

NOTES ON NORTH AMERICAN CRAYFISHES—Family ASTACIDÆ.

BY

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The following notes are the result of an examination of the North American Astacidæ received at the U. S. National Museum and the Museum of Comparative Zoölogy and also those collected by the field parties of the U. S. Fish Commission since the publication of the first part of the author's revision of that group.\* Herein are included full descriptions of all the new species discovered since the publication of that work, together with such additions as have been made to our knowledge of the distribution of these animals. The notes thus form a supplement to the Revision of the Astacidæ.

**Cambarus blandingii (Harl.).**

Additional localities: North River, Lexington, Virginia; Dismal Swamp, outlet of Lake Drummond, Suffolk, Virginia; Tar River, Rocky Mount, North Carolina; Neuse River, Raleigh, North Carolina. Collected by D. S. Jordan (U. S. F. C.).

**Cambarus blandingii acutus (Gir.).**

York, Clark County, Illinois. H. G. Hodge (U. S. N. M.).

**Cambarus versutus Hag.**

Additional locality: Escambia River at Flomaton, above Pensacola, Florida. D. S. Jordan, B. W. Evermann, and C. H. Bollman (M. C. Z.). A young male. The rostrum tapers a little more than in the type specimens from Mobile, Alabama, and is lightly carinate above in the median line. In these respects it agrees with the specimens from Cape Barrañas, Florida, mentioned on page 34 of my Revision of the Astacidæ.

**Cambarus allenii Fax.**

Caloosahatchee River, Florida. W. H. Dall (U. S. N. M.). Two males, form I, two females. In the female (now known for the first time) the chelæ are short and broad compared with those of the male.

\*A Revision of the Astacidæ. By Walter Faxon. Part I. The Genera Cambarus and Astacus. Mem. Mus. Comp. Zoöl., Vol. x, No. 4, 1885.

In an individual 78<sup>mm</sup> long the chela measures 25 by 9.5<sup>mm</sup>, while in a male 71<sup>mm</sup> long the chela is 35 by 9<sup>mm</sup>. The annulus ventralis forms a prominent tubercle. The rostrum is subdenticulate near the apex.

**Cambarus evermanni, sp. nov.**

Male, form I.—Rostrum broad, triangular, smooth, moderately concave above, margins raised into sharp crests which extend well back on the carapace between the post-orbital ridges; no lateral spines. Post-orbital ridges without spines. Carapace compressed laterally, fore border hardly angulated below the eye; punctate above, granulate on the sides, no lateral spine, branchiostegian spine small; distance from the cervical groove to the hind border of the carapace scarcely one-third the length of the whole carapace; areola of moderate width. Abdomen longer than the cephalothorax; two spines on each side of the hind border of the basal segment of the telson; terminal segment of the telson shorter than the basal. Anterior process of the epistoma subtruncate. Basal segment of the antennule furnished with a spine on the inner margin of the ventral surface half way between the proximal and distal extremities. Antennae shorter than the body, spines on the second and third segments obsolescent; antennal scale broad, broadest in the middle, surpassing the rostrum and equaling the peduncle of the antenna. Third pair of maxillipeds setose within and below. Chelipeds slender; chela long, subcylindrical, squamoso-tuberculate, inner border provided with a row of about seven dentiform tubercles; fingers as long as the hand, straight, with longitudinal ribs; carpus tuberculate on the inner side, armed with one prominent spine on the inner border; meros tuberculate on the upper margin, with two rows of spines below. Third and fourth pairs of legs hooked on the third segment; hooks of both pairs simple. Fourth and fifth pairs of legs with a flattened, laminate tubercle on the basal segment, that on the fourth pair the larger. Anterior abdominal appendages of moderate length, somewhat recurved at the end, outer part terminating in a horny truncate head with a slightly developed recurved tooth, beared anteriorly on the outer side; inner part terminating in an articulated spine obliquely placed, and not exceeding the outer part of the appendage.

Length, 70<sup>mm</sup>; from tip of the rostrum to the cervical groove, 22<sup>mm</sup>; from the cervical groove to the posterior margin of the carapace, 10<sup>mm</sup>; abdomen, 37<sup>mm</sup>; cheliped, 65<sup>mm</sup>; chela, 33 by 7<sup>mm</sup>; width of areola in its narrowest part, 2<sup>mm</sup>.

Escambia River at Flomaton, above Pensacola, Florida. D. S. Jordan, B. W. Evermann, and C. H. Bollman (M. C. Z.).

This species belongs to group I, (type, *C. blandingii*). It is nearly related to *C. allenii* Fax. but differs in the form of the first pair of abdominal appendages (*cf.* the description of those parts in *C. allenii*, Rev. Astacidae, p. 35), in the simple structure of the hooks of the fourth

pair of legs, in the presence of a flattened tubercle on the basal segment of the fourth pair of legs, in the shorter metacarapace, broader areola, long spiny telson, etc. The male appendages are similar to those of *C. fallax* Hag., as are also the tubercles on the basal segment of the fourth and fifth pairs of legs. More specimens of the three related species *C. allenii*, *C. evermanni*, and *C. wiegmanni* are much needed in order to elucidate the structure of the female and the two forms of the male.

