. *Cambarus fallax* Hag.**

3182. Lake Jessup, Fla.  
 4382. Indian River, Fla.  
 3163. Near Titusville, Fla.  
 4969. Saint John's River, Fla. Mus. Comp. Zool. 2.

**12. *Cambarus Clarkii* Gir.**

5618. New Orleans, La.  
 3359. New Orleans, La. G. Dunbar's Sons. 3 ♂, 1 ♀.  
 2261. New Orleans, La. G. Kohn. 1 ♂, 2 ♀.  
 4859. New Orleans, La. Dr. R. W. Shufeldt, November 10, 1882. 1 ♀ with young.  
 5502. Louisiana. Dr. Shufeldt.  
 5507. Louisiana.  
 3253. Tangipahoa River, La. Frederick Mather, August, 1875.  
 4952. Ocean Springs, Miss.  
 4512. Pensacola, Fla. Silas Stearns, May 31, 1832. ♂, ♀. 12+.

13. *Cambarus troglodytes* (Le C.) Hag.  
4885. Near Columbia, S. C.  
4053. Oakley, S. C. F. W. Hayward. 1 ♂, 1 ♀.
14. *Cambarus lecontei* Hag.  
4958. Mobile, Ala. Type. Mus. Comp. Zool. 1 ♂.
15. *Cambarus pubescens* Fax.  
3181. McBean Creek. Ga. A. Graves. Types. 1 ♂, 1 ♀.
16. *Cambarus spiculifer* (Le C.) Hag.  
4962. Athens, Ga. Mus. Comp. Zool. 1 ♂.
17. *Cambarus versutus* Hag.  
4963. Spring Hill, Ala. Type. Mus. Comp. Zool. 1 ♂.
18. *Cambarus Wiegmanni* Erichs.?  
3288. Isthmus of Tehuantepec. Prof. Sumichrast. 1 ♀.
19. *Cambarus pellucidus* (Tellk.) Erichs.  
4852. Mammoth Cave, Ky. Peter Parker, 1858. 1 ♂.  
4970. Mammoth Cave, Ky. Mus. Comp. Zool. 1 ♀.  
9314. White Cave, Ky. 3 ♀.
20. *Cambarus simulans* Fax.  
4150. East of Canadian River. Types.  
5500. Shoal Creek, near Austin, Tex.
21. *Cambarus advena* (Le C.) Hag.  
4964. Georgia. Mus. Comp. Zool. 1 ♀.
22. *Cambarus gracilis* Bundy.  
6672. Davenport, Iowa. Young.  
4960. Decatur, Ill. Mus. Comp. Zool. 1 ♂.
23. *Cambarus cubensis* Erichs.  
10129. Near Havana, Cuba. Mus. Comp. Zool. 1 ♂, 1 ♀.
24. *Cambarus bartonii* (Fab.) Gir.  
5624. Fulton Lakes, N. Y.  
8949. Bainbridge, Penn.  
3835. Carlisle, Penn.?  
4863. Spring Creek, Caledonia.  
4955. Rock Creek, D. C.  
5621. Rock Creek, D. C.  
3180. Rock Creek, D. C.  
4620. Rock Creek, D. C.  
4621. Rock Creek, D. C.  
6670. Washington, D. C.  
6669. Washington, D. C.  
6668. Locality unknown.  
5622. Clarke County, Va.  
4128. Holston River, Smyth County, Va.  
4886. Kinston, N. C.  
9383. Doe River., Carter County, Tenn. H. Hemphill. Var. *longirostris*  
Fax. 3 ♀.
25. *Cambarus bartonii* var. *robusta* Fax. (*Cambarus robustus* Gir.).  
5623. Fulton Lakes, N. Y.  
4961. Forestville, N. Y. Mus. Comp. Zool. 1 ♂.
- Cambarus* sp.  
4972. Mobile, Ala. Mus. Comp. Zool. 1 ♀.  
5620. Milton, Fla.  
4871. Near Ashland City, Tenn.

26. *Cambarus latimanus* (Le C.) Hag.  
 3374. South Carolina? M. McDonald.  
 3145. Near Columbia, S. C.  
 4953. Blount Spring and Cullman, Ala.  
 4954. Ocean Springs, Miss.
- Cambarus latimanus* (Le C.) Hag.?  
 4877. Waterloo, Lauderdale County, Ala. C. L. Herrick.  
 4874. Near Bridgeport, Jackson County, Ala.  
 4492. Near Ashland City, Cheatham County, Tenn.
27. *Cambarus Diogenes* Gir.  
 8946. Washington, D. C.  
 3225. Wilmington, N. C.  
 3298. Kinston, N. C.  
 5625. New Orleans, La.  
 5504. New Orleans, La.  
 3373. Knox County, Ind.  
 5492. Abingdon, Ill.  
 4973. Decatur, Ill. Mus. Comp. Zoöl. 1 ♂.  
 5501. Davenport, Iowa.  
 2163. Locality unknown.  
 2491. Locality unknown.
- Cambarus Diogenes* Gir.?  
 4887. Kinston, N. C.  
 4883. South of Decatur, Ala.  
 2262. New Orleans, La.  
 4078. Panama. 1 young ♂.
28. *Cambarus extraneus* Hag.  
 4957. Tennessee River, near border of Georgia. Type. Mus. Comp. Zoöl. 1 ♀.
29. *Cambarus Girardianus* Fax.  
 4882. Cypress Creek, Lauderdale County, Ala. C. L. Herrick, October, 1882. Types.
30. *Cambarus immunis* Hag.  
 2323. White River, Ind.  
 3223. Aux Plains, Ill.  
 4866. Milwaukee, Wis. E. G. Blackford.  
 3222. Near Laramie, Wyo.  
 3257. Orizaba, Mexico.  
 3570. Locality unknown.
31. *Cambarus immunis* var. *spirostris* Fax.  
 4655. Obion County, Tenn. Types.
32. *Cambarus Palmeri* Fax.  
 4872. Obion County, Tenn. Edw. Palmer, May 30, 1882. Types.  
 4654. Obion County, Tenn. Edw. Palmer, May 30, 1882. Types.
33. *Cambarus Alabamensis* Fax.  
 4876. Waterloo, Lauderdale County, Ala. C. L. Herrick. Types. ♂, ♀. 25+.
34. *Cambarus compressus* Fax.  
 4878. Waterloo, Lauderdale County, Ala. C. L. Herrick, October, 1882. Types.  
 4879. Cypress Creek, Lauderdale County, Ala. C. L. Herrick, October, 1882. Type

**35. *Cambarus affinis* (Say) Gir.**

8947. Bainbridge, Pa.  
 4853. Susquehanna River, Pa. F. G. Galbraith. 3 ♂.  
 3842. Bainbridge, Pa.  
 4126. Havre de Grace, Md.  
 4854. Havre de Grace, Md. T. H. Bean. ♂, ♀. 12+.  
 4904. Havre de Grace, Md. T. H. Bean.  
 2081. Potomac River, Washington, D. C. Types of *C. Pealei* Gir. 2 ♂,  
 2 ♀.  
 8952. Potomac River, Washington, D. C.  
 8951. Washington, D. C.  
 8953. Washington, D. C.  
 8955. Washington, D. C.  
 8945. Washington, D. C. 1 ♀.  
 8948. Washington, D. C. 1 ♂.  
 3248. District of Columbia.  
 4145. Potomac River, Gunston, Va.  
 4146. Potomac River, Gunston, Va.  
 4893. Potomac River, Gunston, Va. M. McDonald.  
 2265. Potomac River, Va. ♂, ♀, 12+.  
 8950. Locality unknown. 2 ♂, 1 ♀.

**36. *Cambarus Sloanii* Bundy.**

4965. New Albany, Ind. Mus. Comp. Zoöl. 2 ♂.

**37. *Cambarus propinquus* Gir.**

6671. Grass River, Canton, N. Y.  
 3226. Ogdensburgh, N. Y.  
 4959. Forestville, N. Y. Mus. Comp. Zoöl. 1 ♂.  
 2135. Rocky River.  
 4851. Illinois. G. W. Milner.  
 3250. Aux Plains River, Ill.  
 4149. Northville, Mich.  
 2160. Locality unknown.

**38. *Cambarus propinquus*, var. *obscura*, Fax. (*Cambarus obscurus* Hag.)**

4971. Genesee River, Rochester, N. Y. Type. Mus. Comp. Zoöl. 1 ♂.  
 2531. California (?).

**39. *Cambarus virilis* Hag.**

4865. Illinois.  
 4858. Historical Society, Manitoba.  
 4857. Cedar Lake, Hennepin County, Minn. C. L. Herrick.  
 4868. Cedar Lake, Hennepin County, Minn. C. L. Herrick.  
 4869. Lake Independence, Minn. C. L. Herrick.  
 4870. Bassett's Creek, Hennepin County, Minn. C. L. Herrick.  
 4856. Milwaukee, Wis. E. G. Blackford.  
 4900. Milwaukee, Wis. E. G. Blackford.  
 4153. Souris River, Dak. Elliott Coues, 1873.  
 4154. Souris River, Dak. Elliott Coues, 1873.  
 3256. Souris River, Dak. Elliott Coues, 1873.  
 2309. Souris River, Dak. Elliott Coues, 1873.  
 3154. Red River of the North, near Pembina, Dak. Elliott Coues, May,  
 1873. Types of *C. Couesi* Streets.  
 9429. Des Moines River, Iowa. Jordan & Gilbert. 5.  
 9431. Bedford, Iowa. Jordan & Meek. 1 ♀.  
 2068. Laramie, Wyo.  
 9427. White River, Eureka Springs, Ark. Jordan & Gilbert. 2 ♀.  
 4873. Near Bridgeport, Jackson County, Ala.

**Cambarus** sp.

4867. Cheatham's Ferry, Lauderdale County, Ala.

**40. Cambarus rusticus** Gir.

4968. Cincinnati, Ohio. One of Hagen's types. Mus. Comp. Zoöl. 1 ♂.

4966. Lebanon, Tenn. Type of *C. placidus* Hag. Mus. Comp. Zoöl. 1 ♂.

9427. White River, Eureka Springs, Ark. Jordan &amp; Gilbert. 1 ♀.

4967. Kentucky River, Little Hickman, Ky. Type of *C. juvenilis* Hag.

Mus. Comp. Zoöl. 1 ♂.

**41. Cambarus spinosus** Bundy.

4881. Cypress Creek, Lauderdale County, Ala. C. L. Herrick.

**Cambarus** sp.

4884. Georgia.

**42. Cambarus Putnami** Fax.10130. Grayson Springs, Grayson County, Ky. Type. Mus. Comp. Zoöl.  
1 ♂.**43. Cambarus forceps** Fax.4880. Cypress Creek, Lauderdale County, Ala. C. L. Herrick, October,  
1882. Types.**44. Cambarus Montezumæ** Saus.

4119. Lake San Roque, Trapuato, Mexico.

4864. Mexico.

**45. Cambarus Shufeldtii** Fax.

4860. Near New Orleans, La. Dr. R. W. Shufeldt, 1883. Types.

**46. Cheraps Preissii** Erichs. ?

4889. Sydney, Australia.

**47. Parastacinae**, sp. nov.

4133. Colima, Mexico. J. Xantus.

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**A LIST OF THE FISHES KNOWN FROM THE PACIFIC COAST OF TROPICAL AMERICA, FROM THE TROPIC OF CANCER TO PANAMA.**
**By DAVID S. JORDAN.**

Four hundred and seven species of fishes are now known to inhabit the waters of the Pacific coast of tropical America between Cape San Lucas and Panama. Our knowledge of these species is due chiefly to the studies of Dr. Gill, Dr. Günther, Dr. Steindachner, and Professors Jordan and Gilbert. Only a few collectors have given especial attention to the fish fauna of this region, but the work of these has in nearly all cases been of exceptional value.

The earliest extensive collections were made by Mr. John Xantus at Cape San Lucas, and later at Colima. The specimens obtained by Xantus comprise especially the fishes of the rock-pools. These were studied by Dr. Gill in 1862, and by Professor Gilbert and the writer in 1882. Many of the specimens collected by Xantus still remain unique.

The next collections were made in the bay of Panama, by Capt. John M. Dow, about 1862 to 1866. The first of these were sent to the Smithsonian Institution, where they were studied by Dr. Gill. Later, still

larger collections were sent by Captain Dow to the British Museum. These fishes, and others collected by Dr. Oscar Salvin about Chiapam, were made the subjects of several papers by Dr. Günther, and in 1869 they formed the basis of his general work on the fishes of Central America.

Still later, Dr. Franz Steindachner visited various points along the coast, making collections of fishes. Various local collectors have since sent specimens to the Vienna professor. His various treatises on the fishes of different regions contain many references to the fishes of the Pacific coast of tropical America, and a very large number of the species were first made known by him. The figures published by Dr. Steindachner are the best in ichthyological literature.

A very valuable collection was made by Professor Bradley in the vicinity of Panama in 1866, and by him sent to the museum of Yale College. Unfortunately this collection was allowed to suffer from neglect, and before it was finally studied by Dr. Gilbert and the writer in 1882, most of the species which were new to science when the collection was made had been already described.

Smaller collections have also been obtained by Dr. Bocourt, about La Union, by Dr. Streets, by Mr. Lockington, and by Mr. Belding, in the Gulf of California, and by Lieutenant Nichols at various points on the Mexican coast. The first-named collection has formed the rather insufficient basis for an elaborate memoir by Professor Vaillant and Dr. Bocourt; the last mentioned has been studied by Dr. Gilbert and the writer.

The most extensive collections yet made on the Pacific coast of Mexico and Central America, in number of specimens exceeding all the others combined, are those obtained by Professor Gilbert at Mazatlan and Panama in 1881, and about Panama in 1883.

These collections have formed the subject of numerous papers by Professor Gilbert and the writer in the publications of the United States National Museum.

We had prepared a descriptive catalogue, giving the full synonymy and detailed descriptions of all the known species. In the fire which, in 1883, destroyed the museum of the Indiana University our manuscripts (then ready for the printer) were all burned, and with them about two-thirds of Professor Gilbert's entire collections. All the specimens obtained at Panama in 1883 were destroyed, but most of the collection of 1881 had then been returned to the National Museum.

Among the specimens destroyed were twenty species from Panama which still remain without names.

The present paper is the result of the joint studies of Professor Gilbert and the writer, but for its details the present writer is alone responsible.

I have given a list of the species ascribed on good authority to the region in question. Those species, three hundred and sixty-two in

SMITHSONIAN INSTITUTION.  
UNITED STATES NATIONAL MUSEUM.

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NOTES ON NORTH AMERICAN CRAYFISHES,  
FAMILY ASTACIDÆ.

BY

WALTER FAXON.

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From the Proceedings of the United States National Museum, Vol. XII, pages 619-634.

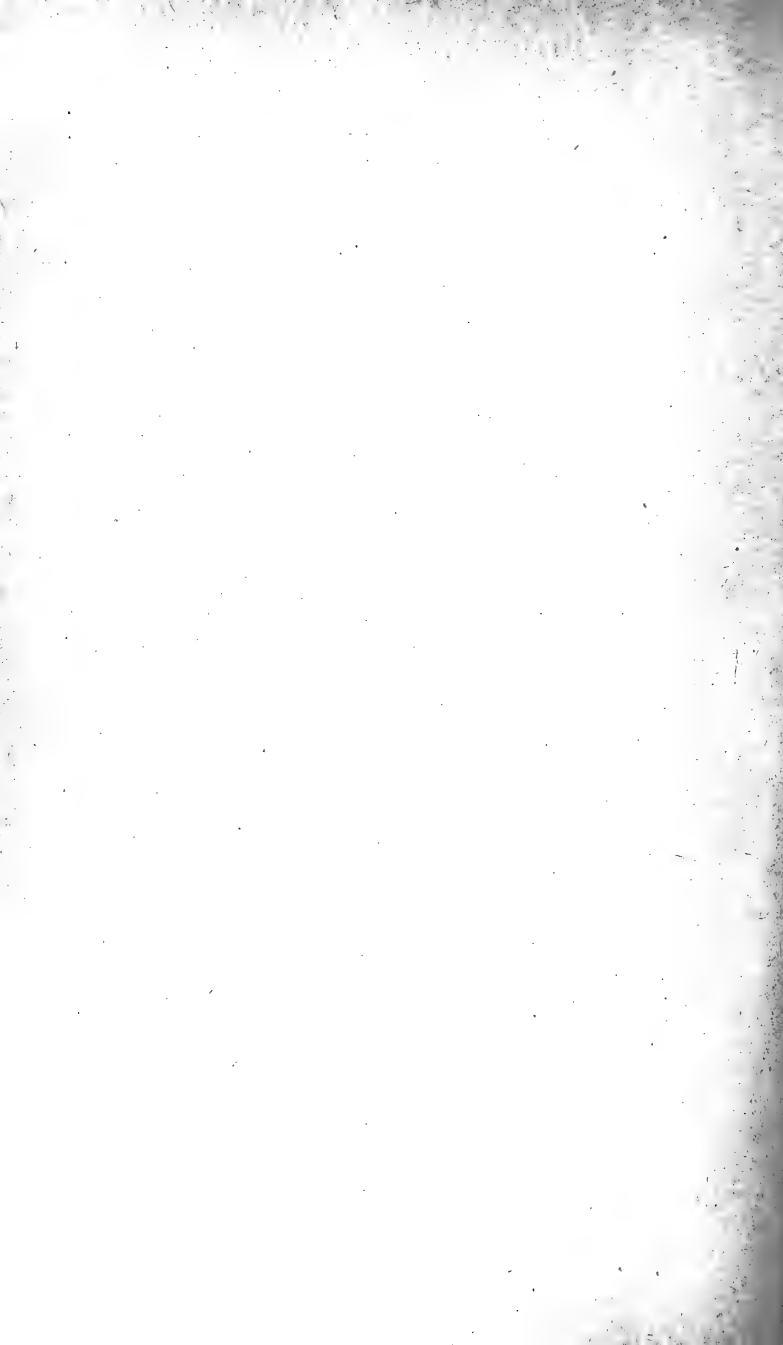
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NOTES ON NORTH AMERICAN CRAYFISHES—Family ASTACIDÆ.

BY

WALTER FAXON.

The following notes are the result of an examination of the North American Astacidæ received at the U. S. National Museum and the Museum of Comparative Zoölogy and also those collected by the field parties of the U. S. Fish Commission since the publication of the first part of the author's revision of that group.\* Herein are included full descriptions of all the new species discovered since the publication of that work, together with such additions as have been made to our knowledge of the distribution of these animals. The notes thus form a supplement to the Revision of the Astacidæ.

*Cambarus blandingii* (Harl.).

Additional localities: North River, Lexington, Virginia; Dismal Swamp, outlet of Lake Drummond, Suffolk, Virginia; Tar River, Rocky Mount, North Carolina; Neuse River, Raleigh, North Carolina. Collected by D. S. Jordan (U. S. F. C.).

*Cambarus blandingii acutus* (Gir.).

York, Clark County, Illinois. H. G. Hodge (U. S. N. M.).

*Cambarus versutus* Hag.

Additional locality: Escambia River at Flomaton, above Pensacola, Florida. D. S. Jordan, B. W. Evermann, and C. H. Bollman (M. C. Z.). A young male. The rostrum tapers a little more than in the type specimens from Mobile, Alabama, and is lightly carinate above in the median line. In these respects it agrees with the specimens from Cape Barrancas, Florida, mentioned on page 34 of my Revision of the Astacidæ.

*Cambarus alleni* Fax.

Caloosahatchee River, Florida. W. H. Dall (U. S. N. M.). Two males, form I, two females. In the female (now known for the first time) the chelæ are short and broad compared with those of the male.

\* A Revision of the Astacidæ. By Walter Faxon. Part I. The Genera *Cambarus* and *Astacus*. Mem. Mus. Comp. Zoöl., Vol. x, No. 4, 1885.

In an individual 78<sup>mm</sup> long the chela measures 25 by 9.5<sup>mm</sup>, while in a male 71<sup>mm</sup> long the chela is 35 by 9<sup>mm</sup>. The annulus ventralis forms a prominent tubercle. The rostrum is subdenticate near the apex.

*Cambarus evermanni*, sp. nov.

Male, form I.—Rostrum broad, triangular, smooth, moderately concave above, margins raised into sharp crests which extend well back on the carapace between the post-orbital ridges; no lateral spines. Post-orbital ridges without spines. Carapace compressed laterally, fore border hardly angulated below the eye; punctate above, granulate on the sides, no lateral spine, branchiostegian spine small; distance from the cervical groove to the hind border of the carapace scarcely one-third the length of the whole carapace; areola of moderate width. Abdomen longer than the cephalothorax; two spines on each side of the hind border of the basal segment of the telson; terminal segment of the telson shorter than the basal. Anterior process of the epistoma subtruncate. Basal segment of the antennule furnished with a spine on the inner margin of the ventral surface half way between the proximal and distal extremities. Antennæ shorter than the body, spines on the second and third segments obsolescent; antennal scale broad, broadest in the middle, surpassing the rostrum and equaling the peduncle of the antenna. Third pair of maxillipeds setose within and below. Chelipeds slender; chela long, subcylindrical, squamoso-tuberculate, inner border provided with a row of about seven dentiform tubercles; fingers as long as the hand, straight, with longitudinal ribs; carpus tuberculate on the inner side, armed with one prominent spine on the inner border; meros tuberculate on the upper margin, with two rows of spines below. Third and fourth pairs of legs hooked on the third segment; hooks of both pairs simple. Fourth and fifth pairs of legs with a flattened, laminate tubercle on the basal segment, that on the fourth pair the larger. Anterior abdominal appendages of moderate length, somewhat recurved at the end, outer part terminating in a horny truncate head with a slightly developed recurved tooth, beared anteriorly on the outer side; inner part terminating in an articulated spine obliquely placed, and not exceeding the outer part of the appendage.

Length, 70<sup>mm</sup>; from tip of the rostrum to the cervical groove, 22<sup>mm</sup>; from the cervical groove to the posterior margin of the carapace, 10<sup>mm</sup>; abdomen, 37<sup>mm</sup>; cheliped, 65<sup>mm</sup>; chela, 33 by 7<sup>mm</sup>; width of areola in its narrowest part, 2<sup>mm</sup>.

Escambia River at Flomaton, above Pensacola, Florida. D. S. Jordan, B. W. Evermann, and C. H. Bollman (M. C. Z.).

This species belongs to group I, (type, *C. blandingi*). It is nearly related to *C. alleni* Fax. but differs in the form of the first pair of abdominal appendages (*cf.* the description of those parts in *C. alleni*, Rev. Astacidæ, p. 35), in the simple structure of the hooks of the fourth

pair of legs, in the presence of a flattened tubercle on the basal segment of the fourth pair of legs, in the shorter metacarapace, broader areola, long spiny telson, etc. The male appendages are similar to those of *C. fallax* Hag., as are also the tubercles on the basal segment of the fourth and fifth pairs of legs. More specimens of the three related species *C. alleni*, *C. evermanni*, and *C. wiegmanni* are much needed in order to elucidate the structure of the female and the two forms of the male.

**Cambarus barbatus** Fax.

*Astacus penicillatus* Le Conte, Proc. Acad. Nat. Sci., Phila., VII, 1855, p. 401, (nec Olivier, 1791).

*Cambarus penicillatus* Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III, 1870, p. 53. Faxon, Proc. Amer. Acad. Arts and Sci., XX, 1884, p. 138. *Id.*, Mem. Mus. Comp. Zoöl, X, No. 4, 1885, p. 36.

Additional locality: Escambia River at Flomaton, above Pensacola, Florida. D. S. Jordan, B. W. Evermann, and C. H. Bollman (M. C. Z.). One male, form I; five females, five young. The annulus ventralis of the female is divided by a deep, longitudinal furrow into two prominent tubercles, each of which is denticulate. The inner margin of the hand is serrate, but not bearded as in the male. Length, 60<sup>mm</sup>. After examining these undoubted specimens of Le Conte's *Astacus penicillatus* I am confident that the second-form males and the females from Charleston, South Carolina, referred to this species by Hagen (*op. cit.*, p. 54; *cf.* Faxon, Mem. Mus. Comp. Zoöl., X, No. 4, p. 37) belong to some other species.

Following the code of nomenclature adopted by the American Ornithologists' Union\* (canon XXXIII, p. 47), Le Conte's specific name *penicillatus* must be rejected, since it had been used previously by Olivier (Encyc. Méth., Hist. Nat. des Insectes, VI, 1791, p. 343), in combination with the same generic name, for another animal (*Palinurus penicillatus* of recent authors).

**Cambarus pellucidus** (Tellk.).

This species has been reported from the following caves in Indiana, besides the Wyandotte and Bradford Caves; caves at Clifty, Bartholomew County (Dr. John Sloan); Mayfield's Cave, near Bloomington, Monroe County (C. H. Bollman).† These caves are in the White River drainage. For further remarks on *C. pellucidus* see below under *C. setosus*.

**Cambarus simulans** Fax.

Additional locality: Tributary of Medicine River, Barber County, Kansas. Messrs. Williams and Cragin (M. C. Z.).

\* The Code of Nomenclature and Check-List of North American Birds adopted by the American Ornithologists' Union; being the report of the committee of the union on classification and nomenclature, New York, 1886.

† Packard, Mem. Nat. Acad. Sci., Vol. IX, No. 1, p. 16.

*Cambarus gracilis* Bundy.

Additional localities: York, Clark County, Illinois, H. G. Hodge (U. S. N. M.); Labette County, Kansas, W. S. Newlon (M. C. Z.).

*Cambarus bartonii* (Fab.).

Additional localities: St. John River, just above Grand Falls, New Brunswick, W. F. Ganong (M. C. Z.); head of Kennebec River, outlet of Moosehead Lake, Maine, Edwin Faxon (M. C. Z.); Shenandoah River, Waynesborough, Virginia, D. S. Jordan (U. S. F. C.); Peak Creek, Pulaski, Virginia, D. S. Jordan (U. S. F. C.); Swannanoa River, Black Mountain, North Carolina, D. S. Jordan (U. S. F. C.); Bloomington, Indiana, W. S. Blatchley (M. C. Z.). Prof. D. S. Jordan informs me that he has found *Cambarus* (*C. bartonii*, doubtless,) in a tributary of the Housatonic River, Berkshire County, Massachusetts. It had been known previously in that county only from Williamstown. With reference to the distribution of *C. bartonii* in the Province of Quebec and in New Brunswick Mr. W. F. Ganong has called my attention to the fact that it was recorded by Dr. Robert Bell,\* as long ago as 1859, as abundant in the Restigouche, Matapedia, and Metis Rivers. Dr. Bell also found one specimen just below the high falls of the Ouiatchouan, a stream which empties into the south side of Lake St. John in Quebec. In 1865 Prof. H. Y. Hind\* mentions a *Cambarus* (doubtless *C. bartonii*) in the Upsalquitch, a tributary of the Restigouche. Mr. Ganong\* himself has lately published a paper on the distribution of *C. bartonii* in New Brunswick, in which attention is drawn to its occurrence at many points in the St. John River and its affluents, from Grand Falls to Fredericton, and additional testimony is given as to its presence in the Restigouche and Upsalquitch. Mr. Ganong was informed that it was very abundant in the southwest Miramichi also, but he searched for it without success in the St. Croix. The northern limit of its distribution, then, so far as known, is the Ouiatchouan, Metis, and Matapedia Rivers, in the Province of Quebec, while the eastern limit is the Miramichi, New Brunswick.

Specimens of *C. bartonii* from Bloomington, Indiana, like all that I have seen from that State, are a smooth form, with very narrow areola and obsolete internal basal carpal spine.

*Cambarus bartonii robustus* (Gir.).

Additional locality: Wytheville, Wythe County, Virginia. Col. M. McDonald (U. S. F. C.).

\* On the Natural History of the Gulf of St. Lawrence, and the Distribution of the Mollusca of Eastern Canada. By Robert Bell, Jr., Canadian Naturalist and Geologist, iv, 1859, p. 210.

\* Prelim. Rep. Geol. New Brunswick, p. 130.

\* The Crayfish in New Brunswick. By W. F. Ganong. Bull. Nat. Hist. Soc. New Brunswick, No. vi, pp. 74, 75, 1887. See also The Crayfish in the Atlantic Provinces. [By W. F. Ganong.] The Educational Review, III, 95, St. John, N. B., Nov. 1, 1889.

*Cambarus longulus* Gir.

*Cambarus longulus* Girard, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 90.

*Cambarus bartonii* (part.)? Hagen, Mon. N. A. Astacidæ, pp. 78, 79, 1870. Faxon, Proc. Amer. Acad. Arts and Sci., xx, 1884, p. 143. *Id.*, Rev. Astacidæ, pt. I, p. 66, 1885.

Waynesborough, Virginia; Lick Run, James River, Virginia; North River, Lexington, Virginia; Wytheville, Virginia; South Fork of Holston River, near Marion, Virginia; Spring Creek, Hot Springs, North Carolina; Watauga River, Elizabethton, Tennessee. Col. M. McDonald and Prof. D. S. Jordan (U. S. F. C.). Specimens in the Museum of Comparative Zoölogy from Bath County, Virginia, from near White Sulphur Springs, West Virginia, and from Knoxville, Tennessee, probably belong to this species, but they are too young to determine with certainty.

It is only after examining the large number of specimens (over one hundred, including females and both forms of the male), collected by Colonel McDonald and Professor Jordan, that I am prepared to restore this form to the full rank of a species. When the Monograph of the North American Astacidæ was written, Dr. Hagen had seen but one specimen (Girard's type), and he inclined to regard it as a deformed individual of *C. bartonii*. His description of the type specimen shows that it is the same as the form now under consideration. Compared with the typical *C. bartonii* from eastern Pennsylvania, the rostrum of *C. longulus* is much longer and narrower, deeply excavated above, the sides thickened, somewhat concave and convergent, with longer acumen; the antennæ scale is produced into a longer spine; the carapace is more finely punctated, the hepatic and branchial areas smoother, the suborbital angle commonly but little or not at all developed; the chelæ are smoother and broader; the fingers more cylindrical, without the longitudinal ridge along the upper face of the outer finger, widely separated at the base, the outer one bearded within at the base and along the margin; the basal spine of the inner margin of the carpus is absent. The beard on the hand is densest in small specimens, being more or less removed by attrition in old individuals. In specimens from Marion, Virginia, Spring Creek, North Carolina, and Elizabethton, Tennessee, the suborbital angle is prominent, as in *C. bartonii*. In *C. bartonii longirostris* Fax. (Rev. Astacidæ, p. 64), the rostrum is not so much contracted, its margins not so much thickened as in *C. longulus*, in fact the rostrum of *spinirostris* has about the same shape as that of *C. bartonii robustus*; the sides of the antennal scale are straight and nearly parallel to one another; the fingers are not separated more than in the typical *C. bartonii* and not so densely bearded as in *C. longulus*. It connects with the typical *bartonii* through *robustus*. But I have hardly enough material before me to give *spinirostris* a firm place as a subspecies.

Girard did not know whence his type of *C. longulus* came. As far as known it is found in the elevated parts of Virginia, West Virginia, western North Carolina, and eastern Tennessee, drained by the Shenandoah, James, Kanawha, and Holston river-systems. It is thus found on both sides of the Appalachian water-shed.

*Cambarus bartonii* and *C. longulus* are both found in Reed Creek at Wytheville, Virginia, with no indication of the two forms interbreeding. But it is not on this account that I consider them two species. I have reason to believe that oftentimes in this genus mere varieties, coming into contact in a given locality, are perpetuated by breeding true, when, by extending our geographical range, every intermediate condition connecting the two forms will be found still surviving. Nowhere do we seem to come so near to seeing the process of evolution of species going on under our very eyes as in this genus *Cambarus*. It seems to me that the only criteria of a species must be the amount and character of the variation, and the absence of intermediate forms not in one locality alone but over the whole area of distribution.

***Cambarus acuminatus* Fax.**

Additional localities: Swannanoa River, Black Mountain, North Carolina; James River, Morgantown, North Carolina; Neuse River, Raleigh, North Carolina; Reedy Fork, Cape Fear River, Greensborough, North Carolina. D. S. Jordan (U. S. F. C.).

The specimen (a female) from Morgantown agrees with the type of *C. acuminatus* from the Saluda River, South Carolina, in the lack of a suborbital spine. In the others this spine is present as in the North Carolinian specimens mentioned on page 68 of the Revision of the Astacidæ.

***Cambarus dubius* Fax.**

Additional locality: "Among the Cherokees," Indian Territory. One male, form I. James Mooney (U. S. N. M.).

This species was previously known only from the remote Appalachian Mountain region of Virginia and West Virginia. According to the label accompanying the specimen it is called *Tsiskágili* (red crayfish) by the Cherokee Indians.

***Cambarus diogenes* Gir.**

Additional localities: Prince William County, Virginia, Dr. H. C. Yarrow; Kankakee River, Riverside, Indiana, C. H. Gilbert; Kokomo, Indiana, A. W. Moore (U. S. N. M.).

***Cambarus argillicola* Fax.**

Additional locality: Lowlands bordering on Wabash River, York, Clark County, Illinois. H. G. Hodge (U. S. N. M.).

According to the manuscript label accompanying these specimens, they were found in burrows from 18 inches to 2 feet in depth, contain-

ing from 6 inches to 1 foot of water. At the mouth of these burrows were mud chimneys 5 inches high. The soil was blue clay mixed with sand and gravel. At least three species build chimneys, viz: *C. diogenes*, *C. argillicola*, and *C. dubius*.

The specimen from Kelley's Island, Lake Erie, Ohio, inadvertently referred to *C. diogenes* in my Revision, p. 71, is *C. argillicola*. I have not yet seen *C. diogenes* from the State of Ohio.

#### *Cambarus setosus* FAX.

*Cambarus setosus* Faxon, Bull. Mus. Comp. Zool., XVII, No. 6, 1889, p. 237, pl. I, figs. 1, 2, 3, 7, pl. II, fig. 1.

Rostrum rather short, triangular, slightly concave above, terminating in a short, upturned horny tip; sides convex, raised into sharp crests; no lateral teeth except in small specimens which show a rudimentary spiny tooth on each side of the base of the acumen; margins setiferous. Post-orbital ridges obsolescent, destitute of spines. Carapace subcylindrical, flattened above, the region behind the cervical groove very long; smooth and punctate above, granulate on the hepatic and branchial areas; a small spine on the antero-lateral border, a little way above the anterior end of the cervical groove. Areola very narrow, sides subparallel for some distance. Abdomen longer than the cephalothorax, sparsely setose; pleura rounded; telson of moderate length, proximal segment bispinose (occasionally trispinose) on each side. Anterior process of the epistoma broadly transverse, anterior border notched or dentate. Sternum tuberculate between the first to third pairs of legs. Eyes and eye-stalks rudimentary, but not wholly covered by the rostrum. Basal segment of the antennule furnished with a sharp spine below, near the distal end. Antennæ as long as, or longer than, the body; antennal scale surpassing the rostrum, very broad, the broadest part near the distal end; outer margin setose, convex, inflated, ending in a sharp but not very long spine. Third maxillipeds hirsute. Chelipeds of moderate length; chela long, setose, inner and outer margins of the hand provided with blunt tubercles irregularly disposed in a double row; fingers, long, incurved, opposed edges straight, bluntly toothed near the base, finely pectinate throughout their length, tips curved, corneous and acute. Carpus armed with a prominent internal median and inferior median spine; in addition to these there are in older specimens a variable number of small spines on the inner, lower, and outer faces. Upper margin of the meros spinulose, lower face with the usual biserial arrangement of spines.

In the male the third pair of legs is hooked on the third segment. The first abdominal appendages are similar to those of *C. bartonii*, ending in two recurved hooks, the outer of which is corneous and acute in form I, the inner long, slender, and membranaceous. In form II both hooks are membranaceous, short, blunt, and not so widely separated as in form I.



In the female the annulus ventralis is very protuberant, especially the posterior border, and subcircular, with a deep central cavity.

In young individuals the chela and carpus are nearly destitute of the tubercles found in full grown specimens.

Length of a female, 65<sup>mm</sup>; cephalothorax 31.5<sup>mm</sup>; from tip of rostrum to cervical groove, 17<sup>mm</sup>; from cervical groove to posterior margin of carapace, 14.5<sup>mm</sup>; chela, 28<sup>mm</sup>; breadth of chela, 8<sup>mm</sup>; movable finger, 18<sup>mm</sup>; abdomen, 34<sup>mm</sup>.

The arrangement of the olfactory setæ on the outer flagellum of the antennules is similar to that in *C. pellucidus*, *i. e.*, of the thirty segments of the flagellum, the sixteenth to the twenty-seventh bear olfactory setæ, and these setæ are long, as in the other blind species of *Cambarus*. The peculiar pectination of the cutting edge of the fingers I have not observed in any other species.

From Wilson's Cave and wells in Jasper County, Missouri. Miss Ruth Hoppin (M. C. Z.). Three males, form I; sixteen males, form II; fifteen females.

The drainage of Jasper County, which lies in the southwestern part of Missouri, goes to the westward and then southward by the Neosho or Grand River into the Arkansas. The following account of Wilson's Cave and the wells from which this crayfish was taken, with remarks on the habits of the animal, is extracted from Miss Hoppin's letters printed in Mr. Samuel Garman's paper on the cave animals of southwestern Missouri.\*

Wilson's Cave is about 50 feet long, nearly as wide, oven-shaped, and high enough to stand erect except around the sides. The farmer had enlarged the entrance to use the place as a creamery. A small very clear stream flowed along the left side, having a width of 2 feet and a depth of 3, with a temperature of +54° F. About 10 feet from the entrance the light struck the stream in such a manner that we could see everything in the water without a lantern. The first things that caught the eye were a lot of white crayfish, a dozen in all, like those I took from the wells. It seemed as if I might take every one of them. But, though blind, they have one or more of the other senses very keenly developed. I am very sure they, as well as the white fishes [*Typhlichthys subterraneus* Gir.], have the tactile sense developed in an unusual degree. At the least touch upon the water they dart away. As the net cautiously follows, they escape adroitly, making no blunders as to the direction of the approaching enemy, and hide in crevices of the jutting rocks or in the muddy bottom of the stream. The mud was easily stirred so that nothing could be seen. These creatures, fish and crayfish, are only to be secured by patient waiting and skillful management. The people at the cave say the fish never bite, and can not be taken with hook and line. The crayfish were all found near the entrance, where there is considerable light. Following the stream back to a dark recess, reached by crawling on the slippery rocks, the light of the lantern revealed a school of little white fishes, such as I secured from the wells. All were very small. I saw half a dozen or more, but secured only one. I concluded the crayfish liked the light. Perhaps they remain near the entrance because they find there a supply of food. We found a few snails floating about, but saw none in the dark pool where the fish were.

\* Cave Animals from Southwestern Missouri. By Samuel Garman. Bull. Mus. Comp. Zool., vol. XVII, No. 6, 1889, pp. 225-240.

Miss Wilson, who was with me, thinks the crayfish devour the others. She has never seen them together, and says the latter keep away from the former, though she had not noticed the crayfish catching or eating them. There was nothing to prevent the crayfish ascending the stream to where the others were.

\* \* \* \* \*

On my first visit, the water being low, no crayfish were seen in the dark nook, the place favored by the fish. After the storm which had flooded the caves, a few were found there. Though I watched for some time, I never saw them pursue the fishes, as they might easily have done, guided by the stir in the water. Both creatures are very sensitive to the slightest ripple. During high water a pool, "the lake," is formed a little way from the stream in another dark part of this cave. In low water the pool is cut off from the creek. I found both species in it, the fish in the darkest part, and saw no signs of enmity. Most of the crayfish were found in the lower part of the stream, in the twilight; the fishes could not be found without the lantern. At the time of the floods the cave is full, and the water rushes out furiously. \* \* \* Another proof that the crayfish are more fond of the light is seen in the shallower wells. That from which most were taken was more exposed to the sun. At noon, when the light was more favorable, we could see them swimming about. No fishes have been taken from this well. They were taken in the narrower, more shaded wells, of which the deep ones on the hills report fishes only.

As to the food of the fishes, I discovered nothing. The mud where they were was not so deep as farther down. An examination of it the length of the cave brought to light many snails; the shells of the living ones are whiter and more nearly transparent than the floating dead ones. The largest crayfish are of a dirty, rusty color, and very bristly, in caves and in wells. One large one is very soft and very white; no doubt it is newly moulted.

Both fish and crayfish were less numerous after the freshet, and apparently less active. The disturbance of the flood may have caused them to retreat into their hiding places, only the weaker being left behind, or some may have been swept away by the torrent. The sensitive creatures would soon die in the light and heat outside, where the water is full of frogs and eyed-crayfishes. \* \* \* The specimens became opaque when they are put into alcohol; they are almost transparent when alive, so much so that the action of their internal organs can be observed. Repeated tests assured me the animals were blind, though very sensitive to the sunlight. They died soon after catching, even in water frequently changed.

The wells from which specimens have been taken are about half a mile from Center Creek, the water level in wells and creeks being nearly the same. The wells were nine or ten in number, from 5 to 80 rods apart, from 11 to 30 feet in depth, deeper in the higher ground, and having a depth of water varying from 2 to 4 feet. In some wells the rock at the bottom had been excavated. The water is what is commonly called hard, *i. e.* impregnated with lime. After rains some of the wells have softer water than others, and the water stands higher in these wells, indicating closer connection with surface drainage. All of the wells soon regain the common level. They become low in times of drouth, but never dry out entirely, as is the case with a cave spring near by, about 12 feet above the level of the creek. The temperatures taken in the wells at low water ranged from +52° to 54° Fahr. During a storm in the well having the highest water, the temperature rose to +57°. When the mercury stood at 90° to 95° in the shade outside, the temperature was only 54° in Wilson's Cave.

According to Miss Hoppin, the young of *C. setosus* when alive are not so white as the older ones.

At first I attributed it to greater transparency, but now I am sure the color is in the shell, not that the internal organs can be seen because of the transparent shell. They are not so dark, however, as the brook species [*C. virilis*] of the same size.

In connection with Miss Hoppin's observations on the crepuscular habits of this species it is interesting to note that the atrophy of the visual organs has not progressed so far as in the other blind crayfishes of the United States, *C. pellucidus* and *C. hamulatus*.\* In other respects, also, *C. setosus* is more closely related to outside, eyed species than is either of the other cave species. This doubtless results either from the twilight conditions under which it lives, or more probably from its having been subjected for a shorter period of time to cavern influences.

The three blind species, although belonging to two sections of the genus, resemble each other in the slenderness of the body and claws and in the width of the antennal scale. The slenderness of the body and claws in these species may be attributed to their life in caves, where competition is largely removed and physical power ceases to be an important factor in their existence. The width of the antennal scale is probably a variation correlated to the atrophy of the adjacent eye and ocular peduncle. In short, these points of resemblance between the three cave species, like the rudimentary state of the eye and the transparency of the shell, are of little value from a taxonomic point of view, not indicating close genetic affinity, but surely appearing in widely diverse species, provided they be subjected to the same subterranean life. The closer *superficial* likeness between *C. pellucidus* and *C. hamulatus*, belonging to different sections of the genus, than between *C. hamulatus* and *C. setosus* belonging to the same section, may be explained by the longer period of time during which the subterranean influences have probably been exerted upon the first two species.

G. C. Broadhead (Report of the Geological Survey of the State of Missouri, 1874, p. 36) states that blind crayfishes are found in the cave region of Christian County, near Ozark, in southern Missouri. It is probable, from the locality, that they are the same species as those from Jasper County.

*Cambarus affinis* (Say).

Additional localities: Shenandoah River, Waynesborough, Virginia; Blackwater River, Zuni, Virginia; Patoka River, Patoka, Indiana. D. S. Jordan (U. S. F. C.).

The specimens from Patoka, Indiana (six males, form I; four females), differ from the typical *C. affinis* as follows: The areola is broader in the middle, there is but one lateral thoracic spine, the hepatic area is smoother (merely granulate, instead of spinous), the branchiostegian

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\* On the contrary, Mr. G. H. Parker concludes that the histology of the retina shows more degeneration in *C. setosus* than in *C. pellucidus*. His researches on the subject will shortly be published in the Bulletin of the Museum of Comparative Zoölogy. From the external morphology alone, one would surely be justified in deeming *C. setosus* the least modified of the three blind species. The eye-stalk and external part of the eye are largest in *C. setosus*, smallest in *C. pellucidus*. *C. hamulatus* stands between the other two in this regard. For the aberrant position of *C. pellucidus* in other respects, see my Revision of the Astacidae, page 18.

spine is much smaller, and the hand more inflated and triangular; the cephalothorax is slenderer, the antennæ longer; the male appendages are very similar to those of the typical form, but the free tips are a little longer and slenderer. In the smoothness of the carapace and, to some extent, in the shape of the hand this form approaches *C. sloanii* Bundy, but the male organs and the annulus ventralis are very nearly like those of the typical *C. affinis*. I prefer to call it a western variety of *C. affinis*. The largest is 60<sup>mm</sup> in length. The specimens from Lake Erie referred to *C. affinis* in my Revision are too small to determine with certainty.

**Cambarus propinquus Gir.**

Additional localities: Marshall, Michigan; St. Mary's Lake, mouth of Battle Creek, Michigan; Kalamazoo River, Michigan, C. H. Bollman (U. S. F. C.); Lafayette, Indiana, H. L. Osborn (M. C. Z.).

**Cambarus neglectus Fax.**

*Cambarus neglectus* Faxon, Bull. Washburn Coll. Lab. Nat. Hist., Topeka, Kansas, Vol. I, 1885, p. 142.

Male, form I.—Rostrum broad, slightly excavated, with a median longitudinal carina toward the apex; sides nearly parallel from the base to the lateral spines, which are very small and of a brown color; acumen of moderate length. Post-orbital ridges with very small anterior spines (sometimes none). Carapace oval, flattened above, punctate, lightly granulate on the sides, lateral spine minute or obsolete antero-lateral border angulated below the eye; anterior segment equals, at the most, twice the length of the posterior segment; areola of moderate width. Abdomen longer than the cephalothorax; basal segment of the telson bi-spinous on each side of the posterior margin. Antennæ shorter than the body; lamina as long as the rostrum, broadest toward the distal end, apical spine of moderate length. Anterior process of the epistoma long, subtruncate. Third maxillipeds hairy within, naked below. Chelipeds short; chela broad, punctate above and below, inner margin furnished with a double row of depressed tubercles; fingers of moderate length, more or less gaping at the base, with a row of round tubercles on their opposed edges, outer margin of the movable finger also furnished with low tubercles; carpus broad, punctate above, with a strong median spine on the internal side and a small one near the base, no spines on the lower side. Superior border of meros armed with two obliquely-placed antepical spines, lower face of meros with two rows of spines. Third pair of legs hooked. First pair of abdominal appendages nearly straight, reaching forward to the first pair of legs, terminating in two long, slender, pointed, horny styles; the anterior style (outer part of the appendage) is a little longer than the posterior and slightly recurved; anterior border of the appendage carinate but not shouldered.

In the second form of the male the first abdominal appendages are ~~ob~~left but a short distance. The terminal part of the appendage is ~~sc~~shorter than in the first form, and not horny, and the tips of the rami ~~are~~rather blunt.

The annulus ventralis of the female is triangular, with a deep transverse fossa bounded on all sides by a prominent wall which is bituberculate in front.

Dimensions of a male, form II: Length, 68<sup>mm</sup>; cephalothorax, 32<sup>mm</sup>; from end of rostrum to cervical groove, 21<sup>mm</sup>; from cervical groove to posterior margin of carapace, 11<sup>mm</sup>; width of areola, 2<sup>mm</sup>; abdomen, 38<sup>mm</sup>; chela, 25 by 10.5<sup>mm</sup>.

Mill Creek, Wabaunsee County, Kansas; Republican River, near Gary, Cheyenne County, Kansas; Sappa Creek, Oberlin, Kansas. (M. C. Z.).

This is the species mentioned, but not named, in my Revision of the Astacidae, page 94, under *C. propinquus*. When that work was written I had seen but three specimens of this crayfish, all of them second-form males, without locality. Collections sent from Kansas by Prof. F. W. Cragin supply the first form of the male and the female. In general appearance this species nearly resembles *C. propinquus*, but the fore border of the carapace is angulated under the eye, and the sexual appendages of the male are quite different, resembling those of *C. rusticus* *plavidus*. The annulus ventralis of the female is different also.

The tips of the fingers in recent alcoholic specimens are orange colored, preceded by a dark annular band.

#### *Cambarus virilis* Hag.

Additional localities: Spencer Creek, Michigan; Barnum Lake, south of Battle Creek, Michigan; Bear Creek and Hinkson Creek, Columbia, Missouri; West Fork of Black River, Reynolds County, Missouri; tributaries of Kansas River and Ward's Creek, Shawnee County, Kansas; Wabaunsee County, Kansas; Garden City, Kansas; Sappa Creek, Oberlin, Kansas; Osage River, La Cygne, Kansas; Topeka, Kansas; Five-mile Creek, tributary of Spring River, Indian Territory (1 mile south of Kansas line, near Baxter Springs, Kansas). (U. S. N. M., M. C. Z., and U. S. F. C.)

Together with specimens of *C. setosus* from wells in Jasper County, Missouri, collected by Miss Ruth Hoppin, occur two very small specimens of a *Cambarus* with well developed eyes. They are too young to identify with certainty, but are probably *C. virilis* Hag. The specimens from the West Fork of Black River, Missouri, differ somewhat from the typical *C. virilis*, agreeing with those described on page 98 of my Revision of the Astacidae, from Irondale, Missouri.

*Cambarus nais* Fax.

*Cambarus nais* Faxon, Bull. Washburn Coll. Lab. Nat. Hist., Topeka, Kansas, Vol. 1, 1885, pp. 140, 141.

Male, form I.—Rostrum long, concave above, lateral margins converging from the base to the lateral spines, which are small but distinct; acumen of moderate length, acute. Post-orbital ridges provided with a minute anterior spine. Carapace smooth and lightly punctate above, granulate on the sides; lateral spine small, acute; cervical groove sinuate, ending anteriorly in a small branchiostegian spine; suborbital angle not prominent; areola very narrow, punctate, the margins parallel from the anterior to the posterior triangular fields; the length of the areola is equal to one half the distance from the tip of the rostrum to the cervical groove. Abdomen as long as the cephalothorax. Proximal segment of the telson bispinose on each side, distal segment shorter than the proximal. Antennæ longer than the body; laminæ a little longer than the rostrum, broad, broadest at the middle, subtruncate at the end, with an external apical spine. Third maxillipeds densely setose within and below. Anterior process of the epistoma with very convex sides. Chela broad, flattened above, punctate, external border marginate; inner margin of the hand short, with a double row of dentiform tubercles; fingers long, movable one tuberculate on the external border, toothed on the internal border; external finger flat above, internal margin toothed, and bearded at the base. Corpus armed with a row of small tubercles on the upper side, with a strong and acute internal median spine and a small one at the base; on the lower side the carpus is provided with a prominent median spine and an external one at the point of articulation with the chela; in some specimens there is a small spine on the lower face of the carpus, between the median spine and the large one on the internal margin. Third pair of legs armed with a hooked tubercle on the inner margin of the third segment. First pair of abdominal appendages of moderate length, twisted, deeply bifid, very broad in the middle; rami slender, styliform, strongly recurved, the inner one a little shorter and more curved than the outer one, the outer one corneous. Length, 57<sup>mm</sup>; cephalothorax, 27<sup>mm</sup>; from tip of rostrum to cervical groove, 18<sup>mm</sup>; from cervical groove to posterior border of carapace, 9<sup>mm</sup>; abdomen, 30<sup>mm</sup>; chela, 24<sup>mm</sup>; width of chela, 10<sup>mm</sup>.

The second form of the male differs from the first form in having smaller chelæ, the tubercles on the third pair of legs less developed, the first abdominal appendages less deeply cleft, the rami stouter, blunter, and not corneous.

In the female the chela is similar to that of the second form of the male, the sternum between the fourth pair of legs is smooth, the annulus ventralis triangular with a median longitudinal fissure.

Labette County, Kansas. W. S. Newlon (M. C. Z.). Five males, form I; five males, form II; seven females.

This species much resembles *C. virilis*, especially the form called *variety A* by Dr. Hagen. It differs in the shape of the first abdominal appendages of the male. In *C. naïs* the rami of these appendages are shorter and more strongly curved than in *C. virilis*, but not so much curved as in *C. immunis*. The areola is narrower than in *C. virilis*. The first abdominal appendages are very like those of *C. palmeri* Fax., as far as can be seen by a comparison of the second-form males alone; but the areola is not obliterated in any part of its course in *C. naïs* and the rostrum is more tapering than in *C. palmeri*.

***Cambarus immunis* Hag.**

Additional localities: Wabash River, New Harmony, Indiana, D. S. Jordan (U. S. F. C.); Lafayette, Indiana, H. L. Osborn (M. C. Z.).

***Cambarus immunis spinirostris* Fax.**

Additional locality: Ward's Creek, Shawnee County, Kansas. F. W. Cragin and J. B. Fields (M. C. Z.).

When I described this variety in 1884, I had not seen the first form of the male, which is included among the specimens collected by Messrs. Cragin and Fields. The lateral spines of the rostrum are distinct, as in the second-form male and in the female; the setæ on the second pair of legs are well developed; the first abdominal appendages are shaped exactly as in the first form male of the typical *C. immunis*.

***Cambarus rusticus* Gir.**

Additional localities: Maramee River, Dent County, Missouri, R. E. Call (M. C. Z.); Harpeth River, Franklin, Tennessee, Gilbert and Swan (U. S. N. M.); Osage River, La-Cygne, Kansas (M. C. Z.). All these are similar to the form *placidus* Hag.

***Cambarus spinosus* Bundy.**

Additional locality: Tar River Rocky Mount, North Carolina. D. S. Jordan (U. S. F. C.).

***Cambarus hylas*, sp. nov.**

Male, form II.—Rostrum broad, excavated, margins thickened, somewhat convergent from the base to the acute lateral spines; acumen of moderate length. Post-orbital ridges ending anteriorly in an acute spine; carapace punctate, with a small lateral and a branchiostegian spine; antero-lateral margin notched but not furnished with a sub-orbital spine; posterior segment equal in length to half the distance from the end of the rostrum to the cervical groove; areola of moderate width, punctate. Abdomen longer than the cephalothorax; basal segment of the telson bispinous on each side of the posterior border.

Anterior process of the epistoma triangular, the apex truncated or even notched. Antennæ shorter than the body; scale broad, broadest near the tip. Chelipeds stout, chela broad, punctate, external margin convex, internal margin furnished with a double row of tubercles; fingers slightly gaping, costate, with longitudinal rows of ciliated dots; external margin of movable finger with a line of ciliated tubercles; tips of fingers incurved, corneous. Carpus smooth, furnished with a well developed internal median and small proximal and distal internal spines; beneath, the carpus has a well developed median anterior spine, and a very minute external spine at the point of articulation with the chela. Meros furnished with two obliquely placed ante-apical spines; of the biserial inferior spines the outer row is represented by the two distal ones only. Third pair of legs hooked. First pair of abdominal appendages very long, reaching the base of the chelipeds, tuberculate on inner border near the base, bifid, anterior border carinate, rami straight, thick; the outer branch much longer than the inner, the tip slightly recurved, the inner branch blunt at the tip, and bent a little outward and backward. Dimensions: length 60<sup>mm</sup>; carapace, 29<sup>mm</sup>; from end of rostrum to cervical groove, 18.5<sup>mm</sup>; from cervical groove to posterior margin of carapace, 9.5<sup>mm</sup>; breadth of rostrum at base, 3.5<sup>mm</sup>; between lateral spines, 2.5<sup>mm</sup>; breadth of areola, 2<sup>mm</sup>; abdomen, 31<sup>mm</sup>; chela, 23<sup>mm</sup>; breadth of chela, 10<sup>mm</sup>; movable finger, 13.5<sup>mm</sup>.

Female: Chela smaller, fingers not gaping, external finger slightly bearded at the base within. Sternum between the fourth pair of legs not tuberculate. Annulus ventralis large, triangular, the anterior margin obsolescent, posterior margin very prominent, projecting backward; fossa transverse, deep, with a sigmoid sulcus.

West Fork of Black River, Reynolds County, Missouri, R. E. Call (M. C. Z.). Four males, form II; two females.

This species is closely related to *C. putnami* Fax., but the sides of the rostrum are more thickened and more convergent from the base to the lateral spines; the antennal scale is widest near the tip (in *C. putnami* it is widest in the middle); the carpus has a well developed anterior spine, and the annulus ventralis is very different. From *C. spinosus* Bundy, it differs in its longer metacarapace, shape of the rostrum, annulus ventralis, etc.

