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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

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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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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.

<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. Astacidae, p. 31, 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 Astacidæ" (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; pleurae 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 Astacidae," *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. I of the "Revision"). The distinction should have been drawn from the rostrum and chela. 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.

*probs 2 in M.C. 2, only 3 have*  
 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. Astacida, 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 turberele 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. Astacidae, 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 chela 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; Belmont, 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 I; 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 papillae 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 cephalothorax. 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 carinae; 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> Ortman, 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 carinae. 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. montezuma 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. s.).<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, Samonelle'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) ERICRISSON, 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*, *Palaemon*, 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. cœrulescens*, *A. fulgens*, and *A. norvegicus*. Two of these, *cœrulescens* 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 *Calata strigosa* polynomially to *Astacus*, using *Astacus* in its old pre-Linnæan sense. In 1772 Pallas, a binomialist, in his "Spicilegium 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 *Cauri 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. fluvialis* as the type of the genus *Astacus*. In 1814 and 1815 Leach<sup>1</sup> further curtailed the genus by removing *A. norregicus* 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. fluvialis* (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. fluvialis* 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. fluvialis* as the type of *Astacus*, the European lobster should be called by the modern rules of nomenclature (restoring the Linnean specific name) *Homarus gammarus* (Linnaeus), while the European crayfish, as *Astacus astacus* (Linnaeus), 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 fluvialis* "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' (Gallie's *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> Samonelle'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* Linnaeus) as the first species of the genus *Astacus*, giving to *A. fluvialtilis* 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 Linnaeus, 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. fluvialtilis* as Fabricius's implied type of his genus *Astacus*, since that species is the *Cancer astacus* of Linnaeus.

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 fluvialtilis*. 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 fluvialis*. 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 fluvialis*; the name *Potamobius europæus* does not appear.

Subgenus **CAMBAROÏDES** Faxon.

*Cambaroïdes* FAXON, Proc. Amer. Acad. Arts and Sci., XX, p. 150, 1884.

Type, *Astacus japonicus* De Haan.

**ASTACUS (CAMBAROÏDES) SIMILIS** Koelbel.

*Astacus (Cambaroïdes) 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. Jony 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 Astacida;" 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 (Schrank).

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, Musenm 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, Fanna 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 Astacidae,"<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 Astacidae," 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 Somnologiques, 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, I, 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 gondotii* 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.	PODOB-RANCHIÆ.	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
$\begin{array}{cccccc} 6+ep r & + & 5+r & + & 4r & + & 1 & = & 12+5r+ep r \end{array}$					

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 gondotii* 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 *Astacoides 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. Mns. 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 margined, 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 chela, 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 chela 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.

*Astacus 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  $3\frac{3}{4}$  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 Crustacés, 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* ERICSON, 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.	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	r	1	= 3+r				
XIV.	0	0	0	1	= 1				
	6+ep r	+	6	+	4+r	+	4	=	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 (*Palaemon*). 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 pterygostomial 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 seriately 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-zealandicus* 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 Waiiau (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.

?*Astacoides tridentatus* WOOD-MASON, Proc. Asiatic Soc. Bengal, 1876, p. 4.

?*Astacoides 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.); Rangiora, 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:

SOMITE.	PODOBRANCHLE.	ARTHROBRANCHLE.		PLEUROBRANCHLE.			
		Anterior.	Posterior.				
VII.	0 (ep r or ep)	0	0	0	= 0 (ep r or ep)		
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 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; chela 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.	PODOBRANCHIE.	ARTHROBRANCHIE.		PLEUROBRANCHIE.		
		Anterior.	Posterior.			
VII.	0 (ep <sup>r</sup> )	0	0	0	=	0 (ep <sup>r</sup> )
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 <sup>r</sup>	6	4+r	4	= 20+r+ep <sup>r</sup>

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 Rüdgersberg (von Martens), Rio Grande do Sul, São Lourenço (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 *Astacina*. 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 margin 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 alæ, 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. (200000000)

*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 Física y Política de Chile*, Zoología, III, p. 211; Atlas, II, Crustáceos, pl. 1, 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 cementarius*,<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 cementarius* of Molina to be a common edible prawn of Chile, *Palæmon (Bithynis) cementarius* 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 cementarius* vividly recalls the "chimneys" constructed by fossorial crayfishes. The character "*rostrum obtuso*," moreover, applies better to *Parastacus nicoletii* or *P. hassleri* than to *Palæmon cementarius* 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. cementarius* 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 cementarius*. 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.  $\times \frac{2}{3}$ . (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 dugesi* Faxon. Female. Guanajuato, Mexico.  $\times 2\frac{1}{3}$ .  
(No. 16087, U.S.N.M.)
2. *Cambarus montezumæ arcolatus* Faxon. Female. Cohahuila, Mexico.  $\times 2\frac{1}{3}$ .  
(No. 3650, Mus. Comp. Zool.)
  3. *Cambarus montezumæ occidentalis* Faxon. Female. Mazatlan, Mexico.  $\times 2\frac{1}{3}$ .  
(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.  $\times 2\frac{1}{3}$ .  
(No. 17698, U.S.N.M.)
2. The same. Right chela, viewed from the outside.  $\times 2\frac{1}{3}$ .
  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.