**Cambarus barbatus** Fax.

*Astacus penicillatus* Le Conte, Proc. Acad. Nat. Sci., Phila., VII, 1855, p. 401, (nec Olivier, 1791).

*Cambarus penicillatus* Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III, 1870, p. 53. Faxon, Proc. Amer. Acad. Arts and Sci., xx, 1884, p. 138. *Id.*, Mem. Mus. Comp. Zoöl., x, No. 4, 1885, p. 36.

Additional locality: Escambia River at Flomaton, above Pensacola, Florida. D. S. Jordan, B. W. Evermann, and C. H. Bollman (M. C. Z.). One male, form I; five females, five young. The annulus ventralis of the female is divided by a deep, longitudinal furrow into two prominent tubercles, each of which is denticleate. The inner margin of the hand is serrate, but not bearded as in the male. Length, 60<sup>mm</sup>. After examining these undoubted specimens of Le Conte's *Astacus penicillatus* I am confident that the second-form males and the females from Charleston, South Carolina, referred to this species by Hagen (*op. cit.*, p. 54; cf. Faxon, Mem. Mus. Comp. Zoöl., x, No. 4, p. 37) belong to some other species.

Following the code of nomenclature adopted by the American Ornithologists' Union\* (canon XXXIII, p. 47), Le Conte's specific name *penicillatus* must be rejected, since it had been used previously by Olivier (Encyc. Méth., Hist. Nat. des Insectes, VI, 1791, p. 343), in combination, with the same generic name, for another animal (*Palinurus penicillatus* of recent authors).

**Cambarus pellucidus** (Tellk.).

This species has been reported from the following caves in Indiana, besides the Wyandotte and Bradford Caves; caves at Clifty, Bartholomew County (Dr. John Sloan); Mayfield's Cave, near Bloomington, Monroe County (C. H. Bollman).† These caves are in the White River drainage. For further remarks on *C. pellucidus* see below under *C. setosus*.

**Cambarus simulans** Fax.

Additional locality: Tributary of Medicine River, Barber County, Kansas. Messrs. Williams and Cragin (M. C. Z.).

\* The Code of Nomenclature and Check-List of North American Birds adopted by the American Ornithologists' Union; being the report of the committee of the union on classification and nomenclature, New York, 1886.

† Packard, Mem. Nat. Acad. Sci., Vol. ix, No. 1, p. 16.

*Cambarus gracilis* Bundy.

Additional localities: York, Clark County, Illinois, H. G. Hodge (U. S. N. M.); Labette County, Kansas, W. S. Newlon (M. C. Z.).

*Cambarus bartonii* (Fab.).

Additional localities: St. John River, just above Grand Falls, New Brunswick, W. F. Ganong (M. C. Z.); head of Kennebec River, outlet of Moosehead Lake, Maine, Edwin Faxon (M. C. Z.); Shenandoah River, Waynesborough, Virginia, D. S. Jordan (U. S. F. C.); Peak Creek, Pulaski, Virginia, D. S. Jordan (U. S. F. C.); Swannanoa River, Black Mountain, North Carolina, D. S. Jordan (U. S. F. C.); Bloomington, Indiana, W. S. Blatchley (M. C. Z.). Prof. D. S. Jordan informs me that he has found *Cambarus* (*C. bartonii*, doubtless,) in a tributary of the Housatonic River, Berkshire County, Massachusetts. It had been known previously in that county only from Williamstown. With reference to the distribution of *C. bartonii* in the Province of Quebec and in New Brunswick Mr. W. F. Ganong has called my attention to the fact that it was recorded by Dr. Robert Bell,\* as long ago as 1859, as abundant in the Restigouche, Matapediae, and Metis Rivers. Dr. Bell also found one specimen just below the high falls of the Ouiatchouan, a stream which empties into the south side of Lake St. John in Quebec. In 1865 Prof. H. Y. Hind\* mentions a *Cambarus* (doubtless *C. bartonii*) in the Upsalquitch, a tributary of the Restigouche. Mr. Ganong\* himself has lately published a paper on the distribution of *C. bartonii* in New Brunswick, in which attention is drawn to its occurrence at many points in the St. John River and its affluents, from Grand Falls to Fredericton, and additional testimony is given as to its presence in the Restigouche and Upsalquitch. Mr. Ganong was informed that it was very abundant in the southwest Miramichi also, but he searched for it without success in the St. Croix. The northern limit of its distribution, then, so far as known, is the Ouiatchouan, Metis, and Matapediae Rivers, in the Province of Quebec, while the eastern limit is the Miramichi, New Brunswick.

Specimens of *C. bartonii* from Bloomington, Indiana, like all that I have seen from that State, are a smooth form, with very narrow areola and obsolete internal basal carpal spine.

*Cambarus bartonii robustus* (Gir.).

Additional locality: Wytheville, Wythe County, Virginia. Col. M. McDonald (U. S. F. C.).

\* On the Natural History of the Gulf of St. Lawrence, and the Distribution of the Mollusea of Eastern Canada. By Robert Bell, Jr., Canadian Naturalist and Geologist, iv, 1859, p. 210.

\* Prelim. Rep. Geol. New Brunswick, p. 130.

