NUMBER 275 DECEMBER 27, 1933

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN THE UNIVERSITY OF MICHIGAN PRESS

DESCRIPTIONS OF SOME NEW AND POORLY KNOWN SPECIES OF NORTH AMERICAN CRAYFISHES[1]

BY EDWIN P. CREASER

THE following descriptions of new and poorly known species of crayfish are based upon specimens which have been obtained during the past few years by expeditions from the University of Michigan, Museum of Zoology. All of the specimens described here are assigned to the genus *Faxonius*, a subgenus to most authors. A discussion of generic differentiation within the Cambarinae as well as a synopsis of the species of *Faxonius* is not contained in the present paper; however, a new subgenus, *Faxonella*, is described.

Faxonius punctimanus, new species

(Figs. 5–6)

(?) *Cambarus virilis* Variety A. Hagen, Ill. Cat. Mus. Comp. Zool., 3, 1870, p. 64.

Cambarus virilis (in part) Faxon, Mem. Mus. Comp. Zool., 10 (4), 1885, p. 98.

Cambarus virilis Faxon, Proc. U. S. Nat. Mus., 20, 1898, pp. 652–653.

(?) *Cambarus virilis* (in part) Steele, Bull. 10, Univ. Cincinnati, 2 (2), 1902, pp. 32–41.

[1] This is Part II of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Science in the University of Michigan.

Cambarus (*Faxonius*) *virilis* (in part) Ortmann, Proc. Amer. Philos. Soc., 44, 1905, p. 113.

Faxon (1898, pp. 652–653) has given a brief and concise, but wholly adequate, description of this species. It distinctly differs from *virilis* in several important characters and deserves specific recognition. Its affinities, in reality, are far removed from *virilis*.

MALE FORM I.—Antennae long, reaching beyond abdomen. Antennal scale with inner margin evenly rounded, terminal spine short. Rostrum with raised subparallel margins, lateral and terminal spines present; acumen about one-third total length of rostrum. Postorbital ridges with small sharp terminal spine. Cephalic groove broken above the sharp, moderate lateral spine. Areola with poorly defined limits; broad, allowing two to four rows of punctations; 2.2 mm. wide in specimen 92.0 mm. long. Cephalothorax ovate, slightly flattened above, branchial region inflated, punctate above, slightly so in cardiac region; laterally granulate towards anterior margin; posterior section of cephalothorax more than half length of anterior section. Chelae with fingers gaping for more than half their length; fingers ribbed above, lightly setose, opposed margins with rounded tubercles; width of palm less than three-fourths length of moveable finger; inner margin of palm and outer margin of moveable finger with rows of tubercles forming about three poorly defined rows; conspicuous dark spot persisting in alcoholic specimens (sometimes turning to a red color) on both dorsal and ventral surface of palm behind the point of insertion of moveable finger; immoveable finger sparsely bearded within at base. Dorsal surface of carpus with row of tubercles along inner edge; inner lateral margin with a prominent anterior spine and a smaller posterior one; ventral surface with two prominent anterior spines or tubercles and two smaller spines or tubercles along anterior margin opposite the prominent inner lateral spine; number, size, and form of these tubercles variable. Merus with two or three ante-apical spines above, and with usual biserial row below. Hooks on third pair of pereiopods.

Sexual appendage with long, straight, slender, tapering, corneous outer tip, slightly recurved abruptly at apex; (in some specimens the outer ramus is gently recurved throughout the entire length); length of outer tip more than half length of posterior section of carapace; inner tip shorter than outer, apex flattened, recurved, and terminating acutely; anterior margin of sexual appendage with faint indication of a shoulder. Quotient of length of sexual appendage in length of cephalothorax: 2.0–2.2. Quotient of anterior width (distance from base of antennal scale on one side to base on opposite side) in total length of cephalothorax: 3.2–3.5.

MALE FORM II.—Cephalothorax and chelae similar to those of first form males. Sexual appendage with outer tip longer than inner, stout, terminating acutely; tips not separate, slightly recurved posteriorly.

FEMALE.—Chelae proportioned similar to those of male specimens but shorter. Annulus ventralis with overhanging posterior margin, produced posteriorly; anterior margin slightly depressed with a median longitudinal groove extending to the fossa; fossa anterior to mid-length, irregular, deep; sinus curved along posterior margin, then abruptly curved into the deepest part of fossa.

VARIATION.—Regenerated chelae with fingers meeting throughout entire length.

Holotype, a male of form I, No. 53278, Museum of Zoology, University of Michigan. Female allotype, No. 53279. Paratypes (males of both forms and females), No. 53280. All of these types are from Rubidoux Creek at Waynesville, Pulaski County, Missouri, and were obtained by E. B. Williamson on August 22, 1929. Other paratypes are listed under distribution. The number following the locality refers to the catalogue entry in the Museum of Zoology, University of Michigan. Paratypes have also been deposited in the United States National Museum.