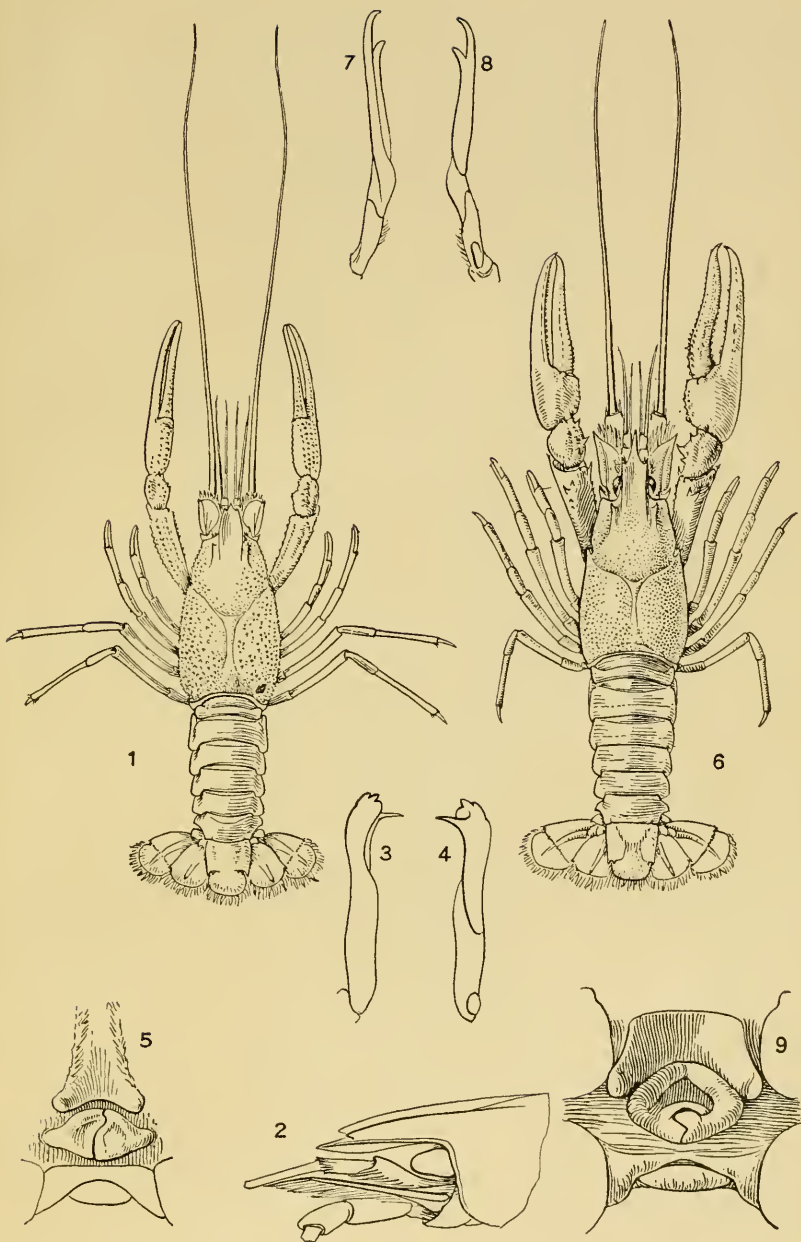
- Fig. 1. *Parastacus saffordi* Faxon. Female. Montevideo, Uruguay. Somewhat enlarged. (No. 12581, U.S.N.M.)  
2. The same. Right claw, from the outside.