\* The Crayfish in New Brunswick. By W. F. Ganong. Bull. Nat. Hist. Soc. New Brunswick, No. vi, pp. 74, 75, 1887. See also The Crayfish in the Atlantic Provinces. [By W. F. Ganong.] The Educational Review, iii, 95, St. John, N. B., Nov. 1, 1889.

*Cambarus longulus* Gir.

*Cambarus longulus* Girard, Proc. Acad. Nat. Sci. Phila., vi, 1852, p. 90.

*Cambarus bartonii* (part.)? Hagen, Mon. N. A. Astacidae, pp. 78, 79, 1870. Faxon, Proc. Amer. Acad. Arts and Sci., xx, 1884, p. 143. *Id.*, Rev. Astacidae, pt. I, p. 66, 1885.

Waynesborough, Virginia; Lick Run, James River, Virginia; North River, Lexington, Virginia; Wytheville, Virginia; South Fork of Holston River, near Marion, Virginia; Spring Creek, Hot Springs, North Carolina; Watauga River, Elizabethton, Tennessee. Col. M. McDonald and Prof. D. S. Jordan (U. S. F. C.). Specimens in the Museum of Comparative Zoölogy from Bath County, Virginia, from near White Sulphur Springs, West Virginia, and from Knoxville, Tennessee, probably belong to this species, but they are too young to determine with certainty.

It is only after examining the large number of specimens (over one hundred, including females and both forms of the male), collected by Colonel McDonald and Professor Jordan, that I am prepared to restore this form to the full rank of a species. When the Monograph of the North American Astacidae was written, Dr. Hagen had seen but one specimen (Girard's type), and he inclined to regard it as a deformed individual of *C. bartonii*. His description of the type specimen shows that it is the same as the form now under consideration. Compared with the typical *C. bartonii* from eastern Pennsylvania, the rostrum of *C. longulus* is much longer and narrower, deeply excavated above, the sides thickened, somewhat concave and convergent, with longer acumen; the antennæ scale is produced into a longer spine; the carapace is more finely punctated, the hepatic and branchial areas smoother, the suborbital angle commonly but little or not at all developed; the chelæ are smoother and broader; the fingers more cylindrical, without the longitudinal ridge along the upper face of the outer finger, widely separated at the base, the outer one bearded within at the base and along the margin; the basal spine of the inner margin of the carpus is absent. The beard on the hand is densest in small specimens, being more or less removed by attrition in old individuals. In specimens from Marion, Virginia, Spring Creek, North Carolina, and Elizabethton, Tennessee, the suborbital angle is prominent, as in *C. bartonii*. In *C. bartonii longirostris* Fax. (Rev. Astacidae, p. 64), the rostrum is not so much contracted, its margins not so much thickened as in *C. longulus*, in fact the rostrum of *spinirostris* has about the same shape as that of *C. bartonii robustus*; the sides of the antennal scale are straight and nearly parallel to one another; the fingers are not separated more than in the typical *C. bartonii* and not so densely bearded as in *C. longulus*. It connects with the typical *bartonii* through *robustus*. But I have hardly enough material before me to give *spinirostris* a firm place as a subspecies.

Girard did not know whence his type of *C. longulus* came. As far as known it is found in the elevated parts of Virginia, West Virginia, western North Carolina, and eastern Tennessee, drained by the Shenandoah, James, Kanawha, and Holston river-systems. It is thus found on both sides of the Appalachian water-shed.

*Cambarus bartonii* and *C. longulus* are both found in Reed Creek at Wytheville, Virginia, with no indication of the two forms interbreeding. But it is not on this account that I consider them two species. I have reason to believe that oftentimes in this genus mere varieties, coming into contact in a given locality, are perpetuated by breeding true, when, by extending our geographical range, every intermediate condition connecting the two forms will be found still surviving. Nowhere do we seem to come so near to seeing the process of evolution of species going on under our very eyes as in this genus *Cambarus*. It seems to me that the only criteria of a species must be the amount and character of the variation, and the absence of intermediate forms not in one locality alone but over the whole area of distribution.

***Cambarus acuminatus* Fax.**

Additional localities: Swannanoa River, Black Mountain, North Carolina; James River, Morgantown, North Carolina; Neuse River, Raleigh, North Carolina; Reedy Fork, Cape Fear River, Greensborough, North Carolina. D. S. Jordan (U. S. F. C.).

The specimen (a female) from Morgantown agrees with the type of *C. acuminatus* from the Saluda River, South Carolina, in the lack of a suborbital spine. In the others this spine is present as in the North Carolinian specimens mentioned on page 68 of the Revision of the Astacidæ.

***Cambarus dubius* Fax.**

Additional locality: "Among the Cherokees," Indian Territory. One male, form I. James Mooney (U. S. N. M.).

This species was previously known only from the remote Appalachian Mountain region of Virginia and West Virginia. According to the label accompanying the specimen it is called *Tsigágili* (red crayfish) by the Cherokee Indians.

***Cambarus diogenes* Gir.**

Additional localities: Prince William County, Virginia, Dr. H. C. Yarrow; Kankakee River, Riverside, Indiana, C. H. Gilbert; Kokomo, Indiana, A. W. Moore (U. S. N. M.).

***Cambarus argillicola* Fax.**

Additional locality: Lowlands bordering on Wabash River, York, Clark County, Illinois. H. G. Hodge (U. S. N. M.).