ECOLOGY.—This species has no peculiar ecological features, except that it can withstand very cold temperatures. I have taken this crayfish from the usual hiding places under rocks

as well as from aquatic vegetation in muddy streams. Nothing is known of the life history.

DISTRIBUTION.—The single previous record which, without doubt, is referable to this species is that given by Faxon (1898, p. 652): Missouri, Texas County, Big Piney Creek at Cabool. I have examined specimens of this species from the following localities:

Missouri, Pulaski County, Rubidoux Creek at Waynesville (Gasconade Drainage (53278).

Missouri, Dent County, Stream at Salem (Gasconade Drainage) (53285).

Missouri, Wright County, Gasconade River 6 miles north of Mansfield (53300).

Missouri, Texas County, Potter's Creek 3 miles northeast of Cabool (Gasconade Drainage) (53288).

Missouri, Texas County, Big Piney Creek at Cabool (Gasconade Drainage) (53291).

Missouri, Texas County, Big Piney Creek 6 miles south of Houston (Gasconade Drainage) (53281).

Missouri, Wright County, Stream 20 miles south of Lebanon (Osage Drainage) (53286).

Missouri, Wright County, Stream 16 miles south of Lebanon (Osage Drainage) (53287).

Missouri, Wayne County, McKenzie Creek at Piedmont (Black Drainage) (53283).

Missouri, Carter County, Pike's Creek 6 miles west of Van Buren (Current Drainage) (53290).

Missouri, Carter County, "Long Bay" 2½ miles south of Big Spring State Park (Current Drainage) (53292).

Missouri, Carter County, Current River at mouth of Pike's Creek 1 mile northwest of Van Buren (53293).

Missouri, Carter County, Stream in "Chub Hollow" at Big Spring State Park (Current Drainage) (53296).

Missouri, Shannon County, Rocky Creek 9 miles northeast Winona (Current Drainage) (53289).

Missouri, Shannon County, Rocky Creek 12 miles northeast Winona (Current Drainage) (53282).

Missouri, Iron County, Ruble Spring Branch 1 mile south of Chloride (St. Francis Drainage) (53295).

Missouri, Wayne County, Clark's Creek 11 miles east of Piedmont (St. Francis Drainage) (53297).

Missouri, Wayne County, St. Francis River 12 miles east of Piedmont (53298).

Missouri, Texas County, North Fork of the White River southwest of Cabool (White Drainage) (53284).

Missouri, Oregon County, Barren Fork near Thomasville (Eleven Point Drainage) (53299).

Arkansas, Fulton County, Spring River at mouth of stream 1 mile south of Mammoth Spring (Black Drainage) (53294).

This crayfish is apparently confined to the Gasconade, Osage, St. Francis, Current, Black, Eleven Point, and White River systems. It was not obtained by extensive collecting in other sections of Missouri.

RELATIONSHIPS.—The sexual appendage of this species approaches that of the species *juvenilis* to which it may be related. The annulus ventralis is somewhat similar to the type found in the species *hylas*; the chelae are distinctly like those of the species *virilis* and *nais*. *F. punctimanus* is perhaps a connecting form.

Faxonius menae, new species

(Figs. 9–10)

MALE FORM I.—Antennae not reaching beyond abdomen. Antennal scale evenly rounded, greatest width anterior to mid-length; terminal spine of moderate length. Rostrum narrow with convex margins, lateral spines small, acumen less than one-third total length of rostrum. Postorbital ridges with sharp terminal spine. Cephalic groove broken on the sides, cephalothorax without lateral spines. Areola narrow, allowing but two or three rows of punctations, not more than one-third width of rostrum at base; 1.2 mm. wide in specimen 60.4 mm. long. Cephalothorax round, punctate with scattered setae above; posterior section one-half or less than one-half length of anterior section; cephalothorax granulate anteriorly on the sides below cephalic groove. Chelae deeply punctate above and below, fingers with deep longitudinal ribs; width of palm about three-fourths length of moveable finger; inner margin of palm and outer margin of moveable finger with tubercles; opposed margin of fingers with rounded tubercles; fingers gaping for more than half their length, gape less than width of rostrum at base; fingers beveled on inner ventral

surface. Carpus with a large sharp spine on inner margin near anterior edge, with a smaller sharp tubercle on inner margin near posterior edge, and with a sharp spine on median ventral surface. Merus with two ante-apical spines above and with biserial row below; outer row represented by one or two spines. Small hooks on third pair of pereiopods. Sexual appendage with corneous tip of outer ramus more than one-third length of appendage, apex gently curved posteriorly; inner ramus shorter than outer, straight, very slightly swollen at the apex, sexual appendage without shoulder along anterior margin; appendage reaching to second pereiopods. Quotient of anterior width (distance between the bases of the antennal scales) in length of cephalothorax: 3.3–3.6. Quotient of length of sexual appendage in length of cephalothorax: 2.2–2.4.