## 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.



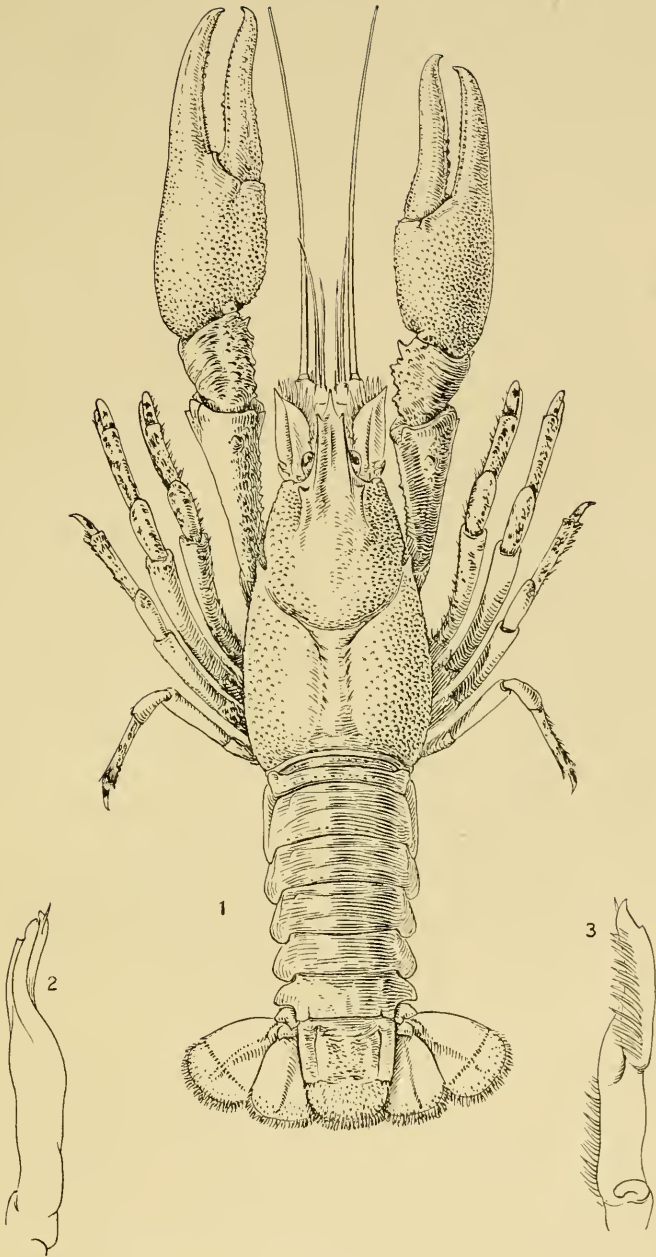
CRAYFISHES.

FIGS. 1-5. *Cambarus acherontis*.

FIGS. 6-9. *Cambarus longidigitus*.

FOR EXPLANATION OF PLATE SEE PAGE 692.





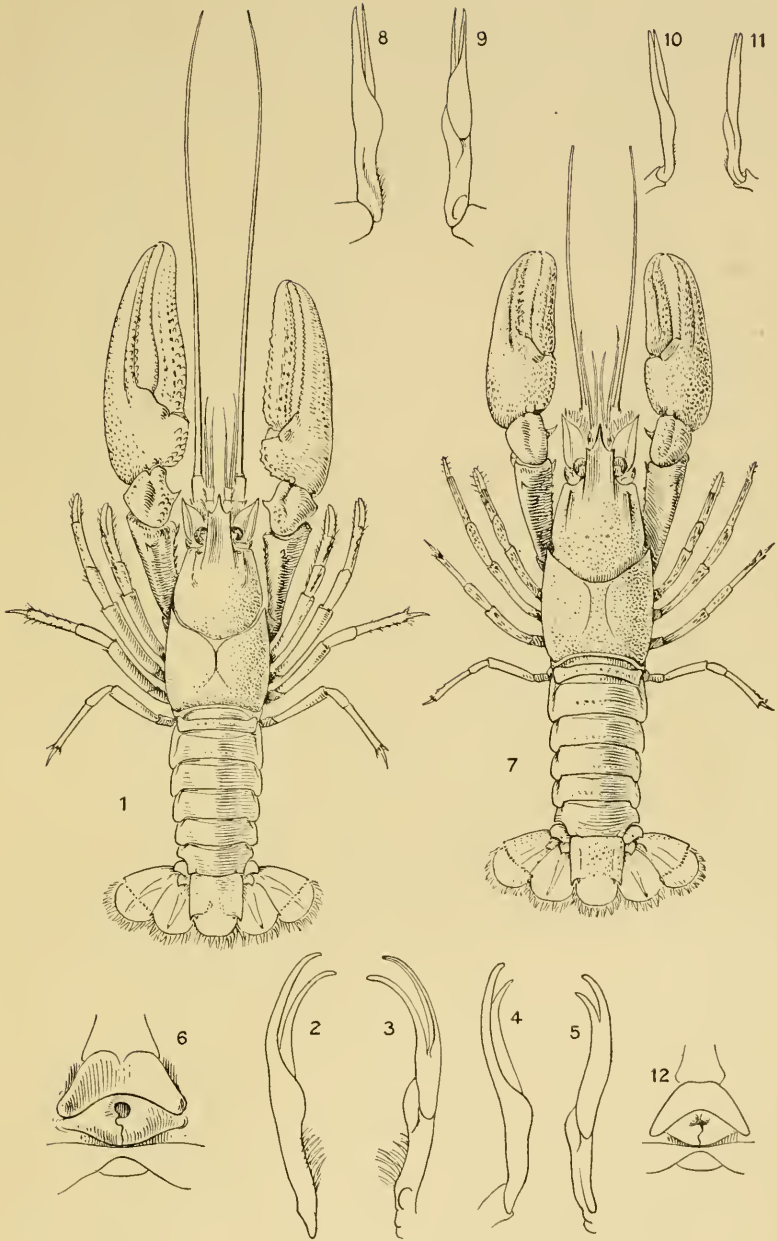
CRAYFISHES.