#### *Cambarus forceps* Fax.

Additional locality: Middle Fork of Holston River, Glade Spring, Virginia. D. S. Jordan (U. S. F. C.). Four males, form I; four females. The specimen from Knoxville, Tennessee, mentioned on page 121 of the Revision, surely belongs to this species.

#### *Cambarus montezumæ* Saus.

Additional locality: Guanajuato, Mexico. A. Dugés (U. S. N. M.). *C. montezumæ* is a variable species. In the specimens from Guanajuato



the rostrum is even flatter than in the typical form, tapering, and furnished with minute ante-apical teeth.

*Astacus klamathensis* Stimps.

Additional localities: Sprague and Williamson's Rivers, near Fort Klamath, Oregon. Dr. J. C. Merrill, U. S. Army (U. S. N. M.). Eel River, Humboldt County, California. *Teste* W. N. Lockington.\* A small specimen, 37<sup>mm</sup> long, collected by Dr. Merrill in Klamath Lake, Oregon, is labeled "Color in life, bluish green." An adult collected by the same gentleman is accompanied by the following note: "Color when fresh, bright red, lighter beneath; large claws darker. Common."

*Astacus nigrescens* Stimps.

"This species appears to be found in most of the larger brooks of the central counties of California, such as the Alameda Creek, Alameda County; Coyote Creek, Santa Clara County, and San Joaquin Slough." Lockington, *l. c.*

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\* Remarks upon the Thalassinidea and Astacidea of the Pacific coast of North America, with description of a New Species. By W. N. Lockington. *Ann. Mag. Nat. Hist.*, 5th series, Vol. II, 1878, p. 303.

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*Rathbun*

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VI.

PRELIMINARY DESCRIPTIONS OF NEW SPECIES OF CRUSTACEA.

BY WALTER FAXON.

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REPORTS ON THE DREDGING OPERATIONS OFF THE WEST COAST OF CENTRAL AMERICA TO THE GALAPAGOS, TO THE WEST COAST OF MEXICO, AND IN THE GULF OF CALIFORNIA, IN CHARGE OF ALEXANDER AGASSIZ, CARRIED ON BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," DURING 1891, LIEUT. COMMANDER Z. L. TANNER, U. S. N., COMMANDING.

VI.

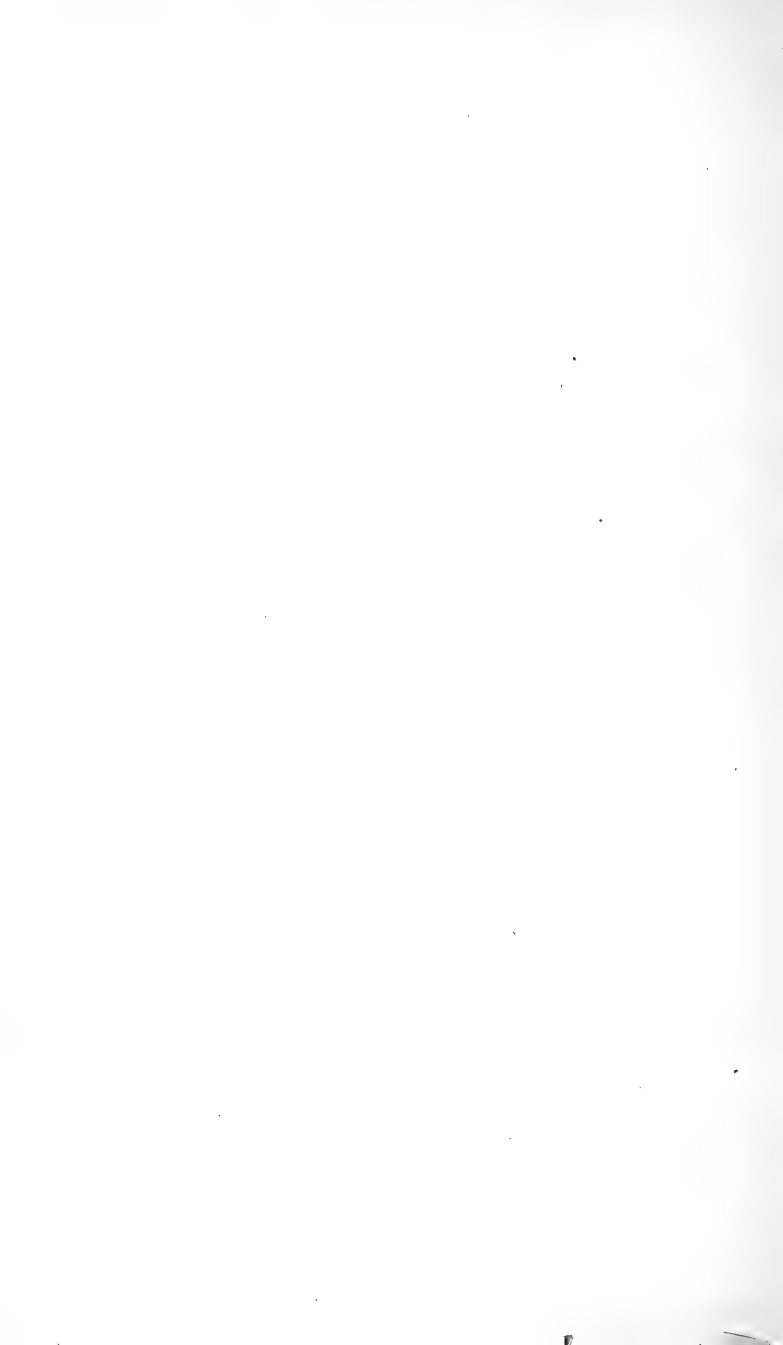
PRELIMINARY DESCRIPTIONS OF NEW SPECIES OF CRUSTACEA.

BY WALTER FAXON.

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## VI.

*Preliminary Descriptions of New Species of Crustacea.*<sup>1</sup> By WALTER FAXON.

### ORDER PODOPHTHALMIA.

#### SUBORDER DECAPODA.

#### Family MAIIDÆ.

#### *Euprognatha granulata*, sp. nov.

Carapace coarsely granulate; two erect blunt spines in median line of carapace, one on the gastric, the other on the cardiac area; a transverse row of four or five small tubercles in front of the gastric spine; a spine near the middle of each branchial area, with a smaller lateral spine below and a little in advance of it; the hepatic area bears a short blunt spine on its most prominent part; there are, besides, three or four prominent tubercles on the angle which divides the hepatic and pterygostomial regions. The antennary spine is very long, reaching beyond the rostral horns; the three horns of the rostrum (interantennular and lateral) are about equal in length; the supra-orbital spines are well developed, and, like the antennary and three rostral spines, are conspicu-

<sup>1</sup> Figures of all the species described in this paper will appear in the final report, whose publication is deferred pending the preparation of the lithographic plates. A record of the stations occupied by the "Albatross" during her cruise of 1891 will be found in Bull. Mus. Comp. Zoöl., Vol. XXIII. No. 1, pp. 4-8.

ously granulated. The post-orbital spines are even more coarsely tuberculated. When viewed from above their margins appear lacinated. Surface of abdomen thickly set with bead-like tubercles; the first segment bears a prominent granulated spine, and there is a rudimentary spine on each of the three following segments. Chela slender, covered with small tubercles; the remaining segments of the cheliped and the ambulatory appendages are furnished with small spines, tubercles, and scattered curled setæ.

Length of carapace, 7 mm.; breadth, 6 mm.

Station 3369. 52 fathoms. 2 females.

#### *Anamathia occidentalis*, sp. nov.

Carapace pyriform, furnished with spines and tubercles which are arranged as follows: four on the gastric region (two in the median line, two lateral); the posterior median has the form of a tubercle, from which a low blunt keel runs back to the cardiac region; one on the cardiac region, one (tubercle) on the intestinal region, one on each hepatic region, five on each branchial region. Of the branchial spines the one near the middle projects upward and forward, the longest spine of the carapace, one half as long as the rostral horns. In addition to these spines and tubercles there are four or five small tubercles on the outer border of the pterygostomial region. Rostrum produced into two divergent awl-shaped horns, which are more than one fourth the length of the carapace. Pre-orbital spines acute, post-orbital processes obtuse. Chelipeds twice as long as the carapace, not much more robust than the ambulatory limbs; chela little longer than the merus, the basal part cylindrical, distal part gradually widening to the base of the fingers; fingers smooth, slightly curved, less than one half as long as the basal portion; prehensile edges regularly dentate, closing throughout their length. The merus of all the legs has a small tubercular projection at the distal end above, most prominent on the anterior pair. The carpus of the chelipeds has two low ridges on the outer face. Abdomen seven-jointed.

Length of carapace without the rostral horns, 45 mm.; length of rostral horns, 12 mm.; breadth of carapace, 38 mm.

Station 3404. 385 fathoms. 1 male.

#### *MAIOPSIS*, gen. nov.

Carapace subtriangular, as broad as long, spinose; rostrum produced anteriorly into two divergent horns with an accessory spine upon their outer margins; interorbital space broad. Eyes small, eyestalks slender, retractile within the orbits. Orbits large, with a forward aspect, incomplete below, the upper margin prominent, with two deep fissures, and supra-ocular spines. Epistome short. Basal segment of antennæ very broad, with three prominent spines upon its anterior margin; flagellum of the antennæ widely separated

from the cavity of the orbit by a broad process of the basal segment. Merus of outer maxillipeds notched at the antero-internal angle. Legs of moderate length; carpus of chelipeds elongated, not carinated; chela elongated and slender, fingers canaliculate within, but not spoon-shaped at their tips, their prehensile edges meeting throughout most of their length, not distinctly toothed; ambulatory legs spinose. Abdomen (male) seven-jointed, terminal joint short and broad.

This genus is proposed for the reception of an interesting Maioid dredged in 182 fathoms on the west coast of the Isthmus of Panama. It combines in one form characters of the genera *Maia*, *Cyclomaia*, *Paramithrax* (subg. *Leptomithrax*), and *Schizophrys*. In its general aspect it bears a close resemblance to *Maia*, and the likeness is enhanced by the small eyes and slender eyestalks, the elongated wrist and hand, and the short epistome. It differs from *Maia* in having a much broader carapace, a less deeply cloven rostrum, spinose legs, supra-ocular spines, and trenchantly in the exclusion of the antennal flagellum from the orbit by a process of the basal segment of the antenna. In the latter regard it agrees with the genus *Cyclomaia*, the basal segment of the antenna being very broad, three-spined on its distal border, and giving off a process which separates the flagellum from the orbit by a wide interval; it also agrees with *Cyclomaia* in having a short epistome, a short and broad terminal abdominal segment, and supra-ocular spines. It differs from *Cyclomaia* by having a subtriangular carapace, longer rostral spines, and a less abruptly declivous front. It is like *Paramithrax* and *Schizophrys* in the exclusion of the basal antennal segment from the orbit, but this segment is much broader than in these genera, and three-spined; moreover, *Maiopsis* differs from *Paramithrax* and *Schizophrys* in having a more broadly triangular carapace, supra-ocular spines, slenderer wrist and hand, less deeply cleft rostrum, and spinose ambulatory legs. Like *Schizophrys*, it has an accessory spine on each rostral horn. In the shape of the carapace *Maiopsis* is intermediate between *Maia* and *Paramithrax* on the one side, and *Schizophrys* and *Cyclomaia* on the other, as the fingers, though canaliculate within, are but slightly excavated at the tips. The synthetic character of the species upon which this genus is based suggests the propriety of ultimately extending the scope of the old genus *Paramithrax* so that it may embrace this form, together with *Cyclomaia* and *Schizophrys*.

#### *Maiopsis panamensis*, sp. nov.

Dorsal surface of carapace thickly set with spines of various sizes and scattered hooked setæ. The largest spines are distributed as follows: five on the gastric region, one on the genital, one on the cardiac, four on the intestinal, and about seven on each branchial region. Margin of carapace armed with twelve prominent spines, three of which are on the hepatic region. The sternum is ornamented with small tubercles along each side of the abdomen. The



first abdominal segment is furnished with a bidentate tubercle. Legs covered with numerous spiny tubercles; the meri armed with three or more prominent spines at the distal end. Chela long and slender, the tubercles of the hand smaller than on the other parts of the legs; fingers nearly smooth. A deep pit at base of movable finger.

Length from base of rostrum to posterior margin of carapace, 112 mm.; breadth, 113.5 mm.; length of rostrum, 22 mm.; length of rostral horns, 11 mm.; breadth between eyebrows, 38 mm.; length of cheliped, 156 mm.

Station 3355. 182 fathoms. 1 male.

### Family PARTHENOPIDÆ.

#### *Lambrus hassleri*, sp. nov.

This is the Pacific coast representative of *Lambrus pourtalesii* Stimps. (*L. verillii* Smith) of the east coast of North America. It differs from the latter species as follows: the carapace is broader in proportion to its length; the branchial regions are more expanded and inflated, the inflation extending farther in toward the cardiac area so as to involve the oblique row of small tubercles; that is to say, this row of tubercles, which in *L. pourtalesii* lies low down in the fossa between the branchial and cardiac regions, is raised up, in *L. hassleri*, on the swell of the branchial region. The spines on the edges of the chelipeds, moreover, are not lacinated to such a degree as in *L. pourtalesii*.

Length of a female specimen, 27 mm.; breadth, including lateral teeth, 38 mm.

Station 3368. 66 fathoms. 1 female.

“ 3427. 80 “ 1 male, 1 female.

This species was previously obtained during the voyage of the “Hassler” at Magdalena Bay, Lower California, August 14, 1872. The specimens then obtained were apparently picked up dead on the shore.

### Family CANCRIDÆ.

#### *Xanthodes sulcatus*, sp. nov.

Carapace granulated, granulation heaviest on the lower surface, and near the borders of the upper surface. Deeply impressed grooves separate the gastric from the branchial regions, and the mesogastric from the lateral gastric lobes. The groove which continues in the median line to the front, anteriorly to the mesogastric lobe, is crossed a short distance behind the frontal margin by a transverse groove, which meets on each side another groove running parallel to the upper margin of the orbit. In this way there are marked off a pair of frontal and a pair of orbital areolets. The frontal margin is nearly straight,

finely denticulate, and separated from the orbital areolets by a groove. Antero-lateral border of the carapace armed with four spines or teeth, E, N, T, S, of Dana's nomenclature, there being no tooth at the external orbital angle; of these teeth the first is the smallest, the third the largest, and the second and fourth are of about equal size; the margins of all the teeth are denticulate. The chelipeds are short and unsymmetrical; the merus is granulated on its outer face, spinulose on the upper edge, and grooved near the articulation with the carpus. The carpus is granulated on its outer side, and furnished with a median internal tooth. The meri of the ambulatory appendages are spinulose along their upper edges.

Length of carapace, 8 mm.; breadth, 11 mm.

Station 3355. 182 fathoms. 1 male, 1 female.

“ 3391. 153 “ 1 male, 3 females.

### *Panopeus latus*, sp. nov.

Carapace broad, convex in antero-posterior direction, granulated, especially on the hepatic, branchial, and cardiac regions; areolations well marked and protuberant. Front divided by a small median incision into two slightly convex lobes, whose edges are simple and not produced into teeth at the lateral angles. Antero-lateral margin cut into five teeth; post-orbital tooth small, separated from the second tooth by a shallow granulated sinus; the third tooth is the broadest, and rounded off at the apex; the fourth is the most salient, and acute; the fifth is very small, and acute; all the teeth have crenate or else spinulose margins. The margin of the orbit is minutely crenulate; its upper part is marked by two closed fissures; the external hiatus of the orbit has the form of a triangular notch; the lower margin is produced to form an obtuse tooth at the inner angle. The subhepatic region is granulous, but not provided with a tubercle. The merus of the third pair of maxillipeds is also granulated. The carpus of the chelipeds is rough with small tubercles, grooved along the distal margin of the outer side, and armed internally with a small blunt tooth; the hands are robust, inflated, smooth except near their articulation with the carpus where scattering granules appear; upper and lower margins rounded; fingers long, down-curved, smooth, canaliculate, their cutting edges irregularly armed with small and rather sharp teeth, without any prominent basal tooth; when closed the fingers are separated by a slight gape, and their tips cross one another; the color of the fingers in alcoholic specimens is very light brown. The chelæ of the right and left sides are unequal in size, but similar in shape. The ambulatory appendages are setose, their merus joints furnished with small teeth along their upper edges. The seventh segment of the sternum in the male is entirely concealed by the base of the abdomen. The coxæ of the fifth pair of legs are in contact with the third abdominal segment. The penultimate segment of the abdomen has concave sides, the terminal segment is broad and rounded.

Length of carapace, 6.5 mm.; breadth, 10.25 mm.

Station 3397. 85 fathoms. 1 male.

In this species the carapace is short, the posterior margin wider than usual in the genus. In its general aspect it recalls *P. xanthiformis* A. M. Edw.; the meri of the ambulatory legs are denticulated on their upper margins as in *xanthiformis*, but in *latus* the carapace is much broader and more convex in an antero-posterior sense, the front is less prominent and destitute of lobes at the lateral angles, the carpal tooth is blunt, etc.

### *Panopeus tanneri*, sp. nov.

Carapace moderately convex both lengthwise and transversely, smooth and polished in the central and posterior part, coarsely granular on the anterior gastric and hepatic regions. The gastric and hepatic areas are well marked off by depressions. Front nearly straight, divided by a median triangular fissure, and projecting as a blunt tooth at each lateral angle; a double edge is formed by a groove which runs along the front, the lower edge projecting farther forward than the upper edge; both upper and lower edges are finely granulate. The antero-lateral margins of the carapace are cut into triangular teeth; the first and second of these teeth are small, coalesced, connected by a shallow sinus; the third and fourth are of about an equal size; the fifth is much smaller; all the teeth are granulous on their anterior border, smooth on posterior border; the depressions between the third and fourth and the fourth and fifth teeth are continued in as furrows for some distance on the carapace, finally uniting and meeting the cervical furrow. The upper margin of the orbit forms a tooth at the inner angle above and outside of the external marginal tooth of the front; there is a closed fissure near the middle of the superior orbital border; the external fissure is a triangular notch; a blunt tooth at the inner angle of the lower margin. There is no subhepatic tubercle. A transverse row of tubercles on the front of the eyestalk (when viewed retracted within the orbit) just inside the eye. Chelipeds unsymmetrical; carpus squamoso-rugose, with a slight transverse groove, and armed with a prominent but not very sharp internal tooth; propodus robust, superior border rounded and squamoso-tuberculate, outer surface smooth, fingers of larger chela gaping, movable finger armed with a blunt tooth at base; fingers of smaller chela slenderer, without prominent teeth; fingers of both hands black, hooked at extremities, tips crossing. Base of abdomen entirely covers the sternal segments; penultimate segment of abdomen short, posterior angles prolonged backward; last segment short, pentagonal. In young specimens the granules of the carpus and propodus are more numerous and sharper pointed.

Length of carapace, 6.25 mm.; breadth, 10 mm.

Station 3405. 53 fathoms. 5 male (3 adult, 2 young).

“ 3368. 66 “ 1 male.

**Family PORTUNIDÆ.*****Achelous affinis*, sp. nov.**

Carapace moderately convex both longitudinally and transversely, the frontal region depressed, horizontal; surface rugose, granular, and pubescent. Front not prominent, composed of four blunt teeth, not counting the internal angle of the orbit; the two teeth near the median line are equilaterally triangular, separated from one another by a triangular notch; the next teeth on the outer side are separated from those within by a shallow sinus, and fall off abruptly on the outer side into a deep notch which separates the front from the inner orbital angle. The two middle teeth of the front are a trifle longer than the lateral teeth. The tooth formed by the projecting inner orbital angle does not attain the level of the frontal teeth; it is double, the orbital margin just outside of it being slightly folded, raised, and projected forward so as to form a secondary tooth similar to that in *A. spinimanus*, but not so well marked. The antero-lateral margin of the carapace is nine-toothed, including the tooth at the outer orbital angle; the posterior tooth is hardly larger than those in front of it; the posterior margin of these teeth is convex. The anterior edge of the merus of the chelipeds is armed with five spines. The carpus has an internal and a smaller external spine. There is a spine on the propodus at the base at the point of articulation with the carpus, and another on the upper margin a little distance back of the articulation with the dactylus. The distal edge of the merus of the fifth pair of legs is spinulose.

Length, 25 mm.; breadth, 39 mm.; length of merus of chelipeds, 24 mm.; length of propodus, including digit, 33 mm.; length of internal carpal spine, measured from distal margin of carpus, 3.3 mm.

Station 3379. 52 fathoms. 5 males, 4 females.

“ 3390. 56 “ 1 male.

A large number were also taken in the tow-net at the surface at the following stations: Off Mala Point; Hydr. 2627; Nos. 3355, 3371, 3382, 3386, 3398; 50 miles south of Guaymas.

The specimens taken at the surface are small, and much darker in color than those that came up in the trawl, but show no structural differences. I take them to be the same species in the pelagic stage of its existence.

This species is very closely related to *Achelous depressifrons* Stimps., from the Atlantic side of the continent. Compared with *A. depressifrons* it is broader, and the curve formed by the front and the antero-lateral margin of the carapace forms an arc with a longer radius; the lateral lobe of the front is broader; the tooth of the inner orbital angle is double, as above described; the teeth of the antero-lateral margin have broader bases, and the anterior one at the outer orbital angle is not so prominent; the protuberances on the cardiac and branchial areas are less prominent; the internal carpal spine is shorter, and the distal margin of the merus of the fifth pair of legs is denticulate behind the articulation of the carpus.

## Family CORYSTIDÆ.

### TRACHYCARCINUS, gen. nov.

Carapace pentagonal, moderately convex, lateral margins long, nearly straight toothed. Front narrow, produced, three-toothed. Orbits large, with forward aspect, imperfect, with two hiatuses above, one below, and one at the inner angle; lower wall formed chiefly by the carapace. Anterior margin of buccal cavity not distinctly defined, epistome short, ridges of the endostome developed. Sternum long and rather narrow. Abdomen of male narrow and five-jointed, the third, fourth, and fifth segments consolidated. Eyestalks very small, retractile within the orbits. Antennules longitudinally folded. The antennæ lie in the inner hiatus of the orbit; their basal segment is but slightly enlarged, not filling the hiatus at the inner angle of the orbit, nor attaining to the front, subcylindrical, unarmed, imperfectly fused with the carapace; the second segment is longer and slenderer than the first, the third segment about equal to the second in length, but slenderer; all these segments are furnished with long and coarse setæ; the whole antenna is less than one half as long as the carapace. The ischium of the outer maxillipeds is produced at its antero-internal angle; the merus of the same appendages is rounded at the antero-external angle, obliquely truncated but not emarginated at the antero-internal angle, where it articulates with the following segment. Legs of moderate length. Right and left chelipeds very unequally developed in the male. Dactyli of ambulatory legs styliform, straight, slender, longer than the penultimate segments.

The pentagonal shape of the carapace recalls the genus *Telmessus* White. But in *Telmessus* the front is divided by a median notch, the orbit is much more complete, the basal segment of the antenna sending off an external process that completely fills the hiatus at the inner angle of the orbit. In the structure of the orbit and antennæ, and in the shape of the merus of the outer maxillipeds, *Trachycarcinus* is much like *Hypopeltarium* Miers (*Peltarion* Jacq.).

### *Trachycarcinus corallinus*, sp. nov.

Carapace irregularly pentagonal, clothed with a dark brown pubescence, and bearing flattened tubercles of ivory whiteness arranged in groups, as follows: two anterior lateral and one posterior median, on the gastric region; four, disposed in two pairs, on the cardiac region; five or six on each branchial region; and one, of a crescentic shape, on each hepatic region. Each group of tubercles resembles the crown of a complex molar tooth whose cusps have been worn down to a common level. Front tridentate, the median tooth twice as long as the lateral. Walls of the orbit furnished with four teeth separated by deep hiatuses; these teeth are a pre-ocular, median superior, post-ocular, and sub-

ocular. Antero-lateral border of carapace armed with three prominent teeth; another minute tooth just back of the largest posterior lateral tooth. Eye-stalks slender; eyes small, unpigmented, with imperfectly faceted cornea. Chelipeds asymmetrical in the male; in adults the larger claw is naked, smooth, and ivory-white, like the tubercles on the carapace; the merus has a few small teeth along its upper margin, most of them near the two ends of the segment; the upper margin of the carpus is armed with one strong tooth, and is denticulated along its whole length; the propodus is short, the immovable finger bent down at an obtuse angle with the lower border of the palm; the dactylus is furnished with small tubercles on its upper border; both fingers are armed with large blunt teeth on their opposed edges. The smaller claw is slenderer than the large claw, and its fingers are proportionally longer. In the female both chelipeds are of approximately equal size, and resemble both in size and shape the smaller cheliped of the male. The ambulatory limbs are unarmed, but clad with coarse setæ.

Length of carapace, 26 mm.; breadth, 27 mm.

Station 3353. 695 fathoms. 1 female.

" 3356. 546 " 5 males, 4 females.

" 3418. 660 " 1 male.

### Family GECARCINIDÆ.

#### *Gecarcinus malpilensis*, sp. nov.

Carapace very broad and convex anteriorly, flattened and narrowed posteriorly; surface microscopically granulated; antero-lateral margin rounded, not denticulated; the median gastric furrow is well marked; the furrow separating the gastric from the branchial regions does not extend forward far enough to separate the gastric from the hepatic area; the so called genital area is separated by a pronounced groove from the branchial and cardiac regions, but not from the gastric; there is a deep indentation at the anterior extremity of the lateral genital furrows; the furrows bounding the cardiac region on either side are moderately developed. Front deflexed at right angles to the axis of the body, deep, concave above the margin, margin not reflexed, granulated. The merus of the outer maxillipeds is five-sided, outer side convex, distal slightly notched, antero-internal straight and parallel to the long axis of the body, forming an obtuse angle with the postero-internal margin, which is slightly concave. Merus and carpus of chelipeds devoid of spines or teeth. Dactylus of the ambulatory legs furnished with six rows of spines.

Length, 55 mm.; breadth, 76 mm.; width of hind border of carapace, 19 mm.; width of front, 11 mm.; depth of front, 7 mm.

Malpelo Island, March 5. 1 male.

This species is very distinct from any previously described. Compared with the previously known species from the Pacific coast, it is nearest to *G. quadratus*

De Saussure, but the outline of its carapace is very different; in this regard it is similar to *G. ruricola* from the eastern coast. Moreover, the front is narrower, deeper, and bent down at a sharper angle than in *G. quadratus*, and the merus of the outer maxillipeds is very different in shape from that of *G. quadratus* or any other known species.

### Family PINNOTHERIDÆ.

#### *Pinnixa panamensis*, sp. nov.

Male. — Carapace short and very broad, smooth and punctate for the most part, granulated at the sides. The lateral angles form a prominent shoulder, back of which the carapace diminishes rapidly in width. A transverse depression involves the hinder part of the gastric and the fore part of the cardiac regions. This depression is bounded behind by a ridge which extends across the carapace between the bases of the last pair of thoracic appendages. Back of this ridge the carapace is deflected at an angle of about forty-five degrees. Front depressed, divided by a median notch into two not prominent lobes; margin setose. The chelipeds are small, with very robust carpus and hand, destitute of spines, but furnished with some setæ along their edges; carpus squamose on the anterior and superior parts of the outer side; propodus not broader than the carpus, compressed laterally; a row of tubercles along the superior border forms a sort of crest; a longitudinal row of setiferous squamous tubercles runs lengthwise of the hand from the proximal end, stopping short of the base of the immobile finger; the surface between this and the dorsal crest is thickly beset with tubercles, but below it the surface is almost smooth down to a row of tubercles which runs along the inferior margin; immovable finger straight, the dactylus closing against it throughout its length; dactylus furnished with long setæ on the upper margin; no prominent teeth or tubercles on the cutting edge of either finger. First and second ambulatory limbs of moderate length, nearly naked, with slender and straight dactyli; last three segments tuberculate on superior margin. Third pair very much enlarged; the merus has a convex anterior border, and is pubescent on the anterior third of the upper surface; posterior margin double, spinulose. Fourth ambulatory legs very small, not reaching beyond the distal end of the merus of the third pair; upper surface smooth. Dactyli of penultimate and last pairs of legs short, acute, set at an angle with the propodi so as to form prehensile hooks. End joint of abdomen broader than the preceding joint, semicircular. The dactylus of the outer maxillipeds articulates with the propodus near the distal end of the latter. The carapace is 5 mm. long by 10 mm. broad.

The female is larger than the male, the carapace is more highly polished, the transverse depression not so pronounced, and the appendages are more thickly clothed with setæ. Length of carapace, 6.3 mm.; breadth, 13 mm.

Panama, March 12. 4 males, 6 females ovig.

**Family MATUTIDÆ.*****Osachila lata*, sp. nov.**

Carapace laterally expanded; three low obtuse protuberances on the gastric region, one on the cardiac, three or four on the branchial. Front prominent, bilobed, the lobes separated by a completely closed fissure. Antero-lateral margin of carapace sharp; behind the point where the subhepatic ridge joins the margin, the margin is divided into five obscure lobes, each of which is denticulate. Merus of chelipeds tuberculous along the upper edge and outside of it; carpus tuberculate externally, distal and superior margins produced to a cristiform tooth which continues back upon the carpus the crest on the superior border of the propodus; propodus tuberculate on the outer face, superior border denticulate and cristate. Edges of ambulatory limbs slightly cristate, dactyli pubescent on distal portion.

Length, 24.5 mm.; breadth, 32 mm.

Station 3427. 80 fathoms. 1 male.

**Family DORIPPIDÆ.*****Æthusa ciliatifrons*, sp. nov.**

Carapace broader than long, branchial regions much inflated; surface granulated on the branchial and cardiac regions, pubescent on the gastric region. Front and anterior part of the lateral border ornamented with long upturned cilia. Front between the orbits divided by a triangular median sinus and two slightly shallower lateral sinuses into four triangular teeth of equal length. Branchio-cardiac lines deeply impressed, meeting together in the median line in front of the heart. Eyes small, mounted on very short peduncles, just reaching, when extended, to the angles of the orbital sinuses. Chelipeds equal, small and slender; chela smooth, not more robust than the carpus; fingers longer than the palm, laterally compressed, curved inward, longitudinally grooved, thin prehensile edges straight and regularly denticulated. Ambulatory appendages very long (the second longer than the first), naked and minutely granulated; propodus slightly shorter than the merus, compressed, grooved longitudinally on both the upper and lower faces; dactylus one half longer than the propodus, flattened, curved, grooved and ribbed longitudinally, its upper edge very sharp. Last two pairs of thoracic limbs densely clothed with setæ. Sternum rather coarsely granulated. Conspicuous red transverse bands adorn the chelipeds and first two pairs of ambulatory appendages.

Length of a male (carapace), 26.5 mm.; breadth, 29.5 mm.

Station 3387. 210 fathoms.

“ 3389. 153 “  
 “ 3391. 259 “  
 “ 3396. 127 “



*Æthusa pubescens*, sp. nov.

Carapace a little broader than long, densely pubescent; frontal margin ciliated; cardiac area open in front, the branchio-cardiac lines not meeting one another in the median line; front four-toothed, the median teeth more widely, but less deeply, separated from each other than from the lateral; the antero-lateral angles reach the level of the frontal teeth. Eyes as in the last described species (*Æ. ciliatifrons*). Chelipeds equal, small, with pubescent merus and naked carpus and hand; fingers longer than palm, compressed, curved, gaping at base. Ambulatory appendages similar to those of *Æ. ciliatifrons*, but free from granulation. Abdomen (of female) very broad, pubescent.

Length, 26 mm.; breadth, 29 mm.

Station 3367. 100 fathoms. 1 female.

This species resembles *Æ. ciliatifrons*, but the median notch of the front forms a more open angle in *Æ. pubescens*, and the sinus separating the front from the external orbital angle is not so deep. The branchio-cardiac lines do not meet in front of the cardiac area, and the cardiac area is not so much sunken below the level of the branchial regions; the branchial areas, moreover, are not so convex, nor is the cardiac region so uneven. The whole surface is densely pubescent, and the abdomen of the female is much broader. The fingers too are different, inasmuch as they are separated by quite an interval at base. The first and second pairs of ambulatory limbs are imperfect in the only specimen at hand, but they are very similar, as far as they go, to the corresponding appendages of *Æ. ciliatifrons*.

*Æ. pubescens* may prove to be the full-grown state of *Æ. lata* Rathbun, the description of which has just appeared in Proc. U. S. Nat. Mus., Vol. XVI, p. 258, 1893.

*Æthusina smithiana*, sp. nov.

In this species the carapace is longer than broad, and is not much narrowed anteriorly. The front is four-toothed, the middle pair of teeth large, triangular, separated from one another by a wide triangular sinus which is broader than the antennular sinus; between these teeth the margin is bent down till it meets the epistoma below; the lateral teeth of the front are spiniform and shorter than the middle teeth. The surface of the carapace is clothed with a short pubescence, and is lightly granulous; the branchio-cardiac grooves are well marked. The post-orbital teeth are spiniform, and they project far beyond the extremity of the small eyestalks. The eyes are smaller than the extremity of their peduncles. The chelipeds are equal, smooth, naked, unarmed; the merus cylindrical, the carpus short and rounded; the fingers about equal in length to the body of the chela, compressed, prehensile edges sharp and not provided with distinct teeth or tubercles. The ambulatory legs are nearly naked, the second pair more than twice the length

of the carapace, the dactylus longer than the propodus. The last two pairs of legs terminate in short recurved claws, which are setose on the posterior edge. The sexes do not seem to differ in any marked degree.

Length of carapace (male), 9.3 mm.; breadth, 8 mm.

Station 3370. 134 fathoms. 3 females.

“ 3380. 899 “ 2 males.

This species is nearly related to *Æ. abyssicola* Smith, but its carapace does not diminish so much in width anteriorly, the external frontal spines are less developed, the external orbital spine is much longer and brought forward so that the orbits face more to the front. From *Æ. challengerii* Miers it differs in the greater development of the frontal and external orbital spines.

### *Cymopolia tuberculata*, sp. nov.

Carapace very broad, subpentagonal, branchial regions swollen. Front four-toothed, the teeth blunt, separated from each other by narrow sinuses which are rounded at the bottom; the two middle teeth are longer than the lateral ones, and the median sinus is deeper than the two lateral. The antero-lateral margin of the carapace is four-toothed, counting the prominent tooth at the external angle of the orbit; the posterior tooth of the series is the smallest. The upper margin of the orbit has three deep fissures defining two triangular teeth; the lower margin of the orbit has two fissures enclosing a broad truncate tooth or lobe; there is also a broad and prominent lobe just below the inner orbital angle; above this lobe is a single tooth at the inner angle. The surface of the carapace is ornamented with granulated tubercles; the parts between the tubercles are more finely granulated, and when viewed under a lens are found to be furnished with fine hairs. The chief tubercles are disposed as follows: one pair on the frontal region behind the margin; four in a transverse row on the anterior part of the gastric area, and five on the posterior part of the same area arranged thus : ' ; of these the posterior pair is the smallest; four in a transverse line on the cardiac region and one median behind the transverse series; about six on each branchial area; six just anterior to the straight posterior margin of the carapace (three on each side). There are three small tubercles on each eye-stalk near the margin of the cornea. The chelipeds are small, slender, equal; the carpus tuberculose, the fingers as long as the hand proper, curved downward and inward, crossing at the tip, their prehensile edges finely denticulate in small specimens, nearly entire in larger ones. The second and third ambulatory limbs are very long, the second slightly longer than the third; their merus joints are granulated and costate above, and armed with a prominent spine at the antero-distal angle and a smaller one each side at the point of articulation with the carpus; this holds good of all three pairs of ambulatory appendages; the carpi are carinate on their anterior margin, with a vestige of a tooth at each end of the carina; the anterior edge of the propodus is also carinate. The ambulatory legs are ornamented with trans-

verse bands of red, three of which cross the merus. The abdomen and sternum are granulated.

Length, 13 mm. ; breadth, 18 mm. ; length of ambulatory leg of second pair, 34 mm. ; merus of do., 9.3 mm. ; carpus, 5.6 mm. ; propodus, 9 mm. ; dactylus, 7.5 mm.

Station 3355. 182 fathoms. 4 males, 1 female.

*Cymopolia zonata* Rathbun (Proc. U. S. Nat. Mus., XVI. 259, 1893), lately described from the Gulf of California, 40 fathoms, differs from *C. tuberculata* as follows. The carapace is narrower and more quadrangular. The median lobes of the front are small and inconspicuous, while the lateral lobes are very broad and are separated from the median lobes by a slight, shallow notch. In *C. tuberculata* the four frontal lobes take on the form of prominent triangular teeth, clearly separated from each other by deep triangular sinuses. The antero-lateral margin of the carapace is three-toothed in *C. zonata*, four-toothed in *C. tuberculata*. The tubercles near the posterior margin of the carapace are more elongated in the former species than in the latter. The hand of the former is much broader, and is armed with prominent spiny tubercles. Finally the meri of the ambulatory legs are much shorter in *C. zonata*, and are armed at the distal end with a blunt triangular tooth, while in *C. tuberculata* this tooth is transformed into a long sharp spine, and a pair of smaller spines is present, one on each side of the proximal end of the carpus.

### Family RANINIDÆ.

#### *Raninops fornicata*, sp. nov.

Carapace very convex from side to side, naked, smooth or nearly so, punctate. Rostrum acute, lightly carinate, the carina extending backward for a short distance on the carapace. Superior margin of orbit armed with three acute teeth, the second of which is curved forward ; the anterior tooth is separated from the rostrum by a deep rounded sinus, from the second tooth by an angular notch ; the second tooth is separated from the third by a nearly straight interval ; the third tooth lies some distance in front of the posterior end of the orbit. Back of the orbit there is a strong procurved spine on the margin of the carapace. Eystalks compressed, equal in length to one half the width of the carapace. Second segment of the third maxilliped equal to the third joint, crossed by a piliferous line; third segment notched at the antero-internal angle. Cheliped: merus unarmed, microscopically spinose above, setose below ; carpus minutely rugoso-spinulose, the superior distal angle projecting as a sharp tooth ; propodus lightly rugose, upper and lower borders margined, unarmed, palmar edge irregularly and inconspicuously toothed ; dactylus without any prominent tooth. The dactylus of the fourth pair of legs has a very convex internal border, the dactylus of the fifth is long, narrow, and spatulate. Abdomen setose ; telson obtuse at the end.

Length of carapace, 12 mm. ; breadth, 8.6 mm.

Station 3369. 52 fathoms. 1 specimen.

**Family LITHODIDÆ.*****Rhinolithodes cristatipes*, sp. nov.**

The carapace is subtriangular in outline, its surface devoid of setæ, but covered with low squamiform tubercles; the whole gastric area is raised into a conical prominence; there is also a prominent crescentic rounded ridge on each branchial region, enclosing the cardiac area in a deep fossa open only behind. The rostrum is straight and conical, with a vertical plate projecting below from the proximal half down between the eyestalks; this plate is toothed anteriorly but does not reach forward nearly to the tip of the rostrum. The antero-lateral margin of the carapace is five-toothed; the second, third, and fourth of these teeth give rise to long thread-like cilia. There is another tooth at the angle between the postero-lateral and posterior margins; posterior margin straight. The upper surface of the eyestalk is covered with small tubercles and a blunt spine projects over the cornea. The movable scale of the antenna is spiniform and bears two blunt spinules on the outer side and two smaller ones on the inner. The chelipeds are unequal (the right being the larger); coxa granulated, setose on the lower inside margin; lower margin of the merus armed with three or four blunt teeth, superior margin toothed, internal distal border setose, external distal border forming a bilobed crest; outer face of carpus squamous, margins cristate, the internal crest expanded and cut into setiferous lobes; propodus tuberculated without, smooth within, toothed and setose on superior margin; immobile finger, as well as the dactylus, excavated within, setose; the larger claw has blunt teeth on the fingers, while the fingers of the smaller claw have nearly straight cutting edges. The ambulatory appendages have cristiform anterior margins from the merus to the propodus inclusive; the crest of the carpus is entire, but that of the merus is bilobed, of the propodus trilobed; the posterior margins of these appendages are dentate and more or less setose, the dactyli are provided with curved acute black tips, and with pencils of hair especially on anterior margins. The abdomen is indurated, with three rows of tuberculated plates.

Length of carapace, 16.5 mm.; breadth, 16.5 mm.

Station 3354. 322 fathoms. 1 male.

I have seen neither specimen nor figure of the type of this genus, *Rhinolithodes wosnesenskii* Brandt, from the coast of Alaska, and the specimen above described possibly does not belong to the same genus. Brandt's generic diagnosis (Bull. Phys.-Math. Acad. Sci. St. Pétersbourg, VII. 174, 1849) appears to include specific as well as generic characters. The specimen above described conforms to Stimpson's diagnosis of the genus (Proc. Acad. Nat. Sci. Phila., 1858, p. 231): "Abdomen scutis triseriatis obsessum. Antennarum aciculum margine spinosum. Pedes mediocres."

**Echinocerus diomedææ, sp. nov.**

Carapace subpentagonal, gastric and branchial regions inflated, the whole surface beset with tubercles which give rise to minute setæ. There is one rather more prominent tubercle in the depression on each side of the gastric area. Rostrum short, three-spined; one of the spines is median and inferior, two are paired near the base above; in one of the two specimens obtained the median spine is toothed below. The antero-lateral margin of the carapace is irregularly toothed. Eyestalks spinulose above, with one prominent spine projecting forward over the cornea. The movable scale or spine of the antenna is spinulose on each side (four or five spines on each margin). The merus of the cheliped bears a spine on the inner side at the distal end; the carpus is smooth outside, the inner border expanded into a seven-toothed crest setose within, the outer border straight, naked, and keeled; the chelæ are of unequal size (the right being the larger), setose, spiny on the upper edge; fingers spoon-shaped within, setose and somewhat gaping. Ambulatory appendages: the meri are spinose on their edges; the anterior border of the carpus of the first pair is furnished with a crest whose edge is even and entire; the propodus of the first pair is crested along the proximal half of its anterior border, while the distal half is armed with two or three teeth; the carpus and propodus of the second and third pairs are toothed on the anterior margin, the propodus of the third pair is also toothed on the posterior margin; all the segments are hirsute, especially the dactyl. When the legs are closely folded against the sides of the carapace a wide interval is left between the carpi of the cheliped and first pair of ambulatory appendages, bounded by the opposite crests of these segments, and forming a passage for the admission of water to the gills. This orifice is similar to that seen in *E. foraminatus* Stimps., but it is not so perfectly formed. The apex of the abdomen (in the female) is turned to the right (most strongly in the larger specimen); the marginal plates are wanting on the left side; all the abdominal appendages excepting the first are aborted on the right side.

Length, 64 mm.; breadth, 71 mm.

Station 3384. 458 fathoms. 1 female.

Station 3394. 511 fathoms. 1 female ovig.

In this species the acicle of the antenna is spinous on the margins only, as in *E. foraminatus* Stimps.

**Paralomis aspera, sp. nov.**

Carapace pentagonal, as broad as long; gastric, cardiac, and branchial regions well defined and prominent; whole surface of carapace and abdomen thickly beset with papillæ or tubercles, each one of which is encircled with a crown of stiff setæ. Rostrum short, indistinctly tripartite, multispinose. A sharp dark-tipped spine at the external orbital angle, another at the antero-lateral angle of the carapace, and four or five, irregularly arranged, on the margin of the branchial region.

The dorsal face of the second abdominal segment consists of a single plate, undivided by longitudinal sutures, with a deep depression on each side of the middle. The following segments are unsymmetrical on the two sides of the unique type specimen (female), the abdomen being twisted to the right. The lateral margins of these segments are laciniated.

Eyestalks spinulose above; eyes very black, with downward aspect. Distal segment of antennule much longer than the antecedent segment, tuberculous above. Antennæ of moderate length; outer margin of first segment spinulose; second segment spinulose, and produced on the outer side to a long spine; movable acicle reaching to the distal end of the peduncle, spinose, the longer spines marginal, one spinule on the lower side and another on the upper side near the base; penultimate and ultimate segments of peduncle bear small setiferous tubercles. Right cheliped more robust than its fellow, thickly beset with strong spines. Ambulatory legs long, robust, spinose like the chelipeds; their basal segments are wellnigh covered by the overlapping margin of the abdomen (in the female).

Length of carapace, 113 mm.; length of rostrum, 9 mm.; breadth of carapace, 113 mm.; length of posterior ambulatory legs, 255 mm.; merus, 68 mm.; carpus, 39 mm.; propodus, 72 mm.; dactylus, 56.5 mm.

Station 3353. 695 fathoms. 1 female.

This species, like the one next described, is much longer legged than *P. granulosa* (Jacquinot), the type of the genus. In this regard it is more like the two "Challenger" species described by Henderson. The specimen above described was infested with a huge *Peltoaster* 36 mm. in breadth.

### *Paralomis longipes*, sp. nov.

Male. — Carapace triangular; gastric, cardiac, and branchial regions well defined, protuberant; the most prominent part of the cardiac area reaches a higher level than the branchial areas; whole surface of carapace thickly covered with blunt papillæ; viewed under a lens each tubercle is seen to be encircled with a ring of short, stiff setæ; one of the tubercles, situate in front of the centre of the gastric region, assumes a spiny form. Rostrum furnished with three prominent spines, one median and inferior, two lateral and superior; the latter are not so long as the inferior spine; there is, too, a spinule on the lower side of the inferior spine, and a still smaller one above, between the roots of the superior pair. There are two pairs of long spines on the anterior margin of the carapace, one at the external orbital angles, the other at the antero-lateral angles of the carapace. There are also three or four prominent spines on the side of each branchial area. Eyestalks spinulose above. Basal segment of the antenna armed with an external spine, the second segment with several spines, the most prominent of which is on the outer side; acicle furnished with five prongs or spines, the largest median, the others lateral; flagellum much longer than the carapace. Cheliped of moderate size (the right one has been lost from

the only male specimen obtained), coxa tuberculate on the lower face, the following segments armed with strong spines, fingers excavated within, slightly gaping, penicillate, cutting edges entire. Ambulatory appendages very long, second and third pairs of about equal length and longer than the first pair; all of them armed, like the chelipeds, with spines; the spines tend toward a regular arrangement in longitudinal rows, and the spaces between the spines are smooth and naked, i. e. nearly free from spinules, tubercles, or setæ. Second segment of abdomen composed of a single calcified plate, marked by a deep hollow on each side of the middle; the other segments of the abdomen are of a leathery, semi-membranaceous consistency, and are made up of five longitudinal rows of plates, viz. one median row, flanked by a row on each side, the latter in turn bounded externally by a marginal series; whole surface of abdomen verrucose.

Length of carapace, including rostrum, 84 mm.; breadth, 78 mm.; breadth between the antero-lateral angles of carapace, 34 mm.; length of last ambulatory appendages, 242 mm.; merus, 76 mm.; carpus, 36 mm.; propodus, 64 mm.; dactylus, 47 mm.

In the female the right chela is larger than the left, and the prehensile edges of the fingers are furnished with blunt teeth. The abdomen is asymmetrical, the apex turned to the right, the marginal plates absent from the left side; the right side bears the ovigerous appendage (the first). The abdomen nearly conceals the basal segments of the thoracic legs, which in the male are almost entirely exposed.

Station 3571—770 fathoms. 1 male, 1 female o. sp.

The egg measures 2 mm. in diameter.

### **Lithodes panamensis, sp. nov.**

Carapace subpyriform, of about equal length and breadth; gastric and branchial regions very convex; a deep depression on each side at the anterior limit of the branchial areas, and another between the gastric and cardiac areas. Rostrum cylindrical, terminating in three spines or teeth, one of which is median, the other two lateral; a long horn, slightly upcurved, is given off from the lower side of the proximal end of the rostrum. The whole surface of the carapace is rough with low warty protuberances; the gastric region bears two pairs of spines, the anterior pair separated by a greater interval than the posterior pair. Two small spines on each branchial area, and two on the intestinal region. The orbit is bounded externally by a prominent spine, and there are five more spines on the lateral border of the carapace, viz. one at the antero-lateral angle, one on the hepatic region, and three on the branchial. Besides these there is a rudimentary lateral spine near the anterior limit of the branchial region. The posterior margin of the carapace is tuberculated, not spinose. The third segment of the antennular peduncle is equal to the first segment in length, and considerably longer than the second segment. The

antennæ are about equal in length to the carapace without the rostrum; the second segment is armed with a long and sharp external spine; there is, moreover, on the antenna of the right side a movable thorn-like acicle equal in length to the last two segments of the peduncle together; the acicle is armed with a small tooth on the external margin midway between the base and the tip. There is no trace of an acicle on the left antenna. As the type specimen is the only one obtained, it is impossible to tell whether the acicle is normally present or absent. The last segment of the peduncle is nearly twice as long as the penultimate segment. The chelipeds are furnished with scattered tubercles, a few of which assume a spiny form. The left cheliped is rather slenderer than its fellow. The ambulatory legs are long and rather slender, their meri sparsely furnished above with tubercles, which tend to a spiny form on the anterior and posterior margins; at the distal end of the anterior margin of the meri there is a prominent spine-like tooth; the carpi and propodi are armed with teeth, chiefly on the anterior margins; the dactyli are equipped with four short spines (two superior and two lateral) near the proximal end. The abdominal segments (of the female) are roughened by low tubercles, and dentate on their margins. The lateral teeth of the marginal plates of the right side are drawn out into long spines. The tergal plate of the second abdominal segment is completely fused with the epimera, showing no trace of an intervening suture. The marginal (episternal?) plates of this segment are bounded within by a distinct suture.

Length of carapace, excluding rostrum, 79 mm.; rostrum, 14 mm.; breadth of carapace, 79.5 mm.; length of posterior pair of ambulatory legs, 193 mm.; merus, 58.5 mm.; carpus, 31 mm.; propodus, 54 mm.; dactylus, 33 mm.

Station 3384. 458 fathoms. 1 female.

This species finds its nearest relative in *L. murrayi* Henderson (Rep. Challenger Anomura, p. 43, Plate IV.), from the distant Prince Edward Island in the Southern Ocean. The latter species differs from *L. panamensis* in having a much longer rostrum, which is forked at the end, a more oval and spiny carapace, shorter external antennal spine, more spinose legs, etc.

### Family PAGURIDÆ.

#### *Cancellus tanneri*, sp. nov.

Differs from *C. canaliculatus* (Herbst) in having a much shorter and broader abdomen, in the lobate character of the marginal crests of the first and second pairs of legs, in the pubescence of the thorax and abdomen, and in the shortness of the antennæ. From *C. typus* M. Edw., it is distinguished by having the anterior border of the carapace less deeply incised on either side of the rostrum, and the telson squarely truncated posteriorly, not notched in the middle; the coxæ of the last pair of legs, too, present a very different shape, since they lack the prominent anterior lobe observable in *C. typus*. *C. parfaiti* A. M. Edw.



et Bouv., compared with *C. tanneri*, displays longer eyestalks, while the thorax and abdomen are less pubescent, and the coxal segments of the posterior legs are much more protuberant.

Length of carapace, 7 mm.; breadth, 5 mm.; length of eyestalk, 3 mm.

Station 3368. 66 fathoms. 1 male.

Found in a cavity in a piece of dead coral rock.

The abdomen in the unique type specimen is not quite symmetrical, but this may be an individual peculiarity resulting from the shape of the cavity in which the animal lived.

### ***Pylopagurus longimanus*, sp. nov.**

Carapace smooth, naked, polished; rostrum short, triangular, subacute, advanced farther than the rounded lateral angles. Abdomen longer than cephalothorax. Eyestalks equal in length to the first two segments of the antennular peduncle. Ophthalmic segment uncovered. Ophthalmic scales separated by a considerable interval, triangular, their tips split in a horizontal plane so that they end in two acute teeth, one above the other, the lower tooth the longer. Last segment of antennular peduncle very long and slender (much longer than the eye-stalk). Right cheliped of enormous size, much exceeding the whole body in length; the outer face of the merus is nearly smooth, the lower and inner faces granulated; carpus very large, equalling in length all the preceding segments combined, its surface granular, the granules assuming the form of small spinulose tubercles on the dorsal face, which is limited within by a row of larger teeth. Chela irregularly oval, the external side flattened to form an opercular facet, which is thickly set with granules and surrounded with a margin of denticles. Left cheliped very small, its segments more hairy than those of the right; basal part of propodus short and swollen, the fingers long, gaping at the base; the outer or upper faces of the propodus and dactylus are granulated, and definitely bounded by a line of regularly arranged granules on the outer margin of the dactylus and the inferior margin of the propodus; the inner or lower face of the chela is pretty free from granules, but is furnished with numerous setæ, those on the dactylus being grouped in conspicuous tufts or pencils. Penultimate pair of thoracic appendages almost perfectly chelate, its rasp restricted to the distal part of the claw, broad, and composed of many rows of scales.

The legs are yellowish, banded and mottled with red.

Length of carapace, 10 mm.; eyestalk, 4 mm.; right cheliped, 34.5 mm. (merus, 8 mm.; carpus, 11 mm.; propodus, 14.8 mm.; dactylus, 10 mm.).

In younger, smaller specimens the chelipeds are shorter in proportion to the length of the body, and the major claw is shorter, broader, and of a more regular oval form. A specimen, whose carapace is 6.5 mm. long, gives the following dimensions for the right cheliped: total length, 16.5 mm.; merus, 4.5 mm.; carpus, 5.5 mm.; propodus, 7.5 mm.; dactylus, 4.5 mm.

Station 3368. 66 fathoms. 5 males.

Resembles *P. unguatus* (Studer), but readily distinguished from that species by the great size of the right cheliped, the irregularly oval outline of the right chela, the great length of the distal segment of the antennular peduncle, etc.

### *Pylopagurus affinis*, sp. nov.

This species is nearly related to *P. unguatus*, from which it differs in the following respects: the eyestalks are longer, and narrower at the distal end; the external prolongation of the second segment of the antenna is longer and slenderer; the upper margin of the carpus of the right cheliped is armed with two or three spines, the largest of which is close to the anterior border; the outer face of the carpus is smooth save where a light tubercular ridge runs along the middle. In *P. unguatus* this face of the carpus is thickly covered with spinulose granules which assume larger proportions and a uniserial arrangement on the superior and inferior margins. On extending the comparison to the large chela, further differences between the two species become apparent. In both species the external face is flat, covered with minute spinulose granules, and surrounded by a border of sharp spines; but in *P. affinis* the marginal spines are larger and more irregular, and the flat opercular facet is not sharply defined at the proximal end by the regular arrangement of the marginal spines as in *P. unguatus*; instead, one finds the marginal series of spines broken down at this point, thus effacing any distinct limit between the opercular face of the chela and the articular surface which connects the propodus with the carpus. The inner or lower surface of the large chela is smooth in *P. affinis*, granulated in *P. unguatus*. The left cheliped is quite different in the two species: in *P. affinis* the several segments of which it is composed give rise to long setæ, which give the appendage a very hairy appearance when contrasted with *P. unguatus*; the inferior border of the chela is conspicuously toothed, while in *P. unguatus* it is entire. The ambulatory legs are more hairy in the Pacific species than in *P. unguatus*, and their carpal joints are not so distinctly dentate on the superior border. The rasps of the fourth pair of legs are multiseriate in both species. The telson is symmetrical, subcircular in outline, its posterior border convex and entire; in *P. unguatus*, the telson has a deep and wide posterior median notch.

Length, about 12 mm. ; length of carapace, 4.5 mm.

Station 3397. 85 fathoms. 1 male.

There are three simple unpaired abdominal appendages on the left side, in the type specimen. The vasa deferentia are extruded from the base of the fifth legs on each side. They appear as slender threads, the one on the right side much longer than its fellow, and twisted into a small bunch.

***Pylopagurus hirtimanus*, sp. nov.**

This species closely resembles *P. rosaceus* A. M. Edw. et Bouv.,<sup>1</sup> from the West Indian seas. Compared with the type of *P. rosaceus* it presents the following differences. The eyestalks are a little slenderer, and together with the ophthalmic scales are separated by a wide interval in which the antennules lie, exposed from above. In *P. rosaceus*, on the contrary, the ophthalmic stalks and scales are closely approximated, concealing the antennules beneath. The outer face of the right chela is ornamented with conical tubercles, whose bases are expanded into circular plates; these plates are closely packed over the surface of the chela, so that no interstices are left between them; their borders are cut into a large number of minute radiating processes; on the basal half of the propodus the tubercles give rise to long setæ, which render that part of the claw conspicuously hirsute, in contrast with the distal part which is naked; furthermore, on the distal half of the propodus, especially on the concave surface of the immovable finger, the tubercular processes tend to become obsolete, leaving only the basal circular radiate plate; the bases of the conical teeth along the outer margin of the hand and the movable finger are expanded at the base into flattened roundish surfaces with radiate margins; these surfaces form a conspicuous outer border to the hand; the inner face of the hand is tuberculated. In *P. rosaceus* the tubercles of the outer face of the chela are encircled by rounded granules much less numerous than the radiating points in *P. hirtimanus*; the tubercles are so loosely arranged that numerous interstices are apparent between them; the hairs on the basal half of the hand are not so well developed as in the Pacific species; the whole outer face of the immovable finger is strongly tuberculated, the teeth of the lower margin are not expanded into conspicuous plates, and the inner face of the chela is nearly smooth. The carpus in *P. hirtimanus* is armed with larger spines on the internal margin, is more hairy, and more coarsely granulated on its inner, inferior, and outer surfaces than it is in *P. rosaceus*. The left chela is comparatively smaller than in *P. rosaceus*, is more strongly toothed along the internal margin of the propodus and dactylus, and exhibits, besides, most of the above specified peculiarities of the right claw. The primary branch of the unpaired abdominal appendages is shorter and broader than in *P. rosaceus*. The rasp on the propodus of the fourth pair of legs is uniserial, as in *P. rosaceus*.