MALE FORM II.—Chelae smaller than in first form specimens. Sexual appendage with tips lying in close apposition, rami blunt at apex and thicker than in first form males; basal tubercle smaller than in first form appendage; apex of outer part recurved posteriorly; inner part straight.

FEMALE.—Chelae smaller than in first form males but with similar proportions. Annulus ventralis unique in being nearly round; margins raised, anterior border with two tubercles with sinus between; fossa median, spherical, deep; sinus straight along posterior margin but with crescentic curve in fossa.

Holotype, a male of form I, No. 53301, Museum of Zoology, University of Michigan. Female allotype, No. 53302. Paratypes (males of both forms and females), No. 53303. All these types are from: Stream tributary to Irons Fork of Ouachita River at Mena, Polk County, Arkansas. Some specimens from a small tributary of the Little Buffalo River near Diamond Cave, three and one-half miles west of Jasper, Newton County, Arkansas, are conspecific and are designated as paratypes, No. 53304, Museum of Zoology, University of Michigan.

ECOLOGY.—The stream at Mena consisted of pools only, at the time I collected in it (July 8, 1931), and these were found

at intervals along the stream bed. The stream had a rocky and mud bottom, and the crayfish were found either under the rocks or in the shallow burrows in the mud. The small stream near Diamond Cave consisted of pools with a slight riffle connection. The crayfish were taken under stones, both in the quiet pools and the swift riffles.

RELATIONSHIPS.—This species is unique in having chelae that are broad, punctate, and grooved, and in the possession of a nearly spherical annulus ventralis. The short posterior section of the carapace and the general shape of the chelae point towards a relationship with *erichsonianus* of Tennessee and northwestern Georgia.

Faxonius luteus, new species

(Figs. 3–4)

Cambarus juvenilis (in part) Hagen, Ill. Cat. Mus. Comp. Zool., 3, 1870, p. 67.

Cambarus rusticus (in part) Faxon, Mem. Mus. Comp. Zool. 10 (4), 1885, p. 113. Faxon, Proc. U. S. Nat. Mus., 12, 1890, p. 632. Faxon, Proc. U. S. Nat. Mus., 20, 1898, p. 658. Steele, Bull. 10 Univ. Cincinnati, 2 (2), 1902, pp. 28–32.

Cambarus rusticus Harris, Kan. Univ. Sci. Bull., 1 (1), 1902, p. 8.

This species, the commonest one in many sections of the Missouri Ozark Mountains, has never been named. Some very able systematists have had this crayfish but apparently have not analyzed it very thoroughly. It is represented in our collections by more than five hundred specimens.

MALE FORM I.—Antennae long, frequently reaching beyond abdomen. Antennal scale with apex of lamina abruptly rounded to the moderate terminal spine; greatest width anterior to mid-length. Rostrum with concave raised margins, narrow in front and increasing in width posteriorly; acumen less than one-third total length of rostrum, frequently carinate above. Postorbital ridges with a small sharp terminal spine. Cephalic groove interrupted on the sides above the small to moderately sharp lateral spine; anterior margin of carapace very slightly excavate behind antennal scale. Limits of areola poorly defined, rather broad allowing about four

rows of punctations, more than half width of rostrum at base; 2.6 mm. wide in specimen 69.0 mm. long. Cephalothorax ovate, punctate, laterally granulate toward anterior margin. Chelae broad, punctate, outer margin of moveable finger and inner margin of palm with two rows of scale-like tubercles; normal chelae not setose within at base; width of palm about three-fourths length of moveable finger; fingers agape, gape not as wide as width of rostrum at base; moveable finger with a double curve, opposed margins of fingers with rounded tubercles. Regenerated chelae with fingers and chelae longer than in normal specimens; fingers not gaping. Carpus with sharp spine on inner lateral margin and a smaller spine or tubercle below. Merus with one (rarely two) ante-apical spines above, and with obsolescent biserial row below represented by one or two blunt tubercles in each row. Hooks on third pair of pereiopods. Sexual appendage reaching to second pair of pereiopods; outer ramus gently curved posteriorly for greater part of length and abruptly curved posteriorly at apex; length of corneous outer tip more than one-third total length of appendage; whole outer ramus obliquely bent anteriorly from main basal part; outer ramus thin, bladelike; anterior margin without a sharply defined shoulder but occasionally with a rounded one; inner ramus very slightly swollen near apex, curved gently inward, shorter than outer ramus. Quotient of length of sexual appendage in length of cephalothorax: 2.3–2.5. Quotient of anterior width (distance between the bases of the antennal scales) in total length of cephalothorax: 3.2–3.4.