*Cambarus carinatus.*

*< digueti, Bouvier*

FOR EXPLANATION OF PLATE SEE PAGE 692.





CRAYFISHES.

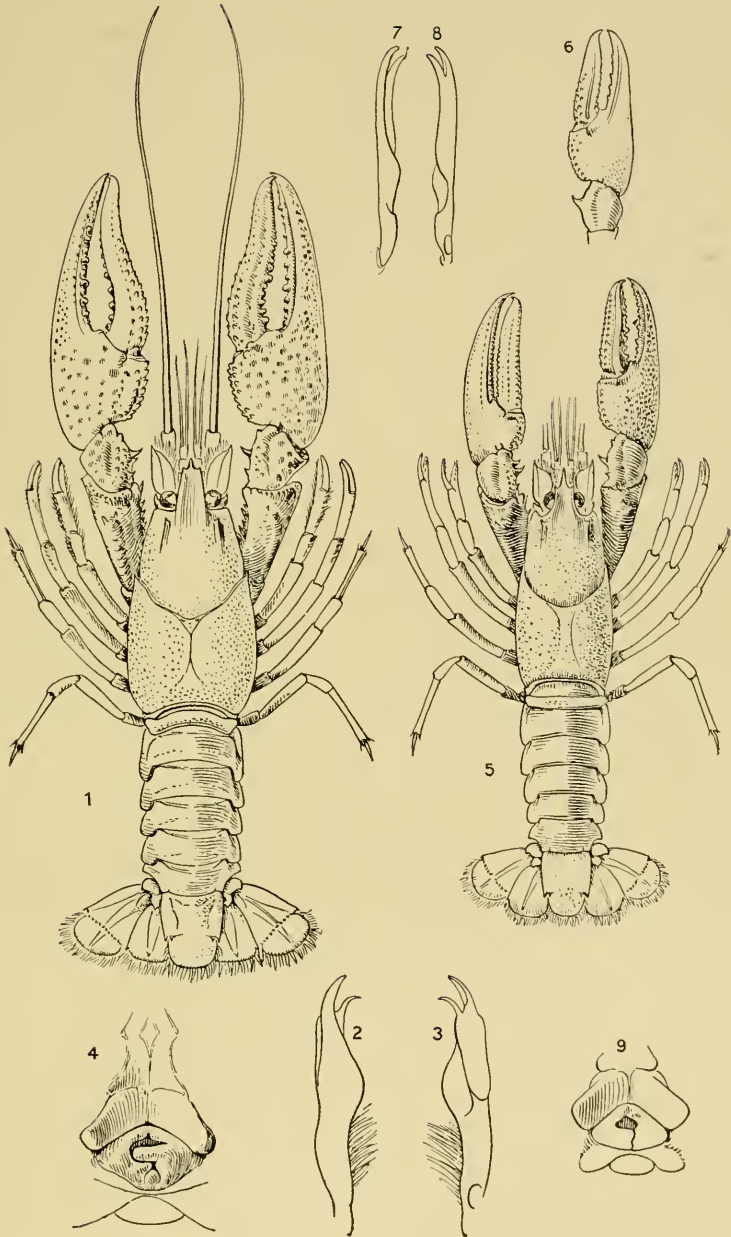
FIGS. 1-6. *Cambarus palmeri longimanus*.

FIGS. 7-12. *Cambarus erichsonianus*.

FOR EXPLANATION OF PLATE SEE PAGE 693.