Length of carapace of largest male, 12 mm.; length of carapace in front of cervical groove, 7 mm.; breadth across the branchial regions, 9.5 mm.; length of large claw, 11 mm.; breadth of large claw, 7 mm.

Station 3367. 100 fathoms. 2 males, 1 female.

“ 3368. 66 “ 5 males, 5 females.

A good deal of the color is still preserved in alcohol. The lower surface of the eyestalk is quite a deep red, while the upper surface is a pale yellow. The

<sup>1</sup> Mem. Mus. Comp. Zool., XIV. No. 3, p. 97, Plate VII. Figs. 10-17, 1893.

merus and carpus of the chelipeds and all the segments of the ambulatory legs from the ischium to the dactylus inclusive are banded transversely with bright red on a yellowish ground.

*Catapagurus diomedea*, sp. nov.

The carapace is smooth and naked, and divided into an anterior and posterior section by the cervical groove. The anterior margin projects slightly between the eyestalks, forming a blunt rudimentary rostrum. The gastric region is sharply defined, and presents an indistinct longitudinal furrow on each side of the median line; it is lightly convex in both directions. The branchial regions of the right and left sides are strongly inflated and sharply separated from each other by a re-entrant angle formed by the curving forward of the posterior border of the carapace on each side of the median line.

The eyestalks are rather long and slender, being about equal in length to the anterior section of the carapace. The ophthalmic scales are very small and minutely bifid at the tip. The third segment of the antennular peduncle is about two thirds the length of the eyestalk, and increases in diameter from the base to the distal end; the superior flagellum is rather longer than the distal segment of the peduncle, and its enlarged ciliated basal portion forms rather more than one third of its whole length. The inferior flagellum is about one half as long as the superior, and is composed of about eleven segments. The peduncle of the antenna surpasses the eyestalk by one half the length of its distal segment; the acicle is long and slender, tipped with a few setae; it reaches forward a little beyond the eye; the flagellum reaches beyond the tips of the ambulatory legs. The chelipeds are nearly alike in shape and size; their segments are clothed with long setae, which assume a tomentose appearance on the chelae; the carpus is about equal in length to the chela, its inner face is perpendicular, the inner margin of the upper side is armed with seven small spines; there is also a spine at the distal end of the superior margin of the carpus; the chela is short and thick, the fingers about the same length as the basal portion of the propodus, slightly down-curved, meeting throughout their length, working horizontally. The ambulatory legs are of nearly equal length, surpassing the chelipeds, setose, the carpus armed with a sharp tooth at the distal end of its upper side; the propodus is twice as long as the carpus, the dactylus is considerably longer than the propodus, and, like that segment, is distinctly curved; it is tipped by a small horny nail. The fourth pair of legs is but slightly subcheliform; the rasp is formed of a single row of scales. There are three small rudimentary appendages on the left side of the abdomen; the first and second of these are two-branched, the secondary branch being exceedingly minute.

The sexual tube, which issues from the coxal segment of the last thoracic appendage of the right side, is very long in this species.

Length of carapace, 5.5 mm.; abdomen, 8 mm.; cheliped, 12.5 mm.; last ambulatory leg, 17.5 mm.; ocular peduncle, 2.5 mm.

Station 3355. 182 fathoms. 1 male.

This species differs much from the more typical species of *Catapagurus*, *C. sharreri* A. M. Edw. and *C. gracilis* Smith, in the shortness of its chelipeds and ambulatory limbs, the symmetry of its chelipeds, and the length of the protruded vas deferens. It is more nearly related to *C. australis* Henderson (Challenger Anomura, p. 76, Plate VIII. Fig. 1). It would seem to have a close general likeness to *Pagurodes piliferus* Henderson, but the gills in *C. diomedæ* are of the phyllobranchiate type.

### *Spiropagurus occidentalis*, sp. nov.

The carapace is smooth and naked except on the sides of the branchial regions, where a few hairs arise; the branchial regions are swollen, membranaceous, and covered with a network of white lines; the cardiac region is long and narrow; the portion of the carapace in front of the cervical groove is calcified, produced in the median line anteriorly to form a short, broad, and obtuse rostrum, which does not conceal the ophthalmic segment; the lateral teeth are acute, and project as far as the rostrum does; they form a sharp demarcation between the front and the oblique antero-lateral border of the carapace.

The ophthalmic scales are triangular, with simple tips. The ocular peduncles are enlarged at the distal end, hardly overreaching the distal end of the second segment of the antennular flagellum and the third segment of the antennary flagellum. The last segment of the antennular peduncle is more than twice as long as the penultimate segment. The second segment of the antennal peduncle is produced externally into a long, sharp tooth; the antero-internal angle is likewise armed with a small spine; the acicle is long, sharp, curved, and furnished with setæ, as are also the several joints of the peduncle.

The chelipeds are subequal, the right chela being appreciably larger than the left; the ischium is armed with about five denticles along the internal margin; the inner margin of the merus is armed with the same number of rather larger teeth; the inner margin of both of these segments is furnished with long and slender setæ; the surface of the carpus is rough with setiferous rugæ, and is armed with scattered spinules upon its upper face and with a row of larger spines along the internal margin of the upper face. The external face of the propodus is armed with spines which are regularly arranged in five longitudinal rows; only at the distal end of the propodus, at the base of the fingers, do these spines lose their regular serial arrangement; from the bases of these spines spring long setæ; the fingers are acute, tuberculo-spinose and setose, like the hand. The fingers of the left hand are longer in proportion to the palm than those of the right hand. The ambulatory legs are rather robust, and longer than the chelipeds; their lateral surfaces are smooth; the upper margins of the carpi are armed with a row of little spines, and the corresponding margins of the propodi are denticulated; the dactyli are longer than the propodi, but not so long as the propodus and carpus combined; the anterior pair of ambulatory

legs differs from the posterior pair in having the dactylus and propodus a little shorter, and the lower edge of the merus more hairy and minutely spinulose. The telson is deeply cut by a broad median notch in its hind margin into two lobes, the left of which is the larger. The margins of both lobes are spinose.

There is (in the alcoholic specimens) a narrow red ring around both fingers near their tips, a broader band of the same color around the base of the fingers, and a red patch on the inner side of the anterior face of the hand.

Length of carapace, 6.5 mm.; greatest breadth of carapace, 6 mm.; length of ocular peduncles, 2.3 mm.

Station 3368. 66 fathoms. 1 male.

“ 3379. 52 “ 1 male.

This species, like *S. iris* A. M. Edw., is characterized by the spiny armature of the chelipeds. It differs from *S. iris* by having a smaller number of spines upon the anterior face of the chela, and in their arrangement in a few definite longitudinal rows, the surface between the rows being spineless and reticulated. The chela does not display the lively iridescence so striking in Milne Edwards's species, nor are the ophthalmic scales bidentate at the end. The merus of the third maxilliped is not armed with a distal spine, as in *S. iris*.

#### **Paguristes fecundus, sp. nov.**

The anterior or gastric section of the carapace is smooth in the central and hinder parts, rugose near the front, and tuberculose in the antero-lateral region, where a few of the tubercles assume a spiny form; from the tubercular surface spring long slender setæ. The anterior margin of the carapace is produced in the median line so as to form an acute triangular rostrum, which projects beyond the subacute lateral processes; between the rostrum and the lateral processes the anterior border is concave and thickened so as to form a rim. The anterior gastric lobes are clearly defined anteriorly.

The ocular peduncles are long and cylindrical, reaching considerably beyond the antennal peduncle, but not quite so far as the antennular peduncle. The ophthalmic scales are of moderate size and bidentate at the tip, the external tooth very minute. The antennal acicle reaches almost to the end of the peduncle; it is setose, and armed with six spines, two of which form a terminal fork, the others being marginal. The external prolongation of the second antennal segment is narrow, setose, and minutely spinulose; there is, moreover, a spinule on the upper face of this segment behind the base of the acicle; the antennal flagellum is very short (about equal in length to the anterior section of the carapace). The third pair of maxillipeds are closely approximated at the base; their merus joints are armed with three or four denticles on the lower margin, and one at the distal end of the upper margin.

The chelipeds are short and of like size and shape; the merus is smooth within, rugose without; the two inferior margins are armed with minute black-tipped spinules. The carpus is tomentose and spinulose, the largest

spines occurring along the superior border; the hand is both spinulose and pubescent, but the hair is less dense upon the fingers than upon the basal portion of the hand, which is short and swollen below; the fingers are short, excavated within, and terminate bluntly in a dark corneous nail. The ambulatory limbs are pubescent, particularly on the upper and lower margins; the distal end of the merus, and also the carpus, propodus, and dactylus, are armed with numerous spines; the most prominent of these spines are arranged in a row along the upper border of the carpus and propodus; the dactylus is about equal in length to the propodus and carpus together. The legs of the fourth pair are furnished with long hairs on their upper margin, and there are a few spines on the upper margin of the carpus; the propodus is rather longer than the dactylus, and the rasping surface on its lower margin occupies two thirds of its length. The last pair of legs is much less hairy than the preceding pair; the rasping surface, which is truncate posteriorly, falls a little short of reaching the middle of the hand. The telson is divided by a pair of lateral incisions and a median one into four lobes, those on the left side the larger; the pair of terminal lobes are obscurely toothed on their margins.

Length of carapace, 9.5 mm.; breadth, 7 mm.; length of ocular peduncle, 4 mm.

Station 3368. 66 fathoms. 2 females ovig.

This species is nearly related to *P. lymani* A. M. Edw. et Bouv.,<sup>1</sup> of the West Indian region, and to *P. subpilosus* Hend.,<sup>2</sup> of New Zealand. From the former it is distinguished by the more prominent and acute rostrum which overhangs the ocular segment, by the smaller number of spines on the antennal acicle, and by the armature of the telson, the margin of which is ornamented with obscure teeth, while in *P. lymani* it is furnished with numerous spines whose tips are horny and dark colored. From *P. subpilosus* it differs in having shorter eyestalks and antennal acicle, fewer spines on the antennal acicle, a longer and narrower external prolongation of the second joint of the antenna, and a differently shaped telson.

The ovisacs of both specimens are large and filled with eggs.

## Family PORCELLANIDÆ.

### *Petrolisthes agassizii*, sp. nov.

In the shape of the carapace and the front this species bears a close resemblance to *Petrolisthes sexspinosus* (Gibbes) and *P. occidentalis* Stimps., but the transverse ridges are more broken anteriorly, while posteriorly they extend without interruption across the whole width of the carapace, being here more perfectly developed than in the two species above named. The carpus and claw,

<sup>1</sup> Mem. Mus. Comp. Zoöl., XIV. No. 3, p 49, Plate IV. Figs. 13-22, 1893.

<sup>2</sup> Challenger Anomura, p. 77, Plate VIII. Figs. 2, 2 a, 1888.

moreover, are longer and narrower; the anterior margin of the carpus is three-toothed instead of five-toothed. The squames of the carpus and claw do not tend to widen out into ridges or folds either on the upper or lower face, but preserve the form of close-set imbricated scales over the whole surface, including the space between the longitudinal depressions of the carpus and along the depressed line of the propodus. The form of the carpus approaches nearer to that of *P. armatus* (Gibbes), but the present species may be readily distinguished from *P. armatus* by the prominent rugæ of the carapace and the squames of the chelipeds. From *P. edwardsii* (Sauss.) it is distinguished by its longer chelipeds, by the ridges of the hinder part of the carapace extending clear across the carapace without interruption, etc. The ridges of the frontal lobes are much more strongly developed in *P. agassizii* than in any of the allied species.

Carapace  $5 \times 5$  mm.; cheliped, 34 mm.

One male, taken with *Petrolisthes occidentalis* Stimps. on the reef at Panama, at low tide, March 12.

#### *Pachycheles panamensis*, sp. nov.

Carapace subcircular, of equal length and breadth; upper surface flattened, granulate, and setose, especially on the gastric and anterior part of the branchial regions; posterior portions of the branchial regions lightly rugose. Front broad, produced to a rounded median lobe, lateral portions straight, inner orbital angle rounded, not produced; outer orbital angle projecting as a triangular tooth between the eye and the base of the antenna. Lateral border of the carapace with a concavity behind the antenna; the margin is slightly raised as a rim which is lost in one of the branchial rugæ before reaching the hind border of the carapace; hind border slightly concave. Chelipeds: unequal, the right being the larger; upper surface of the merus rugose and setose, under surface smooth, internal distal angle produced as a denticulated tooth; carpus short and broad, upper surface tuberculous and setose, internal border armed with a large tooth at the base, followed by one or two smaller teeth, lower surface smooth and naked; upper surface of the propodus furnished with small tubercles which bear stiff bristles, inner margin rounded, not toothed, outer margin granulated, lower surface convex, naked and polished near the centre (where the surface is reticulated in the larger claw), squamoso-granular and setose near the edges; fingers gaping, crossing at tips, toothless on both the inner and outer margins (or at most slightly denticulated on the outer margin). Ambulatory appendages setose.

Length of carapace, 6.5 mm.; breadth, 7 mm.; breadth of frontal margin, 2 mm.

Panama, March 12. 1 female ovig.

*Pachycheles rudis* Stimps. is a larger species, with the posterior margin of the carapace more concave (the concavity having almost the shape of a triangular



notch); the carapace and chelipeds are less setose than in *P. panamensis*, the anterior margin of the carpus not prominently toothed, and there is a strong protuberance near the middle of the upper surface of the propodus. In *P. tuberculipes* Lockington, the central part of the front is triangular and deeply furrowed along the median line, the chelipeds and ambulatory legs are knobbed so as to present "a mass of tubercles above." *P. panamensis* appears to be near *P. barbatus* A. Milne Edwards, from the Azores, but in the latter species the front is broader and the carpus more denticulated.

### Family GALATEIDÆ.

#### *Pleuroncodes monodon* (M. Edw.)?

Compared with Milne Edwards's figure of *P. monodon* (Ann. Sci. Nat., 3<sup>e</sup> sér. Zool., XVI. Plate XI. Figs. 6-9), the "Albatross" specimens present a more obese appearance; their greatest width is across the cardiac region, while in the figure of *P. monodon* it is near the posterior end of the carapace; the cardiac area, too, in the examples before me, is sunk below the level of the rest of the carapace, and the transverse piliferous lines are more broken at this point, as well as on the gastric region, than appears to be the case in *P. monodon*, to judge from the figure referred to. Unless these discrepancies are due to the inaccuracy of Milne Edwards's draughtsman, the "Albatross" specimens belong to a new species.

Station 3385.	286 fathoms.	16 males, 7 females.
" 3386.	242 "	9 males, 14 females.
" 3396.	259 "	2 males, 2 females.
" 3423.	94 "	18 males, 11 females.

#### *Munida obesa*, sp. nov.

In this species we see an approach to the genus *Pleuroncodes*, as the sides or latero-inferior walls of the carapace are somewhat swollen, so that they show a little when the animal is viewed from above. The basal joint of the antennæ, too, is more exposed from above than it is in the typical species of *Munida*. The lateral rostral spines, or supra-ocular spines, are curved upward more than the median rostral spine, and the three are nearly parallel, the lateral spines reaching about half way to the tip of the median; all three are microscopically spinulose on their upper edge. There are two pairs of spines on the anterior part of the gastric region in line with the lateral rostral spines. Of these two pairs the anterior is the larger. There is also a longitudinal line of spinules in the median line between the two pairs just spoken of. There are, in addition to these, several small spines irregularly arranged on each side of the gastric region. The cardiac area is somewhat sunk below the level of

the surrounding parts; its anterior margin is denticulated, with a larger spine on each side. The lateral margins of the carapace are armed with ten or eleven spines, the one on the antero-lateral angle being the longest. The second abdominal segment is ornamented with a transverse row of eight small spines. The other abdominal segments are normally destitute of spines, but in a few of the many specimens before me there are two or four small spinules on the third segment. The pleuræ of the third, fourth, and sixth abdominal segments are acute, the rest blunt. The eyes are large, and are provided with rather long cilia on the edge of the cornea. The basal joint of the antenna is armed with a long and sharp spine which reaches forward beyond the eyes; the second joint also has a long spine on each side. The chelipeds are long and hairy; the merus, carpus, and basal part of the propodus are spiny, the fingers long, slender, the cutting edges straight and finely spinulose. The ambulatory appendages are setose, the upper and lower edges of the merus are spinulose and there is, moreover, a row of spinules on the outer surface, this external line of spinules being best developed on the proximal end of the segment. The carpus is armed with small spines on the upper margin, and one spine on the distal end of the lower margin; the penultimate and terminal joints are unarmed.

Length, 65 mm.; length of carapace, 34.5 mm.; breadth of carapace between epimeral sutures, 21 mm.; length of rostrum, 11 mm., length of cheliped, 84 mm., merus, 26 mm., carpus, 10 mm., basal portion of chela, 18 mm., dactylus, 21 mm.

Station 3389. 210 fathoms. 2 males, 7 females.

“ 3355. 182 “ 5 young.

### *Munida refulgens*, sp. nov.

In this species the setæ on the ridges of the thorax and abdomen and on the legs are resplendent with iridescent hues. The rostrum is long, triangular in cross section, the upper surface scabrous, the lateral margins armed with two to four spines which are generally placed unsymmetrically on the two sides. The supra-ocular spines are short. There is a transverse line of spinules back of the base of the rostrum, the two which lie on either side of the median line being larger than the others. Seven marginal spines on each side of the carapace, the ones at the antero-lateral angles the largest. There are no spines on the abdominal segments. The abdominal pleuræ are acute. The basal joint of the antenna has a plate-like expansion, but is not spinose; the second joint is furnished with an external spine. Chelipeds very long, squamose, and clothed with silky setæ; the merus has a row of spines on the upper margin, another on the inner side, and a row of smaller ones on the outer side; the carpus is provided with three or four spinules at the distal end; the chela is slender, the outer finger flattened, ribbed above, the outer edge rather convex and expanded toward the base; cutting edges of fingers finely denticu-

lated. The anterior border of the merus and carpus of the ambulatory appendages is spinose. The general color in life is red. In the alcoholic specimens the color is retained in the chelæ and particularly in the rostrum.

Dimensions of largest specimen (male). Length, 91 mm.; length of carapace, including rostrum, 43 mm.; breadth of carapace, 34 mm.; length of cheliped, 211 mm., merus, 90 mm., carpus, 15 mm., basal part of chela, 56 mm., dactylus, 42 mm.

Station 3367.	100 fathoms.	13 males, 18 females (7 ovig.).
" 3378.	112 "	15 males, 19 females (14 ovig.).
" 3379.	52 "	1 young.
" 3427.	80 "	1 young.

In *M. iris* A. M. Edw., the setæ are iridescent, as in this species, but the rostrum lacks the lateral spines and the supra-ocular spines are much longer, reaching beyond the eyes; from *M. irrasa* A. M. Edw., our species differs in the shape of the hand, in the relatively shorter median rostral spine provided with lateral spines, etc.

#### *Munida propinqua*, sp. nov.

The carapace of this species is rather flat; the rostral spines are scabrous, the lateral reaching to a point beyond the eyes; there is a prominent spine on the gastric area behind each lateral rostral spine, another on each side behind and external to these, and a pair of very small ones on the median line at the base of the rostrum; besides these there are about four small spines on the anterior half of the carapace. The anterior lateral angle of the carapace is truncated, the lateral border seven-spined. The pleuræ of the abdomen are rounded, short, and broad; the second abdominal segment is furnished with a transverse row of about eight spines, the rest of the segments being destitute of spines; the terga of the second to the fourth segments are very smooth behind the central transverse fossæ. The first joint of the antenna is armed with a long spine, the second joint with one on each side. There is a minute spine at the antero-inferior angle of the carapace. The chelipeds are robust, setose, and spiny; merus spiny on upper and inner parts; carpus spiny on all sides; The hand is furnished with two rows of spines on the lower side, another along the middle of the outer face, and three irregular series along the upper side; both the fingers are spinulose. Ambulatory limbs setose, spinose along the superior and inferior edges. In small specimens the lateral spines of the rostrum may be shorter than the eyestalks.

Length, 84 mm.; carapace (including the rostrum), 45.5 mm.; breadth, 26 mm.; length of cheliped, 96 mm.

Station 3384.	458 fathoms.	11 males, 6 females (1 ovig.).
" 3394.	511 "	1 male.
" 3404.	385 "	1 male juv.

This species resembles *M. miles* A. M. Edw., but the carapace of *M. propinqua* is flatter, the cardiac area is more distinctly circumscribed by a furrow,

the abdomen bears spines only on the second segment, and the abdominal segments are not so much sculptured.

### **Munida gracilipes, sp. nov.**

Carapace rather flat and quadrangular. Lateral spines of rostrum less than one half the length of the rostrum, shorter than the ocular peduncle. Four spinules on the gastric area arranged in the form of a square, — two behind each lateral rostral spine; a longitudinal row of obsolete spinules in the median line from base of rostrum to the cardiac area; one spine on the cardiac region, a pair on the intestinal region, and one on each side of the cardiac region just back of the cervical suture. The lateral margins of the carapace are armed with about seven spines, the first of which is the largest. The second abdominal segment is armed with a transverse row of six spines, the third with a row of four, the fourth with a row of four and one median spine behind the transverse row. This is the normal arrangement, but in one specimen out of the four there is an additional pair of spines on the second and third segments back of the transverse row. The pleuræ of the third, fourth, and fifth abdominal segments are acute. Eyes very large, reniform. The chelipeds are very long and slender, the merus spinose (the chief of the spines being on the inner side of the joint); the carpus also is spinose. The hand has about eight spines on the upper margin and one on the lower; there are several acute spines on the outer border of the movable finger, the cutting edges of the fingers are straight, finely denticulated or spinulose.

Length, 24 mm.; breadth, 8 mm.; length of cheliped, 34 mm.

Station 3391. 153 fathoms. 4 specimens.

This species is very near to *M. stimpsoni* A. M. Edw., but the carapace is flatter, less granulated, more quadrangular in outline, with more evident transverse rugæ; the lateral rostral horns are shorter, the eye larger, the transverse ridges on the abdominal somites fewer in number; the lateral spines of the carapace and the abdominal spines are better developed, the cardiac area narrower and bounded by more distinct furrows.

### **Munida microphthalma A. M. EDW.?**

Bull. Mus. Comp. Zööl., VIII. 51, 1880.

Station 3370. 134 fathoms. 1 female ovig. Length, 20 mm.

Only one specimen of *M. microphthalma* has been returned to this Museum from Paris. It is a very small specimen, without chelipeds. The "Albatross" specimen differs from this one in having the rostral median spine less upturned. The chela, compared with that of *M. microphthalma*, as figured by Henderson (Rep. Challenger Anomura, Plate III. Fig. 4), has no spine on the outer margin of the dactylus, and the row of spines on the outer face of the hand is obsolete.

*M. microphthalmma* was taken by the "Blake" among the West Indies in 573-1030 fathoms, and by the "Challenger" in the same region in 390 fathoms, north of the Kermadec Islands in 600 fathoms, and near Ascension Island in 425 fathoms.

***Galacantha rostrata* A. M. EDW.**

*Galacantha rostrata* A. M. EDW., Bull. Mus. Comp. Zool., VIII. 52, 1880.

*Galacantha bellis* HEND., Ann. Mag. Nat. Hist., 5th Ser., XVI. 418, 1885; Rep. Challenger Anomura, p. 167, Plate XIX. Fig. 6, 1888.

Station 3362.	1175 fathoms.	1 male.
" 3400.	1322 "	3 males, 2 females (1 ovig.).
" 3413.	1360 "	1 female.

The "Albatross" specimens differ from the typical West Indian form in the greater divergence of the lateral spines, the anterior being more nearly parallel with the axis of the body; the abdomen is smoother toward the central part of the segments; the dorsal spine of the fourth abdominal segment is smaller. There is considerable variation among different individuals, and the characters pointed out by Henderson to distinguish *G. bellis* can hardly be deemed of specific value. The color in life is red, paler and yellowish toward the middle of the carapace. *G. rostrata* has been collected in the West Indian seas in from 1098 to 1591 fathoms, and off Juan Fernandez in 1375 fathoms (*G. bellis* Hend.).

***Galacantha diomedææ*, sp. nov.**

Rostrum without lateral spines; distal part turned upward at an angle of less than 95° in most specimens, but in some cases the inclination is greater; basal part marginate, the margin running for some distance along the anterior edge of the carapace; a slight keel runs back from the rostrum to the median gastric spine. Gastric spine smaller than in *G. rostrata*; anterior lateral spine much longer than the posterior; there is an additional small spine on the side of the carapace, just behind the cervical suture. Anterior half of the carapace ornamented with setiferous squamous tubercles; on the posterior half of the carapace the tubercles assume the form of interrupted transverse ridges. The median spines of the abdomen are small, diminishing successively in size from the first to the third, which is obsolete in some examples. Upper surface of abdomen rather hairy, the pleuræ tuberculose, angles rounded. The legs are rough with granular setose tubercles. There are two prominent spines at the distal end of the carpus of the chelipeds, and one at the distal end of the carpus and merus of the ambulatory limbs. The antennæ are twice and a half as long as the body.

Dimensions of a female specimen. Length of body, 79 mm.; length of carapace, 39 mm.; breadth of carapace, not including the lateral spines, 25 mm.

This species runs into a well marked variety, in which the anterior lateral spines, as well as the median gastric spine, are very much smaller than in the

typical form. This variety may be called *Galacantha diomedæ parvispina*. At one station (3429) both forms were obtained at the same haul.

This species differs from *G. rostrata*, *areolata*, *spinosa*, and *talismanii* in the rugose nature of the sculpture of the hinder half of the carapace. In the relative proportion of the anterior and posterior lateral spines it agrees with *G. spinosa*.

Station 3357.	782 fathoms.	1 female juv.
" 3363.	978 "	3 males, 3 females ovig.
" 3364.	902 "	1 female.
" 3366.	1067 "	3 males, 1 female ovig.
" 3371.	770 "	5 males, 2 females (1 ovig.).
" 3373.	1877 "	1 male.
" 3393.	1020 "	3 males.
" 3407.	885 "	2 males, 1 female.
" 3429.	919 "	1 male.

Var. *parvispina*.

Station 3418.	660 fathoms.	1 male.
" 3419.	772 "	1 female ovig.
" 3424.	676 "	1 male.
" 3429.	919 "	1 male.
" 3435.	859 "	18 males, 17 females (6 ovig.).
" 3436.	905 "	6 males, 4 females (3 ovig.).

In both *G. rostrata* and *G. diomedæ* there is a curious sexual difference. In the male the proximal half of the telson is furnished on each side with long amber-colored setæ, which are entirely wanting in the female. The same difference between the sexes is found in some species of *Munidopsis*.

*G. diomedæ* is often infested with parasites. One of the males from Station 3371 bears a *Peltoaster*, while seven specimens (5 males, 2 females) of var. *parvispina* house a *Bopyrus* in the left branchial chamber.

The eggs of this species measure  $3 \times 2.5$  mm.

### *Munidopsis*<sup>1</sup> *vicina*, sp. nov.

Near *M. ciliata* Wood-Mason, from which it differs as follows. It is a very much smaller species, the adult ovigerous female being only twenty-nine millimeters long; the anterior margin of the propodus of the ambulatory appendages bears two very prominent spines. The telson lacks the pair of long and narrow plates which lie on each side of the small central plate in *M. ciliata*. As in *M. ciliata*, the carapace is covered with squamous tubercles, the rostrum is curved slightly upward, and the chela is short.

Length, 29 mm.; breadth, 9.5 mm.

Station 3360. 1672 fathoms. 1 female.

" 3382. 1793 " 1 female ovig.

<sup>1</sup> The genus *Munidopsis*, as here understood, includes *Galatodes*, *Orophorrhynchus*, and *Elasmonotus* of A. Milne Edwards, and *Anoplnotus* of Smith.

**Munidopsis agassizii, sp. nov.**

The carapace of this species is moderately convex, with a deep transverse depression across the anterior part of the cardiac area. The rostrum is long, slightly upturned, and armed near the middle with a pair of lateral spines. The gastric area has four pairs of spines, the anterior pair the largest. The cardiac area bears two or three pairs of spines. The lateral margins of the carapace carry from six to eight spines each, and there is a longitudinal series of small spines within the margin on the branchial area. A small spine is situated on the anterior margin between the eye and the antenna. The posterior border of the carapace is ornamented with six (in one specimen seven) spines. There are also several spines on the sides of the carapace below the epimeral suture. There is a very small spine over each eye. The antennæ are shorter than the body, the first joint bears a long external spine, the second joint two lateral spines, the third joint two lateral spines and one superior. The chelipeds are long and slender, the merus and carpus have no long spines, the propodus carries four spines on the upper edge and several rudimentary spinules, the fingers are spinulose, their cutting edges straight and denticulated. The ambulatory appendages have spiny meri and carpi, the longest spines being one at the distal superior border of each of these joints. The second, third, and fourth abdominal segments bear four spines each. The abdominal pleuræ are rounded.

Length, 23 mm. ; length of carapace, 12.4 mm. ; breadth of carapace, 8 mm. ; length of rostrum, 4.5 mm.

Station 3389. 210 fathoms. 1 male, 1 female.

This species bears a general resemblance to *M. erinacea* (A. M. Edw.) and *M. spinifera* (A. M. Edw.). It differs from both these in having a flatter carapace marked by a deeper transverse depression across the cardiac area, in having a larger number of spines on the sides of the carapace, and in the presence of spines on the pterygostomial regions and a small but distinct spine over the eye. It also has strong spines on the superior edge of the hand which are wanting in *M. erinacea* and *M. spinifera*. In the possession of three pairs of gastric spines it agrees with *M. spinifera*, but differs from *M. erinacea*.

**Munidopsis villosa, sp. nov.**

The whole surface of the body and limbs is beset with setæ, which arise from low squamous tubercles and transverse rugæ on the carapace, and from the transverse ridges of the abdominal segments. The rostrum is triangular, the distal half upturned, cylindrical, and pointed, the proximal half naked below and slightly carinated in the median line. A pair of short, stout, blunt spines on the gastric region. One spine at antero-lateral angle of the carapace, one on margin of the hepatic area, and a rudimentary one on the side of the

branchial region. There is a medium spine on the second, third, and fifth abdominal segments, and a rudiment of one on the fourth. The abdominal pleuræ have rounded external angles. The eyes are freely movable and destitute of spines. The second antennal segment is armed with a prominent external spine. The chelipeds are robust, setose, and granulate; the merus has a short superior spine and two lateral spines at the distal end; the carpus is similarly equipped, though on one side the superior spine is obsolescent; the chela is broad and strong, the fingers excavated, denticulated on their cutting edges and at their tips. The merus of the first pair of ambulatory appendages has an external distal spine; the carpus of all the ambulatory limbs has two longitudinal ridges, and that of the first and second pair has a spine on the upper border at the distal end of the joint.

Length, 55 mm.; breadth, 18 mm.; length of carapace, 31 mm.; rostrum, 8 mm.

Station, 3394. 511 fathoms. 1 male.

### *Munidopsis hystrix*, sp. nov.

Carapace setose and thickly covered with small spiny tubercles; three spines of special prominence on the gastric area disposed in the form of a triangle with apex directed backward; one on the cardiac area; two (rarely six) on the hind margin of the carapace; one on each branchial area. There is a spine at the external angle of the orbit, and the lateral margin of the carapace is spinose. The rostrum is long, lightly curved upward from the base to the tip, and armed with from two to five spines on each side; these spines are unsymmetrically arranged on the two sides. The second, third, and fourth abdominal segments are conspicuously two-ridged; the second segment has a pair of small spines on the anterior ridge, and another pair nearer the median line on the posterior ridge; the third segment also has a pair of spines on the anterior ridge, and in some specimens a third spine in the median line on the posterior ridge. The abdominal pleuræ are truncate. The chelipeds are long, very spiny from the proximal end of the merus to the base of the fingers; the chief spines of the propodus are on the upper margin of the segment; there are two spines near the base of the dactylus. The ambulatory appendages are long, setose, and spinose except the dactylus joint. A spine over the eye. Antennæ shorter than the body; a spine on the outer side of the first segment, one on each side of the second and third segments, and one on the upper side of the third segment.

Length of ovigerous female, 47 mm.; length of carapace, 25 mm.; breadth, 15 mm.; rostrum, 8 mm.

Station 3417. 493 fathoms. 1 male, 2 females ovig.

“ 3424. 676 “ 4 females (2 ovig.).

“ 3425. 680 “ 7 males, 5 females (2 ovig.).



**Munidopsis sericea, sp. nov.**

The whole surface of the body and limbs is covered with a silky pubescence. The rostrum is long, curved gently upward, convex above, but not carinated, armed with a prominent spine on each side near the middle, and with three more minute spinules near the base. Gastric region swollen, armed with two conical spines and ten or twelve small spinuloid tubercles. The cardiac region has a prominent transverse ridge near the centre, in front of which is a deep depression separating it from the gastric region; the ridge is armed with a pair of short spinules. There is a small spine on the anterior border between the eye and the antenna, a large one at the antero-external angle, three on the border of each hepatic region (the middle of one of these is the largest), and one small one on the border of each branchial region just behind the cervical suture; there are besides about ten sharp tubercles on each branchial area, and five or six pairs of spinules on the posterior margin of the carapace. Pterygostomian regions granulated. There is a pair of spines on the second, third, and fourth abdominal segments; besides these there are several small spinules on the terga and pleuræ of these segments; the pleuræ are rather narrow, with rounded lateral angles. The chelipeds are wanting in the unique specimen. The ambulatory appendages are spinulose, the spinules of the dactyli restricted to the hind margin. The eye is provided with a very minute spine. The antennæ are rather longer than the body, the basal joint has a short external spine, a longer one at the lower internal angle, and a small one at a higher level on the inner side. The latter spine shows, when the animal is viewed from above, between the eyestalk and the antenna. The subsequent segments of the antenna are armed as usual in this genus.

Length, 39 mm.; length of carapace, 12 mm.; length of rostrum, 8 mm.; breadth of carapace, 12 mm.

Station 3394. 511 fathoms. 1 male.

**Munidopsis margarita, sp. nov.**

In this species the rostrum has a gentle upward curve near the tip; it is carinate above, and minutely spinulose on the margins. The surface of the carapace is rough with squamous tubercles and forward-pointed spines. The gastric and cardiac regions are prominent, and separated from one another by a deep depression; a pair of spines on the gastric, and one spine on the cardiac region, attain a special prominence. A long sharp spine outside the eye forms the outer wall of a well marked orbit. There are eight spines on each lateral margin, six on the posterior (including those at the postero-lateral angles). The branchial areas are iridescent. Second abdominal segment: the anterior transverse ridge, which is broken down in the centre, bears on each side a prominent hooked spine, which is enlarged at the base and denticulated on the outer margin; the posterior ridge is furnished with three hooked spines; the

pleuræ of this segment bear each a broad, flattened, forward-pointing tooth with denticulated edges; when the animal is viewed from above, this tooth appears to form the lateral extremity of the pleura, which really lies below it, and is rounded. Third abdominal segment: both ridges are spiny and denticulate, three spines being specially prominent on each ridge. Fourth abdominal segment: armed with but one small median spinule. The sides of the carapace below the epimeral sutures are covered with spiny tubercles, and display an iridescent lustre. The eye has two spines projecting over the cornea from the inner side; the posterior of these spines is very minute. The antennæ are very slender and about as long as the carapace; the first and second joints are provided with a prominent external spine, the third joint with three spines, viz. one external, one internal, and one superior. The chelipeds are absent in both the specimens. The ambulatory appendages are spinulose on all the segments except the dactyli, which are finely serrate on the hind margin. The legs, and more especially the sternum, are iridescent, like mother of pearl. This iridescence is seen in a less degree in several other species of this genus.

Length, 20 mm.; length of carapace, 11 mm.; breadth, 7 mm.; length of rostrum, 3.5 mm.

Station 3404. 385 fathoms. 1 male, 1 female.

#### *Munidopsis crinita*, sp. nov.

The whole surface is clothed with long setæ, which are longest and densest on the chelipeds and ambulatory appendages. The rostrum is very broad at the base and ends in three points, the middle of which is the longest; the rostrum is slightly carinate in the median line. The carapace is roughened by low setiferous ridges. The antero-lateral angles are obliquely truncate; a spine over the antennæ, and four on the lateral margin, the last one just behind the cervical suture, the third one obsolescent; hind margin unarmed. A pair of spines on the gastric region, behind the base of the rostrum. The abdomen is devoid of spines, and there is no spine over the eye. The antennæ are slender, shorter than the body; the basal joint is provided with a long spine on the external side, and another on the internal side; the second joint has an external spine, the third an internal one. Chelipeds: merus five-spined; carpus with one prominent spine; hand unarmed, broadest at base of fingers, cutting edges of fingers toothed. Ambulatory limbs setose, hind border of dactyli spinulose.

Length, 19.5 mm.; carapace, 11.5 mm.; rostrum, 2.6 mm.; breadth of carapace, 7.5 mm.

Station 3384. 458 fathoms. 1 female.

This species resembles *M. rosacea* (A. M. Edw.), *M. latifrons* (A. M. Edw.), and *M. tridens* (A. M. Edw.). From the first (*Comptes Rendus*, XCIII. 934, figured in *Recueil de Figures de Crustacés nouv. ou peu connus*, 1<sup>re</sup> livr.) it differs in having a much shorter rostrum, in the presence of a pair of spines on the gastric region, in the different shape of the hand, the absence of prominent

spines on the meri of the ambulatory legs, and its greater pilosity. From the second (judging from Milne Edwards's short description of that species) it is distinguished by the long setæ, gastric spines, and broader carapace. From the last it differs in being very hairy, etc. *M. rosacea* comes from the north coast of Spain, *M. latifrons* from the Barbadoes, *M. tridens* from St. Kitts.

#### ***Munidopsis ornata*, sp. nov.**

Carapace convex, the whole upper surface, including the rostrum, thickly covered with low squamous tubercles; seen under a magnifying power the surface of each tubercle is seen to be made up of a number of secondary scale-like prominences; the tubercles are not lengthened out transversely to form ridges on any part of the surface; two of the tubercles on the gastric region take on a spiny character. The rostrum is nearly horizontal, triangular in cross-section, the margins serrate; the anterior border of the carapace is convex between the eyes and the antennæ, but has no spine at this point; lateral border four-toothed, one of the teeth lying at the antero-lateral angle, two on the hepatic region, and one on the edge of the branchial region behind the cervical suture; the posterior border is delicately festooned, but not armed with spines. The abdomen is spineless, its surface punctate, anterior half of the pleuræ of the second segment tuberculate, all the pleuræ rounded. The eye has a transverse granulated tubercle running over the cornea from the inner side. The antennæ are very slender, and do not exceed the carapace in length. The chelipeds are moderately robust; the merus tuberculate and armed with a row of short spines along the upper edge; the carpus spino-tuberculate, with two longitudinal furrows on the outer side; the hand almost smooth on the inner side, outer side and superior surface roughened with low tubercles; fingers a little curved upward, spoon-shaped at the denticulate and setose tips. Ambulatory appendages: meri flattened, tuberculate, upper edge produced to a spinose carina; the carpi have three denticulate ridges; propodi scabrous, with an irregular row of spines on under side; the dactyli have black tips, and are finely spinulose on their posterior edges.

Length, 23 mm.; length of carapace, 12 mm.; breadth, 8 mm.; length of rostrum, 3 mm.

Station 3404. 385 fathoms. 1 male.

#### ***Munidopsis scabra*, sp. nov.**

The rostrum is triangular, slightly curved upward, carinated above, the lateral edges and the carina lightly denticulated. The carapace is covered with squamous setiferous tubercles which end in spiny points. There is a transverse row of six more prominent spiny tubercles on the gastric region. The posterior border of the carapace is ornamented with a denticulated rim (about eight denticles). There is a spine between the eye and the antenna

below the anterior margin of the carapace. The abdomen is devoid of spines, the pleuræ have truncated lateral angles. A spine projects over the cornea of the eye. The antennæ are shorter than the body; a spine on the outer side of the basal joint, one on each side of the second joint, and one on each side and one on superior margin of third joint. The chelipeds are long, spinose, except the fingers; hand long, the basal part longer than the fingers. All the joints of the ambulatory appendages are spiny except the dactyli.

Length (ovigerous female), 40 mm.; length of carapace, 13.5 mm.; breadth, 14 mm.; rostrum, 5 mm.

Station 3424. 676 fathoms. 2 males, 1 female ovig.

“ 3425. 680 “ 1 male, 1 female ovig.

### *Munidopsis tanneri*, sp. nov.

Carapace flat, quadrangular, covered with squamous setiferous tubercles which have a tendency to develop spiny points on the gastric region. This is especially true of a transverse row of six on the anterior part of that region. The rostrum is triangular and horizontal. There is a prominent spine on each side of the anterior margin of the carapace between the eye and the antenna, another at the antero-lateral angle, and two or three on the side of the hepatic area; the hind border of the carapace is denticulated. A small spine over the eye. Antennæ shorter than the body; one spine on the outer side of the first joint, two lateral and one superior on the second and third joints. Cheliped (present in only one specimen) long, slender; merus and carpus many-spined; propodus spiny along the upper and lower margins; tips of fingers enlarged and denticulated. Ambulatory limbs: a prominent row of spines on the upper edge of the merus and carpus, propodus and dactylus devoid of spines. Abdomen without spines; pleuræ narrow, angles rounded.

Length, 41 mm.; length of carapace, 23.5 mm.; breadth, 15.5 mm.; rostrum, 6 mm.

Station 3396. 259 fathoms. 2 males, 1 female (1 male with *Bopyrus*).

“ 3397. 85 “ 1 male.

This species is nearly related to *M. scabrosa*, but differs from the latter species in having the carapace broader and flatter, with squamous tubercles which are not produced into points except a few on the gastric area. The spine between the eye and the antenna is longer; the propodi of the ambulatory legs are smoother, with no well-developed spines.

### *Munidopsis hamata*, sp. nov.

Body and limbs clothed with short, scattered setæ. Rostrum long, curved slightly upward, basal half furrowed longitudinally, with a row of short spines on each side of the furrow; infero-lateral edges of rostrum also furnished with small spines. Carapace quadrangular, anterior border forming a right angle with lateral border, both borders spinulose; lateral border with an indentation

at anterior boundary of hepatic area; a deep depression back of each hepatic area and another across the anterior part of the cardiac region; the upper surface of the carapace is adorned with spinulose tubercles, and a median longitudinal row of more prominent spines runs along the gastric and cardiac regions; the anterior spine of the cardiac region overhangs the transverse depression, the posterior spine of the row springs from the hinder rim of the carapace. There is a median hooked spine on the tergum of the second, third, fourth, and fifth abdominal segments and many spiny tubercles irregularly disposed on these segments; the pleuræ of the third to the sixth abdominal segments are narrow but blunt, those of the second to the fifth are costate. The ocular peduncle is movable and devoid of a spine. The antennæ are about as long as the body; the basal joint has an inferior and a small external spine; the second joint also bears an external spine. The chelipeds are long and slender; all the joints from the ischium to the propodus are equipped with longitudinal rows of small spines; the chela is not broader than the basal part of the propodus, the fingers are straight, their prehensile edges denticulate. The ambulatory appendages are spinulose.

Length of male, 49 mm.; length of carapace, 25 mm.; breadth of carapace, 14 mm.; length of rostrum, 9 mm.; length of cheliped, 47.5 mm.; merus, 15 mm.; carpus, 5.5 mm.; chela, 19 mm.

Station 3394. 511 fathoms. 13 males, 16 females ovig.

“ 3395. 730 “ 3 males.

### *Munidopsis aspera* (HEND.).

*Elasmonotus asper* Hend., Ann. Mag. Nat. Hist., 5th ser., XVI. 416, 1885; Rep. Challenger Anomura, p. 163, Plate XIX. Fig. 4, 1888.

Station 3357. 782 fathoms. 1 female ovig.

“ 3358. 555 “ 1 male.

“ 3370. 134 “ 1 female.

“ 3402. 421 “ 2 males, 5 females (3 ovig.).

“ 3403. 384 “ 1 male.

“ 3406. 551 “ 2 males.

This species is subject to considerable variation. In the specimens from Stations 3402, 3403, and 3406 the tubercles of the carapace are more numerous and less spiny than in those secured at the other stations. The ambulatory appendages of all the “Albatross” examples are apparently more spiny than in the types from the “Challenger.” The latter came from the Straits of Magellan, 245 fathoms.

### *Munidopsis quadrata*, sp. nov.

Carapace quadrangular, the anterior and lateral margins forming a right angle; upper surface flat, spineless, but furnished with low squamiform tubercles.

Rostrum curved upward, broad at base, narrowing anteriorly to form a long, sharp acumen. Central part of gastric region prominent above the hepatic region, from which it is separated by a deep pit. A prominent transverse ridge on cardiac region, forming the posterior wall of a deep fossa. Antero-lateral angles rounded. Second segment of abdomen armed with a median spine which is curved forward; third and fourth segments with a very prominent ridge which bears an acute median tooth; pleuræ of second segment faintly tuberculate, the others narrow with the external angles rounded but not truncate. Eye spineless, almost concealed by the base of the rostrum. Antennæ about as long as the carapace; a conspicuous spine on the upper side of the third segment. Cheliped long, tuberculate with the exception of the fingers; chela slender, fingers not gaping. Ambulatory legs tuberculate with the exception of the dactyli, which are furnished with small teeth on the posterior margin.

Length of body, 29 mm.; length of carapace, 15.5 mm.; breadth of carapace, 9 mm.; length of rostrum, 6 mm.; length of cheliped, 30 mm.

There is some variation in the length and upward curvature of the rostrum among the different specimens. A female, from station 3424, differs markedly from the males in having the tubercles on the carapace and appendages much more strongly developed.

Station 3424. 676 fathoms. 2 males, 1 female ovig.

“ 3425. 680 “ 1 male.

#### **Munidopsis depressa, sp. nov.**

Closely allied to *M. hamata*, but differs as follows. The cephalothorax is more swollen, so that the sides of the carapace are visible below the epimeral sutures when the animal is viewed from above. The median row of spines on the carapace consists of a smaller number of spines (two on the gastric region, one on the cardiac region, and one on the posterior margin). The spinules of the lateral margin of the carapace are less developed. The depression on the carapace involves the gastric region to a greater degree. The anterior margin of the carapace is not so straight, and it is not spinuliferous. The antero-lateral spine is more prominent, the eyes smaller, and the antennæ shorter (shorter than the carapace). There is, moreover, no spine on the fifth abdominal segment.

Length, 32 mm.; carapace, 19 mm.; rostrum, 5 mm.; breadth of carapace, 12.5 mm.

Station 3425. 680 fathoms. 1 male.

#### **Munidopsis carinipes, sp. nov.**

Carapace quadrangular, flat, marked by a median tuberculated ridge on the gastric and cardiac regions; sides converging a little from front backward; the antero-lateral angles form a rounded shoulder. Rostrum broad at base, nearly horizontal, sides converging near tip, which is blunt; upper surface nearly

flat, lightly granulated. The rest of the upper surface of the carapace has a coarser granulation. There is a conspicuous hooked tooth on the third and the fourth abdominal segment, and in some specimens there is a rudimentary one on the second and the fifth segment; the teeth on the third and fourth segments have denticulated margins in adult specimens; abdominal pleuræ long and narrow. Chelipeds very long, lightly tuberculate; chela long, slender, fingers rather short, smooth, with straight denticulated prehensile margins. The meri of the ambulatory legs granulated, superior border produced to a keel, the edge of which is entire; the lower margin of the meri is also entire; the carpi have three tuberculated ridges, one superior, two external; the propodi are lightly tuberculated; dactyli smooth, their hind margin armed with about five teeth. Eye spineless, nearly hidden under the rostrum. Antennæ shorter than the carapace, first, third, and fourth joints armed with an external spine.

Length, 30 mm.; carapace, 16 mm.; breadth, 9.5 mm.; rostrum, 5 mm.; cheliped, 40 mm.; merus, 13 mm.; carpus, 4.5 mm.; propodus, 17 mm.; dactylus, 7 mm.

Station 3353. 695 fathoms. 2 males, 1 female ovig.

Near *M. longimana* (*Elasmonotus longimanus* A. M. Edw.), from which it differs in having the rostrum more nearly plane, the merus of the cheliped much less strongly tuberculated, the meri of the ambulatory limbs more strongly carinated, with lower margin entire instead of denticulate; the spine on antennal peduncle is more prominent, while the tooth on the second segment of the abdomen is absent or at best rudimentary.

Two specimens (male) of *Elasmonotus longimanus* A. M. Edw., and one (female) *E. brevimanus* A. M. Edw., have been returned to Cambridge from Paris. I suspect that these may prove to be the male and female of one species. The chelipeds of the female specimen of *M. cristatipes* are lost.

### **Munidopsis hendersoniana, sp. nov.**

In this species, as in *M. armata* (*Elasmonotus armatus* A. M. Edw.) and *M. marginata* (*Elasmonotus marginatus* Hend.), the lateral margins of the carapace are extended as sharp crests overhanging the sides of the body. The upper surface of the carapace is rather flat, and is clothed with a close short pubescence; the sides are nearly parallel. The rostrum is long, acute, nearly horizontal, the upper surface roof-shaped. There is an acute tooth on the anterior margin of the carapace external to the eyestalk and another at the antero-lateral angle; otherwise the carapace is unarmed. The eyestalks are immovable and prolonged into a long horn one half as long as the rostrum; seen from above, the eyestalks appear like lateral spines of the rostrum. The eye is rudimentary, occupying the basal part of the lower side of the peduncle. The antennæ are shorter than the body, the basal joint armed with a well developed inferior spine. The chelipeds are short robust and tomen-

tose; there is a spine at the distal superior angle of the ischium and another near the distal end of the lower internal edge; five spines along the superior margin of the merus and two inferior distal spines; the carpus bears a superior proximal tooth together with three teeth on the distal margin; the chela is short and stout, the hand without teeth or spines; the fingers are very thick and short, meeting one another only at their spoon-shaped denticulated tips; there is a rounded tubercle at the base of the inner margin of the immovable finger; the outer margin of this finger is denticulated. Ambulatory limbs: five to seven spines on the superior and external inferior margins of the meri (those on the superior margin the largest); upper edge of carpus three- to four-spined; propodi and dactyli unarmed. Abdomen without spines.

Length, 37 mm.; carapace, 20 mm.; rostrum, 6.5 mm.; breadth of carapace, 12 mm.; length of cheliped, 28 mm.

Station 3393. 1020 fathoms. 3 males, 1 female (with *Peltogaster*).

Nearly related to *M. edwardsii* (*Elasmonotus edwardsii* Wood-Mason, Ann. Mag. Nat. Hist., 6th series, VII. 201, 1891) of the Bay of Bengal, but easily distinguished from that species by the lateral margins of the carapace, which in Wood-Mason's species are divided into two lobes, but in *M. hendersoniana* are entire.

#### ***Munidopsis inermis*, sp. nov.**

In this species the whole surface of the body and appendages is naked and free from spines and tubercles. The carapace is rather flat above, with subparallel sides; the gastric region is protuberant and separated from the hepatic and cardiac areas by conspicuous furrows. The surface of the carapace is punctate and lightly granulate and rugose on the branchial regions. The rostrum is triangular, blunt at the apex, bent strongly downward, and slightly carinate above. The antero-lateral angle is rounded, and a rounded lobe projects from the anterior margin above the base of the antenna. The abdomen is smooth, naked, devoid of spines and ridges; the abdominal pleuræ are rounded. Ocular peduncle free, spineless. The peduncle of the antenna is also destitute of spines; the flagellum is wanting in the only specimen obtained. The chelipeds are also missing. The ambulatory appendages are smooth, unarmed; the dactyli long (equal to the propodi in length), slightly curved, acute at the tips. The appendages of the third, fourth, and fifth abdominal segments are simple and rudimentary. The merus of the third maxilliped is short, its antero-internal margin three-toothed; the palpus of this appendage is nearly as long as the merus and ischium combined.

Length, 12 mm.; carapace, 6 mm.; breadth, 4 mm.

Station 3354. 322 fathoms. 1 male.

This species nearly resembles *M. polita* (*Anoplomotus politus* Smith), but the carapace of the former is longer and narrower, the rostrum is curved more strongly downward, and the propodi of the ambulatory limbs are much shorter in proportion to the dactyli.



***Uroptychus nitidus occidentalis*, subsp. nov.**

Differs from the typical *Uroptychus nitidus* (A. M. Edw.)<sup>1</sup> as follows: the branchial regions are more swollen, giving to the posterior half of the carapace a more convex lateral outline; the rostrum is shorter, the chelipeds shorter and more robust, the fingers shorter in proportion to the length of the basal part of the propodus; the branchial regions are more distinctly margined. It approaches in some respects *U. uncifer* (A. M. Edw.), in which the rostrum and chelipeds are still shorter. In some specimens of *occidentalis* there are a few low tubercles on the inner side of the proximal end of the merus and ischium of the chelipeds, — a condition similar to that in *U. australis* Hend. which may be considered a variety of *U. nitidus*. *U. politus* Hend., another closely related form, is distinguished by its short antennal acicle.

Length of body of a female, 29 mm. ; length of carapace, 15 mm. ; length of rostrum, 4 mm. ; breadth of carapace between antero-lateral spines, 5 mm. ; breadth across the branchial region, 10 mm. ; length of cheliped, 44.5 mm. ; merus, 11 mm. ; carpus, 12.5 mm. ; chela, 17.5 mm. ; dactylus, 6 mm.

Station 3384. 458 fathoms. 2 males, 2 females ovig.

***Uroptychus pubescens*, sp. nov.**

Carapace, without including rostrum, broader than long, pubescent; a transverse row of spines across the gastric region from one side of the carapace to the other; lateral border of carapace spinulose; the anterior margin has a deep concavity above the eye, outer angle of the concavity armed with a spine. Rostrum one half as long as the rest of the carapace, bent downward a little, acute, with entire setiferous margins. Eye small, not broader than the eye-stalk, with brown pigment. Abdomen naked, smooth, pleuræ subacute. Antennæ equal in length to the carapace with the rostrum; acicle shorter than the peduncle. Chelipeds long, all the joints as far as the fingers spinulose, the spinules with broad bases; propodus not broader than the carpus; carpus equal in length to the basal portion of the propodus; fingers straight, a slight tooth near the base of the dactylus; the tips of the fingers cross. Meri of ambulatory legs minutely spinulose on the superior margin, distal end of propodus spiniform on the hind margin, whole hind margin of dactylus armed with spines; all the joints of the ambulatory limbs are furnished with long setæ.

Length (female), 44 mm. ; breadth, 17.5 mm. ; length of carapace, 21 mm. ; length of rostrum, 7.5 mm. ; length of cheliped, 57 mm. ; merus, 12 mm. ; carpus, 15 mm. ; chela, 24 mm. ; dactylus, 9.3 mm.

Station 3354. 322 fathoms. 2 females ovig.

“ 3355. 182 “ 1 female ovig.

This species is more nearly related to *U. insignis* Hend. than to any other described species.

<sup>1</sup> Bull. Mus. Comp. Zool., VIII. 62, 1880.