According to the manuscript label accompanying these specimens, they were found in burrows from 18 inches to 2 feet in depth, contain-

ing from 6 inches to 1 foot of water. At the mouth of these burrows were mud chimneys 5 inches high. The soil was blue clay mixed with sand and gravel. At least three species build chimneys, viz: *C. diogenes*, *C. argillicola*, and *C. dubius*.

The specimen from Kelley's Island, Lake Erie, Ohio, inadvertently referred to *C. diogenes* in my Revision, p. 71, is *C. argillicola*. I have not yet seen *C. diogenes* from the State of Ohio.

**Cambarus setosus** Fax.

*Cambarus setosus* Faxon, Bull. Mus. Comp. Zool., xvii, No. 6, 1889, p. 237, pl. i, figs. 1, 2, 3, 7, pl. ii, fig. 1.

Rostrum rather short, triangular, slightly concave above, terminating in a short, upturned horny tip; sides convex, raised into sharp crests; no lateral teeth except in small specimens which show a rudimentary spiny tooth on each side of the base of the acumen; margins setiferous. Post-orbital ridges obsolescent, destitute of spines. Carapace subcylindrical, flattened above, the region behind the cervical groove very long; smooth and punctate above, granulate on the hepatic and brachial areas; a small spine on the antero-lateral border, a little way above the anterior end of the cervical groove. Areola very narrow, sides subparallel for some distance. Abdomen longer than the cephalothorax, sparsely setose; pleura rounded; telson of moderate length, proximal segment bispinose (occasionally trispinose) on each side. Anterior process of the epistoma broadly transverse, anterior border notched or dentate. Sternum tuberculate between the first to third pairs of legs. Eyes and eye-stalks rudimentary, but not wholly covered by the rostrum. Basal segment of the antennule furnished with a sharp spine below, near the distal end. Antennæ as long as, or longer than, the body; antennal scale surpassing the rostrum, very broad, the broadest part near the distal end; outer margin setose, convex, inflated, ending in a sharp but not very long spine. Third maxillipeds hirsute. Chelipeds of moderate length; chela long, setose, inner and outer margins of the hand provided with blunt tubercles irregularly disposed in a double row; fingers, long, incurved, opposed edges straight, bluntly toothed near the base, finely pectinate throughout their length, tips curved, corneous and acute. Carpus armed with a prominent internal median and inferior median spine; in addition to these there are in older specimens a variable number of small spines on the inner, lower, and outer faces. Upper margin of the meros spinulose, lower face with the usual biserial arrangement of spines.

In the male the third pair of legs is hooked on the third segment. The first abdominal appendages are similar to those of *C. bartonii*, ending in two recurved hooks, the outer of which is corneous and acute in form I, the inner long, slender, and membranaceous. In form II both hooks are membranaceous, short, blunt, and not so widely separated as in form I.

In the female the annulus ventralis is very protuberant, especially the posterior border, and subcircular, with a deep central cavity.

In young individuals the chela and carpus are nearly destitute of the tubercles found in full grown specimens.

Length of a female, 65<sup>mm</sup>; cephalothorax 31.5<sup>mm</sup>; from tip of rostrum to cervical groove, 17<sup>mm</sup>; from cervical groove to posterior margin of carapace, 14.5<sup>mm</sup>; chela, 28<sup>mm</sup>; breadth of chela, 8<sup>mm</sup>; movable finger, 18<sup>mm</sup>; abdomen, 34<sup>mm</sup>.

The arrangement of the olfactory setæ on the outer flagellum of the antennules is similar to that in *C. pellucidus*, i. e., of the thirty segments of the flagellum, the sixteenth to the twenty-seventh bear olfactory setæ, and these setæ are long, as in the other blind species of *Cambarus*. The peculiar pectination of the cutting edge of the fingers I have not observed in any other species.

From Wilson's Cave and wells in Jasper County, Missouri. Miss Ruth Hoppin (M. C. Z.). Three males, form I; sixteen males, form II; fifteen females.

The drainage of Jasper County, which lies in the southwestern part of Missouri, goes to the westward and then southward by the Neosho or Grand River into the Arkansas. The following account of Wilson's Cave and the wells from which this crayfish was taken, with remarks on the habits of the animal, is extracted from Miss Hoppin's letters printed in Mr. Samuel Garman's paper on the cave animals of southwestern Missouri.\*

Wilson's Cave is about 50 feet long, nearly as wide, oven-shaped, and high enough to stand erect except around the sides. The farmer had enlarged the entrance to use the place as a creamery. A small very clear stream flowed along the left side, having a width of 2 feet and a depth of 3, with a temperature of +54° F. About 10 feet from the entrance the light struck the stream in such a manner that we could see everything in the water without a lantern. The first things that caught the eye were a lot of white crayfish, a dozen in all, like those I took from the wells. It seemed as if I might take every one of them. But, though blind, they have one or more of the other senses very keenly developed. I am very sure they, as well as the white fishes [*Typhlichthys subterraneus* Gir.], have the tactile sense developed in an unusual degree. At the least touch upon the water they dart away. As the net cautiously follows, they escape adroitly, making no blunders as to the direction of the approaching enemy, and hide in crevices of the jutting rocks or in the muddy bottom of the stream. The mud was easily stirred so that nothing could be seen. These creatures, fish and crayfish, are only to be secured by patient waiting and skillful management. The people at the cave say the fish never bite, and can not be taken with hook and line. The crayfish were all found near the entrance, where there is considerable light. Following the stream back to a dark recess, reached by crawling on the slippery rocks, the light of the lantern revealed a school of little white fishes, such as I secured from the wells. All were very small. I saw half a dozen or more, but secured only one. I concluded the crayfish liked the light. Perhaps they remain near the entrance because they find there a supply of food. We found a few snails floating about, but saw none in the dark pool where the fish were.