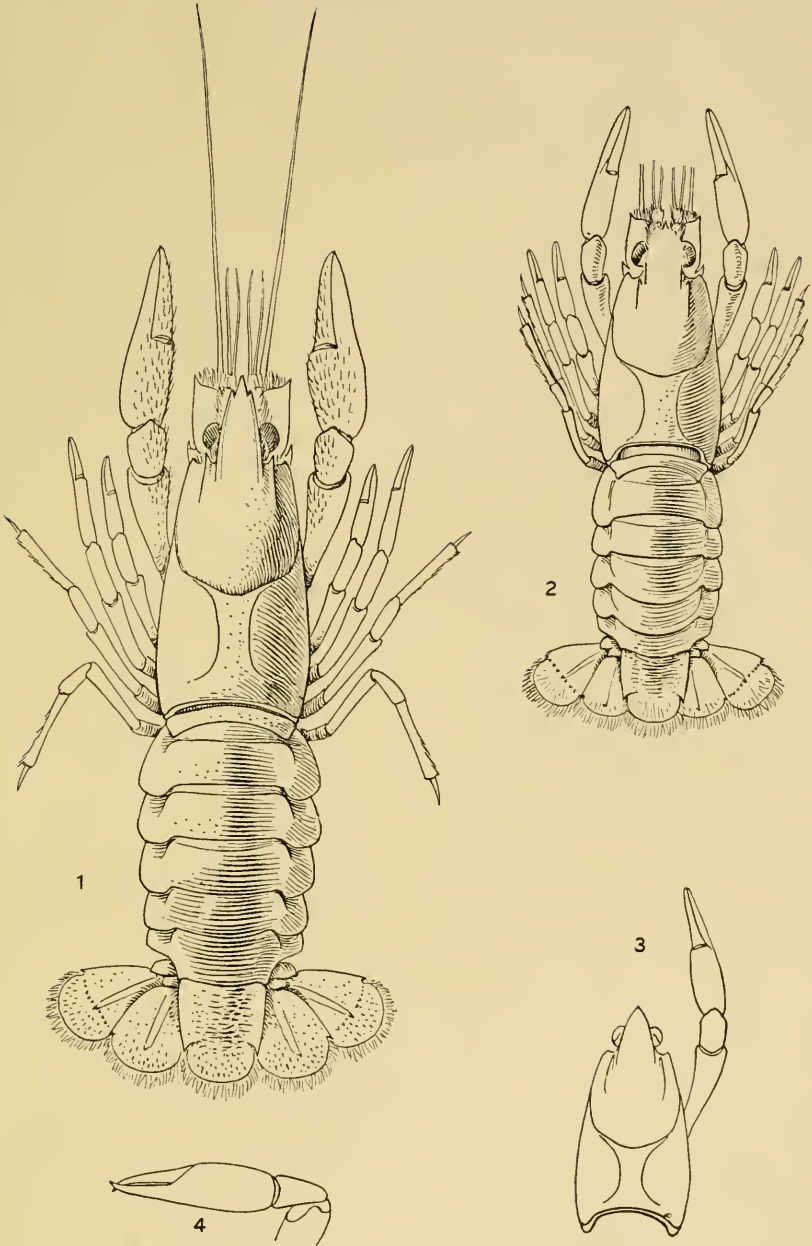
CRAYFISHES.

FIGS. 1-4. *Cambarus difficilis*.

FIGS. 5-9. *Cambarus meeki*.

FOR EXPLANATION OF PLATE SEE PAGE 693.