**Uroptychus bellus, sp. nov.**

Carapace broad, branchial regions inflated, upper surface naked, smooth, and polished; the branchio-cardiac lines meet in the median line of the carapace; the anterior margin has a concavity above the eye, forming an orbit with a spinule at its external angle. There is one spine at the antero-lateral angle, one on the margin of the hepatic area, and eight on the margin of the branchial region; the branchial spines decrease in size posteriorly. The rostrum is long, tapering, acute at the apex, and concave at the base above. The abdomen is smooth, the pleuræ subacute. The eyestalks are short and stout, the eye not wider than the peduncle, black. The antennæ are very slender, shorter than the carapace, the acicle considerably shorter than the peduncle. Chelipeds very long, naked except for a few setæ on the fingers, polished; the ischium bears a spine on the superior margin and several others on the lower side; the merus and carpus are armed with spines arranged in longitudinal rows; there is a row of spines on the upper margin of the propodus (the row is double at the proximal end), another series on the outer face reaching from the proximal end about half-way to the distal end, and another still shorter row of more rudimentary spines just outside the latter series; the fingers are separated by a gap; their prehensile edges are denticulate, with one or more prominent teeth near the base of the dactylus. Ambulatory appendages: meri and carpi of the first and second pairs spinulose along the upper edge, these joints being spineless on the third pair. All of the ambulatory appendages are subchelate, the distal end of the propodus being enlarged and furnished with spines against which the spined dactylus closes.

Length (male), 17 mm.; carapace, 10.5 mm.; rostrum, 4.5 mm.; breadth of carapace, 7.7 mm.; cheliped, 31 mm.; merus, 7 mm.; carpus, 9 mm.; chela, 14 mm.; dactylus, 5 mm.

Station 3354. 322 fathoms. 1 female ovig.

“ 3355. 182 “ 1 male.

**Family AXIIDÆ.*****Axius crista-galli*, sp. nov.**

Near *Axius acutifrons* (*Eiconaxius acutifrons* Bate), but differs in the following regards. The margin of the rostrum is armed with prominent teeth. The median carina of the rostrum, entire or at most but slightly serrate in the former species, is here cut into about seven prominent teeth. The larger claw differs from the corresponding organ in *A. acutifrons* in lacking the serration on the superior margin of the propodus, in the presence of a strong tubercle on the anterior border of the hand between the bases of the fingers, and in the absence of prominent teeth on the prehensile edges of the fingers.

Length, 24.5 mm.; length of carapace, 10 mm.

Station 3359. 465 fathoms. 3 males, 1 female.

The female carries eighteen eggs of large size ( $2 \times 1.5$  mm.).

**Family CALOCARIDÆ.****CALASTACUS, gen. nov.**

Abdomen long, enlarged in the middle, narrowed at each extremity, pleuræ broad and rounded. Cephalothorax laterally compressed, rostrum long, acute; eyes rudimentary, subglobose, unpigmented, unafaceted. Second antenna on a horizontal line with the first antenna; the second segment armed with a long external spine (stylocerite) and a still longer articulated style-shaped scale (scaphocerite). Third maxilliped pediform. First and second pairs of legs chelate. First abdominal appendages of male modified to serve as sexual organs (gonopods). Outer branch of swimmerets divided near the posterior margin by a diagonal suture. Telson long, quadrangular. Gills composed of a central stem which bears two rows of filaments. Branchial formula:

Somite	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	
Epipods . . . .	1	1	1	1	1	1	0	= 6
Podobranchiæ . .	0	1	1	1	1	0	0	= 4
Arthrobranchiæ .	0	2	2	2	2	2	0	= 10
Pleurobranchiæ .	0	0	0	0	0	0	0	= 0

Differs from *Calocaris* in having a long styloid scaphocerite appended to the peduncle of the external antennæ.

**Calastacus stilirostris, sp. nov.**

Carapace naked, punctate; apex of rostrum turned a little upward; two strong spines turned upward and forward at base of rostrum; a light median carina runs along the back from the base of the rostrum, fading out before reaching the hind border of the carapace. Chelipeds long, symmetrical on the two sides; coxa furnished with a small spine on the anterior border of the distal end; ischium armed with from one to four spines on the lower margin; merus laterally compressed, armed with a spine on the upper edge near the distal end and a variable number (four to eight) of spines on the lower edge. Carpus triangular, unarmed. Chela: upper and lower margins sharp, the upper armed with five to seven spines, inner and outer faces with a few scattered spinules; fingers with denticulate prehensile edges and curved crossed extremities. Second pair of legs furnished with small chelæ.

Length of carapace, 22.2 mm.; rostrum, 5.5 mm.; abdomen, 30 mm.; cheliped, 39 mm.; chela, 17 mm.

Station 3418. 660 fathoms. 9 males.

**Family ASTACIDÆ.*****Nephropsis occidentalis*, sp. nov.**

Pubescent. Carapace cylindrical, the branchial regions convex. Rostrum densely ciliated on the margins, armed with a pair of lateral teeth near the middle; a double row of prominent granulations on the dorsal surface, diverging posteriorly and continued backward for some distance on the gastric region. A small, blunt papilla in the median line of the gastric area, a pair of acute teeth near the anterior margin at the base of the rostrum, and another pair just above the insertion of the second pair of antennæ; a small papilla in the median line on the intestinal region. Abdominal pleuræ rather longer-pointed than in *N. stewarti*, but not so much so as in *N. agassizii* and *N. atlantica*; their anterior borders are finely denticulated, but are destitute of spinous processes. Telson armed with a sharp spine in the median dorsal line, near the proximal end.

Length, 119 mm.; carapace, 51 mm.; rostrum, 14 mm.; second antenna, 225 mm.

Station 3418. 660 fathoms. 23 males, 32 females.

“ 3424. 676 “ 2 males.

**Family ERYONTIDÆ.*****Willemoesia inornata*, sp. nov.**

Similar to *W. leptodactyla*, but readily distinguished from it by the small number of spines on the margin and dorsal ridges of the carapace. The armature may be formulated thus:—

Marginal . . . . . 5 to 8 — 2 to 3 — 0 to 6

Median ridge . . . . . 1 to 5 — 0

The marginal spines which lie behind the cervical groove, if found at all, are but rudimentary, while there are no spines on the submarginal carina or along the lateral boundaries of the cardiac area, where they are present in *W. leptodactyla*. The third maxilliped bears only a slender epipod; the membrane that connects this limb with the body carries a small, but perfectly formed gill (arthrobranchia). According to Spence Bate, this gill is absent in *W. leptodactyla*.

Station 3374. 1823 fathoms. 8 males, 6 females.

“ 3381. 1772 “ 1 male, 1 female ovig.

“ 3382. 1793 “ 2 males, 4 females (1 ovig.).

“ 3399. 1740 “ 2 males, 1 female.

“ 3400. 1322 “ 1 female.

***Polycheles*<sup>1</sup> *tanneri*, sp. nov.**

Orbital sinus rounded at the bottom, outer margin spinulose. Median carina of carapace furnished with two anterior rostral spines, followed by five (or six) spines in front of the cervical groove, the fourth (or fifth) of which is double. The arrangement of these spines may be thus formulated: 2. 1. 1. 1. 1. 2. 1 (or, 2. 1. 1. 1. 2. 1). Back of the cervical groove the spines of the median carina are 2. 2. 2. Marginal spines of carapace arranged as follows: 5—3—13 (or 14). A longitudinal row of four small spinules on the anterior division of the carapace midway between the median and marginal rows, and a row of twelve or fifteen on the branchial regions inside the margin of the carapace. There are, besides, two or three spines on each side of the hind margin of the carapace, and a few along the cervical groove.

Resembles *P. nanus* (Smith), but differs in the number of spines on the median and sublateral carinæ of the carapace, in the existence of a spine on the antero-external angle of the first and second abdominal pleuræ, and in the greater number of spines on the merus, carpus, and propodus of the chelipeds. *P. nanus*, moreover, is described as having the posterior pair of thoracic appendages chelate in the male, while in the males of *P. tanneri* that I have examined these appendages are simple. Compared with the types of *P. agassizii* (A. M. Edw.), the carapace of the present species is broader and fewer-spined on the margins; the first and second abdominal pleuræ are armed with an anterior lateral spine; the rostral spine is double; and the orbital sinus is broad and rounded at the bottom. *P. agassizii*, like *P. tanneri*, has non-chelate posterior legs in the male.

Station 3354.	322 fathoms.	1 male.
" 3402.	421 "	2 males, 1 female.
" 3403.	384 "	12 males, 14 females.
" 3409.	327 "	1 female.

***Polycheles sculptus pacificus*, subsp. nov.**

Differs from the Atlantic *P. sculptus* Smith as follows. The carapace is broader in proportion to the breadth of the abdomen, the lateral margins converging strongly at the posterior end, where, in *P. sculptus*, they continue nearly parallel to one another; there is a small spine on each branchial region inside of and on a level with the second spine of the submarginal carina, which spine is entirely wanting in *P. sculptus*; the spine on the anterior border of the ophthalmic lobe is larger and blunter; the pleuræ of the second abdominal somite have a different shape, their anterior margins being in line with the anterior margin of the tergum, whereas in *P. sculptus* they form a strong obtuse angle with that margin.

<sup>1</sup> The genus *Polycheles*, as here defined, comprehends *Polycheles*, *Pentacheles*, and *Stereomastis* of Bate.

These differences, although slight, are constant, and should be recognized in our nomenclature, if any significance is attached to geographical variation.

The last thoracic appendages are chelate in the adult female, while they are but imperfectly so in breeding males; that is, in the male the "thumb" is very much shorter than the index.

Station 3353.	695 fathoms.	1 male.
" 3392.	1270 "	1 female.
" 3393.	1020 "	3 males, 3 females.
" 3394.	511 "	12 males, 20 females.
" 3418.	660 "	1 male, 1 female.
" 3419.	772 "	1 female.
" 3424.	676 "	1 female ovig.

### *Polycheles granulatus*, sp. nov.

Carapace long oval, broadest across the anterior branchial region; dorsal surface granulated, but nearly devoid of spines; there are two small rostral spines, and back of these, on the low granulated median carina, lies another pair followed by one or two spinules on the gastric area. The submarginal ridge is incurved and composed of minute spinulose granules. Orbital notch narrow, armed with a spine at its internal angle and with another at its external angle. Marginal spines thus disposed: 9 (or 10) — 3 — 15. The anterior abdominal pleuræ are rounded, gradually becoming acute as one passes backward to the sixth. The posterior thoracic legs in the sole specimen seen (a female) end in a small but perfect chela.

Length, 99.5 mm.; length of carapace, 45 mm.; greatest width of carapace 37 mm.; length of cheliped, 118 mm.; ischium, 19 mm.; merus, 33 mm.; carpus, 22 mm.; basal part of propodus, 14.5 mm.; dactylus, 22 mm.

Station 3380. 899 fathoms. 1 female.

### *Eryonicus cæcus* BATE?

Station 3375.	1201 fathoms.	1 male, 62.5 mm. long.
" 3377.	764 "	1 female, 40 mm. long.
" 3383.	1832 "	1 juv., 37 mm. long.
" 3388.	Surface to 400 fathoms, submarine tow-net.	4 juv., 19-29 mm. long.

Bate's description of *E. cæcus* was drawn up from a single immature specimen, 13 mm. long, in which the first abdominal appendages were undeveloped. The largest of the "Albatross" specimens is a sexually mature male with well developed gonopods. It differs from Bate's specimen in having much shorter spines upon the carapace and abdomen; the spines of the lowest series on the branchial region decrease in length posteriorly, while in the type specimen the posterior spines in this row are the longest. Whether these discrepancies are

due to difference in age, or whether they denote specific diversity, cannot be determined until more mature specimens are obtained from the Atlantic. In the smallest of the "Albatross" specimens (which have attained a length of 19 mm.) the spines, especially those of the abdomen, are relatively longer than in the adult, though not so long as in the type described by Bate.

As regards the ophthalmic sinuses and lobes, the genus *Eryonicus* is like *Polycheles* (*Pentacheles*).

#### ***Eryonicus spinulosus*, sp. nov.**

In this species the spines of the carapace, instead of being wellnigh limited to nine longitudinal ridges, as in *E. cæcus*, are thickly strewn over the whole surface. The intervals between the spines give rise to slender hair-like setæ. This is the arrangement of the spines of the median carina of the carapace :

2. 1. 1. 1. 2. 1. 1. — 2. 2. 1. 2.

The sublateral carina bears fourteen small spines, the lateral,

5 — 2 — 13 or 14.

The uppermost of the two carinæ below the lateral is denticulated anteriorly and armed with a spine at the front end behind the second antenna. The lowest ridge carries twelve spines, which increase slightly in length posteriorly. The rostral spines are very small, but on each side of the rostrum the front margin of the carapace is produced so as to form a pair of horns over the base of the first pair of antennæ. The abdomen is ornamented with seven longitudinal rows of spines, one dorsal and median, the others paired and lateral. The lowest of the lateral rows is on the upper part of the pleuræ.

Length, 37 mm. ; carapace, 21 × 17 mm. ; abdomen, 17 mm.

Station 3403. 384 fathoms. 1 specimen.

### **Family GNATHOPHYLLIDÆ.**

#### ***Gnathophyllum panamense*, sp. nov.**

Closely related to *G. elegans* of the Mediterranean Sea, but distinguished by a prominent conical protuberance, pigmented with black, on the upper part of the cornea. In *G. elegans* this tubercle is wanting or reduced to the merest vestige, discernible only by aid of a lens. The rostrum of *G. panamense* is furnished with seven teeth above, and one below. Color entirely different from that of *G. elegans*. The ground tint is dark brown, ornamented with a multitude of light blue spots, amongst which are sixteen red spots. Rostrum, eyes, and antennæ whitish, flagellum of second antenna orange. The fifth and sixth abdominal segments, the telson, and the swimmerets are also white. Basal joints of second pair of chelipeds violet, the merus, carpus, and fingers whitish, basal part of propodus orange. Third, fourth, and fifth pairs of legs violet.

Panama, March 12. 1 female ovig.

*G. fasciolatum* Stimps., from Australia and Amboyna, agrees closely in

form with *G. elegans*, but differs wholly in the pattern of its color marks from both *G. elegans* and *G. panamense*. *G. zebra* Richters, from Mauritius, is without much doubt the same as *G. fasciolatum*. Ortmann has lately recorded a *Gnathophyllum* from Tahiti as a new species, *G. pallidum*. It differs from *G. fasciolatum* only in the absence of color marks,—a difference due possibly to the action of alcohol.

### Family CRANGONIDÆ.

#### *Sclerocrangon atrox*, sp. nov.

Of the described species of *Sclerocrangon*, *S. ferox* G. O. Sars comes nearest to this species. These are some of the chief points of difference. In *S. ferox* the upturned rostrum is simple, while in *S. atrox* a long acute tooth is given off from its ventral side, a tooth which reaches as far forward as the tip of the rostrum. In the former species the dorsal carinæ of the sixth abdominal segment bear two pairs of well developed spines, while in the latter species one finds but one pair of very small spines at the posterior end of the carinæ. The pleural spines of the abdomen are much longer in the former than in the latter, and on the fifth somite there are four to five spines on each pleura against two in *S. atrox*. The eyes are much smaller in *S. ferox*, and lack the spine above the cornea seen in *S. atrox*.

Length of the largest specimen (a female), 162 mm.

Station 3418. 660 fathoms. 3 males, 2 females (1 ovig.).

“ 3424. 676 “ 4 females.

#### *Sclerocrangon procax*, sp. nov.

Nearly related to *S. agassizii* Smith, from the Atlantic side of the continent. The rostrum of *S. procax* is longer than in *S. agassizii*, and inclined upward at a much sharper angle; the same is true of the antero-lateral spines of the carapace. The most conspicuous difference is found in the anterior spine of the median carina of the carapace, which is much longer and nearly erect in *S. procax*. The two flagella of the first antenna in the male, *S. procax*, are subequal, while in the male *S. agassizii* the outer flagellum is much longer than the inner; the scale of the second antenna, moreover, is narrower in the former species than in the latter, and the terminal segment of the inner branch of the second abdominal appendage in the male bears on its inner margin a short blunt stylamblys, which is wanting in *S. agassizii*. In neither of these species is this segment produced into a lobe at the base of its outer margin, as it is in the more typical species of *Sclerocrangon*, e. g. *S. ferox* and *S. atrox*.

Length, 49 mm.

Station 3380. 899 fathoms. 1 male juv.

“ 3418. 660 “ 2 males, 3 females.

“ 3435. 859 “ 2 females ovig.

“ 3436. 905 “ 1 female.



**Pontophilus occidentalis, sp. nov.**

Allied to *P. abyssi* Smith and *P. batei*.<sup>1</sup> From the former it differs in having a shorter rostrum, larger eyes, and more strongly developed carinae on the carapace. From the latter it also differs in its shorter rostrum armed with two pairs of lateral teeth; in the presence of a sharp spine on the sternum between the second pair of legs; in the length of the antennal scale, which in *P. occidentalis* is equal to the distance from the tip of the rostrum to the cardiac spine; in the shortness of the second pair of legs, which reach only half way to the distal end of the merus of the first pair; and in the absence of the spine on the outer margin of the merus of the first pair of legs.

The eyes are as large as in *P. gracilis* Smith (much exceeding the rostrum), but they are nearly colorless, and unafaceted, as in *P. abyssi* and *P. batei*.

Length, 73 mm.; carapace, 21 mm.

Station 3361.	1471 fathoms.	2 specimens.
" 3363.	978 "	2 "
" 3366.	1067 "	1 "
" 3381.	1772 "	4 "
" 3382.	1793 "	5 "
" 3392.	1270 "	1 "
" 3398.	1573 "	2 "
" 3413.	1360 "	4 "
" 3414.	2232 "	1 "
" 3415.	1772 "	2 "

**Paracrangon areolata, sp. nov.**

Rostrum long, acute, upturned, inferior margin armed with two spines. A prominent carina extends the length of the carapace in the median dorsal line; it is armed with four spines, three on the gastric, one (obsolescent) on the cardiac region. Orbit incomplete, bounded externally by a slender spine. Just below the base of the second antenna the antero-lateral angle of the carapace is drawn out into another rather stronger spine. Just behind this, and from a little higher level, a strong, sharp horn is directed outward and forward; this horn is in continuity with a rounded ridge which runs inward to the external orbital spine. A longitudinal carina on each side of the gastric region, armed with a small spine a little way behind the middle; from this spine another ridge runs upward and inward, meeting the median carina at the base of the third spine. The branchial regions are traversed by a series of ridges which

<sup>1</sup> *Pontophilus gracilis* Bate, Rep. Challenger Macrura, p. 487, 1888. This name having been previously employed for another species by Smith (Bull. Mus. Comp. Zool., X. 36, 1882), I have substituted the name *Pontophilus batei* for *P. gracilis* of Bate.

anastomose in such a way as to divide these regions into cells of different sizes; they are armed with three small spines, the anterior of which is the spina hepatica.

The thoracic sterna are armed with two median spines, one of which is situated on the somite which normally bears the second pair of legs (absent in this genus), the other on the somite behind this. Abdominal pleuræ acute.

Chelipeds of moderate length, with a spine on each side of the distal end of the carpus, and another long and acute one at the antero-internal angle of the propodus.

Length, 85 mm.

Station 3424. 676 fathoms. 2 males, 3 females (1 ovig.).

“ 3425. 680 “ 1 male.

### Family GLYPHOCRANGONIDÆ.

#### *Glyphocrangon alata*, sp. nov.

Rostrum armed with a pair of lateral spines on a level with the anterior end of the eye; posterior to this pair of spines follows a variable number of smaller marginal spines (three to five on each side). The anterior half of the rostrum is unarmed, although ciliated on the margin. A light spinulose carina runs along the median line of the rostrum from the base to the anterior third (in some specimens this carina is obsolete). On each side of the median line there are, on the basal part of the rostrum, four or five small spinules.

Carapace and abdomen thickly tuberculated. On the antero-lateral regions of the carapace, and on the abdominal pleuræ, the tubercles assume a spiny character. For the rest, the tubercles are mostly compressed, their tops truncate and more or less eroded. It is further to be noted that these tubercles are arranged in longitudinal rows, and that six of these rows on each side of the carapace form, by their prominence, imperfect carinæ, corresponding in position to those commonly found in species of this genus. Between the external orbital spine and the spine at the antero-lateral angle of the carapace lies a strong spinous tooth, acute at the end and vertically compressed, its base broadening out in such a fashion that the whole tooth forms an acute, wing-like expansion. This is, in fact, the greatly developed anterior part of the fourth carina (counting from the median dorsal line). Behind it the carina continues as a low toothed ridge. A median interrupted dorsal carina runs along the abdomen, broken up into two teeth on the base of the telson.

Length, 116 mm.

Station ? 12+ specimens.

“ 3395. 730 fathoms. 1 “

“ 3418. 660 “ 2 “

*Glyphocrangon spinulosa*, sp. nov.

Rostrum long, acute, margins armed with vertically flattened spinous teeth from base to the level of the anterior extremity of the eyes, beyond which point the margins are unarmed; the anterior pair of the lateral spines are the largest. A median longitudinal row of smaller spines extends from the anterior boundary of the gastric area to the anterior fourth of the rostrum; anteriorly, these spines are confluent at their bases, forming a carina which is continued forward beyond the spines to the tip of the rostrum. Just inside the marginal spines is an irregular longitudinal row of very small spinules on each side of the rostrum.

The carapace is thickly covered with spinules which are laterally compressed. Along six longitudinal lines on each side of the carapace the spines are larger, more flattened, forming interrupted carinæ. The third carina (reckoning from the dorsal line) ends anteriorly at the deep branchio-hepatic sulcus. The fourth carina is especially prominent on the hepatic region, where it is broken up into two or three prominent teeth. The two lowermost carinæ are obsolete. The anterior margin of the carapace is produced into a large external orbital spine, directed obliquely upward and outward. The hind margin of this spine is furnished with a variable number of spinules.

The abdomen, like the carapace, is spinulose on the dorsum and pleuræ. An interrupted carina extends the length of the median dorsal line. On the sixth segment this carina is toothed along its edge. The second to the fourth abdominal pleuræ are armed with two spines curved outward and backward, the anterior one being the larger. The fifth pleura is likewise armed with two spines, but in this case the posterior spine is the larger. The sixth pleura ends posteriorly in a single spine directed outward at a greater angle than those of the more anterior somites. The median dorsal abdominal carina is continued along the basal part of the telson as a line of four or five teeth, which decrease in size from before backward.

Length, 105 mm.

Station	3353.	695 fathoms.	11 specimens.
"	3418.	660	" 91 "
"	3419.	772	" 1 "
"	3424.	676	" 19 "
"	3425.	680	" 1 "
"	3435.	859	" 2 "

*Glyphocrangon sicarius*, sp. nov.

Rostrum as long as the rest of the carapace, armed with a pair of short, blunt, lateral teeth, a little in advance of the front of the eyes, and with another pair of obsolete ones at the root. Between these two pairs of teeth the margins of the rostrum are concave and slightly raised. From the anterior

teeth the rostrum tapers regularly to the point. The upper surface is plane and smooth. A slight median carina, most obvious near the tip, runs through the whole length of the rostrum from the anterior end of the gastric area to the tip; the lateral margins are slightly rimmed. The lower surface of the rostrum is longitudinally grooved, and wholly devoid of a median keel.

Orbital spine rather short and thick, directed a little outward and upward. The spine at the antero-external angle of the carapace is also short and thick, slightly exceeding in length the orbital spine. From its base a low keel extends backward over the hepatic area, — a keel unarmed with spines, but broken into two tubercles, the hinder of which is the more prominent. In the small triangular area between this keel and the gastro-hepatic sulcus are several tubercles disposed for the most part in a single row. The gastric region is free from tubercles in the median line save one minute one at the anterior boundary near the base of the rostrum; but on either side, this region is ornamented with tubercles; these are not spiny, nor do they tend to form very well marked carinæ. On the branchial regions there are three carinæ on each side; the uppermost of these is broken up into five or six tubercles; the top of these tubercles, as well as those of the other carinæ on the branchial and hepatic areas, exhibit a corroded surface, and a similar appearance is manifest on the whole lower surface of the carapace where it is bent beneath the thorax. The abdomen is irregularly bestrewn with low tubercles. The telson is straight and much shorter than the rostrum; it is furnished with a small, laterally compressed tooth in the median dorsal line at base; both the dorsal carinæ and the lateral margins are obsoletely dentate along their basal half.

Length, 124 mm.; length of rostrum from tip to anterior gastric groove, 30.5 mm.; length of carapace, including rostrum, 58 mm.

Station 3382. 1793 fathoms. 2 specimens.

### Family PANDALIDÆ.

#### *Heterocarpus vicarius*, sp. nov.

This is the Western representative of *H. gibbosus* Bate, from the Philippine Islands. It differs from that species as follows. The carapace is very much longer both in proportion to its height and to the length of the rostrum, and its dorsal margin is not so convex. The teeth on the upper edge of the rostrum are more numerous and closely set. The lateral carinæ of the carapace are more prominent. The third abdominal somite forms a sharper angle or knee. Finally, the antennular flagella are longer and subequal in length.

Length, 110 mm.; rostrum, 26 mm.; carapace, including rostrum, 55 mm.

Station 3385. 286 fathoms. 49 specimens.

“ 3386. 242 “ 91 “

“ 3389. 210 “ 7 “

“ 3396. 259 “ 68 “

**Heterocarpus hostilis**, sp. nov.

Similar to *H. alphonsi* Bate, from off the Philippine Islands and Japan, but readily distinguished from that species by the stronger upward curve of the rostrum, by the presence of but one tooth in the median dorsal line of the carapace back of the base of the rostrum, and by the *two* spines on the third abdominal segment.

Length, 197 mm.; rostrum, 70 mm.; carapace, including rostrum, 108 mm.

Station 3353. 695 fathoms. 22 specimens.

" 3363. 978 " 24 "

" 3364. 902 " 3 "

" 3371. 770 " 20+ "

" 3380. 899 " 6 "

" 3393. 1020 " 8 "

" 3395. 730 " 2 "

**Heterocarpus affinis**, sp. nov.

Very similar to *H. hostilis*, from which it differs in the following particulars. The rostrum is much shorter; measured from the tip to the posterior limit of the orbit, it about equals the rest of the carapace in length. There are fewer teeth on its dorsal margin (five or six); the number of teeth on its lower margin varies from six to ten. The median dorsal line of the carapace is more convex, and it is armed, back of the base of the rostrum, with two acute teeth, where there is but one tooth in *H. hostilis*.

It bears a resemblance, further, to *H. dorsalis* Bate, collected by the "Challenger" in the Banda Sea, but it may be at once distinguished from the Oriental species by its shorter rostrum and the presence of two median teeth on the third abdominal segment.

*H. affinis* and *H. hostilis* belong to different geographical areas. *H. affinis* is the more northern form, found off Acapulco and Cape Corrientes, while *H. hostilis* was obtained in the Gulf of Panama.

Station 3418. 660 fathoms. 13 specimens.

" 3424. 676 " 5 "

" 3425. 680 " 9 "

**Family NEMATOCARCINIDÆ.****Nematocarcinus agassizii**, sp. nov.

The rostrum is one fifth longer than the rest of the carapace (in some small specimens only equal to the rest of the carapace), slender, nearly horizontal for the basal two fifths of its length, the remaining portion gently upturned and ending in a very acute point; its upper margin is continued backward in the

form of a carina, which becomes obsolete on the hinder part of the gastric region; this carina is pectinate, or armed with close-set, forward-pointing teeth on the anterior part of the gastric region; the teeth are continued on the upper margin of the rostrum through one third or two fifths of its length, the distal third or three fifths of the rostrum being entirely free from teeth above; the lower edge of the rostrum is ciliated above the eyes and armed with three (rarely four) teeth, separated by wide intervals, on the distal half.

The third abdominal segment is somewhat prolonged posteriorly over the next segment, but the hind margin is rounded off and does not form a prominent tooth. The telson is tipped with three pairs of spines, the intermediate pair the longest; there are, besides, about six pairs of small spines on the dorsal side of the telson.

The flagella of both the antennules and antennæ are prodigiously developed, the antennule being nearly twice, the antenna more than twice, the length of the whole body including the rostrum; excepting the proximal part of the organ, the annuli of the antennary flagellum are enlarged at the distal end, giving a beaded appearance to the flagellum. The antennal scale reaches rather more than half-way to the end of the rostrum; it is truncate at the distal end and armed externally with an apical spine.

The legs have the characteristic shape and proportions of the genus. The dactyli of the third and fourth pair are slender, acute, somewhat curved, and invested by a pencil of long hairs. The dactyli of the fifth pair are stouter but very short, and hidden in the tuft of hairs which arises from the distal end of the propodus.

The outer blade of the swimmeret slightly surpasses the telson. It is fringed with long hairs along the internal and distal margin, and furnished with a minute tooth and a movably articulated spine on the external border near the distal end. The inner blade is a trifle shorter than the telson; it is also fringed along its whole margin with long hairs.

Dimensions of a female specimen. Length of body, rostrum included, 139 mm.; length of rostrum, 35 mm.; length of carapace, rostrum included, 61 mm.; length of telson, 20 mm.; length of antennule, 267 mm.; length of antenna, 315 mm.; length of antennal scale, 19 mm.

This species, like all the *Nematocarcini*, is very fragile. The long and slender rostrum is often broken off during life, and the attempt to restore it sometimes results in an abnormally small and otherwise monstrous rostrum, which might easily be mistaken for a specific character if ample material were not at hand.

Station 3353.	695 fathoms.	2 specimens.
" 3354.	322 "	4 "
" 3358.	555 "	90 "
" 3359.	465 "	2 "
" 3364.	902 "	4 "
" 3370.	134 "	8 "
" 3380.	899 "	7 "
" 3384.	458 "	1 "

Station 3393.	1020 fathoms.	8 specimens.	
" 3395.	730 "	3 "	
" 3406.	551 "	1 "	
" 3407.	885 "	14 "	(1 bopyrized).
" 3418.	660 "	4 "	
" ?	?	24 "	

### Family MIERSIIDÆ.

#### *Acanthephyra cristata*, sp. nov.

Differs from *A. debilis* A. M. Edw. (= *A. gracilis* Smith) in having a much shorter and fewer-spined rostrum, two pairs of longitudinal lateral carinæ on the carapace, a dorsal carina on the fourth abdominal segment, and by the absence of a series of denticles on the posterior margin of the dorsum of the fourth and fifth abdominal segments.

From *A. lanceolata* (*Systellaspis lanceolata* Bate) it also differs by having the rostrum shorter, the lateral and dorsal carinæ of the carapace more prominent, and by the absence of a prominent tooth on the anterior margin of the first abdominal segment.

This species, like *A. debilis* and *A. lanceolata*, has no carina on the dorsal surface of the fifth and sixth abdominal segments.

Length, 78 mm.; rostrum, 13 mm.; carapace, including rostrum, 27.5 mm.

Station 3361. 1471 fathoms. 1 specimen.

" 3381. 1772 " 1 "

#### *Acanthephyra cucullata*, sp. nov.

The integument is soft, membranaceous, and transparent in alcohol. The carapace is carinated in the median dorsal line anteriorly; this carina is furnished with seven minute teeth, and is continued forward to a very small acicular rostrum, which hardly reaches forward to the end of the eyes; the infero-lateral margins of the orbit are continued downward for some distance nearly parallel with one another in a nearly vertical direction, and then suddenly diverge and trend backward, forming the upper wall of the orbit; a sort of hood is thus formed of the anterior part of the carapace, overhanging the facial region. The infra-orbital angle is rounded, not spiniferous. The antennal spine is acute, and advanced forward of the infra-orbital angle. The branchiostegian spine is small and continuous with a longitudinal carina that runs along the branchial region of the carapace. A low fold or ridge marks the upper boundary of the branchial region.

The abdomen is carinated in the median dorsal line on the second to the sixth segment inclusive; the carina is most prominent on the third segment,

where it is produced into a strong posterior tooth which overhangs the anterior part of the fourth segment; the three following segments are furnished with minute posterior teeth. The posterior half of the telson in the unique specimen at hand is missing; there is one pair of minute marginal spines at the hind end of the remaining proximal half. The eyes and eyestalks are well developed, the stalks broadening toward the distal end, and projecting a slender blunt process on the inner side close to the cornea; the eye itself is as broad as the distal end of the peduncle.

The basal segment of the antenna is armed with an acute external spine; the antennal scale is long, gradually narrowing distally to the apex, which is furnished with a small spine.

The thoracic appendages have the form characteristic of the genus *Acanthephyra*, and appear to offer no important specific characters.

Length, 87 mm.; carapace, 27 mm.; antennal scale, 16 mm.

Station 3381. 1772 fathoms. 1 male.

### *Notostomus fragilis*, sp. nov.

Dorsal line of carapace convex and keeled from anterior to posterior margin, anteriorly produced into a short, acute rostrum, which does not exceed the eyestalks in length; the dorsal carina is armed with seven or eight minute teeth on the anterior gastric region and the basal portion of the rostrum; lower margin of rostrum unarmed. A longitudinal carina on each side of the carapace begins near the orbit, above the infra-orbital spine, and runs back to the posterior margin; another carina runs obliquely downward and backward, dividing the branchial from the hepatic regions. The inferior lateral carina is obsolete except for a short distance behind the spine which lies near the anterior margin of the carapace behind the base of the second antenna.

The abdomen is strongly compressed, the third, fourth, fifth, and sixth segments dorsally carinated; the carina terminates in a small tooth at the hind end of the fourth, fifth, and sixth segments; on the fourth segment the carina is divided into two parts by a deep notch about two thirds of the distance from the anterior to the posterior margin of the segment. The telson is channelled on the dorsal side, and is tipped with two long spinous setæ.

The eyestalks taper from the base to the tip; their outer and upper margins are nearly straight, but their inner and lower surfaces are swollen; on the inner side of each stalk, a little way behind the eye, there is a blunt tubercle. The eye itself is small and black. The integument of the eyestalk is transparent, and when held to the light discloses the optic ganglion within, giving off a nerve to the retina and another to the tubercle on the inner side of the stalk.

The basal segment of the antennule is armed with a very small but sharp external spine. The outer side of the second antenna, on the contrary, is unarmed. The antennal scale is very broad, oval, and furnished with a small



spine on the external border, near the distal end. The third maxillipeds are robust; they reach forward far beyond the end of the antennal scales; their terminal segment is triangular in cross section. The first pair of legs are also robust, about equal in length to the third maxillipeds, and their chela is strong, with fingers about equal to the hand in length. The second pair of legs are longer but much weaker than the first pair, the carpus and propodus much elongated, and the fingers not more than a third as long as the hand. The ischium and merus of both the first and the second pair are flattened, and the same compression is seen in the three following pairs of legs, which have the form and proportions characteristic of the genus. The inner branches of the swimmerets are about the length of the telson, while the outer branches are rather longer.

Length, 70 mm.; carapace, 30 mm.; telson, 14 mm.; antennal scale, 11 mm.

Station 3371. 770 fathoms. 1 specimen.

In this specimen the integument is soft and membranaceous, and the carapace is so collapsed that it is difficult to restore its true outline. In several respects this species shows an approach to the genus *Hymenodora*, e. g. the soft integument, small eye, and the reduction of the rostrum.

#### **Notostomus westergreni, sp. nov.**

Similar to *N. patentissimus* Bate, with which it agrees in nearly all the details of carinae, etc., but it differs much from Bate's species in its general form and proportions, the carapace being longer in proportion to its height, and less convex along the dorsal line than it is in *N. patentissimus*. The rostrum, besides, is armed with many more spines (at least twelve) on its inferior margin. Bate says that in *N. patentissimus* the antennal carina terminates in the posterior margin of the carapace, where it is confluent with the lowermost, submarginal carina. This is not the case in *N. westergreni*.

Length, 127 mm.; length of carapace, including rostrum, 61 mm.; height of carapace, 31 mm.

Station 3399. 1740 fathoms. 1 male.

### **Family PASIPHAEIIDÆ.**

#### **Pasiphaeia cristata americana, subsp. nov.**

This form is closely allied to *P. cristata* Bate, dredged by the "Challenger" in 315 fathoms, near the Fiji Islands. The "Albatross" specimens differ in some respects from the Fiji specimen. They may be considered a geographical race of the same species.

On comparing the two forms it appears that the carapace of the "Albatross" specimens is considerably longer in proportion to the length of the whole body

than it is in the Fiji form, and that the dorsal crest is smaller and somewhat differently shaped. The fifth and sixth abdominal segments are much shorter in proportion to the length of the telson in the former. The antennular peduncle is only one third as long as the carapace, while in the typical *P. cristata* it is about one half as long as the carapace. Furthermore, the flagellum of the antenna in the former is longer than the body, whereas in the latter it is described as being only one half as long.

Length 65 mm.; carapace, 22 mm.; telson, 7.5 mm.

Station 3385. 286 fathoms. 4 specimens.

" 3396. 259 " 2 "

" 3403. 384 " 2 "

" 3406. 551 " 3 "

### *Pasiphaeia magna*, sp. nov.

This species is second only to *P. princeps* Smith in dimensions. It is most similar to *P. tarda* Kröyer, from the North Atlantic. Differs from the latter species by having the dorsal line of the carapace more convex, the posterior part of the carapace higher in proportion to the anterior part, the dorsal keel of the carapace rounded except on the anterior gastric region, and the anterior rostrum-like tooth longer and differently shaped. The proportional length of the segments of the third pair of legs appears to be quite different in the two species: in *P. tarda*, according to Kröyer, the propodus and dactylus are of equal length and four times as long as the carpus, while in *P. magna* the dactylus is even shorter than the carpus, which is itself only one sixth as long as the propodus. In *P. tarda*, following Kröyer, the lower margin of the second segment of the second pair of legs is furnished with three spines; in *P. magna* this margin is unarmed but for the tooth at its distal end.

Length, 145 mm.; carapace, including the anterior dorsal tooth, 55 mm.

Station 3384. 458 fathoms. 1 specimen.

## Family PENEIDÆ.

### *Sicyonia affinis*, sp. nov.

This species is the Pacific coast representative of *Sicyonia edwardsii*<sup>1</sup> of the Atlantic coast of America. It agrees with *S. edwardsii* in the form and dentition of the carapace, but differs in the form and sculpture of the abdominal segments. In *S. edwardsii* the first four abdominal segments are rugose, and ornamented on the sides with two deeply impressed transverse lines, followed by another less deeply incised near the hind margin of each segment; moreover the pleuræ of these segments are angulated below. In *S. affinis* these

<sup>1</sup> *Sicyonia edwardsii* Miers, Ann. Mag. Nat. Hist., 5th series, VIII. 367, 1881; *Sicyonia carinata* (Olivier) Milne Edwards, Ann. Sci. Nat., XIX. 344-346, Plate IX. Fig. 9, 1830; nec *Sicyonia carinata* (Olivier).

segments are smooth, the impressed lines are absent with the exception of the hinder one of the deeply cut pair, and the pleuræ are broadly rounded below; the peduncle of the second antenna is not much over one half the length of the antennal scale, and the whole appendage is but little longer than the carapace.

Length, 62 mm.; carapace, 20 mm.

Station 3367. 100 fathoms. 1 male, 1 female.

“ 3369. 52 “ 1 male.

“ 3378. 112 “ 2 females.

“ 3379. 52 “ 1 female.

The color in life, as shown in a sketch made by Mr. Westergren, is light greenish yellow, banded with vermilion on the branchial regions and abdomen. Appendages red, antennary flagellum transversely banded with light and dark. The coloration is quite different from that of *S. edwardsii* as given by Dana (Crust. U. S. Explor. Exped., p. 602).

#### *Sicyonia picta*, sp. nov.

Rostrum a little shorter than the eyestalks, laterally compressed, elevated, armed with six teeth, three superior, three terminal; inferior margin ciliated. Carapace carinate in the median dorsal line; the carina is furnished with two teeth, one minute, on the anterior part of the gastric region at the base of the rostrum, the other larger, over the cardiac region. An infra-orbital and an hepatic spine are present. General surface of carapace punctate and sparsely clothed with setæ. Abdominal segments smooth, with a median dorsal carina which rises into a strong tooth on the first segment directed upward and forward; on the fifth and sixth segments the carina is drawn out into an acute tooth which is directed horizontally backward. The pleuræ of the abdominal segments are margined and armed with a tooth on the lower border; on the second, third, and fourth segments the tooth is hamate, being directed outward and backward. The general surface of the abdomen is smooth, with a transverse groove on each side of the segments. The telson is channelled above, acute at the tip, and armed with a pair of small lateral spines near the distal end. The eyes are very large, horizontally flattened. Basal segment of antennule armed with two spines on its exterior border; flagella shorter than the peduncle. The peduncle of the second antenna reaches about two thirds of the way to the end of the scale; the flagellum is about equal to the abdomen in length; the basal segment of the peduncle is furnished with a long and acute external spine. The sternum is armed with a long spine between the bases of the second, third, and fourth pairs of legs, as is usual in species of this genus. The last pair of abdominal appendages are a little shorter than the telson.

Length, 70 mm.; carapace, 24 mm.

Station 3355. 182 fathoms. 1 male.

“ 3387. 127 “ 6 males, 4 females.

On the hinder part of each branchial region there is a dark (in alcohol) ring of pigment. *S. ocellata* Stimpson and *S. penicillata* Lockington are similarly ornamented. The flagellum of the antenna is banded alternately with light and dark color, and there are traces of color on the margins of the rostrum, the dorsal carinæ, and appendages.

*Peneus balboæ*, sp. nov.

Integument thin and membranaceous, its surface thickly beset with minute squamiform tubercles. The rostrum of the sole specimen procured is broken off a little short of the anterior end of the eye; on the upper margin of the part remaining, and on the median line of the gastric region there is a series of eight slender acute teeth, three of which lie behind the orbit. Rostrum continuous posteriorly with a sharp, non-sulcated carina which becomes obsolete before reaching the posterior margin. Suborbital angle prominent, but not armed with a spine; a small branchiostegian spine projects from the margin on a level with the second antenna. Neither the cervical nor any other grooves are apparent on the carapace. A faint longitudinal ridge runs along the side of the carapace on a level with the orbit; this carina is most conspicuous on the gastric region. Another longitudinal ridge runs from the suborbital angle, dividing into two branches near the middle of the carapace. A third ridge extends from the branchiostegian spine to the lower branch of the ridge last noted. Fourth, fifth, and sixth abdominal segments dorsally carinated, the sixth armed with a small horizontal spine. The fourth, fifth, and sixth segments are also ornamented with a lateral ridge. Eyestalks short; eyes large, globular, black.

Length, 93 mm.; carapace, exclusive of rostrum, 29.5 mm.

Station 3371. 770 fathoms. 1 female.

*Solenocera agassizii*, sp. nov.

Similar to *S. siphonocera* (Philippi), but different from that species in having the two antennular flagella much shorter and subequal, and a larger number of teeth on the upper margin of the rostrum and gastric region. Comparison of a specimen fifty-seven millimeters long with *S. siphonocera* of equal size from the Bay of Naples shows that in the former the antennular flagella are but four fifths the length of the carapace, and that there are eight teeth on the rostrum and gastric region, while in the Neapolitan specimen the antennular flagella are as long as the distance from the tip of the rostrum to the middle of the third abdominal segment (two fifths longer than the carapace), and there are but six teeth on the rostrum and gastric region. Moreover, not only is the upper flagellum broader (1 m.) and blunter in *S. agassizii* than in *S. siphonocera* (where it is only  $\frac{1}{2}$  m. in breadth), but is also subequal in breadth to the lower flagellum, while in the Mediterranean species the upper flagellum is conspicuously narrower than the lower one.

In full-grown specimens of *S. agassizii*, which attain a length of 150 mm., the antennular flagella are only one half as long as the carapace, or even less. The flagellum of the second antenna is very slender and enormously long, — more than two and two thirds times the length of the whole body. The number of teeth on the rostrum and gastric region is nine.

Length of an adult female, 149 mm.; carapace with rostrum, 54 mm.; rostrum, 13.5 mm.; second antenna, 410 mm.

Station 3389. 210 fathoms. 2 males, 8 females.

“ 3391. 153 “ 5 males, 6 females.

A *Solenocera* has been recently recorded from the Bay of Bengal by Mr. J. Wood-Mason.<sup>1</sup> In this species the antennular flagella are described as being shorter and broader than in any previously described species. As no other characters are mentioned, it is impossible to tell whether it is the same as the “Albatross” species. When the remoteness of the localities is considered, it seems hardly warrantable to assume the identity of the East Indian and American species of a comparatively shallow-water genus.

#### *Peneopsis diomedææ*, sp. nov.

Integument hard, firm, and smooth. Rostrum long, nearly horizontal, except near the tip, where it is bent up slightly, acute, armed with four teeth above. A dorsal carina, armed with one tooth on the posterior part of the gastric region, runs the length of the carapace. Cervical groove very deep, but not cutting the dorsal carina. Another deep groove runs backward, and then diagonally upward from the cervical groove toward the posterior border of the carapace, stopping just short of the posterior margin. Antennal region well defined by the cervical groove below and a gastro-antennal groove above. A strong antennal tooth on the margin of carapace, below the orbit, another at the infero-lateral angle, a third just behind the groove that marks the posterior limit of the antennal region, and a fourth on the hinder edge of the cervical groove. Above and behind the last mentioned tooth the cervical groove is indented, and the upper angle of this indentation tends to assume the form of a small tooth or spine.

Fourth, fifth, and sixth abdominal segments carinate on the median dorsal line, and produced to teeth posteriorly. Telson deeply grooved on dorsal side, and armed with a pair of spiniform lateral teeth near the tip. The antennules with their long flagella surpass the whole body in length; the prosartema is oval, foliaceous, reaching forward as far as the posterior border of the upper face of the cornea. The exopods of the second maxillipeds are very small, not longer than the short ischial segment of the limb. Upon the appendages back of these, the exopods are reduced to the merest rudiments, discernible only by the use of a lens. In some individuals, indeed, the exopods of the posterior appendages are altogether wanting.

<sup>1</sup> *Solenocera hextii* Wood-Mason, Ann. Mag. Nat. Hist., 6th ser., VII. 188, 1891.

Length, 215 mm.; carapace, 101 mm.; rostrum, 42 mm.; antennal scale, 33 mm.; telson, 33 mm.

Station 3353.	695 fathoms.		2 females.
" 3358.	555 "		1 male.
" 3384.	458 "		3 females.
" 3393.	1020 "		3 females.
" 3394.	511 "		3 males, 1 female.
" 3395.	730 "		1 male, 1 female.

### *Haliporus nereus*, sp. nov.

Integument membranaceous. Carapace lightly granulated. Rostrum about one third the length of the rest of the carapace, horizontal, armed with six teeth above, ciliated below. Median dorsal line of carapace carinate, with two teeth on the posterior half of the gastric region. The antennal, branchiostegian, and hepatic spines are present, besides one behind the branchiostegian, and another still farther back on the hind border of the cervical groove. Orbital region definitively bounded by an hepatic and a gastro-hepatic sulcus. The hindmost of the lateral spines of the carapace lies in the anterior angle of a triangular field enclosed by branches of the cervical groove; from the infero-posterior angle of this triangle two carinæ run backward along the branchial area; the upper one ends at the postero-lateral margin of the carapace, the lower one meets the inferior submarginal carina of the branchial area before attaining the posterior border. These two carinæ, with the submarginal ridge of the carapace, enclose a long oval area on each branchial region. Third to sixth abdominal segments carinated; on the sixth segment the carina ends in a small tooth. Eyestalks about one half the length of the rostrum; eyes large, black, much broader than their stalks.

In the female there is a large process, covered with stiff hairs, and flattened on the inner side, developed from the base of the third pair of legs. Behind this process lies a pair of flat, setiferous sternal processes. Between the legs of the fourth pair there hangs in the median line a nearly vertical curtain-like partition, notched on the free lower margin, and flanked by two lower blunt setiferous tubercles. The sternum of the posterior thoracic segment has a slightly elevated median longitudinal ridge, and a low transverse ridge at the posterior boundary of the segment.

Length, 81 mm.; carapace, 31 mm.; rostrum, 8 mm.

Station 3353.	695 fathoms.		1 female.
" 3366.	1067 "		1 female.
" 3382.	1793 "		2 females.
" 3398.	1573 "		2 females.
" 3399.	1740 "		1 male.
" 3400.	1322 "		2 females.
" 3407.	885 "		1 female.
" 3413.	1360 "		1 male, 2 females.

**Haliporus doris, sp. nov.**

A larger and more robust species than *H. nereus*, with a stronger upward curve to the rostrum. The tubercular processes of the third pair of legs, together with the sternal tubercles immediately behind them, are very like the corresponding structures in *H. nereus*. But here the likeness between the sexual parts of the females of the two species ends. Betwixt the legs of the fourth pair there is a transverse diaphragm consisting of a median tongue, concave on its front face, its lower edge entire, supported on each side by a strong blunt triangular process, of equal height with the median tongue-like plate. Between the bases of the fifth pair of legs, in place of the low longitudinal ridge seen in *H. nereus*, there is, in this species, a large setiferous trigonal tooth, acute at the tip, equalling in height the transverse partition on the sternum of the antecedent segment. The posterior median angle of this tooth abuts against the low transverse ridge that forms the posterior limit of the last thoracic sternum.

Length, 104 mm.; rostrum, 10 mm.; whole carapace, 42 mm.

Station 3414. 2232 fathoms. 4 females.

“ 3415. 1879 “ 1 female.

**Haliporus thetis, sp. nov.**

Integument membranaceous. Rostrum rather less than one third as long as the rest of the carapace, curved strongly upward, upper margin convex, armed with five teeth. A distinct carina, bearing three teeth, runs the length of the median line of the gastric area, from the base of the rostrum to the cervical groove. Back of the cervical groove this carina continues on as a low blunt ridge to the posterior border of the carapace. Posteriorly, this ridge gives off two pairs of lateral branches, which course diagonally backward to the posterior margin of the carapace, marking off two triangular fields on the cardiac region, one enclosed within the other. The spinous armature of the carapace consists of an antennal, a very small branchiostegal, an hepatic, and a lateral spine on the posterior edge of the cervical groove. The spine which lies a little way behind the branchiostegian spine in *H. nereus* and *H. doris* is lacking in this species. Antennal and orbital regions well defined. All the segments of the abdomen are carinate along their median dorsal line. The pleuræ are shallow and rounded. A longitudinal furrow on each side of the abdominal segments. Eyestalks one half the length of the rostrum; eyes large, black, broader than their stalks.

Length, 94 mm.; rostrum, 9 mm.; carapace, including rostrum, 33 mm.

Station 3413. 1360 fathoms. 1 female.

**Aristæus occidentalis, sp. nov.**

Similar to *A. antennatus* (Risso) of the Mediterranean Sea. By comparison with Duvernoy's figures of *A. antennatus* it appears that the Pacific species has a longer, more strongly upturned rostrum, and that it differs furthermore in having the sixth abdominal segment carinated and toothed, and in having much longer abdominal appendages. As in *A. antennatus*, there is no epipod on either the last or the next to the last pair of legs.

Length, 158 mm. ; rostrum, 49 mm. carapace, including rostrum, 85 mm.

Station 3403. 384 fathoms. 1 male.

" 3410. 331 " 2 females.

**Hemipeneus triton, sp. nov.**

This species, like *H. spinidorsalis* Bate, is remarkable for the long, curved thorn on the dorsal side of the third abdominal segment. It differs from *H. spinidorsalis* in having a much shorter rostrum, and longer, more flattened outer antennular flagella. The rostrum is shorter than in any previously described species, being much shorter than the eyestalks ; it is furnished with from two to four teeth above. The sixth abdominal somite is longer than in *H. spinidorsalis*. Another difference between the two species affects the inner branch of the second abdominal appendages of the male ; in both species this branch is triple ; in *H. spinidorsalis* the anterior piece is a horny plate, concave within and furnished with setæ on its distal border ; the middle piece has the form of a long triangular tooth, shorter than the anterior plate ; the posterior piece is a longer multiarticulate flagellum, homologous with the inner branch of the following pairs of appendages. In *H. triton*, the middle tooth-like process is developed into a broad plate which exceeds in length the anterior plate.

Length, 127 mm. ; carapace, 44.5 mm. ; rostrum, 6 mm.

Station 3360. 1672 fathoms. 1 female.

" 3374. 1823 " 1 male, 5 females.

" 3381. 1772 " 3 males, 1 female.

**Benthesicymus tanneri, sp. nov.**

In this species the carina on the fifth and sixth abdominal segments terminates posteriorly in a small acute tooth, whereas in *B. altus* Bate these segments are devoid of teeth, the posterior margin rising to form a peculiar transverse ridge. *B. brasiliensis* Bate differs from *B. tanneri* in having the carapace higher, with more convex infero-lateral borders, the third, fourth, and fifth abdominal segments toothed, the sixth toothless, and in the absence of the tooth or tubercle on the sternum between the abdominal appendages of the



first pair. *B. bartletti* Smith, from the Atlantic side of the continent, resembles *B. tanneri* in many respects, but is distinguishable at a glance by the long spine on the dorsum of the fifth abdominal segment. *B. moratus* Smith, another allied species, differs in having a distinct hepatic spine, a much broader merus joint to the second maxilliped, in the presence of small exopods at the bases of all the thoracic appendages, etc.

Color in life, deep red, with a large patch of bright blue on the back of the second, third, and fourth abdominal segments; eyes black.

Length, 112 mm. ; carapace 44.5 mm. ; rostrum, 8 mm.

Station 3358.	555 fathoms.	3 males, 2 females.
“ 3362.	1175	“ 1 male, 1 female.
“ 3363.	978	“ 3 males, 5 females.
“ 3364.	902	“ 2 males.
“ 3365.	1010	“ 1 female.
“ 3366.	1067	“ 1 male, 1 female.
“ 3376.	1132	“ 2 females.
“ 3377.	764	“ 1 male.
“ 3380.	899	“ 1 male.
“ 3384.	458	“ 27 males, 36 females.
“ 3393.	1020	“ 2 males, 3 females.
“ 3400.	1322	“ 1 female.
“ 3403.	384	“ 1 male, 1 female.
“ 3404.	385	“ 1 female.
“ 3407.	885	“ 5 females.
“ 3410.	331	“ 2 males, 3 females.
“ 3411.	1189	“ 1 male, 1 female.
“ 3418.	660	“ 7 males, 8 females.
“ 3424.	676	“ 1 male.
“ 3425.	680	“ 1 male.
“ 3435.	859	“ 3 males, 2 females.
“ 3436.	905	“ 5 females.

### Family SERGESTIDÆ.

#### *Sergestes inous*, sp. nov.

Near *S. mollis* Smith. Besides differences of minor importance, the following structural difference is apparent: in *S. mollis* the posterior pleurobranchia of the antepenultimate thoracic segment is replaced by a small simple lamella, which is concealed beneath the following gill, while in *S. inous* the said pleurobranchia is well developed and unconcealed.

Length 113 mm. ; carapace, 34.5 mm.

Station 3380. 899 fathoms. 1 female.

**Sergestes phorcus**, sp. nov.

Carapace devoid of spines; rostrum cristiform, short, subquadrate, the anterior margin produced to a short point in the middle. Second, third, and fourth abdominal segments lightly sulcate in the median dorsal line; sixth somite armed with a minute posterior dorsal spine. Eyestalk shorter than proximal segment of the antennular peduncle; eye subspherical, much wider than its stalk. First and second segments of the antennular peduncle of equal length, the third considerably shorter. Thoracic appendages much like those of *S. robustus* Smith.

Length, 65 mm.; carapace, 21 mm.

Station 3382.	1793 fathoms.	1 male.
" 3386.	242	" 1 female.
" 3388.	1168	" 2 females.
" 3401.	395	" 1 female.
" 3437.	628	" 1 female.

**Sergestes halia**, sp. nov.

A small species, in which the cervical groove is nearly obliterated on the dorsal part of the carapace, and the posterior transverse furrow, which in some species of *Sergestes* forms the front boundary of the cardiac area, is obsolete. A sharp spine near the antero-lateral margin of the carapace, and another on the hepatic area. Rostrum cristiform, tapering to a slender, acute point, which overreaches the eye. A longitudinal ridge runs from the base of the antenna backwards, dividing at the hepatic spine into a superior and an inferior branch; the former forms the upper boundary of the branchial area, the latter courses along the middle of the branchial area and fades out before reaching the posterior border of the carapace. Abdominal segments unarmed.

Length, 29 mm.; carapace, 9.3 mm.

Station 3388. Surface to 400 fathoms (submarine tow-net). 3 males.

## SUBORDER SCHIZOPODA.

Family **LOPHOGASTRIDÆ**.**Gnathophausia dentata**, sp. nov.

In this species a thin triangular crest, produced at the apex to a spine, is found at the base of the rostrum, over the anterior part of the gastric region; a minute denticle near the anterior, and another near the posterior end of the crest. The lower spine of the infero-posterior angle of the carapace is reduced to a mere tooth, obsolete in some specimens. Antennal scale very broad (breadth equal to one half the length.)

Distinguished from *G. gracilis* W.-Suhm by the prominent dentate gastric

crest, the small size, or even absence, of the lower spine of the infero-posterior angle of the carapace, the greater breadth of the antennal scale, etc.