\* Cave Animals from Southwestern Missouri. By Samuel Garman. Bull. Mus. Comp. Zoöl., vol. xvii, No. 6, 1889, pp. 225-240.

Miss Wilson, who was with me, thinks the crayfish devour the others. She has never seen them together, and says the latter keep away from the former, though she had not noticed the crayfish catching or eating them. There was nothing to prevent the crayfish ascending the stream to where the others were.

\* \* \* \* \*

On my first visit, the water being low, no crayfish were seen in the dark nook, the place favored by the fish. After the storm which had flooded the caves, a few were found there. Though I watched for some time, I never saw them pursue the fishes, as they might easily have done, guided by the stir in the water. Both creatures are very sensitive to the slightest ripple. During high water a pool, "the lake," is formed a little way from the stream in another dark part of this cave. In low water the pool is cut off from the creek. I found both species in it, the fish in the darkest part, and saw no signs of enmity. Most of the crayfish were found in the lower part of the stream, in the twilight; the fishes could not be found without the lantern. At the time of the floods the cave is full, and the water rushes out furiously. \* \* \* Another proof that the crayfish are more fond of the light is seen in the shallower wells. That from which most were taken was more exposed to the sun. At noon, when the light was more favorable, we could see them swimming about. No fishes have been taken from this well. They were taken in the narrower, more shaded wells, of which the deep ones on the hills report fishes only.

As to the food of the fishes, I discovered nothing. The mud where they were was not so deep as farther down. An examination of it the length of the cave brought to light many snails; the shells of the living ones are whiter and more nearly transparent than the floating dead ones. The largest crayfish are of a dirty rusty color, and very bristly, in caves and in wells. One large one is very soft and very white; no doubt it is newly moulted.

Both fish and crayfish were less numerous after the freshet, and apparently less active. The disturbance of the flood may have caused them to retreat into their hiding places, only the weaker being left behind, or some may have been swept away by the torrent. The sensitive creatures would soon die in the light and heat outside, where the water is full of frogs and eyed-crayfishes. \* \* \* The specimens became opaque when they are put into alcohol; they are almost transparent when alive, so much so that the action of their internal organs can be observed. Repeated tests assured me the animals were blind, though very sensitive to the sunlight. They died soon after catching, even in water frequently changed.

The wells from which specimens have been taken are about half a mile from Center Creek, the water level in wells and creeks being nearly the same. The wells were nine or ten in number, from 5 to 80 rods apart, from 11 to 30 feet in depth, deeper in the higher ground, and having a depth of water varying from 2 to 4 feet. In some wells the rock at the bottom had been excavated. The water is what is commonly called hard, *i. e.* impregnated with lime. After rains some of the wells have softer water than others, and the water stands higher in these wells, indicating closer connection with surface drainage. All of the wells soon regain the common level. They become low in times of drouth, but never dry out entirely, as is the case with a cave spring near by, about 12 feet above the level of the creek. The temperatures taken in the wells at low water ranged from +52° to 54° Fahr. During a storm in the well having the highest water, the temperature rose to +57°. When the mercury stood at 90° to 95° in the shade outside, the temperature was only 54° in Wilson's Cave.

According to Miss Hoppin, the young of *C. setosus* when alive are not so white as the older ones.

At first I attributed it to greater transparency, but now I am sure the color is in the shell, not that the internal organs can be seen because of the transparent shell. They are not so dark, however, as the brook species [*C. virilis*] of the same size.

In connection with Miss Hoppin's observations on the crepuscular habits of this species it is interesting to note that the atrophy of the visual organs has not progressed so far as in the other blind crayfishes of the United States, *C. pellucidus* and *C. hamulatus*.\* In other respects, also, *C. setosus* is more closely related to outside, eyed species than is either of the other cave species. This doubtless results either from the twilight conditions under which it lives, or more probably from its having been subjected for a shorter period of time to cavern influences.

The three blind species, although belonging to two sections of the genus, resemble each other in the slenderness of the body and claws and in the width of the antennal scale. The slenderness of the body and claws in these species may be attributed to their life in caves, where competition is largely removed and physical power ceases to be an important factor in their existence. The width of the antennal scale is probably a variation correlated to the atrophy of the adjacent eye and ocular peduncle. In short, these points of resemblance between the three cave species, like the rudimentary state of the eye and the transparency of the shell, are of little value from a taxonomic point of view, not indicating close genetic affinity, but surely appearing in widely diverse species, provided they be subjected to the same subterranean life. The closer superficial likeness between *C. pellucidus* and *C. hamulatus*, belonging to different sections of the genus, than between *C. hamulatus* and *C. setosus* belonging to the same section, may be explained by the longer period of time during which the subterraneau influences have probably been exerted upon the first two species.