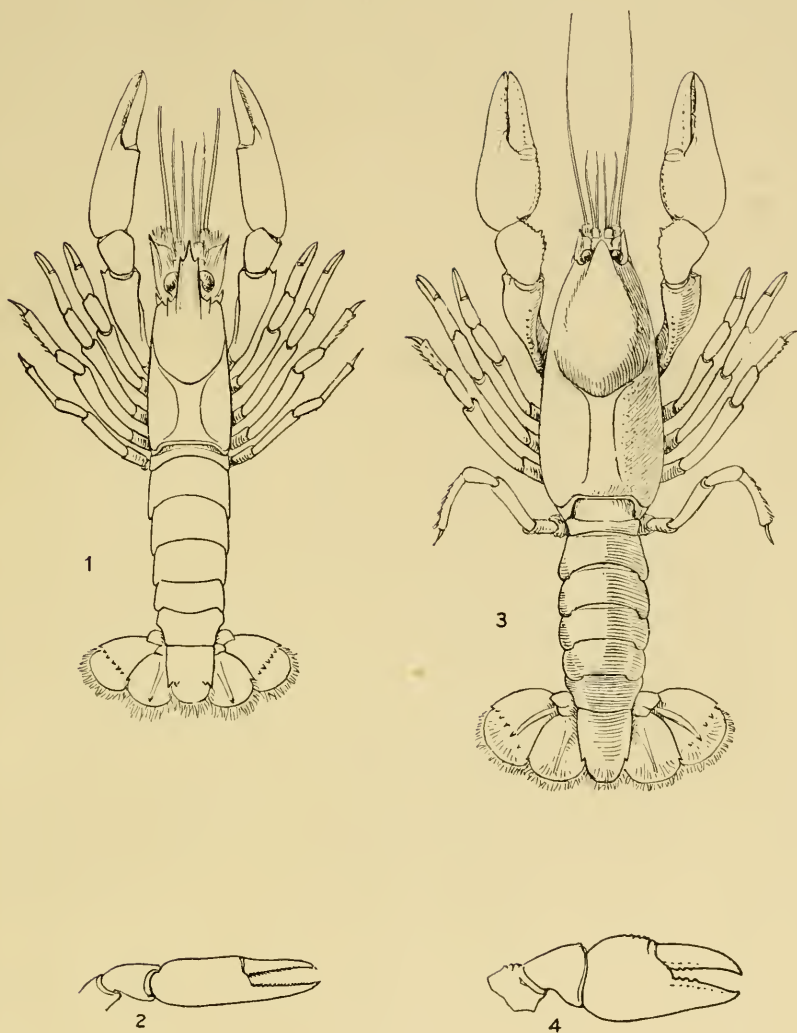
CRAYFISHES.

FIG. 1. *Cambarus montezumae dugesii*.  
FIG. 2. *Cambarus montezumae areolatus*.

FIGS. 3, 4. *Cambarus montezumae occidentalis*.

FOR EXPLANATION OF PLATE SEE PAGE 693.





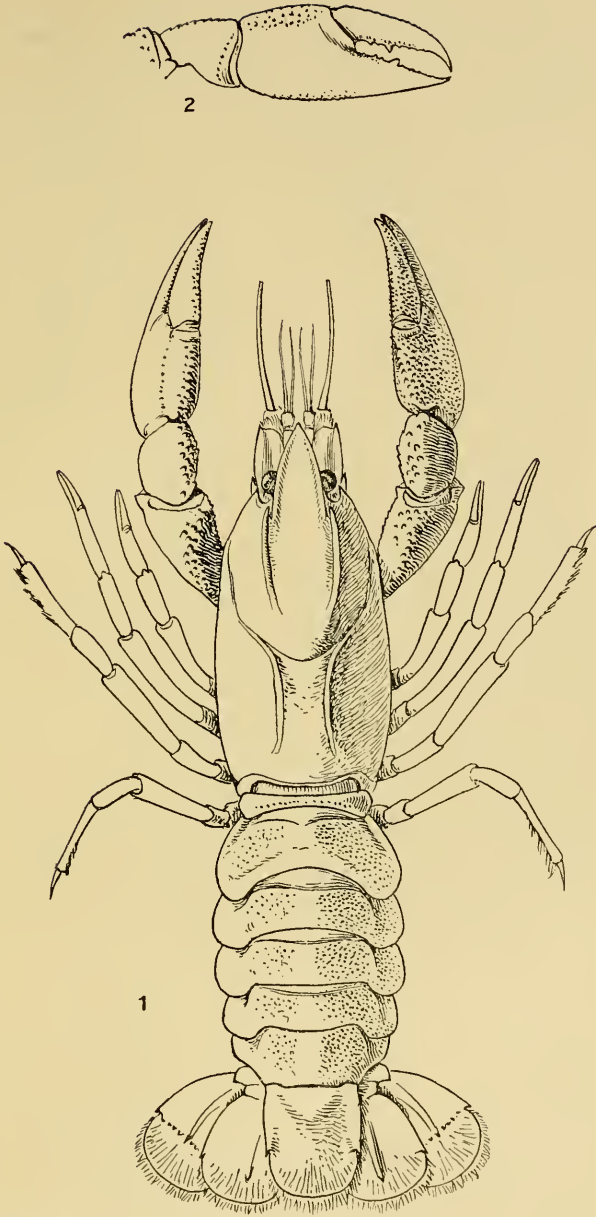
CRAYFISHES.

FIGS. 1, 2. *Cambarus chapalanus*.

FIGS. 3, 4. *Parastacus defossus*.

FOR EXPLANATION OF PLATE SEE PAGE 693.