MALE FORM II.—Chelae similar to those of first form males. Sexual appendage with rami lying in close apposition; outer ramus curved posteriorly at apex and always distinctly tipped with an orange color; inner ramus shorter than outer; basal tubercles weak; whole appendage more slender than in first form type.

FEMALE.—Chelae shorter than in male specimens with fingers relatively shorter; base of immoveable finger setose on ventral side. Annulus ventralis oval with raised margins;

fossa crescentic, deep, extending beneath raised anterior portion; sinus straight along posterior margin and curved within the fossa.

COLOR.—Freshly moulted specimens are golden yellow with a single black band or saddle extending over the posterior part of the carapace. The pleurae have a black streak along the anterior part near the point of articulation. The fingers are tipped with orange. The color pattern is a valuable diagnostic character. *F. luteus* is, in my estimation, the most beautiful of North American crayfishes, and its name *luteus* (golden yellow) seems particularly appropriate.

Holotype, a male of form I, No. 53305, Museum of Zoology, University of Michigan. Female allotype, No. 53306. Paratypes (males of both forms and females), No. 53307. All these types are from: Niangua River at mouth of Greasy Creek, 5 miles southeast of Buffalo, Dallas County, Missouri, and were collected by J. Clark Salyer on August 28, 1931. Other paratypes are listed under the heading on distribution. The number following the locality refers to the catalogue entry in the Museum of Zoology, University of Michigan.

ECOLOGY.—This species lives in clear streams in the usual manner under the rocks. It is also found in clear, shallow, swiftly flowing rivers but does not occur where the stream bed is muddy or sandy.

DISTRIBUTION.—The species is abundant in the headwater streams of the following river systems: Meramec, Osage, Gasconade, Current, St. Francis. It is also found in the White River drainage but probably not as abundantly as in the other drainages, this being possibly due to the presence of a rival species, *F. neglectus*. The localities from which I have taken or examined this species are as follows:

Missouri, Pulaski County, Rubidoux Creek at Waynesville (Gasconade drainage) (53308).

Missouri, Wright County, Smittle's Cave, 20 miles south of Lebanon (Gasconade drainage) (53318).

Missouri, Texas County, Big Piney River, 6 miles south of Houston (Gasconade drainage) (53319).

Missouri, Texas County, Potter's Creek, 3 miles northeast of Cabool (Gasconade drainage) (53321).

Missouri, Madison County, Little St. Francis River, 9 miles east of Ironton (St. Francis drainage) (53309).

Missouri, Iron County, Ruble Spring Branch and Big Creek, 1½ miles south of Chloride (St. Francis drainage) (53311).

Missouri, Washington County, Stream at Irondale (Meramec drainage) (53312).

Missouri, Carter County, Pike's Creek, 3 miles southwest Van Buren (Current drainage) (53313).

Missouri, Carter County, Long Bay, 2½ miles south of Big Spring State Park (Current drainage) (53314).

Missouri, Shannon County, Rocky Creek, 9 miles northeast Winona (Current drainage) (53315).

Missouri, Lawrence County, Johnson Creek near Halltown (Osage drainage) (53316).

Missouri, Camden County, Tributary to Niangua River at Hahatonka (Osage drainage) (53317).

Missouri, Webster County, headwaters Niangua River near Marshfield (Osage drainage) (53323).

Missouri, Texas County, north fork of White River, 9 miles southwest of Cabool (White drainage) (53320).

Missouri, Texas County, Beeler Creek, 3 miles southeast of Cabool (White drainage) (53322).

RELATIONSHIPS.—This species is colored the same as *Faxonius mirus* (Ortmann) 1931. Ortmann's species has, however, a shoulder on the sexual appendage. *F. neglectus* (Faxon), *F. placidus* (Hagen), and *F. forceps* (Faxon) are very closely related to this new species.