*Gnathophausia gracilis*, var. *brevispinis* Wood-Mason, agrees with *G. dentata* in the obsolescence of the lower posterior spine, but I infer from Wood-Mason's short description that this variety conforms to the type of *G. gracilis* as regards the gastric teeth, antennal scale, etc.

Length, 60 mm.; carapace, including rostrum and dorsal spine, 33 mm.; rostrum, 14 mm.; dorsal spine, 4 mm.

Station 3361.	1471 fathoms.	1 specimen.
" 3375.	1201 "	1 "
" 3400.	1322 "	1 "
" 3406.	551 "	1 "
" 3411.	1189 "	1 "

### Family EUCOPIIDÆ.

#### *Eucopia sculpticauda*, sp. nov.

Frontal margin very prominent, forming a three-sided blunt rostrum, which projects between the eyestalks and wholly conceals the subjacent ocular segment. Anterior part of the telson deeply furrowed for a little less than one half its length, the furrow bounded on each side by an elevated, rounded ridge; a low median keel, beginning in the anterior furrow, runs back to the hind end of the telson; a constriction near the hind end divides off a terminal plate, which is broadly rounded at the end, its lateral margin concave; the whole dorsal face of the telson, from the posterior end of the anterior ridges to the terminal plate, is beautifully ornamented with a network of ridges like honey-comb.

Length, 66 mm.; carapace, measured from lower angle of orbit to posterior end of the lateral wings, 23 mm.

Station 2619 Hydr.	1000 fathoms.	1 female juv.
" 3407.	885 "	1 female.
" 3413.	1360 "	1 male.

### Family MYSIDÆ.

#### *Petalophthalmus pacificus*, sp. nov.

Similar to *P. armiger* W.-Suhm,<sup>1</sup> but different in some particulars. The rostrum is more prominent and triangular; there is a median tooth on the

<sup>1</sup> Amongst the material dredged by the "Blake" in the Atlantic in 1877-78, I find the female of *P. armiger*. It agrees closely with the male, barring the usual sexual differences, viz. the presence of an incubatory pouch, and the simple structure of the caudal limbs; the mandibular palp, carapace, telson, etc., are as in the male. The brood-pouch consists of six pairs of incubatory lamellæ. The Schizopod described by Suhm as the female of *P. armiger* is apparently a *Boreomysis*. It may be called *Boreomysis suhm*.

carapace behind the base of the rostrum ; the caudal limbs are simple in the male.

Length, 31 mm.

Station 2637 Hydr. 700 fathoms. 1 male.

### SCOLOPHTHALMUS, gen. nov

Carapace rostrate, small, covering only the anterior part of the thorax, leaving the last two thoracic segments exposed. Abdomen slender, cylindrical, sixth segment the longest. Eyestalks transformed to sharp spines, visual elements wanting. Antennular peduncle rather long and robust. Antennal scale elongate, oval ; proximal fourth of outer edge smooth, naked, terminating in an angle which bears a strong seta ; the rest of the outer edge fringed with hairs like the inner edge. Mandibular palpi reaching to about the middle of the antennular flagellum, terminal segment narrowly oblong. Second maxillæ with inner basal part expanded, three-lobed, terminal segment expanded at distal end, triangular. First maxillipeds without an exopod, but furnished with a well developed epipod. Second maxillipeds of moderate length, subpediform. Legs long and slender, antepenultimate pair reaching forward beyond the base of the antennal scale. Marsupial pouch of the female composed of seven pairs of incubatory lamellæ. Telson large, apex truncate, not incised. Outer plates of the swimmerets (uropods) not divided by a transverse suture.

### *Scolopthalmus lucifugus*, sp. nov.

Frontal margin of carapace produced so as to form an acute rostrum ; anterolateral margins oblique, armed with two spines, one behind the external margin of the antennule, the other at the anterior inferior angle. Cervical sulcus well marked, with a distinct linguiform dorsal area behind it. Posterior lateral wings short and rounded. Abdominal segments smooth and cylindrical, sixth segment nearly as long as the two antecedent segments combined. Telson broad, truncate. Eyes atrophied, their peduncles assuming the form of spines. Antennal peduncles one half as long as the carapace, second and third segments about equal in length, a little longer than the first, the third slenderer than the first and second ; the flagella are equal to or rather longer than the peduncle, and present a uniform structure of small articulations, the basal part of the outer flagellum not being expanded. The antennal scale and mandibular palpi are described in the generic diagnosis ; the antennal scale is equal in length to the antennular flagellum. Abdominal limbs (of the female) simple, increasing in length posteriorly, the fifth pair distinctly two-jointed. Inner branch of uropods slender, lanceolate, surpassing the telson and the outer branch, the latter of which is oval and divided by transverse suture.

Length, 42 mm.

Station 3400. 1322 fathoms. 1 female.

**CERATOMYSIS, gen. nov.**

Cephalothorax robust. Carapace short (leaving the last two segments of the thorax exposed), spinose; frontal margin truncate, not forming a rostrum, armed at the external angles with a pair of long horn-like spines; a conspicuous notch at the anterior end of the lateral margin serving as an excurrent orifice from the respiratory chamber. Abdomen slender, cylindrical, spinose; sixth segment not much longer than the fifth. Eyes absent, their stalks taking the form of slender styles, whose tips are soft and delicate, perhaps serving as tactile organs. Antennular peduncle rather short; flagella much longer than the peduncle, flattened and fringed with long setæ on their margins. Antennal scale linear, ciliated on both margins. Mandibular palpi reaching beyond the antennular peduncle; terminal segment long oval, margins fringed with long setæ. First maxillipeds devoid of an exopod. Distal segment of second maxillipeds oval, ciliate. Legs long and slender, propodi not segmented. Seven pairs of incubatory lamellæ in the female. Fifth and sixth abdominal limbs elongated in the female. Telson linear, setose on the margin. Both branches of the uropods linear, setose on each margin, subequal, shorter than the telson; outer branch not divided by a transverse suture.

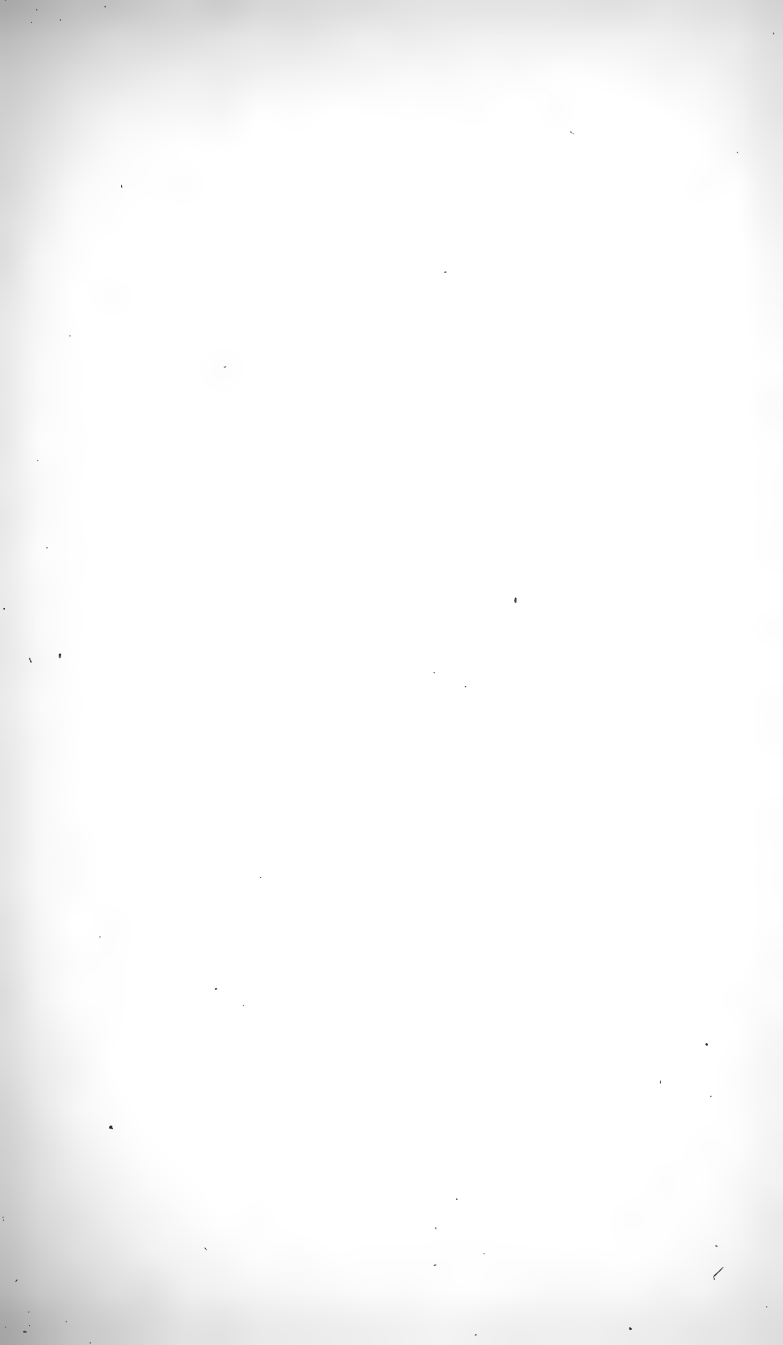
***Ceratomysis spinosa*, sp. nov.**

In front of the cervical groove are three long erect spines in the median line, the foremost of which is on the frontal margin; there is, besides, a spine on each side of the carapace in a transverse line with the middle one of the median row; behind the cervical groove there is one spine in the median line near the posterior margin of the carapace, two on each side of the tongue-shaped dorsal area, and a long row of six on each side, in line with the lateral spines of the gastric area. Abdomen armed with five longitudinal rows of spines (one median, four paired and lateral). Telson very long and narrow, nearly equalling the length of the remaining portion of the abdomen.

Color in life, milk-white.

Length, 36 mm.; carapace, 9 mm.

Station 3357. 782 fathoms. 1 female.





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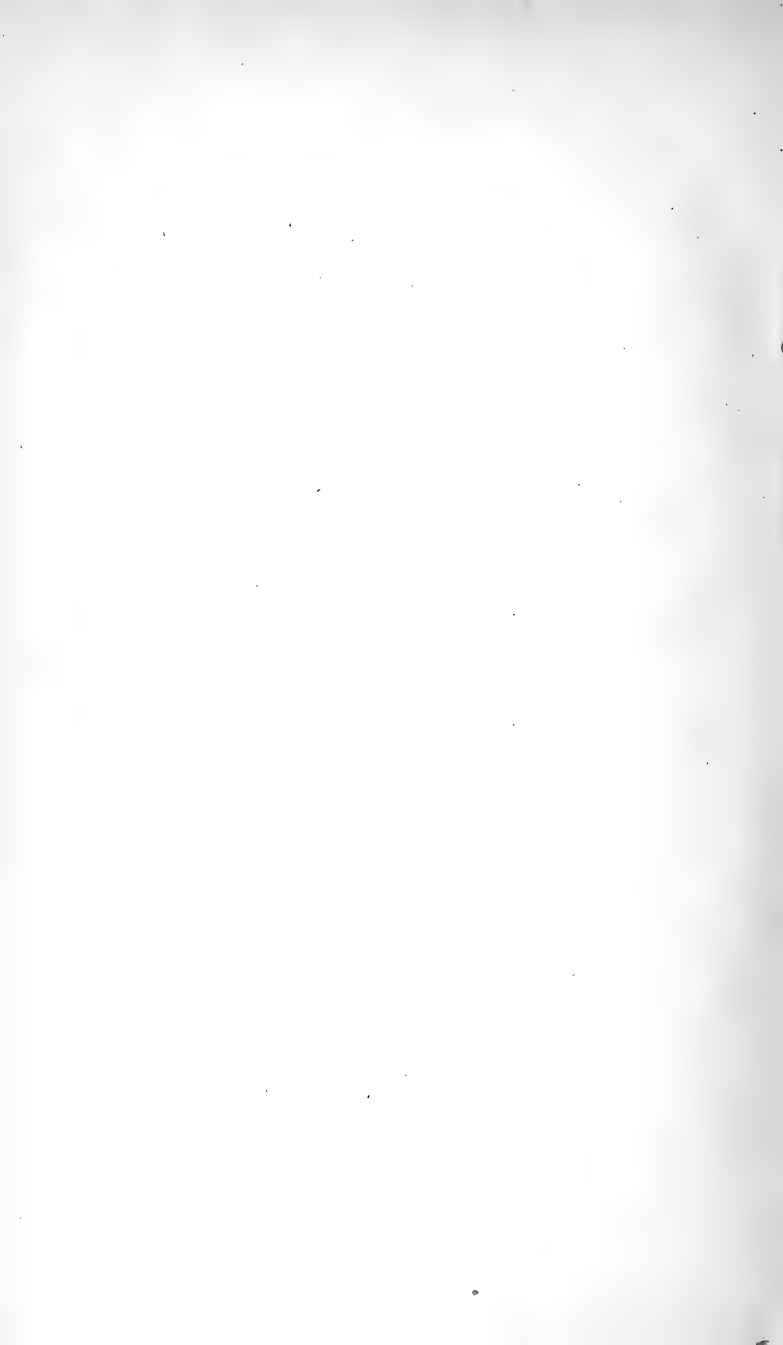


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*Mrs. Bathorn*

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XXXVII.

SUPPLEMENTARY NOTES ON THE CRUSTACEA.

BY WALTER FAXON.

WITH TWO PLATES.

CAMBRIDGE, MASS., U. S. A. :  
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No. 3. — *Reports on the Results of Dredging, under the Supervision of ALEXANDER AGASSIZ, in the Gulf of Mexico and the Caribbean Sea, and on the East Coast of the United States, 1877 to 1880, by the U. S. Coast Survey Steamer "Blake," Lieut.-Commander C. D. SIGSBEE, U. S. N., and Commander J. R. BARTLETT, U. S. N., Commanding.*

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XXXVII.

*Supplementary Notes on the Crustacea.* By WALTER FAXON.

THE following notes were made while identifying some of the "Blake" Crustacea that were retained as "duplicates" when the bulk of the collection was sent to A. Milne Edwards in Paris, and some (Macrura) that were returned by Milne Edwards undetermined. The notes chiefly consist of hitherto unpublished locality records, which add something to our knowledge of the distribution of many species. They also include descriptions of six new species (five Macrura and one Schizopod). Detailed lists of the dredging stations occupied by the "Blake" will be found in the Bulletin of the Museum of Comparative Zoology, Vol. VI. No. 1, and Vol. VIII. No. 4.

DECAPODA.

*Anamathia hystrix* (STIMPS.).

Station 300. 82 fathoms. 1 ♂.

*Anomalothir furcillatus* (STIMPS.).

Station 159. 196 fathoms. 1 ♀.

Off Port Royal, Jamaica. 100 fathoms. 1 ♀.



**Pericera cornuta cælata** (A. M. EDW.).

Station XX. 50 fathoms. 2 specimens.

**Picroceroides tubularis** MIERS.

Station XXI. 33 fathoms. 1 ♂.

The rostral horns and preocular spines are longer than in the male specimen figured by Miers.

**Lambro~~us~~ pourtalesii** STIMPS.

Station XXX. 51 fathoms. 2 ♂.

" 133. 42 " 1 ♂.

**Neptunus (Hellenus) spinicarpus** (STIMPS.).

Station 149. 60 to 150 fathoms. 1 ♀.

**Achelous spinimanus** (LATR.).

Station 144. 21 fathoms. 2 ♀.

**Calappa flammea** (HERBST).

Station 144. 21 fathoms. 1 ♂, 1 ♀.

**Acanthocarpus alexandri** STIMPS.

Station 148. 208 fathoms. 1 ♂, 1 ♀.

" 149. 60 to 150 fathoms. 1 ♂.

**Myropsis quinquespinosa** STIMPS.

Off Port Royal, Jamaica. 100 fathoms. 1 ♂.

**Iliacantha subglobosa** STIMPS.

Station X. 103 fathoms. 1 ♀.

**Cyclodorippe antennaria** A. M. EDW.

Station 238. 127 fathoms. 1 ♀.

" 246. 154 " 2 ♀.

" 274. 209 " 1 ♂, 1 ♀.

**Iconaxius caribbæus**, sp. nov.**Plate I. Figs. 1-4.**

Similar to *Iconaxius acutifrons* Bate, but different in the form of the rostrum, which is much broader than in *I. acutifrons*, less triangular in its outline, and broadly rounded at the anterior end; the upper border of the propodite of the larger cheliped, moreover, is entire, not denticulate as in *I. acutifrons*. The eyes are larger, and more heavily pigmented.

The margins of the rostrum are minutely denticulate, as in *I. acutifrons*, the median keel entire.

Length, 17 mm.

Station 166. 150 fathoms. 1 specimen.

" 232. 88 " 1 "

" 241. 163 " 3 "

" 283. 237 " 1 (type).

Lives as a commensal in Sponges of the genus *Farrea*.

The genus *Iconaxius*, of which four species have been previously described, has a wide distribution in the warm and temperate seas. It has been recorded from such remote localities as the Arabian Gulf, Banda Sea, Japan, Kermadec Islands, and the Gulf of Panama. It is now for the first time recorded from the Atlantic.

**Polycheles crucifer** (W.-S.).

Station 29. 955 fathoms. 3 specimens.

" 135. 450 " 1 "

" 179. 824 " 1 (exuviae).

" 180. 982 " 1 specimen.

" 182. 1,131 " 1 "

" 188. 372 " 1 "

" 190. 542 " 1 "

**Polycheles agassizii** (A. M. EDW.).

Station 129. 314 fathoms. 3 specimens.

" 153. 303 " 1 "

" 238. 127 " 1 "

" 260. 291 " 1 "

" XXVI. 297 " 1 "

**Polycheles sculptus** SMITH.

Station 211. 357 fathoms. 3 specimens.

" 227. 573 " 1 "

" 230. 464 " 1 "

Station 245.	1,058 fathoms.	1 specimen. <sup>1</sup>
“ 257.	553	“ 2 “
“ 265.	576	“ 2 “
“ 268.	955	“ 1 “
“ VII.	610	“ 1 “
“ XVIII.	600	“ 2 “

### *Nephropsis agassizii* A. M. EDW.

*Nephropsis agassizii* A. M. Edw., Ann. Sci. Nat., Zool., 6<sup>e</sup> sér., Vol. IX. No. 2, 1880.

Station 195.	502½ fathoms.	1 ♀.
“ 200.	472	“ 1 ♂.
“ 227.	573	“ 1 ♂.

### *Nephropsis aculeata* SMITH.

*Nephropsis aculeata* Smith, Proc. U. S. Nat. Mus., Vol. III. p. 431, 1881.

*Nephropsis agassizii* Smith, Bull. Mus. Comp. Zool., Vol. XV. p. 44, Fig. 240, 1888 (nec A. M. Edw.).

*Nephropsis rosea* (W.-Suhm MS.) Bate, Rep. “Challenger” Macrura, p. 178, Fig. 39, Pl. XXIII. Figs. 1, 2, Pl. XXIV. Fig. 1, 1888.

Station 185.	333 fathoms.	3 specimens.
“ 188.	372	“ 1 “
“ 222.	422	“ 3 “
“ 226.	424	“ 1 “
“ 230.	464	“ 1 “
“ ?	?	“ 1 “

There are two species of *Nephropsis* in the West Indian region, *N. agassizii* A. M. Edw., with two pairs of lateral spines on the rostrum, and *N. aculeata* Smith, with only one pair of rostral spines. *N. agassizii* was very inadequately described by A. Milne Edwards, and the type specimen, from the Strait of Florida, 1,500 metres, has never been returned to Cambridge. Soon after, the other species, *N. aculeata*, was described by Smith from specimens obtained off the south coast of New England, in 100 to 126 fathoms. Subsequently Smith and other authors supposed that *N. aculeata* was identical with *N. agassizii*. The chief differences between the two species are the following. In *N. agassizii* the rostrum is armed with two or two and a half pairs<sup>2</sup> of lateral teeth; in *N. aculeata* there is only one pair of lateral rostral spines;

<sup>1</sup> Identified as *P. agassizii* by A. Milne Edwards, and so recorded by him in Bull. Mus. Comp. Zool., Vol. VIII. p. 66, 1880.

<sup>2</sup> The third lateral spine may occur on either the right or the left side of the rostrum.

the shell is less coarsely granulated, but more spiny in the former species than in the latter; the two lines on the proximal half of the rostrum in both species, widely diverging as they pass backward over the gastric area, are marked by small tubercles in *N. aculeata*, by distinct acute spines in *N. agassizii*; the top of the small median tubercle on the gastric area is truncated in *N. aculeata*, while in *N. agassizii* it is bluntly triangular, passing into a slight median longitudinal carina both in front and behind; the abdominal pleuræ are produced into longer spines in *N. agassizii* than in *N. aculeata*, and the spines moreover trend more distinctly backward, forming a stronger angle with the vertical axis of the pleura; the outer surfaces of these pleuræ are quite smooth in *N. agassizii*, while in *N. aculeata* they are conspicuously granulated both on their margins and on the distinctly raised central field; the lateral borders of the abdominal terga, which form a festoon on each side of the abdomen, are more strongly convex in the former species; another distinction is apparent in the sixth abdominal somite, viz. in *N. aculeata* the antero-lateral margin of the pleura is shorter than the postero-lateral border, whereas in the other species the antero-lateral border is longer than the postero-lateral; the tergum of this somite in *N. aculeata* sends off a granulated ridge from near its posterior lateral angles, — a ridge which runs forward into the upper, depressed portion of the pleura; this ridge is not found in *N. agassizii*.

*Nephropsis rosea* Bate is without much doubt a young individual of *N. aculeata*. *N. atlantica* Norman<sup>1</sup> is very similar to *N. agassizii*, but has a sharp spine on the anterior margin of the second abdominal pleura.

#### **Stenopus hispidus (OLIV.).**

Station	11.	37 fathoms.	1 specimen.
"	12.	36 "	1 "
"	36.	84 "	1 "
"	132.	115 "	2 "

#### **Pontophilus gracilis SMITH.**

Station	43.	339 fathoms.	1 specimen.
"	47.	321 "	24 "
"	48.	533 "	1 "
"	221.	423 "	1 "

#### **Prionocrangon pectinata, sp. nov.**

##### **Plate II. Figs. 4-7.**

Rostrum spiniform, inclined at an angle of 45° to the axis of the body. Median dorsal line of the carapace armed with a row of eight spiniform teeth,

<sup>1</sup> Proc Roy. Soc. Edinburgh for 1881-82, p. 684; Wood-Mason and Alcock, Ann. Mag. Nat. Hist., 6th Series, Vol. VII. p. 197, Fig. 4, 1891.

which extends backward nearly to the posterior border of the carapace. Antero-lateral margins of the carapace angulated below the orbit. Telson much shorter than the appendages of the sixth abdominal somite, broad, with a pair of dorsal longitudinal ribs, abruptly contracted a short way beyond the middle; tip truncate, setiferous.

The eyes are absent; their peduncles are transformed into a pair of closely apposed tribedral processes, with acute and somewhat divergent tips. The first segment of the antennule is very long, reaching nearly to the end of the antennal scale; the second and third segments are, on the other hand, very short, the third bearing two flagella, the outer of which is very much shorter than the inner. The antennal scale is long and narrow, its outer margin lightly concave.

Length, 28 mm.

Station 201. Off Martinique. 565 fathoms. 1 ♀.

The rostrum is proportionally smaller than in *P. ommatosteres* Wood-Mason,<sup>1</sup> while the dorsal teeth of the carapace are larger, more numerous, and extend farther back on the cephalothorax; the telson is shorter; the antennal scale is longer than the proximal segment of the antennule. According to Wood-Mason, there is no trace of eyes or eye-stalks in *P. ommatosteres*. In *P. pectinata* there are distinct rudiments of the eye-stalks, as above described. *P. ommatosteres* comes from the Andaman Sea, 405 fathoms, and the Bay of Bengal, 200-350 fathoms.

#### *Glyphocrangon aculeata* A. M. EDW.

Station	29.	955 fathoms.	1 specimen.
"	163.	769	" 2 "
"	174.	878	" 1 "
"	190.	542	" 4 "
"	195.	502 $\frac{1}{2}$	" 1 "
"	265.	576	" 2 "
"	VIII.	610	" 1 "

#### *Glyphocrangon spinicauda* A. M. EDW.

Station	148.	208 fathoms.	2 specimens.
"	274.	209	" 12 "
"	275.	218	" 6 "
"	281.	288	" 7 "

<sup>1</sup> Ann. Mag. Nat. Hist., 6th ser., Vol. VIII. p. 362, 1891; Journ. Asiatic Soc. Bengal, Vol LXIII. p. 152, 1894; Ill. Zoöl. R. I. M. S. "Investigator," Crust., Pl. IX. Fig. 4, 1895.

**Glyphocrangon nobilis** A. M. Edw.<sup>1</sup>

Station	41.	860 fathoms.		6 specimens.
"	130.	451	"	2 "
"	162.	734	"	2 "
"	174.	878	"	4 "
"	176.	391	"	1 young.
"	179.	824	"	1 specimen.
"	185.	333	"	7 "
"	211.	357	"	1 young.
"	222.	422	"	2 "
"	227.	573	"	1 specimen.

**Glyphocrangon neglecta**, sp. nov.**Plate I. Figs. 5, 6.**

Rostrum longer than the rest of the carapace, trending a little downward for the anterior half of its length, then curving gently upward to the tip, which is slender and acute; the anterior half of the rostrum is distinctly carinated in the median line, but the carina fades away before attaining the base of the rostrum;

<sup>1</sup> The *Glyphocrangon* doubtfully referred to *G. nobilis* in my Report on the Stalk-eyed Crustacea of the "Albatross" Expedition of 1891 (Mem. Mus. Comp. Zoöl., Vol. XVIII. p. 142, 1895) is distinct from *G. nobilis*, as appears from an examination of a larger number of specimens of the latter species. In the "Albatross" species, which may be called *Glyphocrangon vicaria*, the upper surface of the rostrum is corrugated on each side of the median carina, in front of the anterior pair of lateral spines; in *G. nobilis* this corrugation does not exist. In *G. vicaria* the anterior moiety of the fourth or lateral crest of the carapace is broken into two parts by a deep notch; the part in front of the notch is produced anteriorly to form a strong spine, while the part behind the notch merely forms a projecting angle or shoulder; in *G. nobilis* the anterior moiety of the fourth crest is continuous from the posterior end to the anterior spine. The tubercles of the first and second crests are more prominent and spiniform in *G. vicaria* than in *G. nobilis*: The dorsal carinæ of the telson are dentate anteriorly in *G. vicaria*, simple in *G. nobilis*. *G. vicaria* is even more closely related to *G. longirostris* Smith, which it represents on the Pacific side of the American continent. These are the chief differences between the two species: the rostrum, corrugated above in both species, is narrower in front of the anterior lateral spines in *G. vicaria* than in *G. longirostris*. The anterior moiety of the fourth lateral carina is broken into two distinct parts by a notch in the former, while it is merely sinuate in its outline in the latter. The tubercles on the first and second crests of the carapace are more prominent and spiny in the former than in the latter. The median dorsal crest of the abdomen, moreover, is more prominent. These differences, though very small, appear to be constant, and afford another instance of a slight divergence between two representative forms on the Atlantic and Pacific sides of the American continent. The type specimens of *G. vicaria* were dredged in 1189 fathoms, Lat. 0° 54' N., Long. 91° 9' W., "Albatross" Station 3411.

there are two pairs of lateral rostral spines, one of which lies in advance of the eyes, the other just behind the posterior wall of the orbit; on the lower face of the rostrum there appears just the slightest trace of a median longitudinal carina. The upper surface of the first or dorsal pair of carinæ is eroded; behind the cervical groove this pair of carinæ converge towards one another. Just in front of this pair of carinæ, lying in the median line at the base of the rostrum, is a small tubercle or papilla. In the interval between the first and second carinæ on each side are about four faint tubercles on the cardiac region, and on each side of the gastric region are four larger low tubercles, the hindmost of which is the largest of all. The anterior moiety of the third carina (adopting Wood-Mason's terminology) is well developed as a backward prolongation of the external orbital spine, which is long, acute, and inclined outward and upward. The fourth carina is also developed both anteriorly and posteriorly to the cervical groove, its anterior moiety being continuous with the antero-inferior, or branchiostegian, spine of the carapace. Barring the external orbital and branchiostegian spines, the anterior moieties of both the third and fourth carinæ are entire, without a trace of spine or tooth. The trend of the branchiostegian spine is nearly straight forward, its downward and outward deflection being very slight. With the exceptions noted above, the spaces between the carinæ of the carapace are pretty smooth.

The abdomen is lightly sculptured for the genus to which this species belongs. Only the first and sixth segments are conspicuously carinated above. The pleuræ of the second abdominal segment are one-toothed. The telson exceeds the last pair of abdominal appendages, and is rather abruptly bent upward at the tip.

Length, 75 mm.; cephalothorax including rostrum, 35 mm.; rostrum, 19 mm.; telson, 13 mm.

Station 261, off Grenada. 340 fathoms. 1 ♀ with eggs. Type.

" 153, off Montserrat. 303 " 1 ♂.

" 260, off Grenada. 291 " 1 young.

This species is peculiar in having the anterior moiety of the third and fourth carinæ of the carapace well developed and continuous with the external orbital and branchiostegian spines respectively. In *G. gilesii* Wood-Mason, which also has the anterior portion of both the third and fourth crests developed, these crests are produced anteriorly into small spines independent of the external orbital and branchiostegian spines.

#### **Stylodactylus serratus** A. M. EDW.

Station 205. 334 fathoms. 3 specimens.

" 151. 356 " 1 "

#### **Pantomus parvulus** A. M. EDW.

Station 134 248 fathoms. 2 specimens.

**Pandalus longipes** A. M. EDW.

Station 274.	209 fathoms.	12+	specimens.
" 291.	200	"	12+ "
" 295.	180	"	2 "
" 300.	82	"	12+ "

**Pandalus ensis** A. M. EDW.

Station 208.	213 fathoms.	1	specimen.
" 258.	159	"	2 "

**Pandalus leptocerus** SMITH.

Station 345.	71 fathoms.	1	specimen.
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**Heterocarpus lævis** A. M. EDW.

Station XXVI.	297 fathoms.	1	specimen.
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**Heterocarpus alexandri** A. M. EDW.

Station 196.	1030 fathoms.	1	specimen.
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**Heterocarpus ensifer** A. M. EDW.

Station 146.	245 fathoms.	1	specimen.
" 153.	303	"	1 "
" 258.	159	"	2 "

**Nematocarcinus cursor** A. M. EDW.

Station 151.	356 fathoms.	12+	specimens.
" 160.	393	"	2 "
" 161.	583	"	1 "
" 205.	334	"	2 "
" 227.	573	"	2 "
" 274.	209	"	1 "

**Hoplophorus gracilirostris** A. M. EDW.

Station 100.	250-400 fathoms.	1	specimen.
" 191.	108-250	"	1 "
" 226.	424	"	1 "
" 230.	464	"	1 "
" 258.	159	"	1 "
" 271.	458	"	1 "



**Acanthephyra affinis**, sp. nov.

Plate II. Fig. 1-3.

Similar to *Acanthephyra* (*Systellaspis*) *lanceocaudata* Bate, but different in the following regards: the apical tooth of the antennal scale projects forward far beyond the membranous part of the organ; the telson is shorter than even the inner branches of the posterior pair of abdominal appendages, and its dorsal surface is flattened, but not grooved.

The seven teeth that surmount the gastric crest are closely approximated, and increase in size successively from the first to the fifth. The sixth is about equal to the fifth, the seventh a little smaller. The egg of this species measures  $3 \times 2$  mm.

Length, 100 mm.

Station 258. 159 fathoms. 1 ♀.

This species belongs to the subgenus *Systellaspis*, in which the orbit is continuous to the first antennal tooth (the orbital tooth being absent), the dorsal carina of the sixth abdominal somite is wanting, and a prominent angle or tooth projects from each side of the anterior border of the first abdominal somite, overlapping the posterior margin of the carapace. The eggs, moreover, are of large size, indicating a protracted period of intra-oval development.

**Acanthephyra debilis** A. M. EDW.

Station 107. 428 fathoms. 1 specimen.

**Acanthephyra armata** A. M. EDW.

Station 135. 450 fathoms. 1 specimen.

“ 151. 356 “ 2 “

**Sicyonia edwardsii** MIERS.

Station 142. 27 fathoms. 1 specimen.

**Sicyonia brevirostris** STIMPS.

Station 38. 20 fathoms. 1 specimen.

**Peneus brasiliensis** LATR.

Station 37. 35 fathoms. 2 specimens.

“ 29. 955 “ 3 young.

**Parapeneus megalops** SMITH.

Station 147.	250 fathoms.	4 specimens.
" 148.	208 "	4 "
" 258.	159 "	6 "
" 275.	218 "	4 "
" 281.	288 "	10 "
" 283.	237 "	1 "

**Parapeneus politus** SMITH.

Station 36. 84 fathoms. 27 specimens.

**Haliporus debilis** (SMITH).

Station 47. 321 fathoms. 1 specimen.

**Plesiopeneus armatus** (BATE).

Station 31.	1,920 fathoms.	2 specimens.
" 187.	411 "	1 "

**Hemipeneus triton** FAX.

Station 227. 573 fathoms. 1 specimen.

**Benthesicymus bartletti** SMITH.

Station 29.	955 fathoms.	1 specimen.
" 33.	1400-1568 "	1 "
" 163.	769-878 "	2 "
" 179.	824 "	1 "
" 190.	542 "	1 "
" 227.	573 "	2 "
" 245.	1058 "	1 "
" 265.	576 "	1 "
" 288.	399 "	2 "

**Sergestes robustus** SMITH.

Station 205.	334 fathoms.	1 specimen.
" 211.	357 "	1 "
" 260.	291 "	1 "
" 264.	416 "	1 "
" 265.	576 "	2 "
" 267.	626 "	1 "

**Sergestes mollis** SMITH.

Station 30. 968 fathoms. 2 specimens.

**SCHIZOPODA.****Lophogaster longirostris**, sp. nov.

Plate. II. Figs. 8-10.

Similar to *L. typicus* Sars, but different in the great length of the median spine of the rostrum, which far surpasses the antennular peduncle, and almost attains to the tips of the antennal scales. There are six teeth along the outer edge of the antennal scale. Length, 27 mm.

Station 50. 119 fathoms. 20 specimens.

**Gnathophausia zoëa** W.-SÜHM.

Station 185.	333 fathoms.	2 specimens.
" 201.	565	" 1 "
" 221.	423	" 1 "
" 227.	573	" 1 "
" 228.	785	" 1 "
" 230.	464	" 1 "
" 284.	347	" 2 "
" 288.	399	" 3 "

**Eucopeia sculpticauda** FAX.

Station 30. 968 fathoms. 1 specimen.

**Petalophthalmus armiger** W.-SÜHM.

Station 29. 955 fathoms. 1 ♀.

This is the specimen figured in my Report on the Stalk-eyed Crustacea of the "Albatross" Expedition of 1891, Pl. LIII. Fig. 2 (Mem. Mus. Comp. Zool., Vol. XVIII.).

## STOMATOPODA.

*Squilla empusa* SAY.

Station 36. 84 fathoms. 1 specimen (young).

*Pseudosquilla ciliata* (FABR.).

Martinique. 1 specimen.

## ISOPODA.

*Bathynomus giganteus* A. M. EDW.

Station 179. 824 fathoms. 1 specimen, 157 × 80 mm.

“ VII. 610 “ 1 “ 107 × 49 “

According to Wood-Mason and Alcock (Ann. Mag. Nat. Hist., 6th Series, Vol. VII. p. 270, 1891), this remarkable Isopod was captured in the Bay of Bengal at a depth of 740 fathoms. Dr. Arnold Ortmann<sup>1</sup> has described a second species of *Bathynomus* (*B. dederleini*), taken on the coast of Japan, near Enoshima, Sagami Bay. The depth is not recorded.

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., 1894, p. 191.

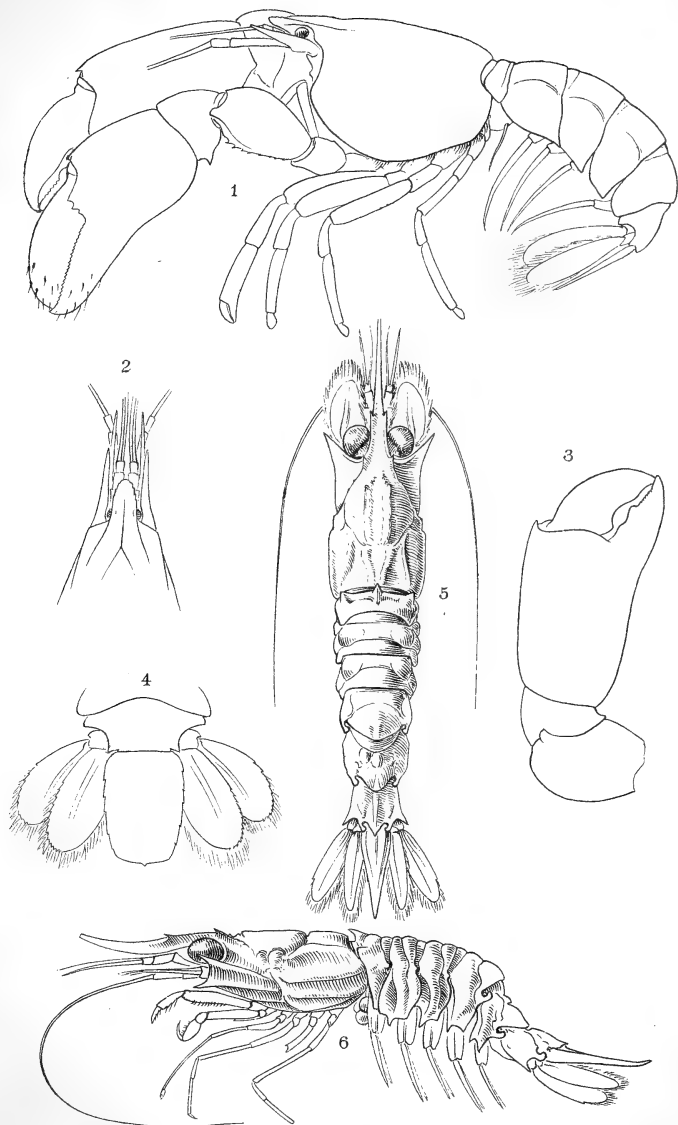
## EXPLANATION OF THE PLATES.

## PLATE I.

- Fig. 1. *Iconaxius caribbæus* Fax. M. C. Z., No. 4195. Blake Sta. 283.  $\times 5\frac{1}{2}$ .  
 Fig. 2. The same. Head, from above.  $\times 5\frac{1}{2}$ .  
 Fig. 3. The same. Right chela, from the outside.  $\times 5\frac{1}{2}$ .  
 Fig. 4. *Iconaxius caribbæus* Fax. Telson and posterior pair of appendages. M. C. Z., No. 4147. Blake Sta. 241. Much enlarged.  
 Fig. 5. *Glyphocrangon neglecta* Fax. Female, dorsal view. M. C. Z., No. 4434. Blake Sta. 261.  $\times 1\frac{1}{3}$ .  
 Fig. 6. The same. Lateral view.  $\times 1\frac{1}{3}$ .

## PLATE II.

- Fig. 1. *Acanthephyra affinis* Fax. Female. M. C. Z., No. 4410. Blake Sta. 258.  $\times 1\frac{1}{2}$ .  
 Fig. 2. The same. Telson.  $\times 1\frac{1}{2}$ .  
 Fig. 3. The same. Antennal scale.  $\times 1\frac{1}{2}$ .  
 Fig. 4. *Prionocrangon pectinata* Fax. Female. M. C. Z., No. 4436. Blake Sta. 201.  $\times 4$ .  
 Fig. 5. The same. Carapace, from above.  $\times 4$ .  
 Fig. 6. The same. Chela.  $\times 4$ .  
 Fig. 7. The same. Telson and posterior pair of abdominal appendages.  $\times 4$ .  
 Fig. 8. *Lophogaster longirostris* Fax. M. C. Z., No. 4380. Blake Sta. 50.  $\times 4$ .  
 Fig. 9. The same. Carapace, from above.  $\times 4$ .  
 Fig. 10. The same. Telson and posterior pair of abdominal appendages.  $\times 4$ .

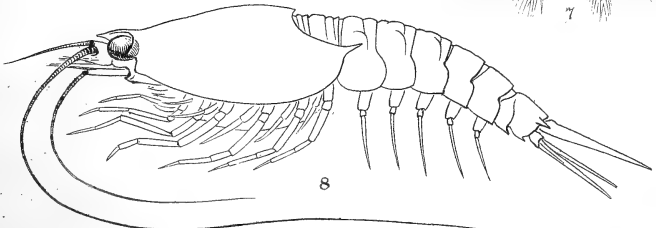
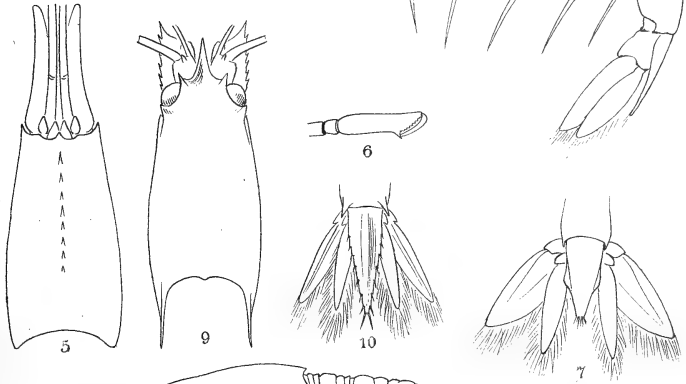
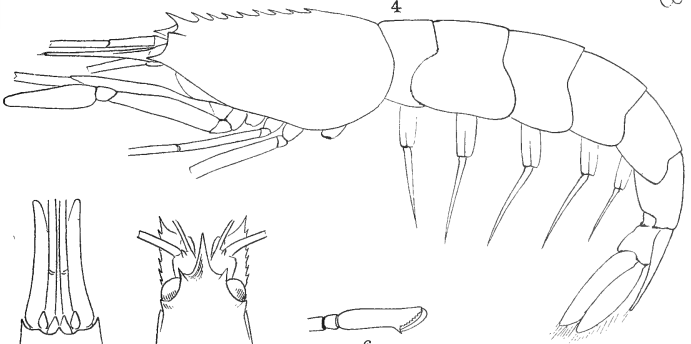
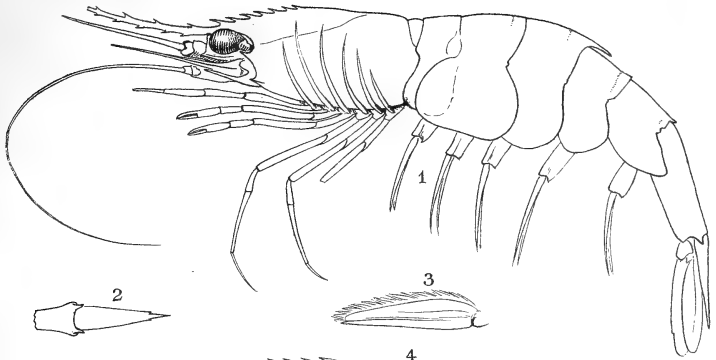


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1-4 *Iconaxius caribbaeus* Fax.  
5-6 *Glyphocrangon neglecta* Fax.





J.H.Emerton del.

Heliotype Printing Co.

1-3 *Acantheptyra affinis* Fax.  
4-7 *Prionocrangon pectinata* Fax.  
8-10 *Lophogaster longirostris* Fax.





Mr. Richard Rathbun  
15 Washington, D.C.  
with the regard of  
W. Faxon

SMITHSONIAN INSTITUTION.

UNITED STATES NATIONAL MUSEUM.

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OBSERVATIONS ON THE ASTACIDÆ IN THE  
UNITED STATES NATIONAL MUSEUM AND  
IN THE MUSEUM OF COMPARATIVE  
ZOOLOGY, WITH DESCRIPTIONS  
OF NEW SPECIES.

BY

WALTER FAXON,

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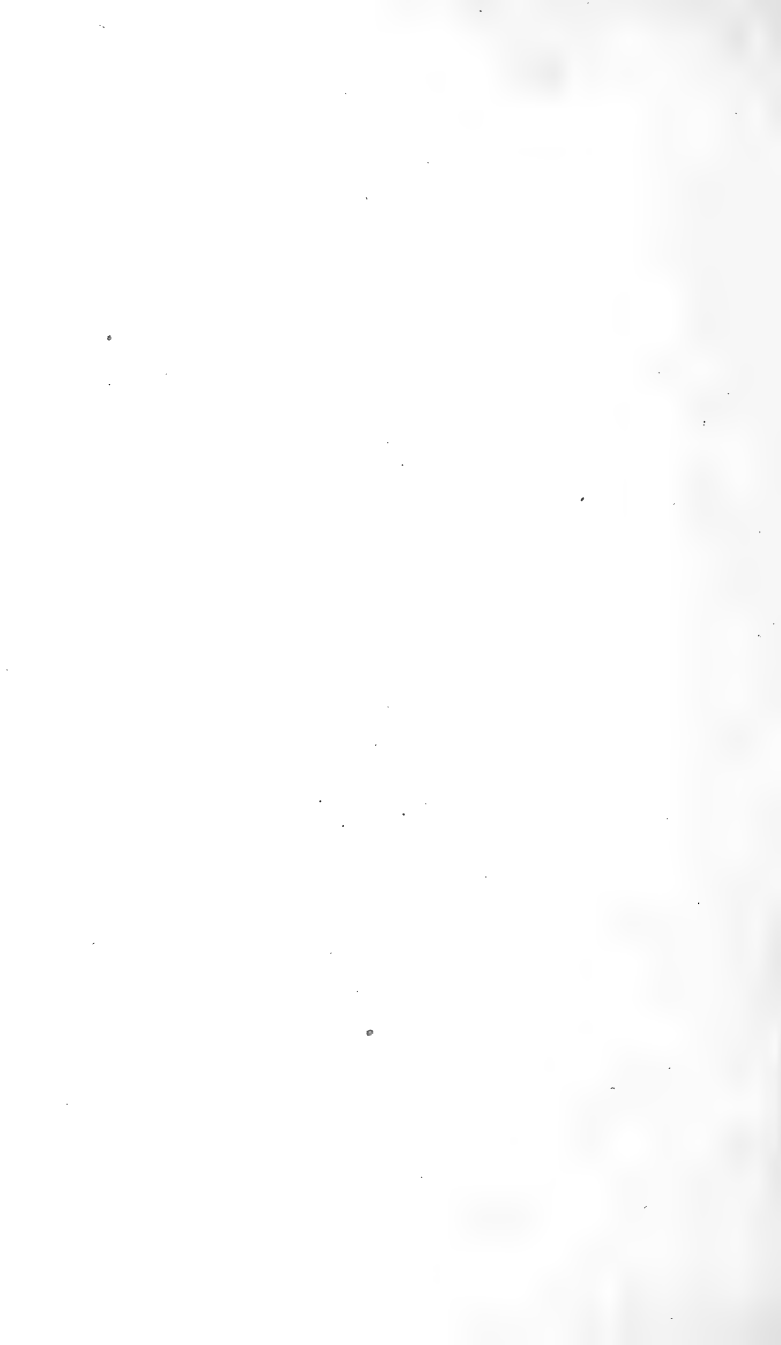
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From the Proceedings of the United States National Museum, Vol. XX, pages 643-694  
(with Plates LXII-LXX).

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OBSERVATIONS ON THE ASTACIDÆ IN THE UNITED STATES NATIONAL MUSEUM AND IN THE MUSEUM OF COMPARATIVE ZOOLOGY, WITH DESCRIPTIONS OF NEW SPECIES.

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By WALTER FAXON,

*Assistant in charge of Mollusca and Crustacea, Museum of Comparative Zoology,  
Cambridge, Massachusetts.*

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SINCE the publication of my "Notes on North American Crayfishes" in 1890, a good deal of material has accumulated in the United States National Museum and in the Museum of Comparative Zoology. The first part of the present article embodies the results of an examination of this material.<sup>1</sup>

The second part relates to the crayfishes of the Southern Hemisphere—the *Parastacinae*. After the publication of Part I of my "Revision of the Astacidae," which treated of the Northern Hemisphere genera, *Cambarus* and *Astacus*, I hoped to get together a collection of the Parastacine crayfishes that would enable me to issue the second part of the revision in a shape similar to the first part. Disappointed in this hope, I have decided to include in this paper such results as I could obtain from a study of the *Parastacinae* in the two museums above named. Thanks to Mr. Charles C. Chilton, of Christchurch, New Zealand, my series of New Zealand crayfishes is ample, but lack of adequate material from Australia, Tasmania, and South America precludes a satisfactory revision of the *Parastacinae* as a whole.

Six new species and three new subspecies of *Cambarus* are described and figured in this paper. Of these, five belong to the United States, four to Mexico. Five new species of *Parastacus* are also described and figured—two from Uruguay, two from Chile, and one ostensibly from Mexico.

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<sup>1</sup>Anyone who undertakes the perplexing study of the North American crayfishes should have at hand the following works: 1. Monograph of the North American Astacidae. By Hermann A. Hagen. Ill. Cat. Mus. Comp. Zool., No. 3 [Mem. Mus. Comp. Zool., II, No. 1], 1871. 2. A Revision of the Astacidae. Part I. The Genera *Cambarus* and *Astacus*. By Walter Faxon. Mem. Mus. Comp. Zool., X, No. 4, 1885. 3. Notes on North American Crayfishes—Family Astacidae. By Walter Faxon. Proc. U. S. Nat. Mus., XII, pp. 619-634, 1890. 4. The present article. In these works all the North American crayfishes are described and many of them figured.

## Family ASTACIDÆ.

Subfamily ASTACINÆ.<sup>1</sup>

## Genus CAMBARUS Erichson.

*Cambarus* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 88, 1846.

Type, *Astacus bartonii* Fabricius.

GROUP I. (Type, *Astacus blandingii* Harlan.)

Third segment of third and fourth pairs of legs of male hooked. Outer part of first pair of abdominal appendages of male truncate at the tip and furnished with one to three small recurved teeth; inner part ending in a short acute spine, which is commonly directed outward.

## CAMBARUS BLANDINGII ACUTUS (Girard).

Specimens of this Southern and Western form of *C. blandingii* have been received through Professor S. E. Meek from Kainister and Good Land, Indian Territory, Mammoth Spring, Batesville, and Camden, Arkansas, and Arthur (Red River), Texas. There are specimens in the United States National Museum from Corpus Christi, Texas, and from Portage River, at Oak Harbor, Ohio. Mr. W. P. Hay<sup>2</sup> has recorded this form from the following new localities in Indiana: Turkey Lake, Kosciusko County; Lake Maxinkuckee, Marshall County; Kankakee River, Lake County; Terre Haute, Vigo County.

Specimens procured by Professor Meek at McAlister, Indian Territory, are peculiar. The rostrum is narrower, more deeply excavated, with more convergent sides than in typical specimens of *C. b. acutus*. The rostral acumen, too, is longer, surpassing the antennular peduncle, the lateral spines more prominent. The rostrum approaches the form seen in the Eastern *C. blandingii*, or even more nearly that of the typical *C. clarkii* from Texas.

## CAMBARUS FALLAX Hagen.

Eustis, Lake County, Florida (Coll. U.S.N.M.); Gainesville, Alachua County, Florida (Coll. Mus. Comp. Zool.).

## CAMBARUS CLARKII Girard.

There is a fine series of specimens in the United States National Museum, collected in Las Moras Creek, Kinney County, Texas, by F. A. Clark and E. A. Mearns, in 1893. As in the specimens collected by Edward Palmer at San Antonio, Texas, and described on page 26 of my "Revision of the Astacidae," the areola, although very narrow, is

<sup>1</sup> Same as Family *Potamobiidae* Huxley = Subfamily *Potamobiinae* Faxon. *Potamobius* being a synonym of *Astacus* (see p. 662), the subfamily name should be *Astacinae*.

<sup>2</sup> The Crawfishes of the State of Indiana. By W. P. Hay. 20th Ann. Rep. Dept. of Geology and Natural Resources of Indiana, pp. 475-507, 1896.

not obliterated and the sides of the rostrum are less strongly convergent. This is without doubt to be considered the typical form of *C. clarkii*, since Girard's specimens were collected in the same region, somewhere between San Antonio and El Paso del Norte.

**CAMBARUS ACHERONTIS** Lönnberg.

(Plate LXII, figs. 1-5.)

*Cambarus acherontis* LÖNNBERG, Zoolog. Anz., XVII, pp. 125-127, 1894; Bihang till K. Svenska Vet.-Akad. Handlingar, XX, Pt. 4, p. 6., figs. 1-6, 1894.

*Female*.—Rostrum broad, excavated, superior lateral margins raised into sharp carinæ which overhang the inferior lateral margins and continue backward inside of and parallel with the postorbital ridges; a pair of sharp projecting angles or teeth near the tip at base of the acumen; acumen short, acute. Rostrum, gastric region, and areola smooth and polished; sides of carapace thickly studded with small papillæ or tubercles; postorbital ridges furnished with a small spine at the anterior end; areola almost obliterated in the middle by the apposition of the branchio cardiac lines; posterior section of carapace equal in length to the distance between the cervical groove and the anterior spines of the postorbital ridges.

Abdomen a little longer than the cephalo-thorax, smooth; telson three or two spined on each side of the anterior segment, posterior segment subtruncate.

Antennæ very long, much longer than the body; a small external spine behind the base of the antennal scale; antennal scale very broad, broadest at the middle, apical end rounded and armed with a small external spine. Epistome short, broad, anterior border convex.

Chelipeds slender; merus furnished with the customary biserial spines below, superior margin spinulose, outer and inner faces sparsely granulated; carpus with a longitudinal furrow above, tuberculiferous, the tubercles tending to assume the form of short spines on the inner side; chelæ subcylindrical, granulated, the granules on the inner or upper margin of the hand taking on the form of blunt spines; fingers long, slender, inner and outer sides costate, upper margin of the dactylus tuberculate, cutting edges of fingers irregularly denticulate on the proximal half.

Length 75 mm.; carapace 39 mm.; from tip of rostrum to cervical groove 23.5 mm.; from cervical groove to posterior border of carapace 16 mm.; length of rostrum from tip to anterior spines of postorbital ridges 9 mm.; width of rostrum 4.5 mm.

Annulus ventralis transverse, with a prominent posterior tubercle and a crescentic anterior fossa.

In a young male of the second form, 43 mm. in length, the third pair of legs are furnished with a blunt hook on the third segment, while the corresponding segment of the fourth pair bears a small tubercle, the vestige of the hook of the adult. The first abdominal appendages

are truncate at the tip, the outer part terminating in two small recurved teeth, the inner part in a slender spine which is directed outward.

Gum Cave, Citrus County, Florida (Coll. U.S. N.M.). Two females, twelve young (male, Form II; female).

Lönnerberg's types of *Cambarus acherontis*, two males, 50 and 55 mm. long, were procured in sinking a well, from a subterranean rivulet about forty-two feet from the surface, in Orange County, Florida. According to Lönnerberg's description and figures, the chela is thicker than in the Citrus County examples above described, the telson is shorter, the abdominal pleuræ more acuminate, and the antennal scales more triangular in form. Following the description alone, the rostral acumen is blunt and its base extends back into the rostral groove as a slight ridge. These conditions are not true of the Citrus County specimens, neither are they shown in Lönnerberg's figures of *C. acherontis*. The only adult examples in the Citrus County lot, moreover, are females, while Lönnerberg's specimens were both males. I am therefore inclined to believe that the discrepancies between the Swedish author's account of *C. acherontis* and the specimens before me are due to differences in age and sex, and in part to inaccuracy of description and delineation.

This species, the fourth blind *Cambarus* described from the United States, is very distinct from any of the others. As pointed out by Lönnerberg, it is probably descended from *C. clarkii*. It is noteworthy that in a specimen of *C. clarkii* collected in St. Johns River, Florida, the areola, although narrow, is not obliterated in the middle. In this respect this specimen agrees with *C. acherontis* as well as with Texan specimens of *C. clarkii*, and differs from the form of *C. clarkii* found in Alabama, Mississippi, and Louisiana. That the maximum age of the caverns in which *C. acherontis* lives is probably Post-pliocene has been shown by Lönnerberg.<sup>1</sup>

#### CAMBARUS PUBESCENS Faxon.

Buckhead Creek, Millen, Burke County, Georgia (Coll. U.S.N.M.).

#### CAMBARUS VERSUTUS Hagen.

Pollard (Escambia County), Greenville (Butler County), and Calera (Shelby County), Alabama (Coll. U.S.N.M.). All of these specimens have a carinated rostrum.<sup>2</sup>

#### CAMBARUS ALLENI Faxon.

This species is recorded by Lönnerberg<sup>3</sup> from Apopka (Orange County), Arcadia (DeSoto County), and from Hillsboro County, Florida.