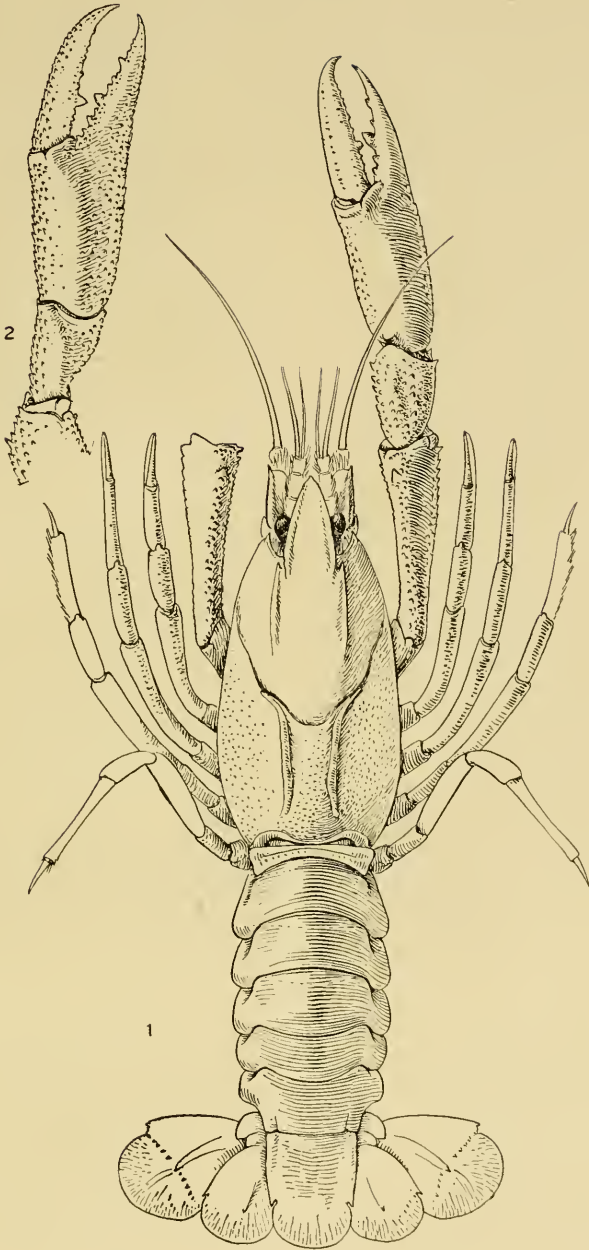
CRAYFISHES.

*Parastacus saffordi.*

FOR EXPLANATION OF PLATE SEE PAGE 694.





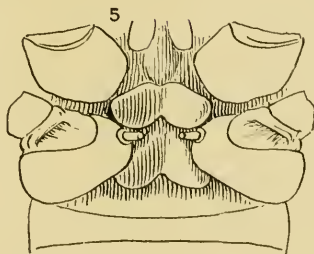
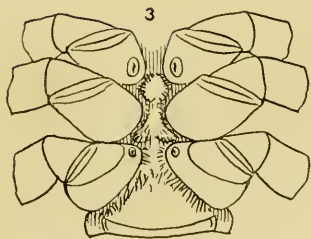
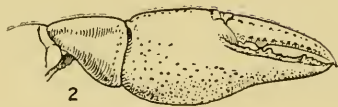
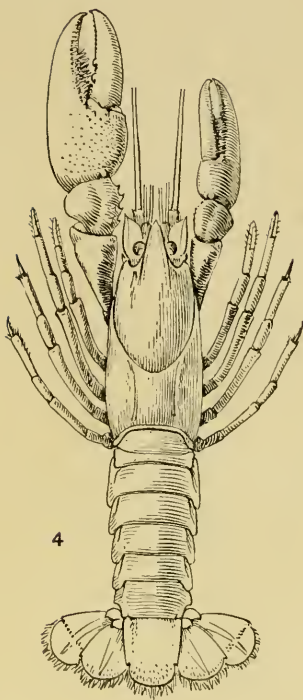
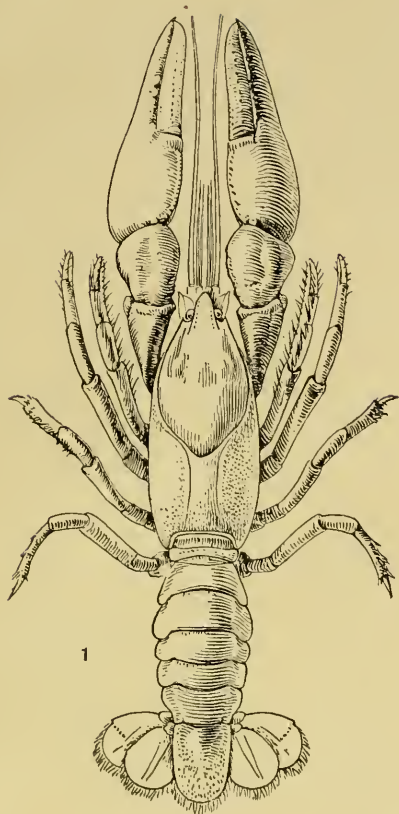


CRAYFISHES.