G. C. Broadhead (Report of the Geological Survey of the State of Missouri, 1874, p. 36) states that blind crayfishes are found in the cave region of Christian County, near Ozark, in southern Missouri. It is probable, from the locality, that they are the same species as those from Jasper County.

***Cambarus affinis* (Say).**

Additional localities: Shenandoah River, Waynesborough, Virginia; Blackwater River, Zuni, Virginia; Patoka River, Patoka, Indiana. D. S. Jordan (U. S. F. C.).

The specimens from Patoka, Indiana (six males, form I; four females), differ from the typical *C. affinis* as follows: The areola is broader in the middle, there is but one lateral thoracic spine, the hepatic area is smoother (merely granulate, instead of spinous), the branchiostegian

\* On the contrary, Mr. G. H. Parker concludes that the histology of the retina shows more degeneration in *C. setosus* than in *C. pellucidus*. His researches on the subject will shortly be published in the Bulletin of the Museum of Comparative Zoölogy. From the external morphology alone, one would surely be justified in deeming *C. setosus* the least modified of the three blind species. The eye-stalk and external part of the eye are largest in *C. setosus*, smallest in *C. pellucidus*. *C. hamulatus* stands between the other two in this regard. For the aberrant position of *C. pellucidus* in other respects, see my Revision of the Astacidae, page 18.

spine is much smaller, and the hand more inflated and triangular; the cephalothorax is slenderer, the antennæ longer; the male appendages are very similar to those of the typical form, but the free tips are a little longer and slenderer. In the smoothness of the carapace and, to some extent, in the shape of the hand this form approaches *C. sloanii* Bundy, but the male organs and the annulus ventralis are very nearly like those of the typical *C. affinis*. I prefer to call it a western variety of *C. affinis*. The largest is 60<sup>mm</sup> in length. The specimens from Lake Erie referred to *C. affinis* in my Revision are too small to determine with certainty.

**Cambarus propinquus** Gir.

Additional localities: Marshall, Michigan; St. Mary's Lake, mouth of Battle Creek, Michigan; Kalamazoo River, Michigan, C. H. Bollman (U. S. F. C.); Lafayette, Indiana, H. L. Osborn (M. C. Z.).

**Cambarus neglectus** Faxon.

*Cambarus neglectus* Faxon, Bull. Washburn Coll. Lab. Nat. Hist., Topeka, Kansas, Vol. 1, 1885, p. 142.

Male, form I.—Rostrum broad, slightly excavated, with a median longitudinal carina toward the apex; sides nearly parallel from the base to the lateral spines, which are very small and of a brown color; acumen of moderate length. Post-orbital ridges with very small anterior spines (sometimes none). Carapace oval, flattened above, punctate, lightly granulate on the sides, lateral spine minute or obsolete antero-lateral border angulated below the eye; anterior segment equals, at the most, twice the length of the posterior segment; areola of moderate width. Abdomen longer than the cephalothorax; basal segment of the telson bi-spinous on each side of the posterior margin. Antennæ shorter than the body; lamina as long as the rostrum, broadest toward the distal end, apical spine of moderate length. Anterior process of the epistoma long, subtruncate. Third maxillipeds hairy within, naked below. Chelipeds short; chela broad, punctate above and below, inner margin furnished with a double row of depressed tubercles; fingers of moderate length, more or less gaping at the base, with a row of round tubercles on their opposed edges, outer margin of the movable finger also furnished with low tubercles; carpus broad, punctate above, with a strong median spine on the internal side and a small one near the base, no spines on the lower side. Superior border of meros armed with two obliquely-placed anteapical spines, lower face of meros with two rows of spines. Third pair of legs hooked. First pair of abdominal appendages nearly straight, reaching forward to the first pair of legs, terminating in two long, slender, pointed, horny styles; the anterior style (outer part of the appendage) is a little longer than the posterior and slightly recurved; anterior border of the appendage carinate but not shouldered.

In the second form of the male the first abdominal appendages are cleft but a short distance. The terminal part of the appendage is stouter than in the first form, and not horny, and the tips of the rami are rather blunt.

The annulus ventralis of the female is triangular, with a deep transverse fossa bounded on all sides by a prominent wall which is bituberulate in front.

Dimensions of a male, form II: Length, 68<sup>mm</sup>; cephalothorax, 32<sup>mm</sup>; from end of rostrum to cervical groove, 21<sup>mm</sup>; from cervical groove to posterior margin of carapace, 11<sup>mm</sup>; width of areola, 2<sup>mm</sup>; abdomen, 36<sup>mm</sup>; chela, 25 by 10.5<sup>mm</sup>.

Mill Creek, Wabaunsee County, Kansas; Republican River, near Guy, Cheyenne County, Kansas; Sappa Creek, Oberlin, Kansas. (M. C. Z.).

This is the species mentioned, but not named, in my Revision of the Astacidæ, page 94, under *C. propinquus*. When that work was written I had seen but three specimens of this crayfish, all of them second-form males, without locality. Collections sent from Kansas by Prof. F. W. Cragin supply the first form of the male and the female. In general appearance this species nearly resembles *C. propinquus*, but the fore border of the carapace is angulated under the eye, and the sexual appendages of the male are quite different, resembling those of *C. rusticus placidus*. The annulus ventralis of the female is different also.