<sup>1</sup> Bihang till K. Svenska Vet.-Akad. Handl., XX, Pt. 4, pp. 8, 9, 1894.

<sup>2</sup> Rev. Astacide, p. 34, and Proc. U. S. Nat. Mus., XII, p. 619.

<sup>3</sup> Bihang till K. Svenska Vet.-Akad. Handl., XX, Pt. 4, p. 1, 1894.

## CAMBARUS PELLUCIDUS (Tellkampf).

This species has been found by Mr. W. P. Hay in Shiloh Cave, Down's Cave, and other caves near Bedford, Lawrence County, Indiana, and in a small cave near Paoli, Orange County, Indiana.<sup>1</sup> The specimens from these caves belong rather to the form described by Cope as *C. inermis* (Wyandotte Cave) than to the typical form commonly found in the Mammoth Cave of Kentucky. Mr. Hay has shown that these specimens are very variable as regards the development of the spines of the rostrum and sides of the carapace, and that the reduction of the spines is most marked in specimens from the more northerly localities. A transition is thus formed through these individuals to the following subspecies:

## CAMBARUS PELLUCIDUS TESTII Hay.

*Cambarus pellucidus testii* HAY, Proc. U. S. Nat. Mus., XVI, 1893, p. 285, pls. XLIV, XLV, figs. 2, 5, 6, 10, 11, 12; Crawfishes of the State of Indiana, p. 484, fig. 4, 1896.

In this form, which has been found in Mayfield's Cave and Truett's Cave, near Bloomington, Indiana (the most northern locality in which cave crayfishes were found by Mr. Hay), the reduction of the spines is carried to the extreme. The lateral spines of the rostrum, the anterior spines of the postorbital ridges, and the spines on the sides of the carapace are altogether wanting, while the external spine of the second antennal segment and the apical spine of the antennal scale are much reduced in length. So this form comes to bear a close likeness to *C. bartonii* and suggests the possible derivation of *C. pellucidus* from *C. bartonii*. It is true that in regard to the structure of the male external organs *C. pellucidus* is similar to those species of *Cambarus* that are placed in Group I. But, as I pointed out in my "Revision of the Astacidae" (p. 18), this type of the male organ is a very simple and primitive one, and might be acquired through an inherent reversionary tendency by cave-dwelling species of any of the groups into which the genus *Cambarus* has been divided. The presence of hooks upon the fourth pair of legs may, in this case, be correlated with the reversion of the male appendages to the type of Group I. It will be observed that in Form II (the less perfect form of the male) the hooks on the fourth pair of legs are more or less abortive not only in *C. p. testii* but also in the typical form of *C. pellucidus* from the Mammoth Cave.

The difference, pointed out by Hay, between *C. p. testii* and *C. pellucidus* from Shiloh and Wyandotte caves, with regard to the shape of the hooks on the third pair of legs, probably results from comparing the second form of *C. p. testii* with the first form of *C. pellucidus*.

Three types (two males, Form II, one female) of this subspecies are in the collection of the United States National Museum (No. 17702, Mayfield's Cave, Indiana, W. P. Hay).

<sup>1</sup>Proc. U. S. Nat. Mus., XVI, 1893, pp. 283-285.



GROUP II. (Type, *Astacus advena* Le Conte.)

Third segment of third pair of legs of male hooked. First pair of abdominal appendages of male similar to those of Group I.

## CAMBARUS CARINATUS, new species.

(Plate LXIII.)

*Male, Form I.*—Rostrum of moderate width, excavated, lateral margins slightly convergent, carinated, and armed near the tip with a pair of spiniform teeth; acumen of moderate length, reaching to the distal end of the antennular peduncle; a median longitudinal carina extends from the base of the acumen backward to the level of the eyes. Carapace coarsely granulated on the sides, armed with a pair of lateral teeth behind the cervical groove; branchiostegian spine small; postorbital ridges furnished with sharp anterior spines, posterior spines represented by slight tubercles; anterior border of carapace angulated below the orbit. Areola of moderate width, about one-half the length of the anterior section of the carapace.

Abdomen equal to the cephalo-thorax in length, smooth; pleuræ broad, bluntly angled. Anterior segment of telson three-spined on each side of the posterior margin; posterior segment short, rounded.

Basal segment of antennule armed with a spine below. Antennal scale broadest at the middle, tapering to a sharp apical spine. A sharp tooth at external base of the antennal scale. Epistoma triangular.

Chelipeds: Merus granulated on superior border, and armed with a single spine near the distal end; lower face with biserial arrangement of spines; carpus tuberculate within, with four spiniform teeth near the anterior border, viz, one near each point of articulation with the propodite and two between these points; hand of moderate width, inflated, covered with small squamous tubercles.

Third segment of third legs hooked.

First abdominal appendages stout, curved forward at apex, inner and outer parts ending in a small horny tooth, anterior margin furnished with a small tooth near the tip.

Length 125 mm.; carapace 62 mm.; length from tip of rostrum to cervical groove 40 mm.; length of rostrum from tip to anterior spine of postorbital ridge 17 mm.; acumen 5 mm.; cheliped 104 mm. (merus 25 mm., carpus 16 mm., chela 51 mm., dactylus 30 mm.); breadth of chela 17 mm.

*Type.*—Guadalajara, Mexico, altitude 5,200 feet (No. 17699, U.S.N.M.), P. L. Jouy. One male, Form I.

Ameca, Jalisco, Mexico (No. 16085, U.S.N.M.), A. Dugès. Hacienda de Villachuato, Michoacan, Mexico (No. 17707, U.S.N.M.), A. Dugès. Three males, Form I.

According to the manuscript label this species is brought to the market of Guadalajara as food.

## CAMBARUS MEXICANUS Erichson.

Mirador and Santa Maria, Mexico (Coll. U.S.N.M.). The annulus ventralis of the female forms a prominent tubercle, with perpendicular posterior wall, facing a roundish tubercle arising from the posterior thoracic segment. The anterior and ventral sides of the annulus are divided by a longitudinal groove which is bounded on each side by a rather prominent lip.<sup>1</sup>

## CAMBARUS GRACILIS Bundy.

Six young specimens from Day Brook, Jasper County, Missouri, Miss Ruth Hoppin, probably belong to this species. (No. 4341, Mus. Comp. Zool.)

GROUP III. (Type, *Astacus bartonii* Fabricius.)

Third segment of third pair of legs hooked. First pair of abdominal appendages of male thick, the inner and outer parts both terminating in a short recurved tooth.

## CAMBARUS BARTONII (Fabricius).

North Adams, Berkshire County, Massachusetts (Coll. Mus. Comp. Zool.); Westmoreland County, Pennsylvania; Waynesville, Haywood County, North Carolina; Roan Mountain, North Carolina, from an altitude of 6,000 feet (Doctor C. H. Merriam); Warren County, Ohio; Albany, Clinton County, Kentucky; Claiborne, Monroe, and McMinn Counties, Tennessee (Coll. U.S.N.M.); caves in Lawrence and Orange Counties, Indiana (W. P. Hay, Proc. U. S. Nat. Mus., XVI, 1893, p. 286).

## CAMBARUS BARTONII ROBUSTUS (Girard).

Oneida Creek, Peterboro, Madison County, New York, G. S. Miller, jr. (No. 4329, Mus. Comp. Zool.). According to Doctor R. W. Shufeldt,<sup>2</sup> *Cambarus bartonii robustus* in Montgomery County, Maryland, builds mud towers at the mouth of its burrow similar to those of *C. diogenes*. A figure of one of these towers, or "chimneys," from a photograph, is given in Shufeldt's article.

## CAMBARUS BARTONII LONGIROSTRIS Faxon.

Two males and one female from Will's Creek, Pollard, Escambia County, Alabama (Coll. U.S.N.M.). The suborbital angle is sharply

<sup>1</sup>In the artificial key to the species of Group II on p. 48 of my "Revision of the Astacida," *C. mexicanus* is distinguished from *C. simulans* by the moderate width of the areola contrasted with the narrow areola of *C. simulans*. In fact, the areola is very narrow in both species (it is too broad in the figure of *C. simulans* on pl. 1 of the "Revision"). The distinction should have been drawn from the rostrum and chelæ. The rostrum is nearly plane above in *C. mexicanus*, deeply hollowed out in *C. simulans*; the chela is much narrower, and more heavily and closely tuberculated in *C. mexicanus* than in the latter species.

<sup>2</sup>The Observer, VII, No. 3, p. 88, March, 1896.

defined and spiniform, as in specimens from Cumberland Gap.<sup>1</sup> *C. b. longirostris* has been previously known from Blountsville and Cumberland Gap, Tennessee, and the Clinch River, West Virginia.

**CAMBARUS LONGULUS** Girard.

Cumberland Gap, Tazewell, Greeneville, and Knoxville, Tennessee (Coll. U.S.N.M.).

**CAMBARUS LATIMANUS** (Le Conte).

Atalla, Etowah County, Alabama (Coll. U.S.N.M.). One male, Form II, three females. The sides of the rostrum are more nearly parallel than in Le Conte's types of *C. latimanus*.

**CAMBARUS DIOGENES** Girard.

Columbus and Lockbourne, Franklin County, Ohio (Coll. Mus. Comp. Zool.). Minnesota River at Fort Snelling, Minnesota (Coll. U.S.N.M.). Spring Creek at Delhi, Delaware County, Iowa; Belmond, Wright County, Iowa; Paragould, Greene County, Arkansas; Fayetteville, Washington County, Arkansas (Coll. S. E. Meek).

The specimen (male, Form II) from Belmond, Iowa, differs from the typical *C. diogenes* in having a long rostrum, with a narrower, more tapering acumen.

Mr. W. P. Hay has recorded this species from the following new localities in Indiana: Irvington, Marion County; Greencastle, Putnam County; North Salem, Hendricks County.

**CAMBARUS ARGILLICOLA** Faxon.

Bay Saint Louis, Hancock County, Mississippi; Brazoria and Victoria, Texas (Coll. U.S.N.M.). Irvington, Bloomington, and Wheatland, Indiana (*teste* W. P. Hay). According to Mr. Hay, *C. argillicola*, like *C. diogenes*, builds mud "chimneys" over its burrows.

**CAMBARUS EXTRANEUS** Hagen.

Five specimens from the Big Cahawba River, Alabama (Coll. U.S.N.M.), combine characters belonging to *C. extraneus* and to *C. girardianus* in such a way as to render it necessary to reduce the latter form to the rank of a subspecies. In these intermediate specimens, the areola is long as in *C. girardianus*; there are two spines on the upper border of the merus as in *C. extraneus*, while the posterior wall of the orbit has an outline midway between these two forms.

**CAMBARUS EXTRANEUS GIRARDIANUS** Faxon.

*Cambarus girardianus* FAXON, Proc. Amer. Acad. Arts and Sci., XX, p. 117, 1884.

Two males of the second form from Eastanaula Creek, near Athens, Tennessee (Coll. U.S.N.M.).

<sup>1</sup> Rev. Astacidae, p. 64.

GROUP IV. (Type, *Astacus affinis* Say.)

Third segment of third pair of legs of male hooked. First abdominal appendages of male bifid, terminating in two styliform branches, which are straight or lightly recurved.

## CAMBARUS LANCIFER Hagen.

*Cambarus lancifer* HAGEN, Monogr. N. A. Astacidae, p. 59, pl. I, figs. 86, 87; pl. III, fig. 159, 1870 (male, Form I).

*Cambarus faxonii* MEEK, Amer. Nat., XXVIII, p. 1042, figs. 1-4, 1894 (male, Form II).

In 1891 Mr. W. P. Hay sent me a female specimen of *C. lancifer* collected at Vicksburg, Mississippi. Up to that time Doctor Hagen's type specimen had remained unique. Mr. Hay's specimen differed from the type in having a median spine on the inner side of the carpus of the chelipeds. In the "American Naturalist" for December, 1894, Professor S. E. Meek described and figured the second form of the male under the name of *Cambarus faxonii*. Professor Meek's specimens were taken in St. Francis River at Greenway and Big Bay, Arkansas. Seven (four males, Form II; three females) have been presented to the Museum of Comparative Zoology (No. 4220). In the second form of the male the tips of the first pair of abdominal appendages are not horny, as in the first form; the inner and outer branches are of about equal length, the inner tapering to a rather sharp, straight point, the outer blunt and rounded. These appendages are cleft only for a short distance from the tip, and so present a form very similar to that seen in Groups I and II. The annulus ventralis of the female is depressed in front, more prominent and unituberculate behind, with a closed, curved fissure.

The areola is very incorrectly represented in Meek's fig. 1. The areola is entirely obliterated in the middle, not open as there portrayed.

## CAMBARUS INDIANENSIS W. P. Hay.

*Cambarus affinis*, var. FAXON, Proc. U. S. Nat. Mus., XXII, 1890, p. 628.

*Cambarus indianensis* HAY, 20th Ann. Rep. Dept. Geol. Indiana, p. 494, fig. 9, 1896.

This form, which I considered as a Western race of *Cambarus affinis*, has been described as a distinct species by Mr. Hay. It has been found in the Patoka River at Patoka, Indiana, and at Huntington, Dubois County, Indiana.

## CAMBARUS SLOANII Bundy.

Madison and Marengo, Indiana (*vide* W. P. Hay).

## CAMBARUS PROPINQUUS Girard.

Lake Douglas and Saginaw River, Michigan; Indian Lake, Waterloo, Indiana; Portage River at Oak Harbor, Ottawa County, Ohio. (Coll. U.S.N.M.)

*C. propinquus* is probably the most abundant crayfish in Indiana, according to Mr. W. P. Hay.

#### CAMBARUS OBSCURUS Hagen.

Westmoreland County, Pennsylvania (Coll. U.S.N.M.).

In the female of *Cambarus obscurus* the anterior part of the annulus ventralis is prominently bituberculate, and behind the tubercles there is a deep transverse fossa. The organ thus has a very different form from that of *C. propinquus*. This difference, together with the peculiarity of the sexual appendages of the first form of the male,<sup>1</sup> supports Doctor Hagen's view that *C. obscurus* is a species rather than a local race of *C. propinquus*, as I considered it in my "Revision."

#### CAMBARUS NEGLECTUS Faxon.

Day Brook, Jasper County, Missouri (No. 4344, Mus. Comp. Zool.); James River, Springfield, Missouri (Coll. U.S.N.M.). There are specimens of *Cambarus neglectus* in S. E. Meek's collection from the following new localities: Turkey River, Fort Atkinson, Winneshiek County, Iowa; Neosho, Newton County, Missouri; Spring Creek, Johnson, Arkansas; Prairie Grove and Fayetteville, Washington County, Arkansas; Batesville, Independence County, Arkansas; Red River, Arthur, Texas.

#### CAMBARUS VIRILIS Hagen.

Jasper County, Missouri (No. 4323, Mus. Comp. Zool.); Spirit Lake, Dickinson County, and Ames, Story County, Iowa (Coll. U.S.N.M.); Lake Douglas, Michigan (Coll. U.S.N.M.). In S. E. Meek's collection *C. virilis* is represented from the following localities: Storm Lake, Buena Vista County, Iowa; Cherokee, Cherokee County, Iowa; Yellow Creek, Postville, Allamakee County, Iowa; Spring Creek, Delhi, Delaware County, Iowa; Boyer River, Arion, Crawford County, Iowa; Belmont, Wright County, Iowa; Shell Rock River, Waverley, Bremer County, Iowa; Neosho, Newton County, Missouri; Blue River, Crete, Saline County, Nebraska; Prairie Grove and Fayetteville, Washington County, Arkansas; McAlister, Indian Territory (one female, var. A); Red River, Arthur, Texas.

In Indiana *C. virilis* is confined, according to Mr. W. P. Hay, to the northern part of the State, where it is extremely numerous.

Specimens from Big Piney Creek, Cabool, Texas County, Missouri (Coll. U.S.N.M.), differ in many particulars from the typical form. The cephalo-thorax is more cylindrical, the chelæ shorter, with more inflated hand and shorter fingers, the immovable finger narrower and less flattened; there are one or two additional spines on the lower side of the carpus between the median and internal spines; the rami of the male sexual appendages are longer, slenderer, and less strongly curved. In the shape of the hand these individuals are very similar to those col-

<sup>1</sup> Rev. Astacidae, p. 93.

lected at Irondale, and in Reynolds County, Missouri.<sup>1</sup> Both in the shape of the claws and in the character of the male appendages the Cabool specimens are transitional forms connecting *C. virilis* with *C. rusticus* and allied species.

CAMBARUS LONGIDIGITUS, new species.

(Plate LXII, figs. 6-9.)

Dorsal surface of the carapace flattened, thickly and coarsely punctate; lateral walls granulate. Rostrum long, concave above, sides parallel from base to the lateral pair of spines, which are sharp and directed forward; acumen long, acute, reaching to the distal extremity of the antennular peduncle, and to the middle of the distal segment of the antennal peduncle. Postorbital ridges curved inward at the posterior end, armed at the anterior end with a sharp spine. Antero-lateral margin of carapace bluntly angulated beneath the orbit, but not armed with a spine. There is a prominent spine on each side of the carapace on the hinder border of the cervical groove; a small branchiostegian spine is also present. The areola is very narrow for the greater part of its length; its narrowest part is well forward, close to the small, but broad, triangular field that borders upon the cervical groove; from this point it widens gradually and slightly to the hinder end.

The abdomen presents no distinctive characters; the pleuræ are punctate, their postero-lateral angles rounded. The telson is rather long, armed with a pair of spines on each side of the transverse suture; its hind margin truncate.

The anterior process of the epistome is broadly triangular, its antero-lateral margins slightly convex, its anterior angle rounded, truncate, or (in a few examples) slightly notched. The basal segment of the antenna bears no spine, but the so-called olfactory turbercle is prominent just in front of the orifice of the green gland; the second segment of the antenna is armed with a small but sharp lateral spine. The antennal scales are about as long as the rostrum, of moderate width, widest at the middle.

The merus of the chelipeds is armed, as usual, with spines biserially disposed on the inferior margins, and with two obliquely placed spines on the superior border near the distal end; the carpus is longitudinally furrowed, punctate, and slightly tuberculate above; there is a small spine near each point of articulation with the manus, two spines besides on the inner border—one median and one smaller one near the posterior end of the segment; the lower surface presents, moreover, a prominent acute median spine together with a minute spinule lying between the inferior median and the internal median spines (the smaller spinule is sometimes obsolete). The palm, or basal part of the propodite, is flattened and very short; its upper face is

<sup>1</sup> Rev. Astacidæ, p. 98, and Proc. U. S. Nat. Mus., XII, p. 630.

coarsely punctate and armed along its inner border with a double row of spiniform tubercles. The fingers are excessively long, the dactylus being more than three times as long as the inner margin of the palm; the fingers meet only at their tips, which cross each other; the grasping edges of both fingers are furnished with blunt teeth, irregular in size, while the opposite margin (or margin toward the median line of the body) of the dactylus is armed with two longitudinal rows of acute teeth. The external finger is barbate within at the base.

The first abdominal appendages of the second form of the male are long and slender, their tips lying between the second pair of legs when directed forward. The outer branch is longer than the inner branch. The tips of both branches are distinctly recurved.

The annulus ventralis of the female is triangular, with a deep transverse central fossa. The anterior wall is indistinctly bituberculate, the posterior wall thickened and divided by a median longitudinal sigmoid closed fissure. The claws of the female do not differ in form from those of the male.

Dimensions of a male, Form II: Length 81 mm.; length of carapace 41 mm.; length of rostrum 13 mm., width of rostrum 4.5 mm.; length of rostral acumen 6 mm.; distance from tip of rostrum to cervical groove 28 mm.; distance from cervical groove to posterior border of carapace 13 mm.; width of areola at its narrowest 0.5 mm.; length of cheliped 67.5 mm.; length of merus 15.5 mm.; length of carpus 10 mm.; length of chela 35 mm.; breadth of chela 10.5 mm.; inner margin of palm 8 mm.; length of dactylus 25.5 mm.

The largest specimen (a female) is 101 mm. long; the large claw measures 47.5 mm. in length, the dactylus 36 mm.

Oxford Bend, White River, Arkansas. (Coll. Mus. Comp. Zool.) Four males, Form II; four females, six young.

This clearly characterized species, discovered by Professor S. E. Meek, is related to *C. virilis*, with which it agrees essentially in the form of the sexual parts, both male and female, and the areola. It is readily distinguished from *C. virilis* by its longer, parallel-sided rostrum, with longer lateral spines and acumen, as well as by the excessive length and slenderness of the fingers. In many individuals the chelæ are unequal in size on the right and left sides, the right being commonly the larger.

In recent alcoholic specimens the fingers are clouded with dusky, and a large spot or blotch of the same hue is seen on both sides of the hand near the articulation with the wrist.

#### CAMBARUS IMMUNIS Hagen.

Small stream flowing into Oneida Lake, New York (No. 4330, Mus. Comp. Zool.). Sandusky, Erie County, Ohio (No. 5038, Mus. Comp. Zool.). Northern Ohio, near shore of Lake Erie; Ames, Story County, Iowa; South Bend, Cass County, Nebraska (Coll. U.S.N.M.). Also

from the following localities (Professor S. E. Meek's collection): Cedar River, Cedar Rapids, Linn County, Iowa; Mapleton River, Mapleton, Monona County, Iowa; Boyer River, Arion, Crawford County, Iowa; Belmond, Wright County, Iowa; Blue River, Crete, Saline County, Nebraska.

**CAMBARUS IMMUNIS SPINIROSTRIS** Faxon.

W. P. Hay reports this form as found in Terre Haute, Indiana. The type locality is Obion County, Tennessee. It has also been recorded by me from Shawnee County, Kansas.

**CAMBARUS PALMERI** Faxon.

St. Francis River, at Greenway and Big Bay, Arkansas; Black River, at Black Rock, Arkansas; Paragould, Green County, Arkansas (Coll. S. E. Meek).

The type specimens of *C. palmeri* are small individuals of the second form of the male and females collected in Obion County, Tennessee. In the collection of Professor S. E. Meek are a good many examples from the above-named localities in northeastern Arkansas which agree essentially with the Tennessee specimens, differing from them merely in the outline of the rostrum, which is somewhat longer and narrower, with more convergent sides. The first abdominal appendages of the first form of the male are strongly recurved, as in *C. immunis*, but the rami are much longer than in that species. The largest specimens attain to a length of 80 mm. The dactylus of the large cheliped in adult individuals varies in length from one and a third to a little over twice the length of the inner border of palm. The upper surface of the claw is ornamented with scattered, roundish, dark spots. In *C. palmeri* there is no very evident spine on the lower face of the carpus between the median spine and the spine on the internal border.

**CAMBARUS PALMERI LONGIMANUS**, new subspecies.

(Plate LXIV, figs. 1-6.)

Similar to *C. palmeri*, but different in the shape of the hand, the body of which (or palm) is thinner (less inflated) and the fingers much longer proportionally. The antennæ, too, are longer, and the rostrum as a rule is more deeply excavated.

Dimensions of the chela of a male, Form I, 83 mm. long: Length from point of articulation with carpus to end of dactylus 44 mm.; inner margin of palm 10 mm.; dactylus 35 mm.

Good Land, Indian Territory; Walnut Creek, Kainister, Indian Territory; Arthur, Texas (Coll. Mus. Comp. Zool., from S. E. Meek).

Many specimens, including both forms of the male, together with females, from each of the above localities. The upper surface of the carpus and hand is spotted with dusky; the tips of the fingers are red, preceded by a transverse band of dark color which runs along the whole outer margin of the hand,



## CAMBARUS DIFFICILIS, new species.

(Plate LXV, figs. 1-4.)

Cephalo-thorax oval, flattened above, of equal length with the abdomen. Carapace obscurely punctate above, lightly granulate on the sides; lateral spines of moderate size, branchiostegian spines obsolete, antero-lateral margins but slightly and bluntly angulated, unarmed with spines. Rostrum of moderate length, reaching a trifle beyond the proximal end of the third antennular segment; upper surface excavate, margins convergent and slightly convex from the base to the single pair of lateral teeth, which are small and acute, with horny tips; acumen of moderate length, acute, horny at the slightly upturned tip. Postorbital ridges ending anteriorly in a sharp tooth or short spine. Areola obliterated throughout a considerable part of its length by the contiguity of the branchio-cardiac lines. Abdominal pleuræ rounded, telson bispinose on each side. Anterior process of epistome squarely truncate at the front end.

Antennæ longer than the body, basal segment unarmed, second segment furnished with a spine on the outer side, at the base of the scale; scale of moderate width, widest near the middle.

The merus of the chelipeds shows the usual biserially arranged spines upon its lower side, and the two obliquely placed spines near the distal end of the upper margin; the carpus is marked by a deep, curved longitudinal furrow on the upper side, just inside of which lies a series of about seven small tubercles, the anterior one sharp pointed and quite near to the upper point of articulation with the propodite; the inner border of the carpus is armed with a stout median spine and a smaller one near the hinder end of the segment; on the lower face of the segment one sees a minute spine at the lower articular surface with the propodite, a prominent median spine, and a much smaller one between the inferior median and the larger spine of the inner border; the chelæ are very large, a little longer than the cephalo-thorax including the rostrum; the palm or basal part is short, its inner border ornamented with a double row of dentiform tubercles, outside of which, on the upper face, appears a row of obsolescent tubercles in line with the axis of the movable finger; the fingers are very long (the movable one being from two and a half to a little over three times the length of the inner border of the palm), pitted and furrowed, armed with blunt teeth along their prehensile edges; the inner border of the dactylus is furnished with dentiform tubercles which show a tendency to an arrangement in two rows, and which decrease in size from the proximal to the distal end of the segment; it is further to be observed that the dactylus is bowed inward in such a fashion that the prehensile edge comes into contact with the immovable finger throughout the distal two-thirds of its length when the fingers are closed, leaving a gape at the base.

The upper surface of the hand and wrist is mottled with dark spots.

The first pair of abdominal appendages of the first form of the male are short and stout, reaching forward only to the base of the antepenultimate pair of thoracic legs. They end in two short, recurved styles, the inner (or posterior) of which is slender and more strongly recurved than the outer one. In males of the second form, these appendages are split for only a short distance from the tip, and the free ends are stouter, blunter, and less strongly recurved. The anterior wall of the annulus of the female is depressed to the level of the sternum so that there is no distinct central fossa. The posterior wall, on the other hand, is very thick and protuberant, forming a transverse tubercle across the hind margin of the penultimate thoracic sternum. The chela of the female is shorter and broader than that of the first form of the male, and the dactylus less bowed. The chela of the second form of the male is similar to that of the female.

Length 93 mm.; carapace 46 mm.; rostrum 11.5 mm.; from tip of rostrum to cervical groove 30 mm.; from cervical groove to hind border of carapace 16 mm.; antenna 106 mm.; cheliped 90 mm.; merus 20 mm.; carpus 13 mm.; chela 48 mm.; dactylus 36 mm.; width of palm 19 mm.; length of inner border of palm 14 mm.; length of first pair of abdominal appendages 12 mm.

McAlister, Indian Territory. (Coll. Mus. Comp. Zool., from S. E. Meek.) Twelve males, Form I; five males, Form II; eleven females. Prairie Grove, Washington County, Arkansas. (Coll. S. E. Meek.) One male, Form I.

This species bears the closest possible resemblance to *Cambarus palmeri longimanus*, with which it would surely be confounded if it were not for the peculiar form of the sexual appendages of the male. These organs consist of a stout peduncle terminating in two very short recurved spines. In *C. palmeri longimanus* the two terminal spines are represented by two very long slender branches, equal in length to the peduncle itself. The annulus ventralis of the female also differs from that of *C. palmeri* inasmuch as the central fossa is well-nigh obliterated.

The upper side of the wrist and hand display the same spots of dark color which are seen in *C. palmeri longimanus*.

**CAMBARUS MEEKI**, new species.

(Plate LXV, figs. 5-9.)

Cephalo-thorax cylindrical, polished, conspicuously punctate, except in the middle of the gastric area, granulated on the anterior portion of the sides, lateral spine small or obsolete, antero-lateral border bluntly angulated below the orbit, postorbital ridges armed with a sharp anterior spine. Rostrum deeply excavated, often very faintly carinated near the tip; margins thickened, concave, strongly divergent at base, each with a longitudinal row of impressed dots; lateral spines and acumen horny-tipped, strongly upturned; acumen reaching to distal end of antennular peduncle. Areola narrow, punctate. Anterior

process of epistome blunt at the anterior end, the sides convex, the lateral angles protuberant. Carpus armed with a large median and a small posterior spine on the inner border; below, the carpus presents a prominent median spine together with a smaller one situated between the latter and the median internal spine. The chela is of moderate size, punctate, doubly serrate on the internal border, fingers armed with blunt teeth along their prehensile edges, the base of the immobile fingers commonly beared within; dactylus about twice as long as the inner margin of the palms. Antennal scale broad, broadest beyond the middle, internal margin very convex.

First pair of abdominal appendages of the male similar to those of *C. palmeri*.

Annulus ventralis of the female triangular, central cavity roundish, not elongated transversely, posterior wall much swollen and divided in the middle by an almost straight, longitudinal closed fissure.

Length 59 mm.; carapace 29 mm.; rostrum 7 mm.; from tip of rostrum to cervical groove 18.5 mm.; from cervical groove to posterior margin of carapace 10.3 mm.; cheliped 46 mm.; merus 11.5 mm.; carpus 7 mm.; chela 22.5 mm.; dactylus 15 mm.

Walnut Fork, Piney, Arkansas (Coll. Mus. Comp. Zool., from S. E. Meek.). Twelve males, Form II; fifteen females.

Fayetteville, Arkansas (Coll. S. E. Meek.). One male, Form 1; seven males, Form II; five females.

This small species, discovered in northwestern Arkansas by Professor S. E. Meek, appears to be distinct from any hitherto described. In its general appearance it resembles *C. rusticus*, but the areola is much narrower, as in *C. virilis*, while the male appendages are fashioned like those of *C. palmeri*. The first pair of abdominal appendages of the female are reduced to the merest rudiments in the shape of a pair of soft papillæ springing from the first sternal segment of the abdomen.

#### CAMBARUS RUSTICUS Girard.

Grand Rapids, Wood County, Ohio; Defiance, Defiance County, Ohio; Ottawa, Putnam County, Ohio; McCutchenville, Wyandot County, Ohio; Tiffin, Seneca County, Ohio; Waterloo, Indiana; Moscow, Hickman County, Kentucky; Saginaw and Tiffin, Michigan; Springfield and Marshfield, Missouri. (Coll. U.S.N.M.) Black River, Black Rock, Arkansas; Shell Rock River, Waverley, Iowa; Indian Creek, Marion, Iowa. (Coll. S. E. Meek.)

#### CAMBARUS SPINOSUS Bundy.

Indian Creek, tributary of Powell's River, six miles southeast of Cumberland Gap, Tennessee; Clinch River at Walker's Ford, eleven miles southwest of Tazewell, Tennessee; Courtland, Alabama. (Coll. U.S.N.M.)

The specimens from Courtland, Alabama, are three females and one

male, Form II, with uncommonly long rostral acumen and long-spined antennal scale. The epistoma is not emarginate in front in these four specimens.

CAMBARUS ERICHSONIANUS, new species.

(Plate LXIV, figs. 7-12.)

*Male, Form I.*—Rostrum of moderate width, sides parallel, not thickened, lateral spines minute, acumen reaching to the distal end of the antennular peduncle. Carapace cylindrical, heavily punctated, lightly granulate and ciliate on the sides; lateral spines well developed; postorbital ridges armed with a small anterior spine; anterolateral border scarcely angulated below the eye; areola of moderate width, but little longer than the distance from the cervical groove to the lateral spines of the rostrum. Abdomen as long as the cephalo-thorax. Epistome triangular, often truncate or notched in front. Carpus of chelipeds with an internal median and inferior median spine. Chela broad, inflated, setiferous, fingers somewhat longer than the palm; internal margin of palm with a double row of depressed tubercles. First pair of abdominal appendages straight, without any prominent angle or shoulder on the anterior border, bifid, the two branches slender and acute, reaching forward to the base of the second pair of legs.

In the second form of the male the first pair of abdominal appendages are thicker, blunter at the tips, and not horny, as in the first form.

In the female the annulus ventralis is depressed, only very imperfectly bituberculate in front, the hind border more prominent than the front border, the central fossa obsolescent.

Dimensions of a male, Form I: Length 70 mm.; cephalo-thorax 35 mm.; areola 11 mm.; rostrum 5 mm.; chela 25 mm.; dactylus 15.5 mm.; breadth of chela 6 mm.

Rip Roaring Fork, five miles northwest of Greeneville, Tennessee; Eastanaula Creek, Athens, Tennessee; Matlock Spring Creek, near Athens, Tennessee; Big Cahawba River, Alabama. (Colls. U.S.N.M. and Mus. Comp. Zool.)

In large males, Form I, the inner branch of the first abdominal appendages is somewhat enlarged and spoon-shaped at the tip.

This species has the facies of *C. spinosus*, but the male appendages are nearly like those of *C. propinquus*, although the rami are a little longer. Compared with *C. spinosus*, the rami of the sexual appendages in the male, Form I, are much shorter, and there is no angle or shoulder on the anterior margin of these appendages; in the second form of the male of *C. erichsonianus* the sexual appendages are much shorter and blunter than in *C. spinosus*, and the two rami are of equal length. The female of *C. spinosus*, may be distinguished from the present species by the prominent annulus ventralis with bituberculate anterior border and deep transverse central fossa. *C. propinquus*, compared with *C. erichsonianus*, is distinguished by its more ovoid cephalo-thorax,

the greater length of the section of the carapace behind the cervical groove, and its shorter, more tapering, and carinated rostrum. All of these characters, with the exception of the carination of the rostrum, also serve to separate *C. propinquus sanbornii* from the present species.

The habitat of *C. erichsonianus*, eastern Tennessee and northern Alabama, is closely adjacent to that of *C. spinosus*. *C. propinquus* is a more northern form, unknown south of the Ohio. *C. propinquus sanbornii* has been found in Kentucky and Ohio.

#### CAMBARUS FORCEPS Faxon.

Clinch River at Walker's Ford, eleven miles northwest of Tazewell, Tennessee; Bull's (or Big Sycamore) Creek, tributary of Clinch River, seven miles south of Tazewell, Tennessee. (Coll. U.S.N.M.)

#### GROUP V. (Type, *Cambarus montezumæ* Saussure.)

Third segment of second and third pairs of legs of male hooked. First abdominal appendages similar to those of Group IV.

#### CAMBARUS MONTEZUMÆ Saussure.

The typical form of *C. montezumæ* comes from the plain of the City of Mexico. It has also been recorded from Puebla<sup>1</sup> and from Vera Cruz.<sup>2</sup> The Puebla specimens (var. *tridens* von Martens) are described as having a pair of small lateral teeth near the apex of the rostrum, but this is also true of many of the specimens, especially the second form males and the females, from the type locality. In the typical form the rostrum is smooth and lightly hollowed out above, the sides of the rostrum are nearly parallel (but slightly convex) from the base to the proximal end of the acumen, which is short (not surpassing the second antennular segment) and flanked by very small lateral teeth (often obsolete). The postorbital ridges are unarmed, or furnished at the most with the merest vestige of the anterior spines. The portion of the carapace posterior to the cervical groove is much more than half the distance from the groove to the anterior extremity of the rostrum.

#### CAMBARUS MONTEZUMÆ DUGESII, new subspecies.

(Plate LXVI, fig. 1.)

*Cambarus montezumæ* FAXON, Proc. U. S. Nat. Mus., XII, 1889, p. 633.

Differs from *C. montezumæ* as follows: The upper surface of the rostrum is perfectly flat, except for the margins, which are raised so as to form lateral carinæ; the sides of the rostrum converge from the base to the proximal end of the acumen, which is slenderer and a little longer than in *C. montezumæ*; the lateral teeth of the rostrum are

<sup>1</sup> Von Martens, Arch. f. Naturgesch., 38ter Jahrg., 1872, I, p. 130.

<sup>2</sup> Ortmann, Zoolog. Jahrb., Abth. f. Syst., VI, 1891, p. 12.

more strongly developed; the postorbital ridges bear distinct anterior spines; the hand is broader and more hirsute, and the fingers are tipped with more conspicuous, yellow, corneous nails.

Length 38 mm.

State of Guanajuato, Mexico, A. Dugès (No. 16087, U.S.N.M.).

**CAMBARUS MONTEZUMÆ AREOLATUS** Faxon.

(Plate LXVI, fig. 2.)

*Cambarus montezumæ*, var. *areolata* FAXON, Rev. Astacidæ, Pt. 1, 1885, p. 123.

In this form the outline of the rostrum is similar to that of *C. m. dugesii*, but the lateral margins are not raised so as to form prominent carinæ. The lateral rostral spines and the spines at the anterior end of the postorbital ridges are developed to about the same degree as in *C. m. dugesii*. The characteristic feature of this form is the shortness of the posterior section of the carapace, which involves a very short and broad areola.

Parras, Coahuila, Mexico, Edward Palmer (No. 3650, Mus. Comp. Zool.).

**CAMBARUS MONTEZUMÆ OCCIDENTALIS**, new subspecies.

(Plate LXVI, figs. 3, 4.)

*Cambarus montezumæ* FAXON (pars), Rev. Astacidæ, Pt. 1, 1885, p. 123.

Rostrum plane above, margins but very slightly raised, tapering gradually from the base to the tip without distinct lateral spines or definitely limited acumen. It reaches at the most to the distal end of the second antennular segment. Postorbital ridges unarmed.

Mazatlan, Mexico (No. 3652, Mus. Comp. Zool.).

**CAMBARUS CHAPALANUS**, new species.

(Plate LXVII, figs. 1, 2.)

Similar to *C. montezumæ*, but differs in the following regards: Body slenderer and more cylindrical; rostrum much longer and narrower, reaching to the end of the antennular peduncle, somewhat hirsute, armed with a pair of stout and sharp lateral spines, and a long spiniform acumen; postorbital ridges terminating anteriorly in long and strong spiniform teeth; antennal scales much longer and narrower and armed with a much longer apical spine.

*Type*.—Lake Chapala, State of Jalisco, Mexico, P. L. Jouy (No. 17698, U.S.N.M.). One male.

Same locality and collector (No. 16294, U.S.N.M.). Three males.

The upper surface of the rostrum is plane, with raised lateral margins. The sides of the rostrum are convex, distinctly converging before attaining to the lateral spines. The chelipeds and the male sexual organs are like those of the typical form of *C. montezumæ*.

In some respects *C. montezumæ dugesii* shows an approach toward this species, but the two forms can not be confounded on account of the greater slenderness of *C. chapalanus*, the great length of the rostral and postorbital spines, etc. *C. shufeldtii* is distinguished from *C. chapalanus* by the presence of lateral spines on the carapace, broader rostrum, differently shaped male appendages, etc.

Genus *ASTACUS* Fabricius (s. z.).<sup>1</sup>

- < *Cancer* LINNÆUS, Syst. Nat., 10th ed., I, p. 625, 1758.  
 < *Astacus* FABRICIUS, Syst. Entomol., p. 413, 1775; Species Insectorum, I, p. 514, 1781; Mantissa Insectorum, I, p. 331, 1787; Entomol. Syst. emend., II, p. 478, 1793; Suppl. Entomol. Syst., p. 382, 1798.  
 < *Astacus* LATREILLE, Considérations Générales, p. 101, 1810 (*Astacus fluviatilis* FABRICIUS = *Cancer astacus* LINNÆUS, specified as the type, p. 422).  
 < *Astacus* LEACH, Edinb. Encycl., VII, p. 398, 1814; Trans. Linn. Soc. London, XV, pp. 336, 343, 1815.  
 < *Potamobius* LEACH, Samouelle's Entomologist's Useful Compendium, p. 95, 1819 (Type, *Potamobius fluviatilis* = *Cancer astacus* LINNÆUS).  
 < *Astacus* MILNE-EDWARDS, Hist. Nat. Crust., II, p. 329, 1837.  
 = *Astacus* (subgenus) ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 90, 1846.  
 Type, *Cancer astacus* Linnæus.

The genus *Astacus*, as first established by Fabricius,<sup>2</sup> included eighteen species. The dismemberment of this heterogeneous assemblage was begun by Fabricius himself in 1781,<sup>3</sup> by the removal of three species to the genus *Squilla*. In 1798,<sup>4</sup> he eliminated several other species from *Astacus*, forming for their reception the genera *Crangon*, *Alpheus*, *Palæmon*, and *Palinurus*. As left by its founder in 1798, the genus *Astacus* contained only five of the original species, namely, *A. marinus* (= *Cancer gammarus* Linnæus), *A. fluviatilis* (= *Cancer astacus* Linnæus), *A. cærulescens*, *A. fulgens*, and *A. norvegicus*. Two of these, *cærulescens* and *fulgens*, are indeterminable. In 1810 Latreille,<sup>5</sup>

<sup>1</sup>Those who accept the genera defined by polynomialists after the year 1758 will ascribe the genus *Astacus* to Gronovius, 1764 (Zoophylacium Gronovianum, Fasciculus II, p. 227). Even as early as 1760 Gronovius (Acta Helvetica, IV, p. 23) assigned *Galatea strigosa* polynomially to *Astacus*, using *Astacus* in its old pre-Linnæan sense. In 1772 Pallas, a binomialist, in his "Spicilegia Zoologica," Fasciculus IX, p. 81, used the combination *Astacus dauricus* in treating of the Daurian crayfish. Pallas wrote in Latin, and it is evident that *Astacus* was here used merely as the Latin word for "crayfish" or "lobster," and not as a technical generic name; for the diagnosis of the Daurian crayfish is headed "Descriptio *Caneri daurici*," conformably with Linnæus's nomenclature. Even if one forces the point and carries the genus *Astacus* back to Pallas, 1772, it will not make the Daurian crayfish the type of the genus, since the description of the Daurian crayfish is a comparative one, the lesser European *Astacus* [*Astacus nostras minor*], i. e., *Cancer astacus* Linnæus, serving as the standard for comparison. To regard as a type the thing compared, rather than the standard of comparison, would be a manifest absurdity.

<sup>2</sup>Syst. Ent., 1775.

<sup>3</sup>Species Insectorum.

<sup>4</sup>Suppl. Ent. Syst.

<sup>5</sup>Considérations Générales sur l'Ordre Naturel des Animaux composant les Classes des Crustacés, des Arachnides, et des Insectes.

in a "Table des Genres avec l'indication de l'espèce qui leur sert de type," designated *A. fluviatilis* as the type of the genus *Astacus*. In 1814 and 1815 Leach<sup>1</sup> further curtailed the genus by removing *A. norvegicus* as the type of the new genus *Nephrops*. The genus *Astacus*, thus restricted, retained only two of the valid original species, namely, *A. marinus* (the European lobster) and *A. fluviatilis* (the common European crayfish). In 1819<sup>2</sup> Leach went a step further, and separated the crayfishes from the lobster, instituting a new genus *Potamobius* for the former, leaving the latter as the representative of the restricted genus *Astacus*. This restriction of *Astacus* to the marine species is nullified by Latreille's specification of *A. fluviatilis* as the type of *Astacus* in 1810.<sup>3</sup> In 1837 Milne-Edwards<sup>4</sup> did essentially the same thing that Leach had done in 1819, but he left the crayfishes in *Astacus*, and made the lobster the type of the new genus *Homarus*. This being in accord with Latreille's designation of *A. fluviatilis* as the type of *Astacus*, the European lobster should be called by the modern rules of nomenclature (restoring the Linnæan specific name) *Homarus gammarus* (Linnæus), while the European crayfish, as *Astacus astacus* (Linnæus), stands as the type of the genus *Astacus*.

Mr. T. R. R. Stebbing<sup>5</sup> argues that Latreille, in his "Table des Genres avec l'indication de l'espèce qui leur sert de type," probably designated *Astacus fluviatilis* "not as the type, but merely as a type, an example," of the genus *Astacus*, and that Leach's restriction in 1819 was therefore valid. As I understand it, the French word 'type' means 'model,' 'type,' or 'standard,' not 'example' or 'illustration' (Gallicè *exemple*). I see no reason for going behind Latreille's plain words, to indulge in uncertain speculation concerning his possible meaning. If Mr. Stebbing is unwilling to allow Latreille the use of the word 'type' in its technical sense, by what 'statute of limitation' will he fix the year when the word acquired that meaning? Even if it be admitted that there is some doubt concerning the significance of the word 'type' as employed by Latreille, the benefit of the doubt should, by a reasonable ruling applicable to all such cases, be given to a long-established terminology. Between 1819 and 1893, the date of Stebbing's "History of the Crustacea," the name *Potamobius* was applied to the crayfishes but thrice, so far as I know, namely, by Adam White in his "Catalogue of British Crustacea," 1850, and in his "Popular History of British Crustacea," 1857, and by G. B. Sowerby in his continuation of Leach's "Malacostraca Podophthalma Britannicæ," 1875. "But," continues Mr. Stebbing, "if it be insisted that Latreille here intended to set up the crayfish as technically type of the genus, in preference to the lobster, of which his book makes no mention, the answer is simple. His inten-

<sup>1</sup> Edinb. Encycl., VII, p. 398; Trans. Linn. Soc. London, XV, pp. 336, 343.

<sup>2</sup> Samouelle's Entomologist's Useful Compendium, p. 95.

<sup>3</sup> F. H. Herrick, Bull. U. S. Fish Comm. for 1895, p. 9.

<sup>4</sup> Hist. Nat. des Crustacés, II, p. 329.

<sup>5</sup> Natural Science, IX, 1896, p. 40.



tion was inoperative, because he had been forestalled by an earlier writer. J. C. Fabricius, in his various writings, of which it will be sufficient to cite the 'Species Insectorum,' 1781, and the 'Entomologia Systematica,' 1793, consistently places *Astacus marinus* (*Cancer gammarus* Linnæus) as the first species of the genus *Astacus*, giving to *A. fluviatilis* invariably the second place. There can therefore be no reasonable gainsaying that he made the European lobster, and not the river crayfish, the type. From this it follows \* \* \* that the generic name of the lobster is properly *Astacus*, and that of the European crayfish *Potamobius*."

It is hard to believe that this contention of Mr. Stebbing's is made in good faith, involving as it does an unreasonable and long-discarded method of ascertaining a type. Such a method is repudiated every time we concede to an author who first subdivides a genus in which no type has been specified, the right to restrict the original name to such part of it as he pleases. It is not true that the first species is presumably the author's implied type. Fabricius's genus *Astacus* was formed by a dismemberment of the genus *Cancer* of Linnæus, and the sequence of the two species under consideration in Fabricius's works was undoubtedly derived from the "Systema Naturæ," where (in the twelfth edition) *Cancer gammarus* stands as No. 62, *Cancer astacus* as No. 63, in the genus *Cancer*. A better, though not a valid, claim might be set up for *A. fluviatilis* as Fabricius's implied type of his genus *Astacus*, since that species is the *Cancer astacus* of Linnæus.

In Agassiz's "Nomenclator Zoologicus" the name *Potamobius* is entered as a genus of Brachyura, with a citation of Leach's article in "Dictionnaire des Sciences Naturelles," XII, 1818. By reference to this work it appears that the name occurs on page 75, under the Gallicized form "Potamobie," in a merely nominal, alphabetical list of the genera of Crustacea. Since the crayfish and lobster are both entered elsewhere in the same list, by the names of "Ecrevisse" and "Homard," I am inclined to think that "Potamobie" was here really intended for a genus of fluviatile crabs, as assumed in the "Nomenclator," and that it was written through a *lapsus penna* for "Potamophile," i. e., *Potamophilus* or *Potamon*. As the name occurs as a pure *nomen nudum* in the "Dictionnaire," it would be unworthy of notice but for the fact that Desmarest said in 1823:<sup>1</sup> "Il est probable que ce genre [*Thelphusa* ou *Potamophilus*] diffère peu, ou ne diffère pas de ceux qui ont été nommés *Potamon* par M. Savigny, et *Potamobia* par M. Leach," and that Risso in 1826<sup>2</sup> adopted "*Potamobius* Leach" (with "Potamophile" as the French equivalent) as the generic name for the fresh water crab, *Potamon fluviatilis*. In this way, probably, it came to pass that Huxley<sup>3</sup> was led into the essentially erroneous assertion that *Potamobius* had been used in another sense before it was applied to the crayfish.

<sup>1</sup> Dictionnaire des Sciences Naturelles, XXVIII, p. 246.

<sup>2</sup> Hist. Nat. de l'Europe Mérid., V, p. 14.

<sup>3</sup> Proc. Zool. Soc. London, 1878, p. 752.

White, in his "List of the Specimens of Crustacea in the Collection of the British Museum," 1847, page 71, gives "*Potamobius europæus* Leach, Edin. Enc." as a synonym of *Astacus fluviatilis*. This seems to be an error. Leach's article, "Crustaceology," in the seventh volume of the Edinburgh Encyclopædia, was published in 1814. The European crayfish is there called *Astacus fluviatilis*; the name *Potamobius europæus* does not appear.

Subgenus **CAMBAROÏDES** Faxon.

*Cambaroides* FAXON, Proc. Amer. Acad. Arts and Sci., XX, p. 150, 1884.

Type, *Astacus japonicus* De Haan.

**ASTACUS (CAMBAROÏDES) SIMILIS** Koelbel.

*Astacus (Cambaroides) similis* KOELBEL, Anzeiger d. kais. Akad. d. Wissensch. in Wien, math.-naturw. Classe, 29ter Jahrg., 1892, pp. 176, 177; Sitzungsberichte, CI, Pt. 1, 1892, pp. 650-656, figs. 1, 2, 4, 5, 7-11.

There are three specimens (two males, one female) of this species in the United States National Museum, collected by P. L. Jouy near Fusan, and at Seoul, Korea; Koelbel's specimens came from the Province of Kjöng-Kwi-do, Korea.

The Korean crayfish is exceedingly close to *Astacus japonicus*. The only constant differences appear to be these: In *A. japonicus* the rostrum terminates in a minute horny denticle, and the lateral margin bears a similar denticle<sup>1</sup> on each side, a little way behind the apex, while in *A. similis* the lateral denticles are wanting. The fingers of *A. japonicus* are a little shorter than those of *A. similis* and there is some difference in the form of the first pair of abdominal appendages (See Plate X, fig. 10, of my "Revision of the Astacidæ" and figs. 8, 9 of Koelbel). The other differences pointed out by Koelbel are not constant; the median rostral carina is more pronounced in two of the specimens of *A. similis* in the National Museum than in any of the nine specimens of *A. japonicus* that I have seen, and in one of the three Korean specimens the spine on the inner branch of the sixth abdominal appendage is as far removed from the margin as it is in *A. japonicus*.

In two of the examples in the United States National Museum (including the largest one of the three) the rostrum is shorter than the antennal peduncle.

Subgenus **ASTACUS**.

**ASTACUS KLAMATHENSIS** Stimpson.

Klamath River, Siskiyou County, California; Umatilla River, Pendleton, Oregon; Hangman Creek, Tekoa, Washington; Dart's Mill, Little Spokane River, Washington; Cœur d'Alene Lake, Idaho (Coll. U.S.N.M.).

Specimens from the Walla Walla River at Wallula, Washington, and

<sup>1</sup> According to Koelbel (Sitzungsber. d. kais. Akad. d. Wissensch. in Wien, CI, Pt. 1, p. 651, fig. 3) there are two denticles on each side of the rostrum in some specimens of *A. japonicus*.

from Potlatch Creek, at Lewiston, Idaho, with the general facies of *A. klamathensis*, show certain characters of *A. trowbridgii*. For instance, in most of them the posterior pair of postorbital spines is very evident, while the rostral spines, the apical spine of the antennal scale, the external spine of the second segment of the antenna, and the spine at the anterior internal angle of the carpus are much more strongly developed than in typical specimens of *A. klamathensis*.

#### ASTACUS TROWBRIDGII Stimpson.

A large female specimen, 138 mm. long (Coll. U.S.N.M.), said to have been taken from a bunch of seaweed in salt water at Monterey, California, approaches *A. leniusculus* in three respects, namely: The posterior pair of spines on the back of the carapace, behind the eyes, are rather more strongly developed than in the typical *A. trowbridgii*; the rostral acumen is as long as in *A. leniusculus*; the tubercle at the orifice of the green gland ends in a sharp, horny point. In other respects this specimen agrees with *A. trowbridgii*. The body is very broad across the branchial region, and there are three spines on the left side of the telson, two on the right. There is a rudimentary limb on the right side of the first abdominal segment, a condition seldom seen in the American species of *Astacus*.

*Astacus trowbridgii* has been previously known only from the region near the mouth of the Columbia River.

#### ASTACUS LENIUSCULUS Dana.

There is a large female, 122 mm. long, from San Francisco County, California, in the collection of the California Academy of Sciences (No. 3259). The right and left chelipeds of this specimen are of equal size; the upper margin of the right merus is armed with two spines, of the left merus with three spines; the telson is armed with one spine on the right side, two on the left. This species has been previously recorded from the Columbia River and Puget Sound.

#### ASTACUS GAMBELII (Girard).

Crawfish Creek, at Moose Falls, one mile above junction with Lewis River, Yellowstone National Park, Wyoming; Snake River, just south of Yellowstone Park, Wyoming; Mink Creek and Port Neuve River, Pocatello, Idaho; Shoshone Falls, Idaho; Blue Lakes, four miles below Shoshone Falls, Idaho (Coll. U.S.N.M.).

All of these localities are in the Snake River drainage.

#### ASTACUS TORRENTIUM (Schränk).

Recorded from Cologne, Germany, and from St. Gallen, eastern Switzerland, by Doctor A. P. Ninni.<sup>1</sup>

<sup>1</sup>Atti della Soc. Italiana di Sci. Nat., XXIX, pp. 322-326, 1886.

ASTACUS PALLIPES Lereboullet.<sup>1</sup>

Neighborhood of Madrid, Spain (No. 4349, Mus. Comp. Zool.). These Spanish crayfishes do not differ from French and English specimens of *A. pallipes*.

Doctor Ninni,<sup>2</sup> in a note on the crayfishes of Italy, shows that *A. pallipes* is the common crayfish of that country, being widely distributed through the Kingdom, as far south as Naples. A form found in the province of Belluno, characterized by the presence of spines on the outer margin of the antennal scale, is named by him *Astacus pallipes*, var. *fulcisiana*.<sup>3</sup>

Two specimens in the United States National Museum from Piobezzi, near Turin, vary in the direction of *A. astacus*. This variation is chiefly shown in the outlines of the rostrum.

The *Astacus rugosus* of Rafinesque,<sup>4</sup> presumably from Sicily, is quite indeterminable, and the *Astacus tomentosus* of the same writer<sup>5</sup> is a pure *nomen nudum*.

## ASTACUS ASTACUS Linnæus.

*Cancer astacus* LINNÆUS, Syst. Nat., 10th ed., I, p. 631, 1758.

*Astacus fluviatilis* FABRICIUS, Syst. Entomol., p. 413, 1775, et auct. plurim.

*Astacus astacus* MEUSCHEN, Museum Gronovianum, p. 85, 1778; Zoophyl. Gronov., Fasc. III, Index [p. 389], 1781.

*Cancer (Astacus) astacus* GMELIN, Linn. Syst. Nat., 13th ed., Pt. 5, p. 2985, 1788 (in part).

*Cancer nobilis* SCHIRANK, Fauna Boica, III, p. 246, 1803.

*Potamobius fluviatilis* LEACH, Samouelle's Entomologist's Useful Compendium, p. 95, 1819 (in part).

*Potamobius astacus* WHITE, List of the Specimens of British Animals in the Collection of the British Museum, Pt. 4, Crustacea, p. 34, 1850 (in part).

*Astacus fluviatilis communis* GERSTFELDT, Mem. Acad. Impér. Sci. St. Pétersbourg, IX, pp. 554, 584, 1859.

*Astacus nobilis* HUXLEY, The Crayfish, p. 233, fig. 61, B, E, H; p. 245, fig. 62, B, E; p. 296, 1880.

A. P. Ninni<sup>2</sup> records *Astacus astacus* from Carniola and Göritz. One young specimen from Belluno, northern Italy, is also considered by Ninni to belong to this species.

Since the publication of my "Revision of the Astacidæ,"<sup>6</sup> V. M. Shimkevitch<sup>7</sup> has printed (in Russian) a fuller account of the Turkestan crayfish, *Astacus kessleri* Shimkevitch.

<sup>1</sup> On page 141 of my "Revision of the Astacidæ," lines 2 and 5, for "antennule" read "antennal peduncle."

<sup>2</sup> Atti della Soc. Italiana di Sci. Nat., XXIX, pp. 322-326, 1886.