Faxonius quadruncus, new species

(Figs. 11–12)

MALE FORM I.—Antennae not reaching beyond abdomen. Antennal scale evenly rounded, inner margin subparallel with outer, greatest width anterior to mid-length. Rostrum with lateral spines, margins slightly concave; quotient of length in cephalothorax (rostrum included): 3.5. Postorbital ridges with small sharp terminal spines. Cephalic groove interrupted on the sides above the single lateral spine. Limits of areola poorly defined: 1.6 mm. wide in specimens 54.2 mm. long. Cephalothorax rounded, punctate, finely pubescent,

granulate on the sides anteriorly. Chelae shorter than cephalothorax, setose, fingers agape; width of palm equal to one-half the length of chela; opposed margins of fingers with rounded tubercles; edge of moveable finger and palm with small blunt tubercles. Carpus with two spines on inner lateral margin and two on ventral surface. Merus with one ante-apical spine above and a biserial row below; outer row represented by two or three spines. Hooks on third pair of pereiopods of moderate size, hooks on fourth pair of pereiopods very small and obsolescent in some specimens but present and well developed in others. Sexual appendage with corneous tip of outer part less than one-third total length of appendage, narrow, tapering slightly, curved posteriorly; inner part about same length as outer, anterior surface grooved, apex dilated, posterior border just before apex with small shoulderlike protuberance. Quotient of length of sexual appendage in length of cephalothorax: 2.2–2.4. Quotient of anterior width (distance between bases of antennal scales) in length of cephalothorax: 3.3–3.5.

MALE FORM II.—Chelae smaller than in first form specimens. Sexual appendage with tips lying in close apposition; outer part blunt at apex, inner ramus with groove and widened apex and shoulder on posterior margin before the apex. Quotient of length of sexual appendage in length of cephalothorax: 2.2–2.4.

FEMALE.—Chelae with smaller fingers than in male; cutting edges meeting for most of length. Annulus ventralis with depressed anterior margin; posterior margin triangular, overhanging, produced posteriorly; fossa with a shallow depression anteriorly situated; sinus straight along posterior section then curved either to observer's right or left, terminating in the center of the fossa.

Holotype, a male of form I, No. 53324, Museum of Zoology, University of Michigan. Female allotype, No. 53325. Paratypes (males of both forms and females), No. 53326. All of these types are from: Stout's Creek tributary to St. Francis River, between Ironton and Arcadia, Iron County, Missouri.

Paratypes: No. 53327 from: Little St. Francis River, 9 miles east of Ironton, Madison County, Missouri. All of the specimens were collected on June 26, 1931. Paratypes have also been deposited in the United States National Museum.

Ecology.—The streams in which this species occurs, and to which it is undoubtedly confined, are swiftly moving, the water tumbling over the boulders and rocks in the stream bed. The crayfish population in these streams is almost unbelievable. Three hundred specimens were obtained in a very few seine hauls in Stout's Creek; they were practically all of this species.

Distribution.—The localities mentioned above are all in the St. Francis River headwater streams. The species appears to be very local in distribution.

Relationships.—This species resembles *F. peruncus;* the similarity is due to close lineage. The only significant difference between the two species is that of the form and length of the sexual appendage. The appendages in the two species are, however, constructed essentially upon the same plan.

Faxonius immunis (Hagen) 1870

An opportunity to measure and compare specimens of this species from widely scattered localities has been possible due to the large series at my disposal. This study has brought to light some consistent differences between the specimens from the eastern and western extremes of the range. Accordingly subspecific treatment seems warranted. A curt diagnosis of the features which the two subspecies have in common follows.

Antennal scale irregularly rounded; apex truncate; widest at mid-length. Cephalothorax ovate; granulate anteriorly below the cephalic groove, small lateral spine present. Areola narrow; allowing a single row of punctations. Moveable finger of chelae with an incision at the base just posterior to a prominent tubercle. Merus with a biserial row of spines below; inner row of sharp spines decreasing in size posteriorly; outer row represented by two or three spines likewise decreasing in size posteriorly. Sexual appendage about the

same length or slightly longer than posterior section of carapace; tips curved at about right angles to the basal part. Annulus ventralis of female with a deep fossa sloping obliquely to the observer's left (ventral view with anterior end of crayfish up); fossa not located in the middle but to the left of the middle.

Several characters immediately distinguish this species from any other in the *virilis* group (both rami of the sexual appendage recurved) with an areola: 1, the irregularly rounded antennal scale; 2, the short abruptly curved sexual appendage; 3, the deep sloping annulus ventralis of the female; 4, the incision at the base of the moveable finger.

Faxonius immunis immunis (Hagen)

Cambarus immunis Hagen, Ill. Cat. Mus. Comp. Zool., 3, 1870, pp. 71–73.

Cambarus (*Faxonius*) *immunis* Ortmann, Proc. Amer. Philos. Soc., 44, 1905, p. 113. Faxon, Mem. Mus. Comp. Zool. 40, 8, 1914, pp. 378–382.

Cambarus immunis spinirostris Faxon, Proc. Amer. Acad. Arts Sci., 20, 1884, p. 146. Faxon, Mem. Mus. Comp. Zool. 40, 8, 1914, pp. 378–382.