*Parastacus varicosus.*

FOR EXPLANATION OF PLATE SEE PAGE 694.





CRAYFISHES.

FIGS. 1-3. *Parastacus hassleri*.

FIGS. 4, 5. *Parastacus ayassizii*.

FOR EXPLANATION OF PLATE SEE PAGE 694.





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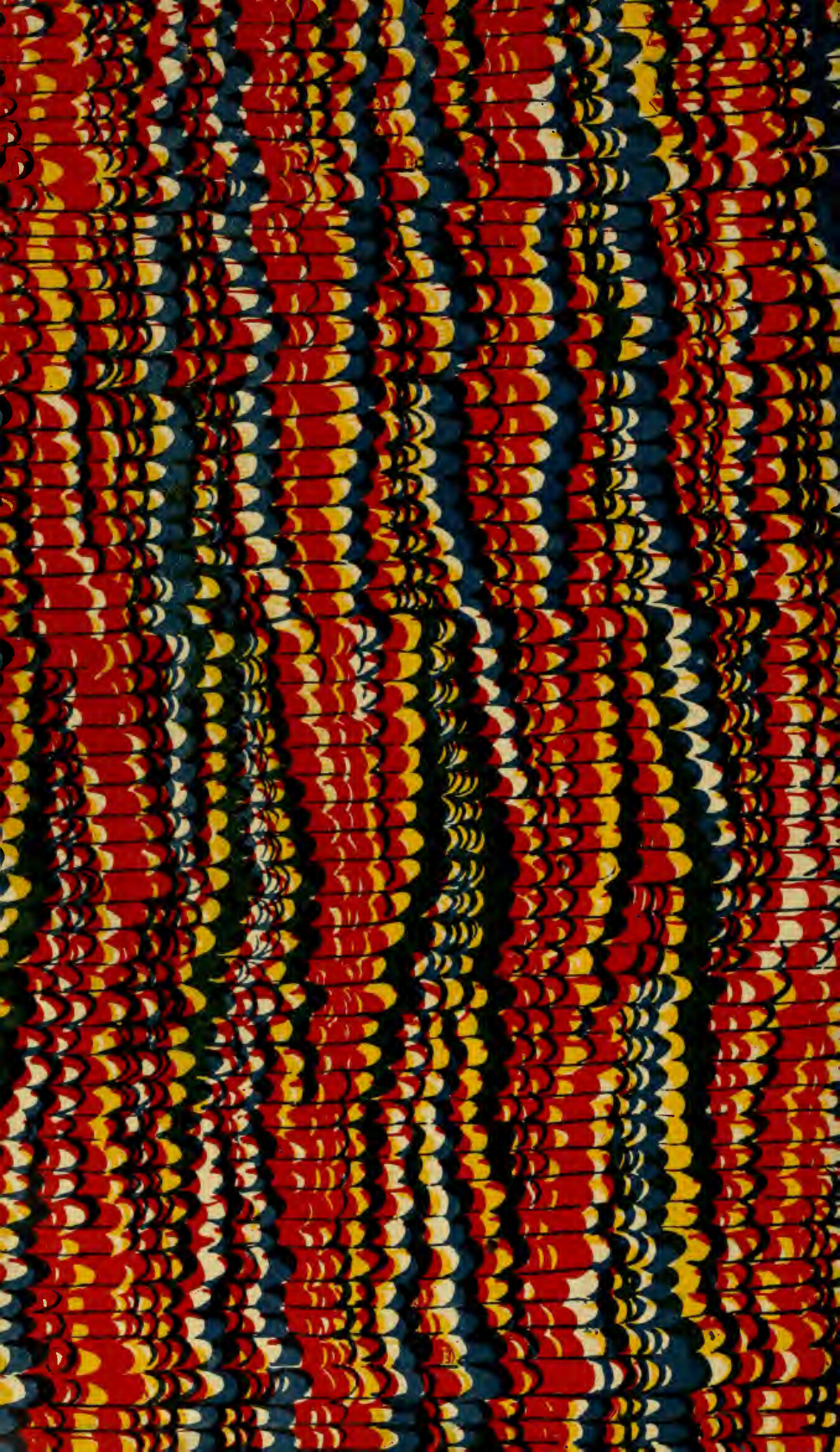






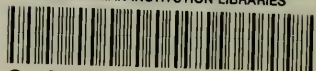








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