<sup>3</sup> Ibid., p. 326.

<sup>4</sup> Précis des Découvertes et Travaux Somiologiques, p. 22, 1814.

<sup>5</sup> Ibid.

<sup>6</sup> See p. 152 of that work.

<sup>7</sup> Bull. Imper. Soc. Friends of Nat. Hist., Anthropol., Ethnogr., Moscow, L, Pt. 1 (Proc. Zoolog. Sect., I, Pt. 1, p. 20), 1886.

## Subfamily PARASTACINÆ.

First abdominal somite devoid of appendages in both sexes; podobranchiæ lacking a bilobed plaited lamina, although the stem may be expanded into a wing; epipod of first maxilliped generally furnished with branchial filaments, coxopoditic setæ hooked at the end; telson not divided by a transverse suture.

## ASTACOÏDES Guérin.

*Astacoïdes* GUÉRIN, Revue Zoologique, II, p. 109, 1839.

Type, *Astacoïdes goudotii* Guérin = *Astacus madagascariensis* Audouin et Milne-Edwards.

Rostrum short, quadrilateral, concave above, margins furnished with small teeth or tubercles. Antennal scale very small.<sup>1</sup> Anterior process of epistome long triangular. Superior border of the hand dentate. Sides of the carapace armed with small tubercles, some of which assume the form of small spines. Number of well-developed gills reduced to twelve on each side of the body; posterior arthrobranchiæ rudimentary and functionless; one pair of pleurobranchiæ (on the fourteenth somite); the branchial formula, according to Huxley,<sup>2</sup> being as follows:

SOMITE.	PODOBRANCHIÆ.	ARTHROBRANCHIÆ.		PLEUROBRANCHIÆ.	
		Anterior.	Posterior.		
VII.	0 (ep r)	0	0	0	= 0 (ep r)
VIII.	1	r	0	0	= 1 + r
IX.	1	1	0	0	= 2
X.	1	1	r	0	= 2 + r
XI.	1	1	r	0	= 2 + r
XII.	1	1	r	0	= 2 + r
XIII.	1	1	r	0	= 2 + r
XIV.	0	0	0	1	= 1
6 + ep r		+	5 + r	+	4 r
					+
					1
					= 12 + 5 r + ep r

One species known.

*Habitat.*—Madagascar.

## ASTACOÏDES MADAGASCARIENSIS (Audouin et Milne-Edwards).

*Astacus madagascariensis* AUDOUIN ET MILNE-EDWARDS, Journ. de l'Institut, 1839, p. 152; Arch. du Mus. d'Hist. Nat., II, p. 35, pl. III, 1841.

*Astacoïdes goudotii* GUÉRIN, Revue Zoologique, II, p. 109, 1839.<sup>3</sup>

*Astacus (Astacoïdes) madagascariensis* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 89, 1846.

<sup>1</sup> Erroneously said to be wanting by Guérin.

<sup>2</sup> Proc. Zool. Soc. London, 1878, p. 775.

<sup>3</sup> Guérin's description of the Madagascar crayfish must have been published about the same time as Audouin and Milne-Edwards's. The Revue Zoologique was issued monthly. Guérin's description occurs in the April number, 1839. Audouin and Milne-Edwards's description in the Institute, p. 152, was communicated to the Société Philomatique on the 27th of April, 1839. In cases like this it seems reasonable to retain the name adopted by the next following author who treated of the species—in this instance, Audouin and Milne-Edwards in the Archives du Muséum d' Histoire Naturelle, II, 1841.

*Astacus caldwelli* BATE, Proc. Zool. Soc. London, 1865, p. 469, pl. XXVII.

*Astacoides madagascariensis* HUXLEY, Proc. Zool. Soc. London, 1878, p. 759, fig. 2 B; p. 773, fig. 7; The Crayfish, p. 251, fig. 65, 1880.

*Habitat.*—Madagascar.

The only specimen of this species that I have seen is Guérin's type, in the Museum of the Academy of Natural Sciences of Philadelphia (No. 290, Guérin Coll.). The color in life, according to Goudot, is brownish green.

ASTACOPSIS Huxley.

*Astacopsis* HUXLEY, Proc. Zool. Soc. London, 1878, p. 764.

Type, *Astacus franklinii* Gray.

Rostrum triangular, concave above, margins toothed. Antennal scale of moderate width, tapering off to an apical spine. Anterior process of epistome long triangular. Superior border of hand dentate. Carapace and abdomen more or less tuberculous or spinous, at least in mature individuals. Form homaroid. Twenty-one gills on each side of the trunk, disposed as shown in the following formula:

SOMITE.	PODOBRANCHIÆ.	ARTHROBRANCHIÆ.		PLEUROBRANCHIÆ.					
		Anterior.	Posterior.						
VII.	0 (ep r)	0	0	0	=	0 (ep r)			
VIII.	1	1	0	0	=	2			
IX.	1	1	1	0	=	3			
X.	1	1	1	0	=	3			
XI.	1	1	1	1	=	4			
XII.	1	1	1	1	=	4			
XIII.	1	1	1	1	=	4			
XIV.	0	0	0	1	=	1			
	6 + ep r	+	6	+	5	+	4	=	21 + ep r

*Habitat.*—Australia and Tasmania.

ASTACOPSIS FRANKLINII Gray.

*Astacus franklinii* GRAY, Eyre's Journals of Expeditions of Discovery into Central Australia, I, p. 409, pl. III, fig. 1, 1845; List Crust. Brit. Mus., p. 72, 1847 (no description).

*Astacus franklinii* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 375, 1846 (after Gray).

*Astacopsis franklinii* HUXLEY, Proc. Zool. Soc. London, 1878, p. 764, figs. 4, 5.

*Astacopsis franklinii* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crustacea, p. 176, 1882 (after Gray).

*Habitat.*—Tasmania. One specimen (male), 96 mm. long, in Museum of Comparative Zoology (No. 1140), from Hobart Town, Mr. Robertson. The angles of the abdominal pleuræ in this specimen tend to develop spiny points.

*Astacopsis franklinii* is similar in external appearance to the Madagascar crayfish (*Astacoides madagascariensis*). The latter, however, as has been shown by Huxley, has the number of gills reduced to twenty-four, against forty-two in the former. *A. franklinii* appears to be rep-

resented in New South Wales by an allied species, *Astacopsis nobilis* (Dana), through which we pass to the great Murray River crayfish, *Astacopsis spinifera* (Heller).

ASTACOPSIS SPINIFERA (Heller).

*Cancer serratus* SHAW, Zoology of New Holland, pl. VIII, 1794. (Nec *Cancer serratus* Forskål, 1775.)

*Potamobius serratus* WHITE, Proc. Zool. Soc. London, XVIII, p. 95, pl. XV, 1850.

*Astacoides spinifer* HELLER, Reise der Novara, Zool. Th., II, Pt. 3, Crust., p. 102, pl. IX, 1865.

*Astacus armatus* VON MARTENS, Ann. Mag. Nat. Hist., 3d ser., XVII, p. 359, 1866.

*Astacoides serratus* MCCOY, Ann. Mag. Nat. Hist., 3d ser., XX, p. 189, 1867; Prodromus of the Zoology of Victoria, Decade II, pl. xv, 1878.

*Astacus serratus* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 615.

*Australian crayfish* HUXLEY, The Crayfish, p. 307, fig. 76, 1880.

*Astacopsis serratus* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 174, 1882.

*Astacopsis spinifer* BATE, Rep. Challenger Crust. Macrura, p. 195, pl. XXVIII, 1888.

*Habitat*.—Australia, in Murray River, the Murrumbidgee and tributaries, the Paramatta River at Sydney (Bate), Richmond River (White), Brisbane Water (White), and at Mount Wilson (Haswell).

List of specimens examined: Australia, Doctor F. Müller, one male (Coll. Mus. Comp. Zool.); Melbourne, Doctor F. Müller, one female ovig. (Coll. Mus. Comp. Zool.); Murray River, one female ovig. (Coll. Mus. Comp. Zool.); Murrumbidgee River, one male (Coll. Mus. Comp. Zool.), and Moreton Bay, one (Coll. Acad. Nat. Sci. Phila.).

The largest specimen in the Museum of Comparative Zoology (an egg-bearing female) is  $12\frac{1}{4}$  inches (310 mm.) long. Von Martens records a specimen 13 inches (330 mm.) in length, while according to Stebbing a length of 20 inches (507 mm.) is sometimes attained. The eggs measure 4 by 3 mm.

According to McCoy the Murray lobster is brought to the Melbourne market from the Murray River in considerable numbers. In living specimens the anterior legs, the middle of the back, and the apices of the spines and tubercles are rich, creamy white or ivory color; the ground color of the other legs, sides of the carapace, and the abdomen pale prussian blue of varying shades of intensity in different individuals, or sometimes mottled with dull olive green. The semicorneous, flexible edges of the tail fin are brownish. Some specimens are olive green where the blue appears in others.

According to Haswell, "specimens from Mount Wilson differ from those from the Murrumbidgee in having the apical spine of the rostrum very short, the tubercles of the carapace blunt, and the tubercles of the abdomen small, the inner row being altogether rudimentary; the color of this variety is deep red, with bluish shades on the sides of the carapace and legs, as in Shaw's figure."

The telson of the specimen figured by Heller is more spiny than usual.

This species was first described by Shaw as *Cancer serratus*, a name already used by Forskål for a different animal, *Scylla serrata*. Following the American Ornithologists' Union Committee's code of nomenclature,<sup>1</sup> the name *serratus* must be discarded in favor of *spinifer* of Heller.

The number and arrangement of the gills are the same as in *A. franklinii*, as shown in the formula on page 669. But the inner wall of the stem of all the podobranchiæ, except the hindmost, develops a broad limb or ala, as in the genus *Cheraps*; this ala, however, bears long hair-like setæ in place of the hooked branchial filaments seen in *Cheraps*. In *A. franklinii* this ala is very rudimentary, in which regard that species shows again its affinity to *Astacoïdes madagascariensis*. The epipod of the first maxilliped bears a large number of hookless branchial filaments.

Genus CHERAPS Erichson.

*Cheraps* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 101, 1846.

Type, *Astacus (Cheraps) preissii* Erichson.

Rostrum rather narrow, triangular, plane or even a little convex above, obscurely marginate, entire or obscurely toothed near the tip. Antennal scale broadly oval, or often broadly truncate at the distal end. Anterior process of epistome broadly triangular. Superior border of hand with a denticulated carina. Carapace and abdomen smooth, nearly free from spines and tubercles; areola narrow. Distal moiety of telson and of both branches of the posterior abdominal appendages membranaceous; median carina of inner branch of the latter terminating in a small spine near the middle of the segment; transverse suture of the outer branch halfway between the proximal and distal ends. Form cambaroid. Gills forty-two (one pair very small—almost rudimentary), disposed as shown in the following table:<sup>2</sup>

SOMITE.	PODOBRANCHLE.	ARTHROBRANCHLE.		PLEUROBRANCHLE.		
		Anterior.	Posterior.			
VII.	0 (ep r)	0	0	0	= 0 (ep r)	
VIII.	1	1	0	0	= 2	
IX.	1	1	1	0	= 3	
X.	1	1	1	0	= 3	
XI.	1	1	1	1	= 4	
XII.	1	1	1	1	= 4	
XIII.	1	1	a1	1	= 4	
XIV.	0	0	0	1	= 1	
		6+ep r	6	5	4	= 21+ep r

a Very minute, almost rudimentary.

*Habitat.*—Australia.

<sup>1</sup>Canon XXXIII.

<sup>2</sup>The arrangement and structure of the branchial apparatus in *Cheraps* was first described by Huxley, from an undetermined specimen in the British Museum from the Yarra-Yarra River, Australia. From the locality, this specimen was presumably *Cheraps bicarinatus*. I have examined the branchial organs in specimens of *C. bicarinatus* in the Museum of Comparative Zoology and find that they agree in every respect with Huxley's description (Proc. Zool. Soc. London, 1878, pp. 768, 769, fig. 6). Erichson was manifestly wrong in saying that *Cheraps*, like *Cambarus*, lacked gills on the last thoracic somite.



## CHERAPS PREISSII Erichson.

- Astacus* (*Cheraps*) *preissii* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 101, 1846.
- ?*Astacoïdes plebejus* HESS, Arch. f. Naturgesch., 31ter Jahrg., I, p. 164, pl. VII, fig. 17, 1865.
- Astacus preissii* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 617 (after Erichson).
- Astacopsis preissii* HASWELL, Cat. Australian Stalk and Sessile-eyed Crust., p. 177, 1882 (after von Martens).

Southwestern Australia (Erichson). Erichson's types could not be found in the Berlin Zoological Museum by Doctor von Martens in 1868. Victoria, Australia (No. 4356, Coll. Mus. Comp. Zool., one male).

The specimen in the Museum of Comparative Zoology agrees well with Erichson's diagnosis, so far as it goes. It shows a low postorbital ridge on each side of the gastric area, terminating anteriorly in a minute blunt tubercle. The rostrum is flat and punctate, lightly marginate, the margins passing anteriorly into the short, triangular acumen without developing lateral spines or teeth. The areola is much broader than in *C. bicarinatus*, measuring 5.5 mm. in width (length of the whole animal, 109 mm.). The outer part of the upper surface of the hand is thickly sown with very large, deep pits. The fingers are strongly curved, the movable one armed within with a large, blunt tooth. The carpus bears a long and stout tubercle on its inner border; this tubercle is curved forward and is blunt at the end; there are, besides, a few low tubercles on the anterior border of the lower face of the carpus. The anterior process of the epistoma is bounded behind by a slight transverse furrow; its sides are very convex, and its anterior angle is produced so as to form a thin, vertical plate.

Hess's *Astacoïdes plebejus* came from Sydney, New South Wales. The shape of the large chelæ, the breadth of the areola, and the color (yellowish, the large claws dusky) make it probable that this specimen was *Cheraps preissii*. The specimen (dry) of *C. preissii* in the Museum of Comparative Zoology has chelipeds of a very dark purplish color, in striking contrast with the yellow hue of the rest of the body. It is true that the deep, large pits seen on the chelæ of *C. preissii* are ignored in both the description and the figure of *Astacoïdes plebejus*, and that the telson has a very different shape, if Hess's figure be correctly drawn. Ortmann treats *Astacoïdes plebejus* as a synonym of *Cheraps preissii*, but I think that Ortmann's specimen of *C. preissii* was in reality *C. bicarinatus*. (See below.)

## CHERAPS BICARINATUS (Gray).

- Astacus bicarinatus* GRAY, Eyre's Journals of Expeditions of Discovery into Central Australia, I, p. 410, pl. III, fig. 2, 1845; List Crust. Brit. Mus., p. 72, 1847 (no description).
- Astacus bicarinatus* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 376, 1846 (after Gray).

*Astacus bicarinatus* HESS, Arch. f. Naturgesch., 31ter Jahrg., I, p. 164, 1865 (after Gray; no description).

*Astacus bicarinatus* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 617.

*Astacoides bicarinatus* MCCOY, Prod. Zool. Victoria, Decade III, pl. XXIX, 1879.

*Astacopsis bicarinatus* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 177, 1882 (after Gray).

*Cheraps bicarinatus* ORTMANN, Zoolog. Jahrb., Abth. f. Syst., VI, p. 7, pl. I, fig. 2, 1891; Semon's Zoolog. Forsch. in Australien, V, 1 Lief., p. 21 (Denkschr. med.-naturwissensch. Gesellsch. zu Jena, VIII), 1894.

? *Cheraps preissii* ORTMANN, Zoolog. Jahrb., Abth. f. Syst., VI, p. 8, pl. I, fig. 1, 1891.

*Habitat.*—Australia. Port Essington (Gray), Cape York (von Martens), Rockhampton (Ortmann), Manning River (Haswell), Sydney (Coll. Mus. Comp. Zool.), Murray River (von Martens), Melbourne (Coll. Mus. Comp. Zool.).

Gray's description and figure of *Astacus bicarinatus* (from Port Essington, northern Australia) do not apply very closely to the species now commonly known by this name. The wrist, for instance, is described and figured as "triangular, angularly produced in front;" the areola is too broad, and the account of the carinæ on the tail fin is not at all clear. Gray's type should be in the British Museum. In close connection with his description of *A. bicarinatus*, Gray notices a drawing brought home by Eyre, representing the "Ukodko," or smaller crayfish of the Murray River—undoubtedly the *Cheraps bicarinatus* of more recent authors. Gray's failure to identify the "Ukodko" with his own *Astacus bicarinatus* may have been due to the inaccuracy of the drawing, which showed no indications of the carinæ or postorbital ridges.

*Cheraps bicarinatus* attains to a length of about 6 inches. The rostrum is long triangular in outline, plane above, the margins slightly raised, commonly armed with a minute tooth on each side near the tip; but the lateral teeth are wholly wanting in some individuals. The postorbital ridges may terminate anteriorly in a blunt tubercle, or in others they may be quite free from any tendency to develop tubercle or spine. The areola is narrow, widening gradually from the anterior end backward. The antennal scale is very broad, broadest at the distal end, its inner margin very convex. In large specimens the dactylus of the chelipeds is equal in length to the inner margin of the palm, but in small specimens the fingers are commonly longer in proportion to the palm. The upper surface of the hand is sparsely and not very conspicuously punctate, the punctations being most evident on the outer half of this surface.

According to Mr. Eyre, as quoted by Gray, this crayfish (known to the aborigines of the Murray River district as the *Ukodko* or *Koongola*) "is found in the alluvial flats of the river Murray, in South Australia, which are subject to a periodical flooding by the river. It burrows deep below the surface of the ground as the floods recede and are dried up, and remains dormant until the next flooding recalls it to the surface. At

first it is in a thin and weakly state, but soon recovers and gets plump and fat, at which time it is most excellent eating. Thousands are procured from a small space of ground with ease, and hundreds of natives are supported in abundance and luxury by them for many weeks together. It sometimes happens that the flood does not occur every year, and in this case the eu-kod-ko lie dormant until the next, and a year and a half would thus be passed below the surface. I have often seen them dug out of my garden, or in my wheat field, by men engaged in digging ditches for irrigation. The floods usually overflow the river flats in August or September, and recede again in February or March."

This species has been well figured (in color) by McCoy. Different specimens vary considerably in color, "some having the body and abdomen dark olive, others paler or with a yellow tinge, and some are of a dull pale brown or horn color; the large anterior pair of claws are always blue, with red joints, and the flexible part of the five tail fins dull brown; the smaller pairs of legs are blue, or greenish, or whitish in different living individuals." According to the same author, this species is commonly known about Melbourne by the native name of *Yabber* or *Yabbie*. It does not inhabit the streams, "but is abundant in the quarry holes and swamps round Melbourne and in most water-holes in the colony, doing great damage to drains and reservoirs from burrowing holes through the banks. The individuals live for a long time underground in their burrows after the pools of water on the surface have dried up." Professor McCoy could detect no difference between specimens from the swamps near Melbourne and those of the Murray district.

As noted above, the lateral teeth near the tip of the rostrum are sometimes obsolete, and the proportional length of the fingers may vary according to the size of the specimen. It therefore seems to me probable that the specimen from Victoria in the Strasburg Museum assigned to *Cheraps preissii* by Ortmann is in reality *Cheraps bicarinatus*. The obsolescence of the lateral rostral spines is, in a few cases, accompanied by an appreciable shortening of the rostrum, but, after examining all the material before me, I can see no ground for forming two species.

List of specimens examined: Australia, eight males, four females (Coll. Mus. Comp. Zool.); Sydney, Australia, one male, one female (Coll. Mus. Comp. Zool.); Melbourne, Australia, two females (Coll. Mus. Comp. Zool.); no locality, one male, one female (Coll. Mus. Comp. Zool.); southern Australia, two males (Coll. U.S.N.M.); Happy Valley Creek, South Australia, two males (Coll. U.S.N.M.).

For convenience of reference I append a summary of the Australian and Tasmanian species of crayfish that are doubtful or that are unknown to me.

## ASTACOPSIS NOBILIS (Dana).

*Astacoides nobilis* DANA, U. S. Explor. Exped., XIII, Pt. 1, p. 526, 1852; Atlas, pl. XXXIII, fig. 3, 1855.—HESS, Arch. f. Naturgesch., 31ter Jahrg., I, p. 164, 1865 (Göttingen Mus.).—HELLER, Reise der Novara, Zool. Th., II, Pt. 3, Crust., p. 101, 1865.

*Astacopsis nobilis* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 616 (after Dana, Hess, and Heller).

*Astacopsis nobilis* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 175, 1882 (after Dana).

*Habitat.*—New South Wales? (Dana); Sydney, New South Wales (Heller, Hess).

Von Martens and Haswell incline to identify this species with *A. franklinii*; Huxley with *A. spinifera*. It seems to me more likely that it is a valid species, the Australian representative of the Tasmanian *A. franklinii*.

## ASTACOPSIS PARAMATTENSIS Bate.

*Astacopsis paramattensis* BATE, Rep. "Challenger" Crust. Macrura, p. 202, pl. XXVII, fig. 1, 1888.

*Habitat.*—Paramatta River, Sydney, Australia (Bate).

Bate described this species from a single female specimen 94 mm. (about 3¾ inches) long, collected by the "Challenger" expedition. *Astacopsis spinifera* was collected at the same place (Paramatta River, Sydney), and I am inclined to think that *A. paramattensis* is nothing but a young, small specimen of *A. spinifera*. It can be demonstrated that among the *Parastacinae*, as, for instance, in the genus *Paraneohropsis*, the heavy armature of spines or tubercles may be acquired only by large individuals, long after sexual maturity has been reached.

## ASTACOPSIS SYDNEYENSIS Bate.

*Astacopsis sydneyensis* BATE, Rep. "Challenger" Crust. Macrura, p. 204, pl. XXVII, fig. 2, 1888.

*Habitat.*—Sydney, Australia (Bate).

Based on single female specimen in the "Challenger" collections, 50 mm. (about 2 inches) long. Probably an immature specimen of an *Astacopsis*, perhaps *A. spinifera*.

## "ASTACUS" AUSTRALASIENSIS Milne-Edwards.

*Astacus australasiensis* MILNE-EDWARDS, Hist. Nat. des Crustacis, II, p. 332, pl. XXIV, figs. 1-5, 1837.—AUDOUIN ET MILNE-EDWARDS, Arch. du Mus. d'Hist. Nat., II, p. 36, 1841.

*Astacus australiensis* ERICHSON, Arch. f. Naturgesch., 12ter, Jahrg., I, p. 94, 1846 (after Milne-Edwards).—HELLER, Reise der Novara, Zool. Th., II, Pt. 3, Crust., p. 100, 1865.—VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 618 (after Milne-Edwards and Heller).

*Astacopsis australiensis* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 178, 1882 (after Milne-Edwards).

*Habitat*.—Australia (Milne-Edwards), Sydney, Australia (Heller). Length about 2 inches (Milne-Edwards),  $2\frac{1}{4}$  inches (Heller). Color greenish (Heller, as also in Milne-Edwards's figure).

Probably an immature specimen of an *Astacopsis*, possibly *A. nobilis*.

“ASTACUS” TASMANICUS Erichson.

*Astacus tasmanicus* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 94, 1846.—  
VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 618.

*Astacopsis tasmanicus* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 178, 1882 (after von Martens).

*Habitat*.—Tasmania. Type in Berlin Zoological Museum, No. 1579, female (von Martens).

“ENGÆUS” FOSSOR Erichson.

*Astacus (Engæus) fossor* ERICHSON, Arch. f. Naturgesch., 12ter. Jahrg., I, p. 102, 1846.

*Astacus fossor* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 618.

*Engæus fossor* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 178, 1882 (after von Martens).

*Habitat*.—Tasmania (Erichson, von Martens), Australia (von Martens). Types in Berlin Zoological Museum, Nos. 1123, 1124 (von Martens).

“ENGÆUS” CUNICULARIS Erichson.

*Astacus (Engæus) cunicularis* ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 102, 1846.

*Astacus cunicularis* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 619.

*Engæus cunicularis* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 179, 1882 (after von Martens).

*Habitat*.—Tasmania (Erichson, von Martens). Type in Berlin Zoological Museum, No. 1122 (von Martens).

“ASTACOÏDES” PLEBEJUS Hess.

*Astacoïdes plebejus* HESS, Arch. f. Naturgesch., 31ter Jahrg., I, p. 164, pl. VII, fig. 17, 1865.

*Astacus plebejus* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 616 (after Hess).

*Astacopsis plebejus* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 175, 1882 (after Hess).

*Habitat*.—Sydney, Australia (Hess). Type in Göttingen Museum (Hess).

This is probably a *Cheraps*—*C. preissii* Erichson, or else *C. bicarinatus* (Gray). (See p. 672.)

## CHERAPS QUINQUE-CARINATUS (Gray).

*Astacus quinque-carinatus* GRAY, Eyre's Journals of Expeditions of Discovery into Central Australia, I, p. 410, pl. III, fig. 3, 1845; List. Crust. Brit. Mus., p. 72, 1847 (no description).—ERICHSON, Arch. f. Naturgesch., 12ter Jahrg., I, p. 376, 1846 (after Gray).—VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 616 (after Gray).

*Astacopsis quinque-carinatus* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 176, 1882 (after Gray).

*Habitat.*—Western Australia, near Swan River (Gray).

## CHERAPS QUADRICARINATUS (von Martens).

*Astacus quadricarinatus* VON MARTENS, Monatsber. Akad. Wissensch. Berlin, 1868, p. 617.

*Astacopsis quadricarinatus* HASWELL, Cat. Australian Stalk- and Sessile-eyed Crust., p. 177, 1882 (after von Martens).

*Habitat.*—Cape York, Australia (von Martens). Type in Berlin Zoological Museum, No. 2972 (von Martens).

## Genus PARANEPHROPS White.

*Paranephrops* WHITE, Gray's Zoolog. Miscell., No. 2, p. 79, 1842.

Type, *Paranephrops planifrons* White.

Rostrum triangular, upper surface plane or subplane, margins raised and armed with spines or teeth. Carapace more or less spiny or tuberculate (at least in large individuals). Chelæ more or less armed with spines and teeth. Form astacoid. Branchial formula:

SOMITE.	PODOBRANCHLÆ.	ARTHROBRANCHLÆ.		PLEUROBRANCHLÆ.	
		Anterior.	Posterior.		
VII.	0 (ep r)	0	0	0	= 0 (ep r)
VIII.	1	1	0	0	= 2
IX.	1	1	1	0	= 3
X.	1	1	1	0	= 3
XI.	1	1	1	1	= 4
XII.	1	1	1	1	= 4
XIII.	1	1	r	1	= 3+r
XIV.	0	0	0	1	= 1
	$\overline{6+ep r}$	$\overline{+ 6}$	$\overline{+ 4+r}$	$\overline{+ 4}$	$\overline{= 20+r+ep r}$

*Habitat.*—New Zealand.<sup>1</sup>

<sup>1</sup>Huxley (Proc. Zool. Soc. London, 1878, p. 771) mentions two specimens of a *Paranephrops* in the British Museum, said to have come from the Fiji Islands. Mr. Edward J. Miers wrote to me, February 4, 1894, that he could not find any such specimens in the collection of the British Museum. Mr. Charles Chilton, of Christchurch, New Zealand, to whom I am indebted for a fine collection of the crayfishes of that country, has been at some pains to procure specimens of the fresh-water Crustacea of the Fijis, and he informs me that all the "crayfishes" have proved to be fresh-water prawns (*Palæmon*). It is probable that the specimens of *Paranephrops* labelled "Fiji Islands" in the British Museum were assigned to the wrong locality.

## PARANEPHROPS PLANIFRONS White.

*Paranephrops planifrons* WHITE, Gray's Zoolog. Miscell., No. II, p. 79, 1842; Dieffenbach's Travels in New Zealand, II, p. 267, 1843; List Crust. Brit. Mus., p. 72, 1847 (no description).

?*Paranephrops tenuicornis* DANA, U. S. Explor. Exped., XIII, Crust., Pt. 1, p. 527, 1852; Atlas, pl. xxxiii, fig. 4, 1855.

*Paranephrops tenuicornis* HELLER, Reise der Novara, Zoolog. Th., II, Pt. 3, Crust., p. 104, 1865.

*Paranephrops planifrons* MIERS, Zool. "Erebus and Terror," Crust., p. 4, pl. III, fig. 1, 1874; Cat. Stalk- and Sessile-eyed Crustacea of New Zealand, p. 72, 1876; Ann. Mag. Nat. Hist., 4th ser., XVIII, p. 413, 1876; Trans. and Proc. New Zealand Inst., IX, p. 476, 1877.

*Paranephrops planifrons* HUXLEY, Proc. Zool. Soc. London, 1878, p. 770.

*Paranephrops planifrons* CHILTON, Trans. and Proc. New Zealand Inst., XXI, pp. 242, 249, pl. x, figs. 1-3, 1888.

Types in British Museum (White, Miers).

*Paranephrops planifrons* is a very puzzling species. The type locality is the river Thames, North Island, New Zealand. In specimens from Puriri Creek, a tributary of the Thames, the rostrum tapers off into a long and sharp acumen, which overreaches the distal end of the antennular peduncle. Each side of the rostrum is armed with three teeth, which are produced into long spine-like points. In one of the five specimens before me there are four spines on the right side, three on the left; the lower side of the rostrum is furnished with one or two spines. The antennal scale is long, and diminishes in width from the basal third to the tip; it exceeds the rostrum in length. The postorbital ridge is interrupted between the two sharp spines with which it is armed. A median ridge runs along the gastric area, reaching forward as far as the anterior pair of postorbital spines, but not continued on the rostrum. There are two or three sharp spines on each side of the carapace, just behind the cervical groove, besides several more on the hepatic and pterygostomial regions. The areola is very short and broad—not much over one-third as long as the distance from the cervical groove to the tip of the rostrum. The abdominal pleuræ are bluntly angulated. The hand is long and narrow, its superior and inferior margins nearly straight, parallel, and armed with a double row of spines—those on the superior margin the longest. The inner and outer faces of the hand are convex and sparsely armed with spines, the largest of which are disposed in a median longitudinal row on each face.

Specimens from Karaka, Manukau Harbor (near Auckland), are altogether similar to typical examples from the Thames. The largest of these (an ovigerous female) measures 83 mm. from tip of rostrum to end of telson.

Individuals from localities south of the Thames basin, from the lake called Roto-Iti (North Island) southward to Cook Strait and beyond, differ almost constantly from the typical form in having a shorter rostral acumen, shorter lateral rostral teeth, shorter and broader antennal

scale; the areola, or, in other words, the posterior section of the carapace, is much longer, being nearly one-half as long as a line drawn from the cervical groove to the anterior end of the rostrum; the hand, too, is provided with shorter fingers and the lower half of the hand is more heavily tuberculate both on the inner and outer faces. The number of lateral rostral spines varies from three to five on each side; the number of inferior spines on the rostrum is one or two. In large specimens from Roto-Iti and Napier the sides of the carapace are thickly set with blunt tubercles which become spiny only on the hepatic and pterygostomian regions, and along the cervical suture; but in similarly large examples from Nelson (South Island) all the tubercles, even those on the branchial regions, tend to assume the form of sharp spines. Finally, in individuals collected at Wellington and in Pelorus River, Marlborough (localities on opposite sides of Cook Strait), a tendency is manifested to variation in the direction of *Paranephrops zealandicus*, inasmuch as the lateral rostral spines are increased in number and reduced to short, blunt teeth, and the antennal scale is short and broad, broadest at the middle, with very convex internal border. The largest of these specimens is only 73 mm. long. The number of lateral rostral spines varies between three and eight on each side, the average number being five. The lower side of the rostrum is in many cases destitute of teeth. In three out of the four specimens from Pelorus River the median carina of the carapace is very prominent, and extends forward from the gastric area half way to the tip of the rostrum. Usually in *P. planifrons* it runs forward only as far as the anterior postorbital spines.

The most southern locality where *P. planifrons* has been found is Greymouth, on the western side of the South Island.

It thus appears, as was first pointed out by Mr. Chilton, that *P. planifrons* is a variable species distributed throughout the whole length of the North Island (where it is the only species found) and through the northern part of the South Island as far south as Greymouth. Hence it would seem, in the words of Mr. Chilton, "that Cook Strait has not proved so great, or rather so old a barrier to these crayfish as the mountains in Nelson forming the northern continuation of the Southern Alps. As this point seemed to be of some importance in connection with the geographical distribution of the fauna of New Zealand, and as I was ignorant of the configuration of that part of the South Island, I applied to Professor Hutton for information. With his characteristic kindness and promptness, he at once told me that there was no great division (by mountains, that is,) between Nelson and Greymouth, but that the first great division would be along the Kaikoura Mountains and across westerly to Mount Franklin, and then down the Spencer Mountains and the Southern Alps; though the part between the Kaikoura Mountains and Mount Franklin is much broken by rivers, some running north and some south. He also told me that several North Island plants extend to Nelson and down the



west coast to Westport and Greymouth. Another fact pointing in the same direction is found in the distribution of *Armadillo speciosus*, a terrestrial isopod. This is known from the North Island (Bay of Islands, Dana, and Wellington, Hutton), and I have specimens from Nelson; but I have never heard of it occurring in the southern part of the South Island." On either side of Cook Strait (Wellington, Pelorus River) specimens were found which show a marked approach in the form of the rostrum, antennal scale, etc., to *P. zealandicus*.

*Paranephrops tenuicornis* Dana, from fresh-water streams about the Bay of Islands, northern New Zealand, is described as having a short point or tooth on the inner border of the antennal scale, near the apex, and the lower margin of the hand spinuli-scabrous, but not seriatly spinous. It is probably the same species as *P. planifrons*.

List of specimens examined:

Karaka, Manukau Harbor (North Island), four males, three females (Colls. Mus. Comp. Zool. and Dunedin Mus.); Puriri Creek, River Thames (North Island), three males, four females (Colls. Mus. Comp. Zool. and Dunedin Mus.); Roto-Iti (North Island), eight males, one female (Colls. Mus. Comp. Zool. and Dunedin Mus.); Napier (North Island), one male, one female (Coll. Dunedin Mus.); Wellington (North Island), three males, four females, four young (Coll. Dunedin Mus.); Pelorus River (South Island), two males, three females (Coll. Dunedin Mus.); Nelson (South Island), three males, two females (Colls. Mus. Comp. Zool. and Dunedin Mus.); Greymouth (South Island), one female (Coll. Dunedin Mus.).

#### PARANEPHROPS ZEALANDICUS (White).

*Astacus zealandicus* WHITE, Proc. Zool. Soc. London, Pt. 15, p. 123, 1847; List Crust. Brit. Mus., p. 72, 1847 (no description); Ann. Mag. Nat. Hist., 2d ser., I, p. 225, 1848; Zool. "Erebus and Terror," pl. II, fig. 2, 1874.

*Paranephrops zealandicus* MIERS, Zool. "Erebus and Terror," Crust., p. 4, 1874. *Paranephrops zealandicus* MIERS, Cat. Stalk- and Sessile-eyed Crust. of New Zealand, p. 73, 1876; Ann. Mag. Nat. Hist., 4th ser., XVIII, p. 413, 1876; Trans. and Proc. New Zealand Inst., IX, p. 476, 1877.

*Paranephrops neo-zealanicus* CHILTON (in part), Trans. and Proc. New Zealand Inst., XXI, p. 249, 1888.

Types in British Museum (Miers).

In *P. zealandicus* the chela is much shorter and broader than in *P. planifrons*, and it is furnished with conspicuous dense tufts of silky hair, disposed in longitudinal rows. The upper margin of the hand is armed with a series of prominent spines, continued as a double row on the margin of the dactylus. The lower margin of the hand is furnished with a double row of shorter spinous teeth. The outer face of the hand is provided with a few tubercles, which seldom develop any spinous points; the inner face bears two longitudinal rows of short teeth. The rostrum is armed on each side with small, blunt teeth, usually five in number, but in some individuals three, four, or six; the inferior edge is either unarmed or else provided with one or two acute teeth; a median carina runs over the gastric area, ceasing abreast of the ante-

rior pair of postorbital spines, the rostrum proper being wholly destitute of a median dorsal keel. In small specimens the sides of the carapace are smooth, or at the most reveal only the slightest trace of low, rounded papillæ; but in large specimens, that have attained a length of 115 mm. or more, the sides of the carapace are thickly studded with rounded tubercles. The antennal scale is rather short, and it is broadest in the middle.

White does not state from what part of New Zealand his type specimens came. These are still in the British Museum, and belong to this form, judging from the figure in the Zoology of the "Erebus and Terror," and from Miers's brief notice of them,<sup>1</sup> rather than to the following species, *P. setosus*.

List of specimens examined:

Near Dunedin (South Island), ten males, thirteen females (Colls. Mus. Comp. Zool. and Coll. Dunedin Mus.); Oamaru (South Island), one male (Coll. Dunedin Mus.).

According to Chilton,<sup>2</sup> *P. zealandicus* has been found in the western tributaries of the Waiau (in the southwestern part of Otago) and in Stewart Island.

Of a series of specimens collected in a small valley at Sawyer's Bay, near Dunedin, sent to me by Mr. Charles Chilton, some were taken from small streams affording a small flow of water, while others were captured in a little reservoir, not more than ten feet deep, formed by damming up one of the small streams. The maximum length attained by the individuals inhabiting the streams is about 84 mm. These specimens are sexually mature, as is shown by the fact that some of the females carry young beneath the abdomen. In all these examples from the small streams the carapace is well-nigh destitute of spines and tubercles. The specimens from the reservoir, on the contrary, are all very large, attaining a length of 118 to 158 mm., and heavily tuberculated on the sides of the carapace, the tubercles having the form of prominent, smooth, rounded papillæ.

#### PARANEPHROPS SETOSUS Hutton.

*Paranephrops setosus* HUTTON, Ann. Mag. Nat. Hist., 4th ser., XII, p. 402, 1873.

*Paranephrops setosus* MIERS, Cat. Stalk- and Sessile-eyed Crust. New Zealand, p. 72, 1876; Ann. Mag. Nat. Hist., 4th ser., XVIII, p. 413, 1876; Trans. and Proc. New Zealand Inst., IX, p. 476, 1877.

*Paranephrops horridus* "S[EMPER ?] MS.," MIERS, Cat. Stalk- and Sessile-eyed Crust. New Zealand, p. 73, 1876.

?*Astacoïdes tridentatus* WOOD-MASON, Proc. Asiatic Soc. Bengal, 1876, p. 4.

?*Astacoïdes zealandicus* WOOD-MASON, Ann. Mag. Nat. Hist., 4th ser., XVIII, p. 306, 1876.

*Paranephrops setosus* CHILTON, Trans. and Proc. New Zealand Inst., XV, p. 150, pls. XIX-XXI, 1882.

*Paranephrops neo-zealandicus* CHILTON (in part), Trans. and Proc. New Zealand Inst., XXI, pp. 246, 249, pl. x, figs. 1a, 2a, 1888.

<sup>1</sup> Ann. Mag. Nat. Hist., 4th ser., XVIII, p. 413, 1876.

<sup>2</sup> Trans. New Zealand Inst., XXI, p. 241, 1888.

*Paranephrops setosus* is nearly related to *P. zealandicus*, but may be distinguished by the following characters: The cephalothorax is more oval than in *P. zealandicus*, owing to the bulging of the sides of the carapace; the sides of the carapace are thickly strewn with acute, forward-turned spines, which take the place of the rounded tubercles in *P. zealandicus*. The rostrum and antennal scale are longer, the lateral rostral teeth longer and more spiniform; the rostrum is furnished with an evident median keel, most prominent on the distal half of the rostrum (in *P. zealandicus* there is a gastric keel, but no keel on the rostrum). These characters are manifest even in small specimens not more than 65 mm. in length, although in them the carapacial spines are much reduced in number—limited, indeed, to the hepatic area and the parts near the cervical groove. In *P. zealandicus* of a similar size the carapace is smooth.

The number of spines on each side of the rostrum varies between three and six. In every specimen I have examined there is at least one spine on the under side of the rostrum; in several individuals there are two, in one individual three.

The largest specimen before me is 145 mm. long.

When Professor Hutton described *P. setosus* he was apparently unacquainted with White's description of *P. zealandicus*,<sup>1</sup> and his type material probably included both the present species and *P. zealandicus*, for he gives as the habitat of *P. setosus* "stream near Invercargill, Province of Otago, and the river Avon, near Christchurch, Canterbury." The form from Invercargill is presumably (from what we know of the distribution of the New Zealand crayfishes) *P. zealandicus*. This is rendered the more certain in that Chilton<sup>2</sup> tells us that a large specimen in the Otago Museum, labeled *P. setosus* by Professor Hutton himself, has a cylindrical carapace, furnished with numerous rounded tubercles—features peculiar to large specimens of *P. zealandicus*. Hutton's description, however, seems to have been drawn up from the Avon River form, to which the name *setosus* may be properly restricted. I have received specimens of *P. setosus* (*sensu strictiori*) from Mr. Chilton, collected in the neighborhood of Christchurch, in the Avon and Heathcote rivers, and one pair taken at Rangiora, fifteen or twenty miles north of Christchurch.

Mr. Chilton<sup>3</sup> considers *P. zealandicus* and *P. setosus* to be one and the same species. As far as can be determined from the material at my disposal, the two species are perfectly distinct, even young, very small specimens being easily distinguishable.

List of specimens examined:

River Avon, Christchurch, New Zealand (South Island), four males, four females (Coll. Mus. Comp. Zool. and Coll. Dunedin Mus.); river Heathcote, near Christchurch, New Zealand (South Island), one male,

<sup>1</sup> Chilton, Trans. New Zealand Inst., XXI, p. 237.

<sup>2</sup> Ibid., p. 248.

<sup>3</sup> Ibid., p. 238.

three females (Coll. Mus. Comp. Zool. and Coll. Dunedin Mus.); Raugiora, New Zealand (South Island), one male, one female (Coll. Dunedin Mus.).

Genus PARASTACUS Huxley.

*Parastacus* HUXLEY, Proc. Zool. Soc. London, 1878, p. 771.

Type, *Astacus pilimanus* von Martens.

Form cambaroid. Rostrum of moderate width, rather flat above, marginate, entire or armed with a pair of denticles near the tip. Antennal scale broad. Anterior process of epistome broadly triangular. Superior margin of hand not carinate. Carapace and abdomen smooth (without prominent spines or tubercles). Telson and posterior pair of abdominal appendages more or less membranaceous at distal end, but no sharp line of demarcation between the membranaceous and calcified portions. Median carina of inner branch of the posterior abdominal appendages terminating not far from the posterior border (usually in a small spine); transverse suture of outer branch one-third way from the posterior border. Gills forty, arranged as shown in the subjoined table:

SEGMENT.	PODOBRANCHLE.	ARTHROBRANCHLE.		PLEUROBRANCHLE.							
		Anterior.	Posterior.								
VII.	0 (ep r or ep)	0	0	0	0	= 0 (ep r or ep)					
VIII.	1	1	0	0	0	= 2					
IX.	1	1	1	0	0	= 3					
X.	1	1	1	0	0	= 3					
XI.	1	1	1	1	1	= 4					
XII.	1	1	1	1	1	= 4					
XIII.	1	1	r	1	1	= 3+r					
XIV.	0	0	0	1	1	= 1					
		6+ep r or ep+6		+	4+r		+	4		=	20+r+ep r or ep

*Habitat.*—South America (and Mexico?).

Von Martens<sup>1</sup> notes the existence of a pair of genital orifices on the basal segment of the third pair of legs in a male *Parastacus pilimanus* and in a male *P. brasiliensis*. The coexistence of sexual orifices in both the third and fifth pairs of legs of the same individual appears to be the normal condition in the burrowing species of *Parastacus*. I have found it in every specimen of the following species examined: *P. saffordi*, *P. varicosus*, *P. defossus*, and *P. hassleri*. In most cases the vulvæ are closed by a chitinous membrane.

PARASTACUS SAFFORDI, new species.

(Plate LXVIII.)

Rostrum of moderate length, plane above, with raised toothless margins, which extend backward for a short distance on the gastric area inside the postorbital ridges; margins parallel throughout their basal third, then gradually converging to the acute, depressed acumen; the end of the rostrum reaches to the distal end of the antennular peduncle; infero-lateral margins fringed with long cilia. Cephalo-thorax laterally compressed. Postorbital ridges continuous, parallel with each

<sup>1</sup>Sitzungs-Berichte der Gesellschaft naturforschender Freunde zu Berlin, 1870, p. 3.

other except posteriorly, where they converge; they are armed anteriorly with a minute spine. Anterior border of the carapace produced to form a short subocular spine. Branchiostegian spinule minute. Cervical groove sinuous. Areola broad, about one-half as long as the anterior section of the carapace. The branchio-cardiac lines form a slightly raised, blunt ridge in the anterior part of their course. Sides of carapace granulate; no lateral spines. Abdomen longer than cephalothorax, pleuræ broadly rounded. Telson truncate, with posterior corners rounded; a pair of lateral spines about two-thirds the way from the proximal to the distal ends. Anterior process of epistome broad, separated from the posterior part by a transverse furrow, sides slightly convex, apex blunt.

Antennæ rather short; proximal segment armed with one small spine external to the orifice of the green gland; two more small spines on the external side of the antenna, one at the base of the scale, the other farther forward and at a lower level; antennal scale short and broad, broadest at the middle, internal border very convex, external border inflated and terminated by a small spine. Third maxillipeds densely bearded. Chelipeds of moderate length; margins of merus spinulose, lower face spinuloso-granular, as is also the distal part of the inner face; carpus triangular, upper border and inner face thickly set with small spiniform tubercles, outer face squamoso-tuberculous; chelæ of moderate length, symmetrical, inflated, ornamented with low squamous tubercles on the superior and inferior margins, outer face nearly smooth, inner face clothed with long hairs; fingers longer than the palm, incurved, their inner faces excavated, bearded, cutting edges denticulate, with one prominent denticle on each finger—the one on the movable finger proximad of the one on the immovable finger; tips acute.

Length 90 mm.; carapace 42 mm.; from tip of rostrum to cervical groove 28 mm.; from cervical groove to posterior border of carapace 14 mm.; length of abdomen 45 mm.; width of areola 5 mm.; length of cheliped 59 mm.; merus 16 mm.; length of chela 25 mm.; breadth of chela 11 mm.; length of dactylus 15 mm.

*Habitat*.—Montevideo, Uruguay. W. E. Safford, U. S. S. "Vandalia." (No. 12581, Coll. U.S.N.M.) Three specimens. There is also a small specimen in the collection of the Philadelphia Academy of Sciences labeled, "Brazil" (No. 287 Guérin Coll.). According to the manuscript label accompanying the specimens in the United States National Museum, they were found in burrows one hundred meters from the coast and two meters deep, in strata of sand covered by soil.

This species is allied to *Parastacus pilimanus*<sup>1</sup> and *P. brasiliensis*.<sup>2</sup>

<sup>1</sup> *Astacus pilimanus* VON MARTENS, Arch. f. Naturgesch., 35ter Jahrg., I, p. 15, pl. II, figs. 1, 1b, 1869.—*Parastacus pilimanus* HUXLEY, Proc. Zool. Soc. London, 1878, p. 771. *Habitat*.—Porto Alegre, and also Santa Cruz, in upper part of the Rio Pardo basin, a tributary of the Jacuhy, Brazil. Types in Berlin Zool. Mus., Nos. 3323, 3447 (von Martens).

<sup>2</sup> *Astacus brasiliensis* VON MARTENS, Arch. f. Naturgesch., 35ter Jahrg., I, p. 16, pl. II, figs. 2, 2b, 1869.—*Parastacus brasiliensis* HUXLEY, Proc. Zool. Soc. London, 1878,

PARASTACUS VARICOSUS, new species.

(Plate LXIX.)

Similar to *P. saffordi*, but different in the following particulars: The branchio-cardiac lines bounding the areola are elevated so as to form very prominent, rounded ridges, serrated externally; these ridges run a short distance down the cervical groove in front, but cease before reaching the hind border of the carapace. The cheliped is very much longer than in *P. saffordi*; the distal end of the merus, which in the latter species only reaches to the subocular angle, in *P. varicosus* attains to the level of the rostrum; the hand, too, is very much longer, and different in outline, the superior and inferior margins being straight instead of convex, while the external face is beveled off so as to form a nearly flat field, oblique to the vertical plane of the hand, on each side of a low, blunt, longitudinal keel, which runs from the carpal joint to the base of the thumb. In *P. saffordi* the superior and inferior margins of the hand are distinctly convex, the external face swollen and roundish. The dorsal surface of the rostrum is conspicuously pitted in *P. varicosus*, obscurely or not at all pitted in *P. saffordi*. The anterior ventral margin of the proximal antennal segment is armed with two spines in the former species; one of these spines lies in front of the orifice of the green gland, the other at the external angle of the segment. In *P. saffordi* only one of these spines exists—the one at the external angle of the segment. The posterior border of both branches of the swimmerets has a more truncate outline in *P. varicosus* than in *P. saffordi*.

Length 100 mm.; carapace 49 mm.; from tip of rostrum to cervical groove 34 mm.; from cervical groove to posterior border of carapace 15 mm.; abdomen 52 mm.; width of areola 5 mm.; cheliped 91 mm.; merus 24 mm.; length of chela 40 mm.; breadth of chela 13 mm.; length of dactylus 22 mm.

The number and arrangement of the branchial organs are exhibited in the subjoined table:

SOMITE.	PODOBANCHLE.	ARTHROBRANCHLE.		PLEUROBRANCHLE.		
		Anterior.	Posterior.			
VII.	0 (ep r)	0	0	0	=	0 (ep r)
VIII.	1	1	0	0	=	2
IX.	1	1	1	0	=	3
X.	1	1	1	0	=	3
XI.	1	1	1	1	=	4
XII.	1	1	1	1	=	4
XIII.	1	1	r	1	=	3+r
XIV.	0	0	0	1	=	1
		6+ep r	+ 6	+ 4+r	+ 4	= 20+r+ep r

The epipod of the first maxillipeds bears about twenty gill filaments on the upper half of its external face. The posterior arthrobranchia

p. 771; The Crayfish, p. 250, fig. 64, 1880.—ORTMANN, Zoolog. Jahrb., Abth. f. Syst., VI, p. 9, 1891. *Habitat.*—Southern Brazil: Porto Alegre and near Rödgersberg (von Martens), Rio Grande do Sul, São Lourenzo (Ortmann). Types in Berlin Zoolog. Mus., Nos. 3322, 3448 (von Martens).

of the thirteenth somite is reduced to a small, simple filament. The podobranchiæ are alate and the alæ are provided with hooked tubercles similar to those of the *Astacinae*. The coxopoditic setæ are long and hooked at the end.

*Habitat*.—Colima, Mexico. J. Xantus. (No. 4133, Coll. U.S.N.M.) One specimen.

The locality is notable as being the only one north of the equator where Parastacine crayfishes occur. Furthermore, the close affinity between this species and a native of Uruguay (*Parastacus saffordi*) is surprising. But beyond this there appears to be no reason to discredit the legend which accompanies the type specimen of *P. varicosus* in the United States National Museum.

PARASTACUS DEFOSSUS, new species.

(Plate LXVII, figs. 3, 4.)

Cephalo-thorax laterally compressed, the sides high and nearly vertical. Anterior segment of abdomen small. Rostrum small, triangular, deflexed, plane above, lateral borders slightly marginate, strongly converging from the base to the blunt tip which hardly reaches to the proximal end of the third antennular segment. The margins of the rostrum are prolonged backward for a short distance on the gastric area, where they tend to fuse with the anterior end of the postorbital ridges. The latter are but slightly marked, unarmed, strongly divergent in their backward course. The suborbital angle is prominent, but perfectly rounded off. The dorsal surface of the carapace is smooth, polished, and sparsely punctate, the lateral walls lightly granulate. The areola is very long and narrow, the gastric area proportionally short. Abdominal pleuræ rounded, telson long, posteriorly oval in outline. Anterior process of epistome rather long, but slightly separated from the body of the epistome by transverse suture; anteriorly truncate. Antennæ about equal in length to the cephalo-thorax; scale small, broad, broadest near the distal end, external border terminating in a long, stout spine directed a little outward; a blunt spine or tubercle on the lower side of the first antennal segment, just in front of the orifice of the green gland; no external spine at base of the scale. Third maxillipeds hairy within. Chelipeds symmetrical; merus trigonal, outer face smooth, inferior edges serrate, superior edge armed with one blunt tooth near the distal end; carpus broadly triangular, internal border armed with a single series of blunt teeth which increase in size toward the distal end of the segment; hand short and broad, the palm as broad as long, outer face convex, smooth, with scattering coarse puncta, superior (or internal) margin ornamented with a low crest of squamous, setiferous tubercles, inferior border similarly adorned with single row of tubercles running from the proximal end of the hand as far as to the base of the immobile finger, where they are replaced by shallow pits; dactylus equal in length to the breadth of the hand, upper margin rounded, with a single

row of confluent pits, outer face with a longitudinal furrow just below the superior margin; cutting edges of the fingers armed with a few blunt teeth near the proximal end. The inner branch of the last pair of abdominal appendages bears a longitudinal median rib, which runs nearly to the posterior margin of the segment, but this rib does not end in a spine as it usually does in the crayfishes.

Length 47 mm.; length of carapace 23.5 mm.; from tip of rostrum to cervical groove 15 mm.; from cervical groove to hind border of carapace 9.3 mm.; breadth of areola 1.75 mm.; length of cheliped 31 mm.; length of merus 9 mm.; length of carpus 6 mm.; breadth of carpus 6 mm.; length of chela 13.5 mm.; breadth of chela 8 mm.; superior margin of propodite 6.2 mm.; length of dactylus 8 mm.

*Habitat.*—Montevideo, Uruguay. W. E. Safford, U. S. S. "Vandalia." (Coll. U.S.N.M.) Three specimens. Taken, together with *P. saffordi*, in burrows two meters deep, one hundred meters from the coast, in strata of sand covered by soil.

*Parastacus defossus* is a species whose appearance clearly reveals its subterranean mode of life, like *Cambarus diogenes* of the United States and the so-called *Engaei* of Tasmania. It has some affinity with *P. brasiliensis* of southern Brazil, a species not especially fossorial in habit, but found in brooks and springs. *P. defossus* is easily distinguished from *P. brasiliensis* by the extreme lateral compression of the cephalo-thorax, the small size of the anterior end of the abdomen, the strong convergence of the lateral margins of the rostrum, the length and narrowness of the areola, the shape of the chela (which is much shorter and broader than in *P. brasiliensis*), the long oval outline of the telson, etc.

#### PARASTACUS HASSLERI, new species.

(Plate LXX, figs. 1-3.)

Cephalo-thorax narrow. Rostrum rather short, reaching nearly to the distal end of the second segment of the antennular peduncle; upper surface slightly excavated, with raised, toothless margins convergent from the base to the blunt (sometimes truncate) extremity. Postorbital ridges slightly marked, strongly divergent from before backward, not confluent with the margins of the rostrum, inflated at the posterior end so as to form a low tubercle. Wall of the orbit produced to form a prominent angle under the eye, but not armed with a spine. Dorsal surface of carapace smooth, polished, nearly free from impressed dots over the gastric area, areola rather narrow, its field thickly strewn with impressed dots; a group of six to nine small, blunt tubercles on the anterior part of the lateral walls of the carapace; branchial regions lightly granular. Distance from tip of rostrum to cervical groove about twice the length of the areola. Abdominal pleuræ rounded. Hind border of telson rounded, lateral spines obsolescent. Anterior process of epis-



tome triangular, bounded behind by a transverse furrow, apex subacute. Basal segment of antenna devoid of spines, neither is there any trace of an external spine at the base of the antennal scale; the latter is small, broad, its inner border rounded, its outer border terminating in a long, stout, straight tooth or spine. Third maxillipeds hairy within. Chelipeds long, usually symmetrical on the two sides of the body, but in some individuals distinctly unsymmetrical; upper margin of merus lightly serrate, without any prominent tooth; lower margins armed with a row of small, blunt teeth or tubercles, lower face more or less tuberculous, inner and outer faces smooth; carpus short, triangular, superior internal margin with a series of small obsolescent teeth or tubercles; there is also a short row of similar teeth near the external lower angle of the carpus, near the point of articulation with the chela; chela large and powerful, palm inflated, outer and inner faces smooth, superior margin nearly straight, adorned with low, squamous tubercles which are irregularly disposed in two rows; the inferior margin of the hand is convex, and is similarly ornamented with biserial, depressed obsolescent tubercles which cease at the base of the immobile finger. The fingers are conspicuously marked with longitudinal rows of pits, three rows on each finger; the cutting edges are irregularly toothed, two teeth on the movable finger and three on the immovable finger; the fingers are not conspicuously bearded. The median carina of the inner branch of the posterior pair of abdominal appendages ends near the hind margin without developing a spine.