Cambarus signifer Herrick, 10th Ann. Rept. Geol. Sur. Minn., 1882, p. 253.

DIAGNOSIS.—Rostrum long and narrow, anterior termination of margins always distinct; with or without lateral spines. Distance from tip of rostrum to apex of postorbital ridge contained in length of cephalothorax (rostrum included) less than four times. Length of posterior section half or less than half length of anterior section.

Concerning *spinirostris* Faxon (1914, pp. 379–380) writes:

> Compared with the typical form of *C. immunis* from Illinois, *C. immunis spinirostris* differs in having a distinct spine or tooth on each side of the rostrum near the tip, more prominent postorbital and branchiostegan spines and a shorter posterior section of the carapace in relation to the section in front of the cervical groove (the proportion being 1: 2 or even less in *C. i. spinirostris*); the claw too is narrower with proportionally longer and slenderer fingers.

I have examined material from Illinois and have found specimens with the short posterior section of the carapace.

Faxon is doubtless right regarding the condition of the claws.

The systematic difficulty involved here is that the original description is based upon specimens coming from an area of intergradation. This necessitates the retention of the original name and its more or less arbitrary assignment by the reviser to one or the other of the two subspecies. Hagen's and Faxon's types are more closely related to the eastern form than to the western plains subspecies while Herrick's *signifer* is intermediate (ratio of posterior section of cephalothorax to anterior: 1:1.86; quotient of length from tip of acumen to tip of postorbital ridge in length of cephalothorax: 3.8–3.9). Specimens of the eastern *immunis* throughout the entire range are frequently found in the same pond with and without lateral spines. The western subspecies consistently lacks the rostral spines. I have examined all of the types in the synonymy and assign them all to one form.

Faxonius immunis pedianus, new subspecies

Cambarus immunis (in part) Faxon, Mem. Mus. Comp. Zool., 10 (4), 1885, p. 99.

Cambarus (*Faxonius*) *immunis* (in part) Ortmann, Proc. Amer. Philos. Soc. 44, 1905, p. 113.

Cambarus (*Faxonius*) *immunis* Engle, Bull. U. S. Bur. Fish., 42 (994) 1926, p. 91.

DIAGNOSIS.—Rostrum moderately broad, margins gently converging, then abruptly contracted to form acumen; termination of anterior tip of margin indistinct; acumen with concave edges. Length from tip of rostrum to apex of postorbital ridge contained in length of cephalothorax more than four times. Length of posterior section of cephalothorax more than half length of anterior section.

Holotype, a male of form I, No. 53328, Museum of Zoology, University of Michigan, from Colorado, Denver County, Reservoir at Englewood, collected by Dr. Peter Okkelberg on September 3, 1912. Female allotype, No. 53329, from Nebraska, Boyd County, Dead Creek at Bristow, collected by Dr. C. E. Burt on June 6, 1928. Paratypes, No. 52830, from Colorado, Denver County, ponds at Fort Logan; No. 53331,

from Colorado, Denver County, ponds at Littleton; No. 53330, from Nebraska, Boyd County, Dead Creek at Bristow; No. 53272, from North Dakota, Cass County, ponds 10 miles west of Fargo.

ECOLOGY.—This subspecies occurs in the same type of habitat as the eastern form, namely in ponds and slowly moving waters.

LIFE HISTORY.—The breeding season of the two subspecies appears to be at different times as the eggs are found on the females of the western form at a much later date than on the eastern form. The specimens taken on June 6, 1926, in the vicinity of Fargo, North Dakota, included females with eggs. In Michigan *immunis* females with eggs are taken late in November and in the early spring as late as April. Probably we have here a true physiological difference between the two subspecies.

DISTRIBUTION AND VARIATION.—The exact distribution of the subspecies needs to be determined. One or the other of these subspecies is found from Massachusetts to Wyoming and from Tennessee to Ontario. The species is not found in swiftly moving waters and accordingly is not found in the mountainous areas contained in the above range.

Measurements have been obtained on a rather large series of these crayfish from various portions of the range in order to show the variation in one of the chief characters used in subspecific differentiation.