The tips of the fingers in recent alcoholic specimens are orange colored, preceded by a dark annular band.

#### *Cambarus virilis* Hag.

Additional localities: Spencer Creek, Michigan; Barnum Lake, south of Battle Creek, Michigan; Bear Creek and Hinkson Creek, Columbia, Missouri; West Fork of Black River, Reynolds County, Missouri; tributaries of Kansas River and Ward's Creek, Shawnee County, Kansas; Wabaunsee County, Kansas; Garden City, Kansas; Sappa Creek, Oberlin, Kansas; Osage River, La Cygne, Kansas; Topeka, Kansas; Five-mile Creek, tributary of Spring River, Indian Territory (1 mile south of Kausas line, near Baxter Springs, Kansas). (U. S. N. M., M. C. Z., and U. S. F. C.)

Together with specimens of *C. setosus* from wells in Jasper County, Missouri, collected by Miss Ruth Hoppin, occur two very small specimens of a Cambarnus with well developed eyes. They are too young to identify with certainty, but are probably *C. virilis* Hag. The specimens from the West Fork of Black River, Missouri, differ somewhat from the typical *C. virilis*, agreeing with those described on page 98 of my Revision of the Astacidæ, from Irondale, Missouri.

*Cambarus naïs* Faxon.

*Cambarus naïs* Faxon, Bull. Washburn Coll. Lab. Nat. Hist., Topeka, Kansas, Vol. I, 1885, pp. 140, 141.

Male, form I.—Rostrum long, concave above, lateral margins converging from the base to the lateral spines, which are small but distinct; acumen of moderate length, acute. Post-orbital ridges provided with a minute anterior spine. Carapace smooth and lightly punctate above, granulate on the sides; lateral spine small, acute; cervical groove sinuate, ending anteriorly in a small branchiostegian spine; suborbital angle not prominent; areola very narrow, punctate, the margins parallel from the anterior to the posterior triangular fields; the length of the areola is equal to one half the distance from the tip of the rostrum to the cervical groove. Abdomen as long as the cephalothorax. Proximal segment of the telson bispinose on each side, distal segment shorter than the proximal. Antennæ longer than the body; laminæ a little longer than the rostrum, broad, broadest at the middle, subtruncate at the end, with an external apical spine. Third maxillipeds densely setose within and below. Anterior process of the epistoma with very convex sides. Chela broad, flattened above, punctate, external border marginate; inner margin of the hand short, with a double row of dentiform tubercles; fingers long, movable one tuberculate on the external border, toothed on the internal border; external finger flat above, internal margin toothed, and bearded at the base. Corpus armed with a row of small tubercles on the upper side, with a strong and acute internal median spine and a small one at the base; on the lower side the carpus is provided with a prominent median spine and an external one at the point of articulation with the chela; in some specimens there is a small spine on the lower face of the carpus, between the median spine and the large one on the internal margin. Third pair of legs armed with a hooked tubercle on the inner margin of the third segment. First pair of abdominal appendages of moderate length, twisted, deeply bifid, very broad in the middle; rami slender, styliform, strongly recurved, the inner one a little shorter and more curved than the outer one, the outer one corneous. Length, 57<sup>mm</sup>; cephalothorax, 27<sup>mm</sup>; from tip of rostrum to cervical groove, 18<sup>mm</sup>; from cervical groove to posterior border of carapace, 9<sup>mm</sup>; abdomen, 30<sup>mm</sup>; chela, 24<sup>mm</sup>; width of chela, 10<sup>mm</sup>.

The second form of the male differs from the first form in having smaller chelæ, the tubercles on the third pair of legs less developed, the first abdominal appendages less deeply cleft, the rami stouter, blunter, and not corneous.

In the female the chela is similar to that of the second form of the male, the sternum between the fourth pair of legs is smooth, the annulus ventralis triangular with a median longitudinal fissure.

Labette County, Kansas. W. S. Newlon (M. C. Z.). Five males, form I; five males, form II; seven females.

This species much resembles *C. virilis*, especially the form called *variety A* by Dr. Hagen. It differs in the shape of the first abdominal appendages of the male. In *C. naïs* the rami of these appendages are shorter and more strongly curved than in *C. virilis*, but not so much curved as in *C. immunis*. The areola is narrower than in *C. virilis*. The first abdominal appendages are very like those of *C. palmeri* Fax., as far as can be seen by a comparison of the second-form males alone; but the areola is not obliterated in any part of its course in *C. naïs* and the rostrum is more tapering than in *C. palmeri*.

**Cambarus immunis Hag.**

Additional localities: Wabash River, New Harmony, Indiana, D. S. Jordan (U. S. F. C.); Lafayette, Indiana, H. L. Osborn (M. C. Z.).

**Cambarus immunis spinirostris Fax.**

Additional locality: Ward's Creek, Shawnee County, Kansas. F. W. Cragin and J. B. Fields (M. C. Z.).