Dimensions of a specimen: Length 96 mm.; carapace 48 mm.; from tip of rostrum to cervical groove 32 mm.; from cervical groove to posterior border of carapace 15.5 mm.; width of areola 4.5 mm.; length of cheliped 86 mm.; length of merus 22 mm.; length of carpus 17 mm.; breadth of carpus 13 mm.; length of chela 39.5 mm.; breadth of chela 18 mm.; length of dactylus 25 mm.

In the number and arrangement of the branchial organs, *Parastacus hassleri* agrees with *P. varicosus*.<sup>1</sup> The epipod of the first maxilliped bears gill filaments, as in the latter species, the podobranchiæ have narrow aæ, the posterior arthrobranchia of the thirteenth somite is reduced to a small filament which bears a single lateral branch. The coxopoditic setæ are long and hooked at the end.

*Habitat*.—Talcahuano, Chile, No. 3401, Coll. Mus. Comp. Zool., (Hassler Exped., April, 1872). One hundred specimens.

*Astacus chilensis* Milne-Edwards,<sup>2</sup> from "the coast of Chile," is not described with enough detail to be determinable. The type, however, may be still extant in Paris. It is said to bear a close resemblance to *Astacus australasiensis* Milne-Edwards,<sup>3</sup> but to differ from the latter species in having a shorter rostrum, a carpus destitute of teeth or

<sup>1</sup> Page 685.

<sup>2</sup> Hist. Nat. des Crustacés, II, p. 333, 1837.

<sup>3</sup> Ibid., II, p. 332, pl. xxiv, figs. 1-5, 1837.

tubercles, hands swollen, rounded above and below, slightly tuberculate on their upper margin, and scarcely punctate. The anterior process of the epistome is shaped as in *Astacus astacus*, but it is separated from the body of the epistome by a transverse furrow. Length about three inches. It would seem from Milne-Edwards's diagnosis and from the same author's description and figure of *Astacus australasiensis* that, whatever *Astacus chilensis* may prove to be, it is neither of the two Chilean crayfishes described in this paper. In 1849, Nicolet<sup>1</sup> described and figured as *Astacus chilensis* Milne-Edwards, a species of crayfish found "in the rivers of Chile"—a species manifestly distinct from Milne-Edwards's. For, not to mention other peculiarities, the carpus is described and figured by Nicolet as furnished with a crest of blunt, tuberculiform teeth on its inner border, whereas Milne-Edwards distinctly says that there are neither teeth nor tubercles upon the carpus of *A. chilensis*. I therefore propose to call Nicolet's crayfish *Parastacus nicoletii* (= *Astacus chilensis* Nicolet nec Milne-Edwards).

*Parastacus hassleri* is similar to *P. nicoletii*. That both of them are fossorial in their habits is evinced by the marked compression of the cephalo-thorax, small size of the first abdominal segment, etc. The following comparison will make clear the chief specific differences between the two species: In *P. nicoletii* the anterior part of the sides of the carapace is covered with fine spinules; in *P. hassleri* these spinules are replaced by a small group of blunt tubercles. In *P. nicoletii* the rostrum does not overreach the proximal end of the second segment of the antennular peduncle; it is quadrate in form, with straight and parallel lateral margins, its upper surface deeply concave. In *P. hassleri* the rostrum is longer, attaining almost to the distal extremity of the second segment of the antennular peduncle; its upper surface is but lightly hollowed out, while its lateral borders are distinctly convergent from the base forward. The carpus of *P. nicoletii* is furnished with a conspicuous crest of rounded, tuberculiform teeth along its inner superior border, and the outline of the opposite, lower or external border is extremely convex or protuberant. In *P. hassleri* the tubercular crest is obsolete, being represented merely by a few lightly pronounced denticles; the lower or external border is but slightly convex, whereby the carpus comes to have a triangular outline. Finally, the hand of *P. hassleri* is much longer than that of *P. nicoletii*, its upper border longer, straighter, and less strongly tuberculate, the fingers less deeply sulcated.

According to Nicolet, crayfishes are found in the rivers, brooks, and even in the forests, of southern Chile, where they live in holes in the ground, around the entrance of which they construct earthworks in the shape of a cone nearly a foot in height. As is well known, *Cambarus diogenes* Girard, erects similar mud towers or "chimneys" in the

<sup>1</sup>Gay's *Historia Fisica y Política de Chile, Zoología*, III, p. 211; Atlas, II, Crustáceos, pl. I, fig. 4.

United States, and Mr. P. R. Uhler tells me that *Cambarus dubius* Faxon, has the same habit in western Virginia.<sup>1</sup> Titian R. Peale informed Girard<sup>2</sup> that he had observed mud chimneys, altogether similar to those of *C. diogenes*, along the Rio Magdalena in New Grenada, several hundred miles from the seashore. But the builders of these chimneys in New Grenada still remain unknown to science. In this connection it is worthy of note that the earliest mention of adobe towers, erected at the mouth of Crustacean burrows, occurs in Molina's work on the natural history of Chile,<sup>3</sup> page 208: "I gamberi fluviali più rimarchevoli sono i *Muratori*, *Cancer cæmentarius*,<sup>4</sup> i quali hanno circa otto pollici di lunghezza; il lor colore è bruno rigato di vene di un rosso vivo, e la carne bianca e più saporosa di quella de' gamberi marini e degli altri fluviali. Questi si trovano in gran quantità in tutti quei fiumi e rivi, nei margini dei quali essi si fabbricano con dell' argilla un' abituro cilindrico alto un mezzo piede sopra il terreno, ma profondo di maniera che l' acqua corrente vi passa per mezzo di un canaletto sotterraneo."<sup>5</sup>

Pöppig considered the *Cancer cæmentarius* of Molina to be a common edible prawn of Chile, *Palæmon (Bithynis) cæmentarius* Pöppig.<sup>6</sup> This prawn is said to dig deep holes in the clayey banks of the Chilean rivers near the sea, closing up the mouths of the holes with mud. Molina's description of the mud tenements of *Cancer cæmentarius* vividly recalls the "chimneys" constructed by fossorial crayfishes. The character "*rostrum obtusum*," moreover, applies better to *Parastacus nicoletii* or *P. hassleri* than to *Palæmon cæmentarius* Pöppig, although the rostrum of the latter is obliquely truncated at the tip. On the other hand, the aculeate claws and the length of *C. cæmentarius* point rather to the *Palæmon*.

#### PARASTACUS AGASSIZII, new species.

(Plate LXX, figs. 4, 5.)

Body robust, subcylindrical, first abdominal somite of normal size. Rostrum long, triangular, slightly surpassing the antennular peduncle, and attaining the distal end of the antennal peduncle; upper face flat,

<sup>1</sup> Since the above was written, crayfish "chimneys" observed by Mr. W. P. Hay in Indiana and by Doctor R. W. Shufeldt in Montgomery County, Maryland, have been ascribed to *Cambarus argillicola* and *C. bartonii robustus*, respectively.

<sup>2</sup> Proc. Acad. Nat. Sci. Phila., VI, p. 90, 1852.

<sup>3</sup> Saggio sulla Storia Naturale del Chili. Del Signor Abate Giovanni Ignazio Molina. Bologna, 1782.

<sup>4</sup> *Cancer macrourus*, thorace lævi cylindrico, rostro obtuso, chelis aculeatis.

<sup>5</sup> Translation: The most remarkable of the river prawns are the "Masons," *Cancer cæmentarius*. They are about eight inches in length, of a brown color, veined with bright red; the flesh is white and more delicious than that of any other kind of prawn, either fluvialile or marine. They are found in great abundance in all the rivers and brooks, on whose banks they build of clay a cylindrical dwelling rising half a foot above the ground, but so deep withal that the current passes into it by means of a small subterranean canal.

<sup>6</sup> Arch. f. Naturgesch., 2ter Jahrg., I, p. 143, 1836.

with scattered setæ; margins slightly raised, convergent, lightly convex, armed near the tip with a pair of small, blunt denticles; acumen short, subacute. Suborbital angle prominent, but rounded off, unarmed with tooth or spine. Postocular ridges obsolete except their anterior ends, which form a tubercle on each side of the base of the rostrum—a tubercle channeled along its outer face and terminating anteriorly in an obsolescent tooth. Carapace smooth and lightly punctate above, minutely granular on the sides. Cervical groove sinuous, no lateral spine. Areola very broad. Distance from tip of rostrum to cervical groove upward of twice and a half as long as the areola. Abdomen smooth, pleuræ rounded. Sides of telson slightly convergent, armed with a spine on each side, one-third way from the distal end; distal border truncate, postero-lateral corners rounded. Anterior process of the epistome triangular, sides straight or slightly convex, tip blunt or slightly truncate; a slight furrow divides the anterior process from the body of the epistome, and the latter is divided in halves by a longitudinal depression. Basal segment of antenna armed with a sharp spine in front of the orifice of the green gland; another spine lies at the base of the outer edge of the antennal scale; the antennal scale is of moderate size, a little longer than the rostrum, broadest near the middle, its outer margin slightly convex, ending in a small apical spine. Third pair of maxillipeds hairy within and below. Right and left chelipeds very unequal, the left usually the larger; lower margins of the merus denticulate, upper margin furnished with one small tooth near the distal end of the segment; outer and inner faces smooth; carpus marked with a conspicuous longitudinal groove on its upper outer face, and with a few small, blunt tubercles on its inner margin; lower external border of carpus short, rounded, and protuberant; chelæ without prominent tubercles or spines, but when viewed under a lens the surface is finely squamoso-tuberculate proximally, punctate distally; the superior and inferior borders of the chela are rounded, the fingers setose along their cutting edges; the fingers of the left (larger) chela are stout, somewhat gaping, with one evident round tubercle on the prehensile margin; the fingers of the right (smaller) chela are relatively longer and slenderer and are devoid of tubercles on the prehensile margins. The median longitudinal ridge on the inner blade of the last abdominal appendages ends in a small spine near the posterior border.

Length of a male 83 mm.; cephalo-thorax 38 mm.; abdomen 45 mm.; length of rostrum 9 mm.; width of rostrum at base 5 mm.; length of telson 12 mm.; width of telson at base 11 mm.; from tip of rostrum to cervical groove 28 mm.; from cervical groove to posterior margin of carapace 10 mm.; width of areola 8.8 mm.; length of left cheliped 67 mm. (merus 15 mm., carpus 11 mm., chela 32 by 16 mm., dactylus 20 mm.); length of right cheliped 54 mm. (merus 14 mm., carpus 9 mm., chela 25 by 8.5 mm., dactylus 16 mm.).

The largest individual (a male) is 97 mm. long.

The branchial formula for *P. agassizii* is as follows:

SOMITE.	PODOBRANCHIÆ.	ARTHROBRANCHIÆ.		PLEUROBRANCHIÆ.						
		Anterior.	Posterior.							
VII.	0 (ep)	0	0	0	=	0 (ep)				
VIII.	1	1	0	0	=	2				
IX.	1	1	1	0	=	3				
X.	1	1	1	1	=	4				
XI.	1	1	1	1	=	4				
XII.	1	1	1	1	=	4				
XIII.	1	1	r	1	=	3+r				
XIV.	0	0	0							
		6+ep	+	6	+	4+r	+	4	=	20+r+ep

The epipod of the first maxilliped is destitute of branchial filaments, a condition rarely found among the *Parastacinae*. The stems of the podobranchiæ are alate. The posterior arthrobranchia of the thirteenth somite is a simple, slender filament. Coxopoditic setæ long, hooked at the free end.

*Habitat*.—Talcahuano, Chile, No. 3400, Coll. Mus. Comp. Zool., (Hassler Exped., April, 1872). Nine males, eight females (two ovig.).

The egg measures 3.5 by 2.5 mm.

In nine out of fourteen specimens the larger claw is on the left side.

Judging from the form of the body, this is probably not a burrowing species.

*Museum of Comparative Zoology,*

*Cambridge, Massachusetts, August 1, 1896.*

#### EXPLANATION OF PLATES.

[NOTE.—All of the figures were drawn by James H. Emerton. Owing to errors in the photographic reduction of the original drawings, it is impossible to give the exact scale for many of the figures in these plates.]

#### PLATE LXII.

Fig. 1. *Cambarus acherontis* Lönnberg. Female. Gum Cave, Citrus County, Florida. Reduced. (U.S.N.M.)

2. The same, lateral view of the head.

3. *Cambarus acherontis* Lönnberg. First abdominal appendage of a young male, Form II, from the outside.

4. The same, from the inside.

5. *Cambarus acherontis* Lönnberg. Annulus ventralis of adult female.

6. *Cambarus longidigitus* Faxon. Male, Form II. White River, Arkansas. Reduced. (No. 4364, Mus. Comp. Zool.)

7. The same, first abdominal appendage from the outside.

8. The same, first abdominal appendage from the inside.

9. *Cambarus longidigitus* Faxon. Annulus ventralis of female.

#### PLATE LXIII.

Fig. 1. *Cambarus carinatus* Faxon. Male, Form I. Guadalajara, Mexico.  $\times \frac{3}{4}$ . (No. 17699, U.S.N.M.)

2. The same, first abdominal appendage from the outside.

3. The same, first abdominal appendage from the inside.

## PLATE LXIV.

- Fig. 1. *Cambarus palmeri longimanus* Faxon. Male, Form I. Arthur, Texas.  $\times \frac{2}{3}$ .  
(Mus. Comp. Zool.)
2. The same, first abdominal appendage from the outside.  $\times 2\frac{2}{3}$ .
  3. The same, first abdominal appendage from the inside.  $\times 2\frac{2}{3}$ .
  4. *Cambarus palmeri longimanus* Faxon. First abdominal appendage of the male, Form II, from the outside.  $\times 2\frac{2}{3}$ .
  5. The same, from the inside.  $\times 2\frac{2}{3}$ .
  6. *Cambarus palmeri longimanus* Faxon. Annulus ventralis of female. Arthur, Texas.  $\times 2\frac{2}{3}$ .
  7. *Cambarus erichsonianus* Faxon. Greeneville, Tennessee.  $\times 1$ . (No. 4347, Mus. Comp. Zool.)
  8. *Cambarus erichsonianus* Faxon. First abdominal appendage of the male, Form I, from the outside. Greeneville, Tennessee.
  9. The same, from the inside.
  10. *Cambarus erichsonianus* Faxon. First abdominal appendage of the male, Form II, from the outside. Greeneville, Tennessee.
  11. The same, from the inside.
  12. *Cambarus erichsonianus* Faxon. Annulus ventralis of female. Greeneville, Tennessee.

## PLATE LXV.

- Fig. 1. *Cambarus difficilis* Faxon. Male, Form I. McAlister, Indian Territory.  $\times \frac{2}{3}$ .  
(Mus. Comp. Zool.)
2. The same, first abdominal appendage of the male from the outside.  $\times 2\frac{2}{3}$ .
  3. The same, first abdominal appendage of the male from the inside.  $\times 2\frac{2}{3}$ .
  4. *Cambarus difficilis* Faxon. Annulus ventralis of female. McAlister, Indian Territory.  $\times 2\frac{2}{3}$ .
  5. *Cambarus meeki* Faxon. Male, Form II. Piney, Arkansas.  $\times 1$ . (Mus. Comp. Zool.)
  6. *Cambarus meeki* Faxon. Chela of female. Piney, Arkansas.  $\times 1$ .
  7. *Cambarus meeki* Faxon. First abdominal appendage of the male, Form II, from the outside. Piney, Arkansas.  $\times 2\frac{2}{3}$ .
  8. The same, from the inside.  $\times 2\frac{2}{3}$ .
  9. *Cambarus meeki* Faxon. Annulus ventralis of female. Piney, Arkansas.  $\times 2\frac{2}{3}$ .

## PLATE LXVI.

- Fig. 1. *Cambarus montezumæ dugesii* Faxon. Female. Guanajuato, Mexico.  $\times 2\frac{1}{2}$ .  
(No. 16087, U.S.N.M.)
2. *Cambarus montezumæ arcolatus* Faxon. Female. Cohahuila, Mexico.  $\times 2\frac{1}{2}$ .  
(No. 3650, Mus. Comp. Zool.)
  3. *Cambarus montezumæ occidentalis* Faxon. Female. Mazatlan, Mexico.  $\times 2\frac{1}{2}$ .  
(No. 3652, Mus. Comp. Zool.)
  4. The same. Left chela, viewed from the outside.

## PLATE LXVII.

- Fig. 1. *Cambarus chapalanus* Faxon. Male, Form I. Lake Chapala, Mexico.  $\times 2\frac{1}{2}$ .  
(No. 17698, U.S.N.M.)
2. The same. Right chela, viewed from the outside.  $\times 2\frac{1}{2}$ .
  3. *Parastacus defossus* Faxon. Montevideo, Uruguay.  $\times 1\frac{1}{2}$ . (U.S.N.M.)
  4. The same. Right chela, viewed from the outside.  $\times 1\frac{1}{2}$ .

## PLATE LXVIII.

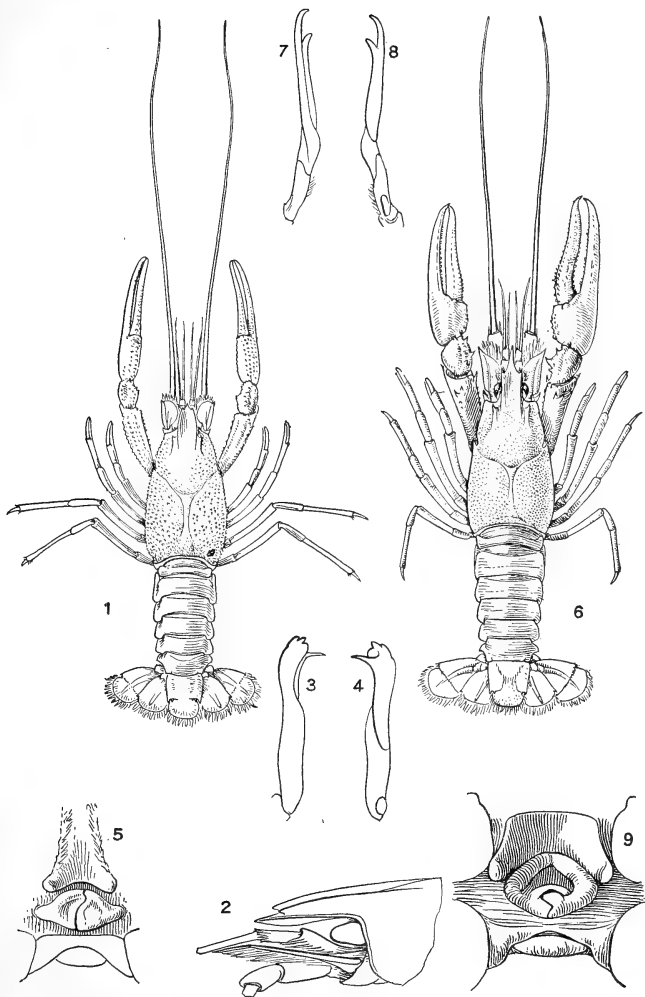
- Fig. 1. *Parastacus saffordi* Faxon. Female. Montevideo, Uruguay. Somewhat enlarged. (No. 12581, U.S.N.M.)
2. The same. Right claw, from the outside.

## PLATE LXIX.

- Fig. 1. *Parastacus varicosus* Faxon. Colima, Mexico. Slightly enlarged. (No. 4133, U.S.N.M.)
2. The same. Right chela, viewed from the outside. Slightly enlarged.

## PLATE LXX.

- Fig. 1. *Parastacus hassleri* Faxon. Talcahuano, Chile. Somewhat reduced. (No. 3401, Mus. Comp. Zool.)
2. The same. Right chela, viewed from the outside. Somewhat reduced.
3. The same. Part of the sternum, showing sexual orifices on the proximal segments of the third and fifth pairs of legs.
4. *Parastacus agassizii* Faxon. Male. Talcahuano, Chile. Somewhat reduced. (No. 3400, Mus. Comp. Zool.)
5. The same. Part of the sternum, showing the extended *vasa deferentia* on the proximal segments of the fifth pair of legs.



CRAYFISHES.

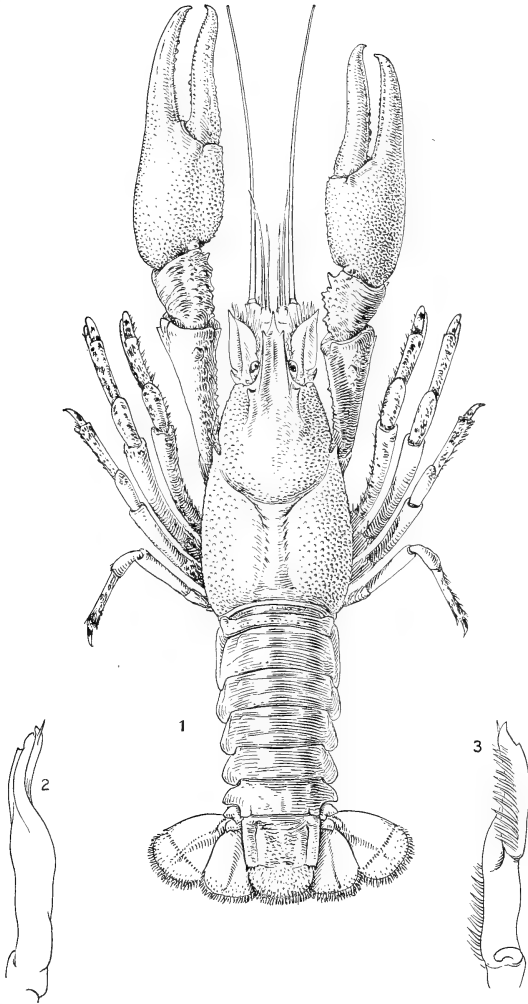
FIGS. 1-5. *Cambarus acherontis*.

FIGS. 6-9. *Cambarus longidigitus*.

FOR EXPLANATION OF PLATE SEE PAGE 692.





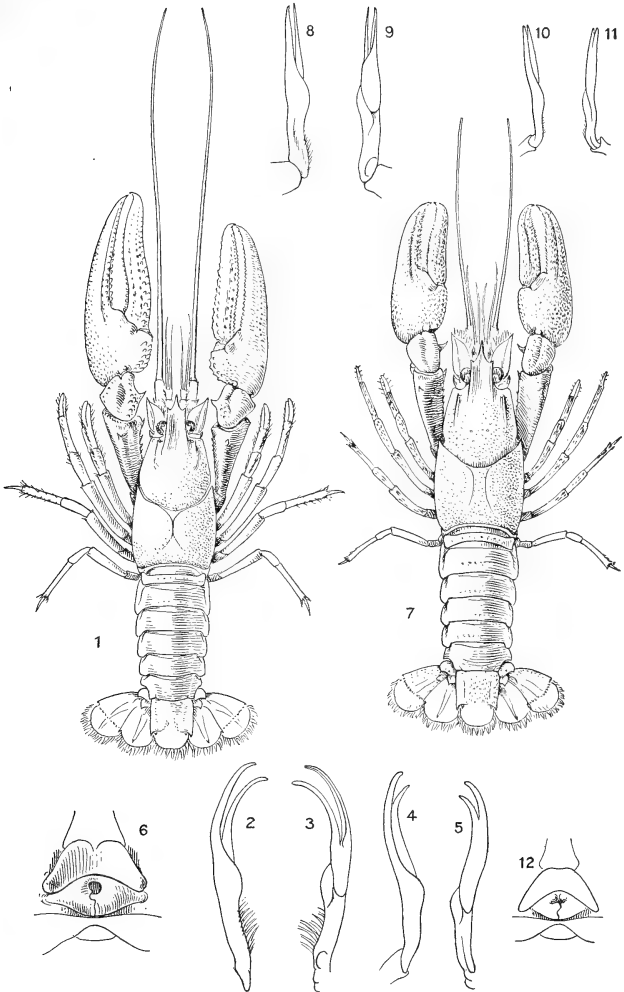


CRAYFISHES.

*Cambarus carinatus.*

FOR EXPLANATION OF PLATE SEE PAGE 692.





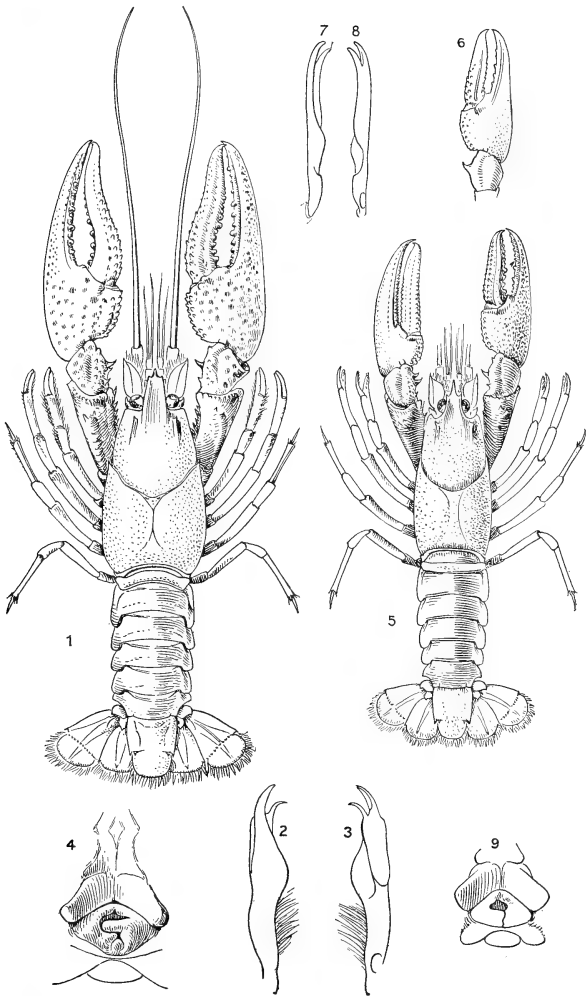
CRAYFISHES.

FIGS. 1-6. *Cambarus palmeri longimanus*.

FIGS. 7-12. *Cambarus erichsonianus*.

FOR EXPLANATION OF PLATE SEE PAGE 693.





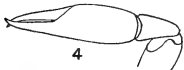
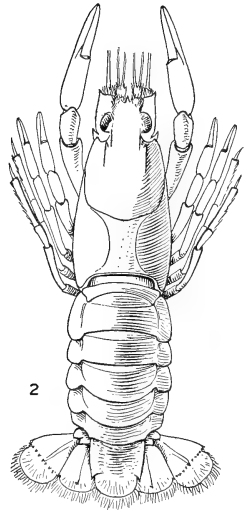
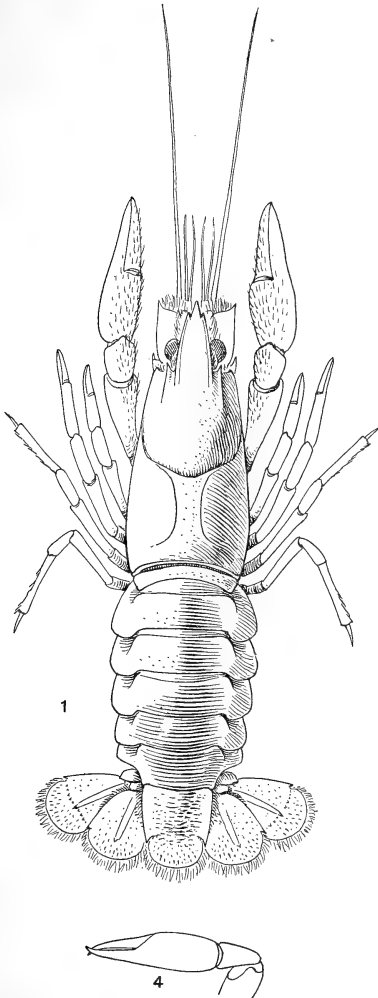
CRAYFISHES.

Figs. 1-4. *Cambarus difficilis*.

Figs. 5-9. *Cambarus meeki*.

FOR EXPLANATION OF PLATE SEE PAGE 693.





CRAYFISHES.

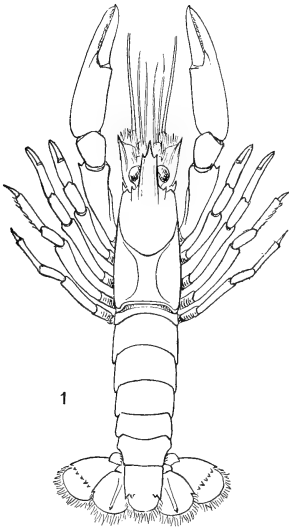
FIG. 1. *Cambarus montezumae dugesii*.  
FIG. 2. *Cambarus montezumae areolatus*.

FIGS. 3, 4. *Cambarus montezumae occidentalis*.

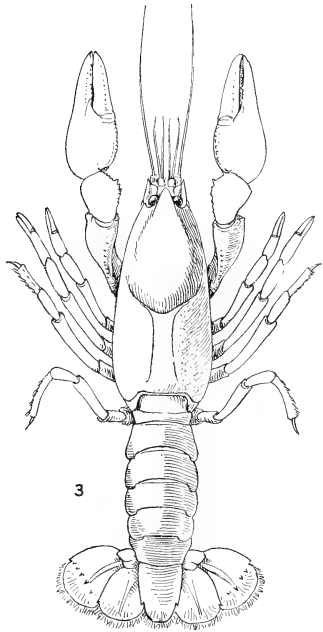
FOR EXPLANATION OF PLATE SEE PAGE 693.



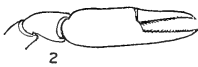




1



3



2



4

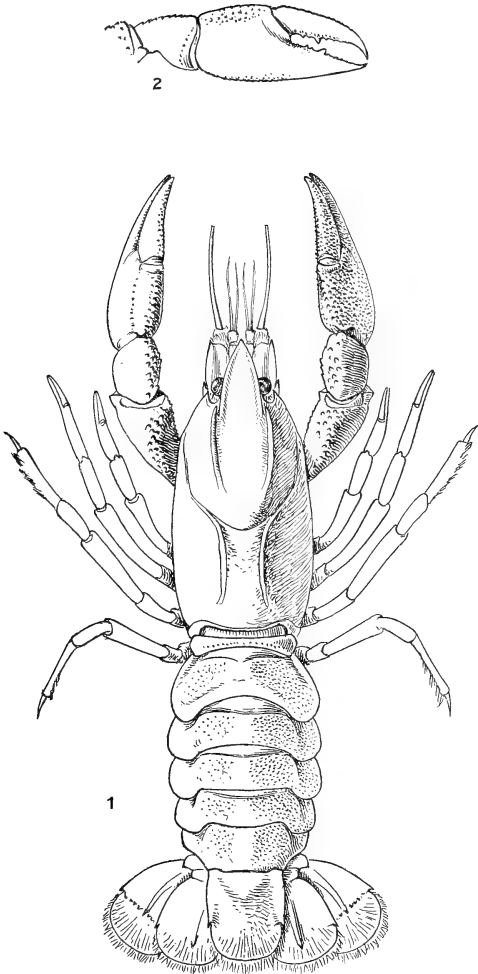
CRAYFISHES.

FIGS. 1, 2. *Cambarus chapalanus*.

FIGS. 3, 4. *Parastacus defossus*.

FOR EXPLANATION OF PLATE SEE PAGE 693.



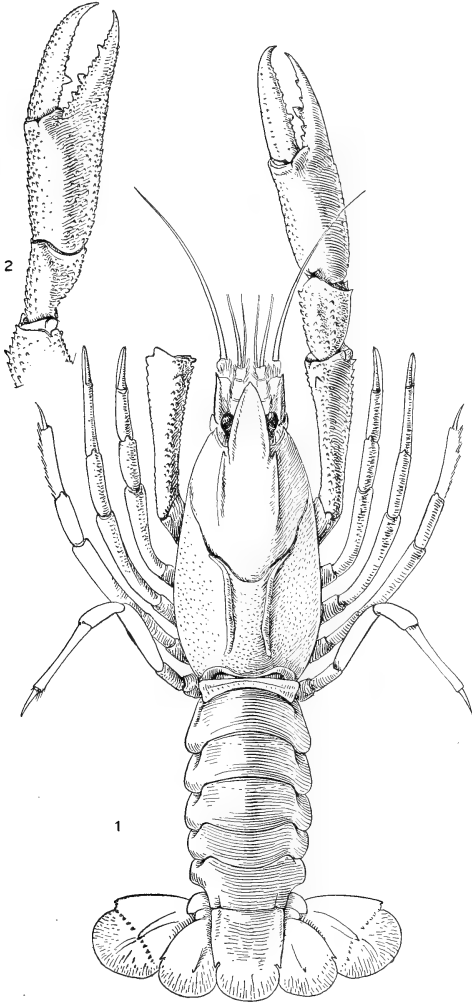


CRAYFISHES.

*Parastacus saffordi.*

FOR EXPLANATION OF PLATE SEE PAGE 694.



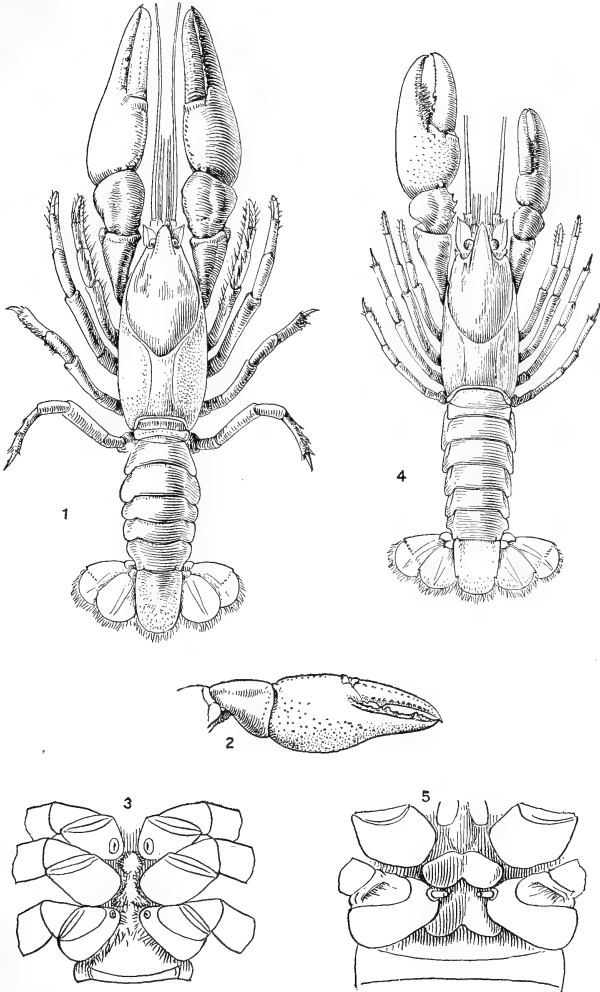


CRAYFISHES.

*Parastacus varicosus.*

FOR EXPLANATION OF PLATE SEE PAGE 694.





CRAYFISHES.

FIGS. 1-3. *Parastacus hassleri*.

FIGS. 4, 5. *Parastacus agassizi*.

FOR EXPLANATION OF PLATE SEE PAGE 694.





**83. *Melanoplus Packardii*** Seudd.—Barber Co. and Garden City (Cragin).

This is the locust which was described as *Caloptenus fasciatus*, Seudd., but afterwards changed to the above name by the same author to avoid conflicting with the *Cal. fasciatus* of Walker, a species found at St. Martin's Falls, Hudson Bay. This is an upland insect and may be met with throughout the western half of the United States and British America at all suitable localities. It bears some resemblance to *M. bivittatus* Say, but never leaves the open country for timbered or low localities where the vegetation is rank, as does this and several of our larger species of this genus.

**84. *Melanoplus bivittatus*** Say.—Laporte Co. (Newlon); Topeka, Garden City and Barber Co. (Cragin).

This is the common two-striped locust of our meadows and fields, and usually occurs where vegetation is rankest. It is found from ocean to ocean, and from the Gulf of Mexico northward to the Saskatchewan River in the British possessions. Mr. Seudder says that the variety with red posterior tibiae is the *Caloptenus femoratus* of Burmeister, and considers it a distinct species.

**85. *Melanoplus differentialis*** Thos.—Laporte Co. (Newlon); Topeka, Garden City and Barber Co. (Cragin).

This is our largest species of the genus and occurs in suitable localities throughout the central and eastern portions of the United States, where it also frequents low grounds among the rankest of vegetation. *M. robustus* and *M. ponderosus* are allied species which occur in Texas.

**86. *Melanoplus Turnbullii*** Thos.—Garden City (Cragin).

This species is one of the few that is partial to some particular food-plant or set of food-plants, and in this instance it is the members of the *Chenopodiaceae*, and especially the different kinds of pigweeds. It occurs at various points throughout Arizona, New Mexico, Colorado, Kansas, Wyoming and Montana. Scudder's *Pezotettix plugosus* is a synonym of this insect, at least this is what Mr. Scudder himself states.

**87. *Tettix granulata*** Say.—Topeka (Cragin).

The small Grouse Locusts, of which there are quite a number of species in the United States, are very difficult to identify, and appear to vary so much that I have never done much toward trying to separate the material in my collection. They all winter over as larvæ, pupæ or mature insects, and are to be found on sunny hill slopes throughout winter. Their favorite haunts are the edges of groves and the margins of streams. Closely browsed pastures are also frequented by them during the warm days of late fall and early spring, where they appear to congregate for sunning themselves. They never become so numerous as to injure crops, and but seldom enter cultivated grounds, except where these are low and damp, or lie alongside of meadows or groves near streams.

**88. *Tettigidea polymorpha*** Burm.—Barber Co. (Cragin).

The members of this genus, like those of the preceding and also those of *Batrachidea*, are found in like localities with them, and are also similar in general appearance and habits.

## Preliminary Catalogue of the Crayfishes of Kansas.

BY WALTER FAXON, A. B., SC. D.

1. **Cambarus simulans** Faxon.—Proc. Amer. Acad. Arts and Sci., XX, 112, 1884.—Mem. Mus. Comp. Zool., Vol. X., No. 4, p. 48, Pl. I., fig. 12; Pl. VIII., figs. 3, 3', 3a, 3a', 1885.

Tributary of Medicine River, Barber Co. Messrs. Williams and Cragin. Fort Hays (Coll. Mus. Comp. Zool.).

2. **Cambarus gracilis** Bundy.—Bull. Ill. Mus. Nat. Hist., No. I., p. 5, 1876.—Trans. Wis. Acad. Sci., V. 182, 1882.—Geol. Wis., Surv. of 1873-79, I. 403, 1883. Faxon, Mem. Mus. Comp. Zool., Vol. X., No. 4, p. 56, Pl. VIII., figs. 4, 4', 4'', 1885.

Labette Co. W. S. Newlon.

3. **Cambarus Diogenes** Girard.—Proc. Acad. Nat. Sci. Phila., VI. 88, 1852. *Cambarus obesus* Hagen, Ill. Cat. Mus. Comp. Zool., No. III., p. 81, Pl. I., figs. 39-42; Pl. III., fig. 163; Pl. IX., 1870.

Leavenworth (Coll. Mus. Comp. Zool.).

4. **Cambarus immunis** Hagen.—Ill. Cat. Mus. Comp. Zool., No. III., p. 71, figs. 101, 102; Pl. III., fig. 160; Pl. VIII., fig. 6, 1870. *Cambarus signifer* Herrick, Tenth Ann. Rep. Geol. Nat. Hist. Surv. Minn. for 1881, p. 253, 1882.

Leavenworth (Coll. Acad. Nat. Sci. Phila.). Ellis (Coll. C. H. Gilbert).

4a. **Cambarus immunis** Hagen, var. **spinirostris** Faxon.—Proc. Amer. Acad. Arts and Sci., XX. 146, 1884.—Mem. Mus. Comp. Zool., Vol. X., No. 4, p. 100, Pl. I., fig. 5, 1885.

Ward's Creek, Shawnee Co.; F. W. Cragin and J. B. Fields. When I described this variety in 1884, I had not seen the first form of the male, which is included among the specimens collected by Messrs. Cragin and Fields. The lateral spines of the rostrum are distinct as in the second-form male and in the female; the setæ on the second pair of legs are well developed; the first abdominal appendages are shaped exactly as in the first-form male of the typical *C. immunis*.

5. **Cambarus Nais**, sp. nov.—Male, form I.—Rostrum long, concave above, lateral margins converging from the base to the lateral spines, which are small but distinct; acumen of moderate length, acute. Post-orbital ridges provided with a minute anterior spine. Carapace smooth and lightly punctate above, granulate on the sides; lateral spine small, acute; cervical groove sinuate, ending anteriorly in a small branchiostegian spine; sub-orbital angle not prominent; areola very narrow, punctate, the margins parallel from the anterior to the posterior triangular fields; the length of the areola is equal to one-half the distance from the tip of the rostrum to the cervical groove. Abdomen as long as the cephalothorax. Proximal segment of the telson, bispinose on each side, distal segment shorter than the proximal. Antennæ longer than the body; laminae a little longer

than the rostrum, broad, broadest at the middle, subtruncate at the end, with an external apical spine. Third maxillipeds densely setose within and below. Anterior process of the epistoma with very convex sides. Chela broad, flattened above, punctate, external border marginate; inner margin of the hand short, with a double row of dentiform tubercles; fingers long, movable one tuberculate on the external border, toothed on the internal border; external finger flat above, internal margin toothed, and bearded at the base. Carpus armed with a row of small tubercles on the upper side, with a strong and acute internal median spine and a small one at the base; on the lower side the carpus is provided with a prominent median spine and an external one at the point of articulation with the chela; in some specimens there is a small spine on the lower face of the carpus, between the median spine and the large one on the internal margin. Third pair of legs armed with a hooped tubercle on the inner margin of the third segment. First pair of abdominal appendages of moderate length, twisted, deeply bifid, very broad in the middle; rami slender, styliform, strongly recurved, the inner one a little shorter and more curved than the outer one, the outer one corneous. Length from tip of the rostrum to the end of the telson, 61 mm. Length of antennæ, 67 mm.

The second form of the male differs from the first form in having smaller chelæ, the tubercles on the third pair of legs less developed, the first abdominal appendages less deeply cleft, the rami stouter, blunter, and not corneous.

In the female the chela is similar to that of the second form of the male, the sternum between the fourth pair of legs is smooth, the annulus ventralis triangular with a median longitudinal fissure.

Labette Co.; W. S. Newlon. 5 males form I., 5 males form II., 7 females.

This species much resembles *C. viridis*, especially the form called *variety A* by Dr. Hagen. It differs in the shape of the first abdominal appendages of the male. In *C. Nais* the rami of these appendages are shorter and more strongly curved than in *C. viridis*, but not so much recurved as in *C. immutis*. The areola is narrower than in *C. viridis*. The first abdominal appendages are very like those of *C. Palmeri*, as far as can be seen by a comparison of the second-form males alone; but the areola is not obliterated in any part of its course in *C. Nais* and the rostrum is more tapering than in *C. Palmeri*.

**6. *Cambarus viridis*** Hagen.—Ill. Cat. Mus. Comp. Zool., No. III, p. 63, Pl. I. figs. 23–28, Pl. II. figs. 128–132, Pl. III. fig. 155, Pl. VIII., 1870. *Cambarus debilis* Bundy, Bull. Ill. Mus. Nat. Hist. No. I. p. 24, 1876.—Trans. Wis. Acad. Sci. V. 181, 1882.—Geol. Wis. Surv. 1873–79, I. 403, 1883. *Cambarus couesi* Streets, Bull. U. S. Geol. Geogr. Surv. Terr., III. 803, 1877.

Tributary of Kansas River, Shawnee Co. F. W. Cragin. Ward's Creek, Shawnee Co. J. B. Fields and F. W. Cragin. Wabaunsee Co. J. B. Fields. Garden City, F. W. Cragin. Leavenworth (Coll. Acad. Nat. Sci. Phila.) Manhattan, (Coll. Acad. Nat. Sci. Phila.) Republican River, northwest of Fort Riley (Coll. Acad. Nat. Sci. Phila.) Ellis, (Coll. Peabody Acad. Sci. Salem.)\*

7. *Cambarus neglectus* sp. nov.—Male, form I.—Rostrum broad, subexcavated, with a median longitudinal carina; sides nearly parallel from the base to the lateral spines, which are very small, brown, and horny; acumen of moderate length. Post-orbital ridges with very small anterior spines, or none. Carapace oval, flattened above, punctate, lightly granulate on the sides, lateral spine obsolete, antero-lateral border angulated below the eye; areola of moderate width, dilated anteriorly and posteriorly. Abdomen equal to the cephalothorax in length; basal segment of the telson two-spined on each side. Antennæ shorter than the body; lamina as long as the rostrum, broadest toward the distal end, apical spine of moderate length. Anterior process of the epistoma long, subtruncate. Third pair of maxillipeds hairy within, naked below. Chelipeds short; chela broad, punctate above and below, inner margin furnished with a double row of depressed squamous tubercles; fingers of moderate length, more or less gaping at the base, with a row of round tubercles on their opposed edges, outer margin of the movable finger furnished with low tubercles. Carpus broad, punctate above, with a strong median spine on the internal border and a small one near the base; there are no spines below. Superior border of meros armed with two obliquely-placed ante-apical spines; the lower face of the meros presents two rows of spines. Third segment of the third pair of legs hooped. First pair of abdominal appendages nearly straight, terminating in two long, slender, pointed, horny styles; the anterior style (outer part of the appendage) a little longer than the posterior and slightly recurved.

In the second form of the male the first abdominal appendages are cleft but a short distance. The terminal part of the appendages is stouter and not corneous, and the tips of the rami are rather blunt.

In the female the annulus ventralis presents a deep transverse fossa, bounded on all sides by a prominent wall, which is bituberculate in front.

Length of a male, form II., 74 mm. Length of areola 13 mm. Breadth of areola in the middle, 3 mm.

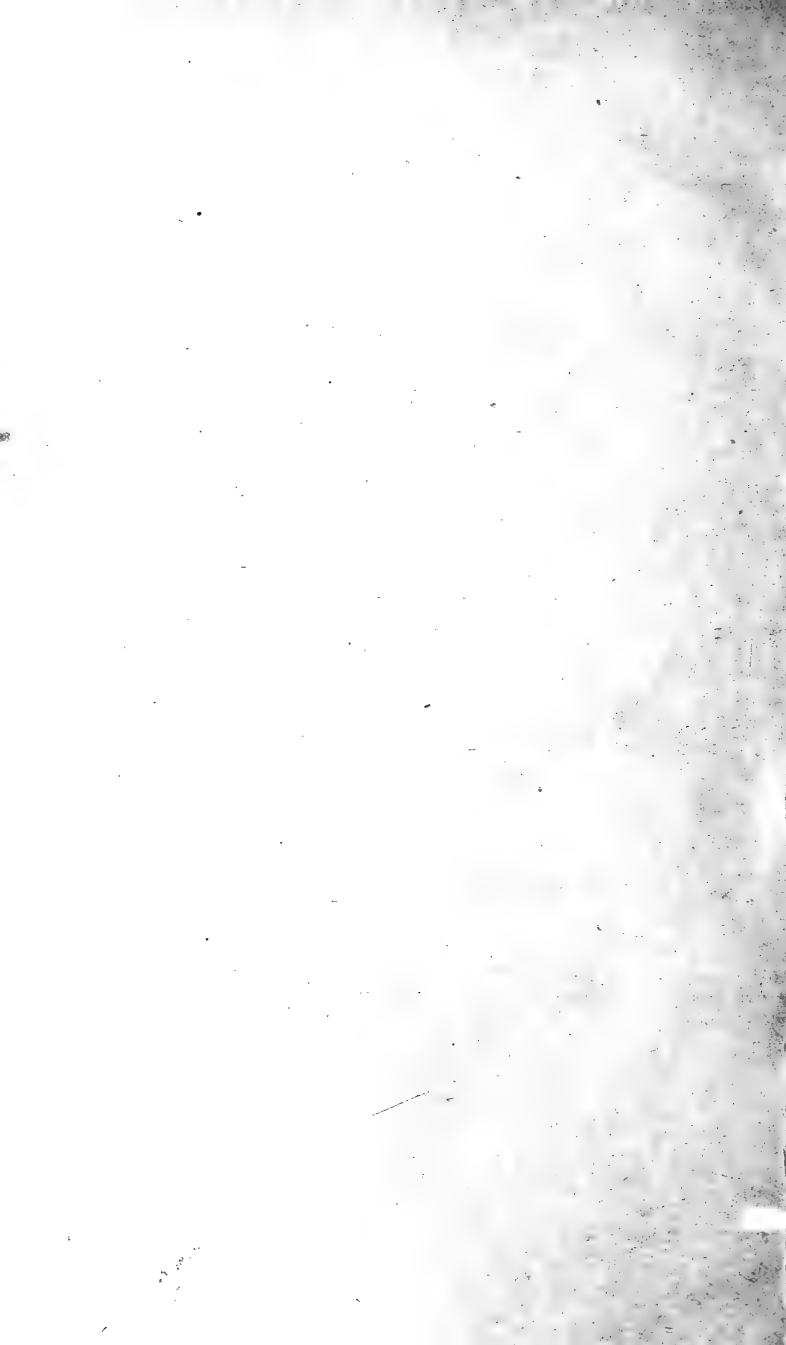
Mill Creek, Wabaunsee Co.; F. W. Cragin and J. B. Fields. 2 males f. I., 1 female.

This is the species mentioned, but not named, in my Revision of the Astacidae, page 94, under *C. propinquus*. When that work was written I had seen but three specimens of this crayfish, all of them second-form males, without locality. I then forbore to present a complete description of it. The collection of Messrs Cragin and Fields supplies the first-form male and the female. In general appearance this species nearly resembles *C. propinquus*, but the sexual appendages are quite different, resembling those of *C. rusticus*, var. *placidus*.

The tips of the fingers are orange-colored, preceded by a dark-colored annular band.

\*The Peabody Academy specimens from Ellis were collected some years ago by Dr. L. Watson.







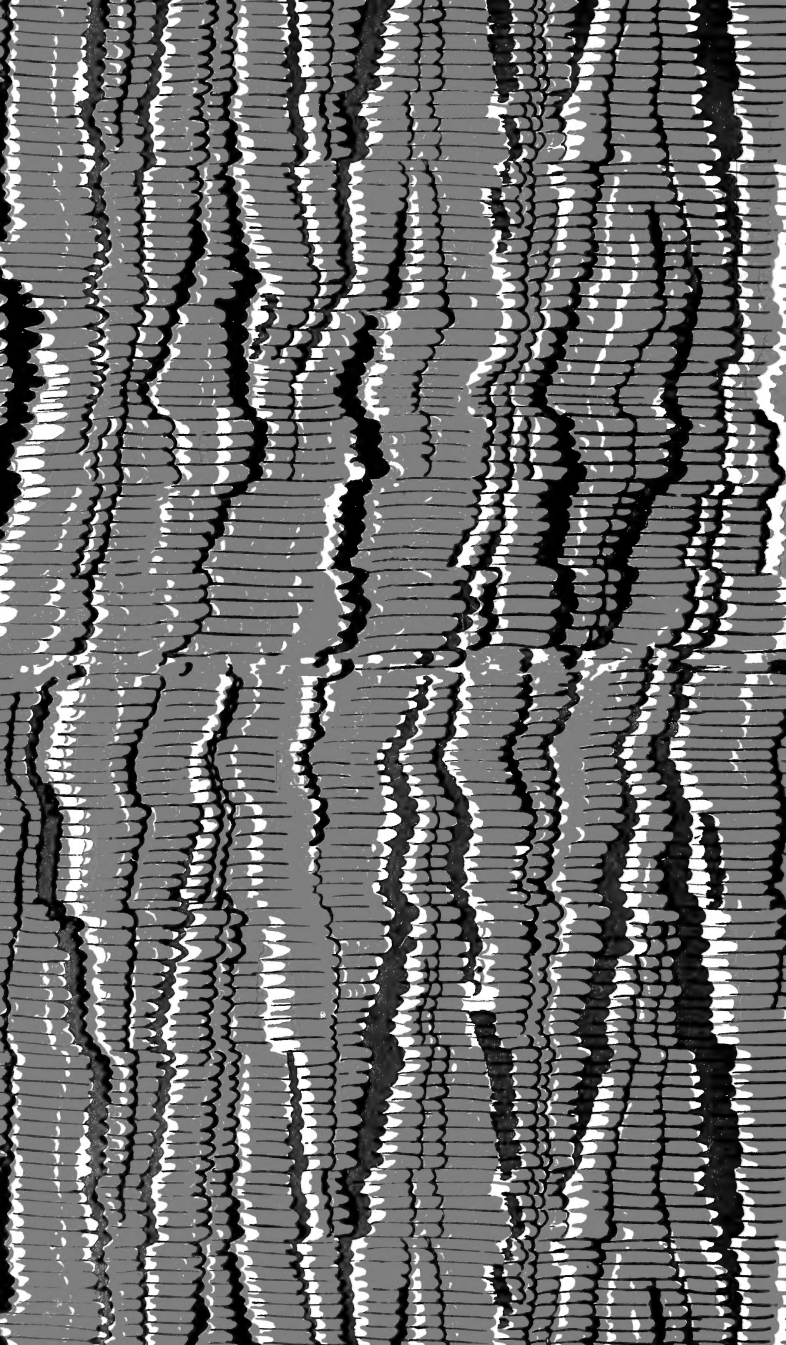


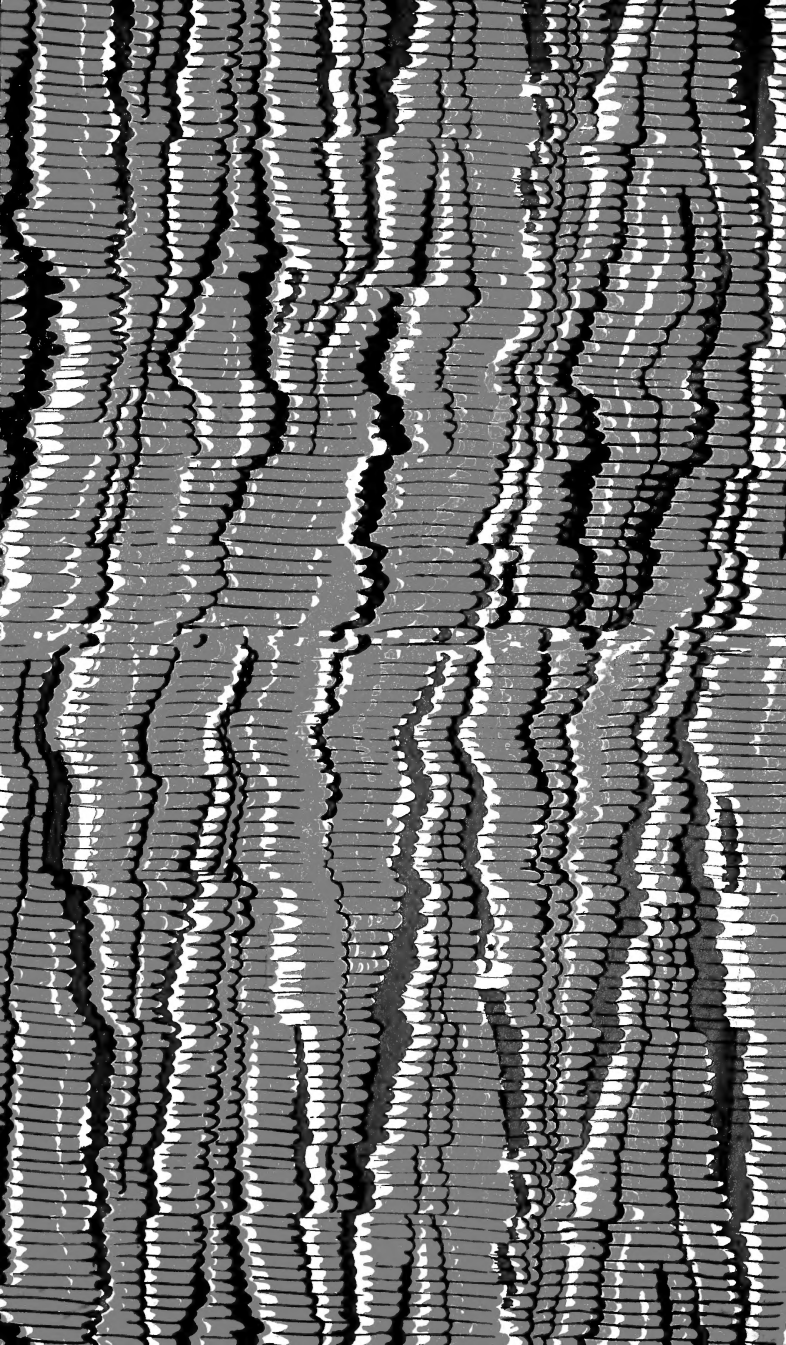












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