Locality	Number of specimens	Ratio of posterior section of carapace to anterior
Englewood, Colo.	2	1: 1.70
Omaha, Neb.	4	1: 1.73
Fargo, N. Dak.	12	1: 1.80
Bristow, Neb.	2	1: 1.83
Palo Alto Co., Iowa	1	1: 1.94
Richfield, Minn.	3	1: 1.86
Washington Co., Kansas	2	1: 1.85
Charleston, Ill.	4	1: 2.00

Locality	Number of specimens	Ratio of posterior section of carapace to anterior
Calhoun, Ill.	2	1 : 1.89
Carmi, Ill.	2	1 : 2.00
Ann Arbor, Mich.	10	1 : 1.84
Ypsilanti, Mich.	3	1 : 2.01
Huron Co., Mich.	8	1 : 1.98
Washtenaw Co., Mich.	8	1 : 2.07
Monroe, Mich.	6	1 : 2.03
Wells Co., Ind.	5	1 : 1.88
Reelfoot Lake, Tenn.	4	1 : 2.20
Morrisville, N. Y.	4	1 : 2.12
Cayuga Co., N. Y.	2	1 : 2.10
Ayer, Mass.	8	1 : 2.09
Lake Winnisquam, N. Hamp.	12	1 : 2.23
Pittsfield, Mass.	6	1 : 2.02

The departure from the average ratio from a given locality by a single specimen is very slight. All the specimens from Lake Winnisquam, for example, have a ratio of more than 1 : 2.00. Specimens from Illinois, Michigan, and Minnesota are apparently intermediate, and with more material it is possible that Indiana specimens may also be shown as intermediate forms.

Relationships.—*Faxonius immunis* in my estimation has its closest affinities with *F. alabamensis.*

Faxonius creolanus, new species

(Figs. 1–2)

Male form I.—Antennae long reaching to tip of abdomen. Antennal scale with inner margin evenly rounded to the sharp, moderate terminal spine; greatest width at mid-length. Rostrum with a faint median carina above, lateral and terminal spines small and acute, broad, margins converging; acumen less than one-third total length of rostrum. Postorbital ridges with long sharp terminal spines. Cephalic groove interrupted on the sides above the sharp prominent lateral spine. Areola obliterated. Cephalothorax ovate, finely punc-

tate above, laterally granulate on the sides; posterior section of cephalothorax less than one-half length of anterior section. Chelae with fingers conspicuously flattened, with tufts of setae above and below; fingers meeting throughout entire length, opposed margins with small evenly rounded tubercles; inner margin of palm and outer margin of moveable finger with two rows of sharp spines; immoveable finger bearded within at the base; palm inflated, width a trifle more than one-half length of moveable finger. Carpus tuberculate above along inner margin and with a sharp spine anteriorly situated on upper inner margin (a valuable diagnostic character); inner lateral margin with a single well developed spine; ventral surface with two sharp anterior spines. Merus with two well developed ante-apical spines above; usual biserial row below with sharp spines. Ischium with one or two tubercles along ventral surface. Hooks on third pair of pereiopods. Sexual appendage with tips curved at less than a right angle to basal part; inner part more strongly recurved than outer and directed slightly inward; corneous outer part gently tapering to an acute tip; length about one-third total length of appendage; anterior margin of sexual appendage with faint indication of a shoulder just below the corneous outer tip. Quotient of length of sexual appendage in length of cephalothorax: 3.0. Quotient of anterior width (distance between bases of antennal scales) in length of cephalothorax: 3.1–3.3. Anterior width about equal to length of posterior section of cephalothorax.

MALE FORM II.—Tips of sexual appendage stout, recurved, and separate but for a short distance. Chelae and cephalothorax similar to those of first form male.

FEMALE.—Annulus ventralis with rounded posterior and anterior margins. Fossa anterior to mid-length, crescentic, the horns pointed anteriorly to the margins around a tubercle on anterior margin; sinus straight along posterior and anterior margins and curved within the fossa.

VARIATIONS.—Some of the specimens have rather prominent spines at the point of articulation of the moveable finger with

the palm on the ventral surface. This character is very variable in the males but is seemingly always present in a more or less well-developed condition in the female specimens.

COLOR.—In life this species is greenish blue with mottlings of a darker shade and with red tips to the chelae and along the postorbital ridges.

Holotype, a male of form I, No. 53332, Museum of Zoology, University of Michigan. Female allotype, No. 53333. Paratypes (males of form II and females), No. 53334. All these types are from a stream tributary to the Amite River, one-half mile north of Ethel, East Feliciana Parish, Louisiana, and were collected by the writer on July 17, 1931. Paratypes are also known from the following localities: No. 53335 from stream tributary to Little River at Jena, La Salle Parish, Louisiana; No. 53336 from stream tributary to Little River at Pollock, Grant Parish, Louisiana.

ECOLOGY.—In the stream near Ethel, Louisiana, this species was found in great abundance. Here it lived in the aquatic vegetation in rapidly moving water. This stream as well as the others in which this species was taken had a sandy bottom and the usual hiding places under stones were not available. Percy Viosca, Jr., of New Orleans, informs me that this species in Louisiana is confined to streams flowing through sand hill areas, and my field work bears out this observation.