When I described this variety in 1884, I had not seen the first form of the male, which is included among the specimens collected by Messrs. Cragin and Fields. The lateral spines of the rostrum are distinct, as in the second-form male and in the female; the setæ on the second pair of legs are well developed; the first abdominal appendages are shaped exactly as in the first form male of the typical *C. immunis*.

**Cambarus rusticus Gir.**

Additional localities: Maramee River, Dent County, Missouri, R. E. Call (M. C. Z.); Harpeth River, Franklin, Tennessee, Gilbert and Swan (U. S. N. M.); Osage River, La Cygne, Kansas (M. C. Z.). All these are similar to the form *placidus* Hag.

**Cambarus spinosus Bundy.**

Additional locality: Tar River Rocky Mount, North Carolina. D. S. Jordan (U. S. F. C.).

**Cambarus hylas, sp. nov.**

Male, form II.—Rostrum broad, excavated, margins thickened, somewhat convergent from the base to the acute lateral spines; acumen of moderate length. Post-orbital ridges ending anteriorly in an acute spine; carapace punctate, with a small lateral and a branchiostegian spine; antero-lateral margin notched but not furnished with a sub-orbital spine; posterior segment equal in length to half the distance from the end of the rostrum to the cervical groove; areola of moderate width, punctate. Abdomen longer than the cephalothorax; basal segment of the telson bispinous on each side of the posterior border.

Anterior process of the epistoma triangular, the apex truncated or even notched. Antennæ shorter than the body; scale broad, broadest near the tip. Chelipeds stout, chela broad, punctate, external margin convex, internal margin furnished with a double row of tubercles; fingers slightly gaping, costate, with longitudinal rows of ciliated dots; external margin of movable finger with a line of ciliated tubercles; tips of fingers incurved, corneous. Carpus smooth, furnished with a well developed internal median and small proximal and distal internal spines; beneath, the carpus has a well developed median anterior spine, and a very minute external spine at the point of articulation with the chela. Meros furnished with two obliquely placed ante-apical spines; of the biserial inferior spines the outer row is represented by the two distal ones only. Third pair of legs hooked. First pair of abdominal appendages very long, reaching the base of the chelipeds, tuberculate on inner border near the base, bifid, anterior border carinate, rami straight, thick; the outer branch much longer than the inner, the tip slightly recurved, the inner branch blunt at the tip, and bent a little outward and backward. Dimensions: length 60<sup>mm</sup>; carapace, 29<sup>mm</sup>; from end of rostrum to cervical groove, 18.5<sup>mm</sup>; from cervical groove to posterior margin of carapace, 9.5<sup>mm</sup>; breadth of rostrum at base, 3.5<sup>mm</sup>; between lateral spines, 2.5<sup>mm</sup>; breadth of areola, 2<sup>mm</sup>; abdomen, 31<sup>mm</sup>; chela, 23<sup>mm</sup>; breadth of chela, 10<sup>mm</sup>; movable finger, 13.5<sup>mm</sup>.

Female: Chela smaller, fingers not gaping, external finger slightly bearded at the base within. Sternum between the fourth pair of legs not tuberculate. Annulus ventralis large, triangular, the anterior margin obsolescent, posterior margin very prominent, projecting backward; fossa transverse, deep, with a sigmoid sulcus.

West Fork of Black River, Reynolds County, Missouri, R. E. Call (M. C. Z.). Four males, form II; two females.

This species is closely related to *C. putnami* Fax., but the sides of the rostrum are more thickened and more convergent from the base to the lateral spines; the antennal scale is widest near the tip (in *C. putnami* it is widest in the middle); the carpus has a well developed anterior spine, and the annulus ventralis is very different. From *C. spinosus* Bundy, it differs in its longer metacarapace, shape of the rostrum, annulus ventralis, etc.

#### *Cambarus forceps* Fax.

Additional locality: Middle Fork of Holston River, Glade Spring, Virginia. D. S. Jordan (U. S. F. C.). Four males, form I; four females. The specimen from Knoxville, Tennessee, mentioned on page 121 of the Revision, surely belongs to this species.

#### *Cambarus montezumæ* Saus.

Additional locality: Guanajuato, Mexico. A. Dugés (U. S. N. M.). *C. montezumæ* is a variable species. In the specimens from Guanajuato

the rostrum is even flatter than in the typical form, tapering, and furnished with minute ante-apical teeth.

**Astacus klamathensis** Stirps.

Additional localities: Sprague and Williamson's Rivers, near Fort Klamath, Oregon. Dr. J. C. Merrill, U. S. Army (U. S. N. M.). Eel River, Humboldt County, California. Teste W. N. Lockington.\* A small specimen, 37<sup>mm</sup> long, collected by Dr. Merrill in Klamath Lake, Oregon, is labeled "Color in life, bluish green." An adult collected by the same gentleman is accompanied by the following note: "Color when fresh, bright red, lighter beneath; large claws darker. Common."

**Astacus nigrescens** Stimpson.

"This species appears to be found in most of the larger brooks of the central counties of California, such as the Alameda Creek, Alameda County; Coyote Creek, Santa Clara County, and San Joaquin Slough." Lockington, *l. c.*

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\* Remarks upon the Thalassinidea and Astacidea of the Pacific coast of North America, with description of a New Species. By W. N. Lockington. Ann. Mag. Nat. Hist., 5th series, Vol. II, 1878, p. 303.

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