LIFE HISTORY.—Only a single male was taken having the first form of the sexual appendage in a collection of about one hundred specimens. This I attribute to the season of the year; it illustrates the manner in which a knowledge of the fluctuation of the male population as regards the form of the sexual appendage affects field work for crayfish material.

RELATIONSHIPS.—The species is closely related to *palmeri*. The relationship is manifest in the form of the sexual appendage as well as in the structure of the cephalothorax. It is like *palmeri* in several other characters. The flattened fingers, the spinosity of the inner margin of the palm and outer margin of the moveable finger, and the small tubercles along the opposing margins of the non-gaping fingers are alike in

the two species. The color of *F. mississippiensis* is similar to that of *creolanus*, but the first mentioned species lacks the lateral spines on the rostrum. Doubtless the four species, *longimanus, palmeri, creolanus*, and *mississippiensis*, are very closely related. The ranges of each of these species, so far as we now know, do not overlap. The relative lengths of the sexual appendage are sufficient to distinguish *creolanus* from *palmeri*, and *palmeri* from *longimanus*.

Faxonius clypeatus (Hay)

(Figs. 7–8)

Cambarus clypeatus Hay, Proc. U. S. Nat. Mus., 22, 1899, pp. 122–123.
Faxon, Mem. Mus. Comp. Zool. 40, 8, 1914, p. 401.

As Hay's description, based upon a single female specimen, did not exactly coincide in all details with my material, I sent some of my specimens to Dr. Waldo L. Schmitt, of the United States National Museum, asking him to compare them with the type. He writes as follows:

> I feel certain that your tagged females and the type are one and the same species. Hay's rostrum, and as he has also drawn it, is broader than that of your specimens, particularly toward the anterior extremity and is quite rounded there, but the more I look at it and compare it with your material the more I am convinced it is an abnormality or else the result of an injury which is no longer evident in the rostrum except in its different shape. I certainly think that you are entitled to redescribe the species and that you would be safe in doing so.

Male form I.—Antennae not extending beyond abdomen. Antennal scale broad and short, terminal spine small, greatest width at mid-length. Rostrum without lateral spines and with scarcely a trace of an acumen; upper surface scarcely excavate, margins very thin. Postorbital ridges placed closely to margins of rostrum and lacking anterior spine. Cephalic groove interrupted on the sides, lateral spine lacking. Areola broad; 2.4 mm. wide in specimen 41.2 mm. long. Cephalothorax slightly compressed laterally, smooth above, laterally punctate, and very slightly granulate along the anterior lateral margin of the cephalothorax; abdomen longer than cephalothorax. Chelae with inflated palm; length of inner

margin of palm and moveable finger about equal; opposed margins of fingers without tubercles; fingers slender, weak. Carpus cylindrical with one small anterior spine along inner lateral margin but without spines below. Merus tuberculate above and with a biserial row of very minute spines below. Third pair of pereiopods with exceptionally long, pointed hooks. Sexual appendage with a long curved, corneous outer ramus which instead of being recurved posteriorly is recurved inward so that the tip of the outer part of the right appendage (as viewed by the observer) rests across the outer tip of the left appendage; inner part about one-third length of outer corneous tip, recurved slightly and densely setose; basal protuberance of sexual appendage small. Quotient of length of sexual appendage in length of cephalothorax: 2.3. Quotient of anterior width (distance between bases of antennal scales) in length of cephalothorax: 3.2 (exceptionally constant).

MALE FORM II.—Similar to first form male with exception of sexual appendage which has thicker rami and a relatively longer inner part.

FEMALE.—Annulus ventralis subcircular with two prominent tubercles along raised anterior wall, which is divided by the fossa; fossa behind anterior depression transverse; extending beneath the anterior tubercles, then following the sinus curve toward the posterior margin; sinus curved either to the observer's right or left.

COLOR.—In life *F. clypeatus* is a dark greenish brown, with a darker brown pattern on the abdomen. The abdominal design consists of a median brown line and two lateral ones on the pleurae.

ECOLOGY.—The ecological situations in which I found this species probably explain why it has not been rediscovered sooner. The bog at Crichton contained water of a typical "bog water" hue, and this species was fairly abundant in the aquatic vegetation. The water in the pools along the roadside in Grant Parish, Louisiana, was very shallow and very muddy. Many burrows were found along the edge of these

pools, and no doubt this species is a burrower, for the pools must certainly dry at certain seasons of the year.

DISTRIBUTION.—Hay's description was based on a single female specimen obtained in a skiff at Bay St. Louis, Hancock County, Mississippi. For thirty-two years this has been the only known locality. During my expedition in 1931, I obtained the species in two localities as follows: Louisiana, Grant Parish, pools along roadside, 3.4 miles south of Selma; Alabama, Mobile County, pools in a bog or swamp at Crichton, 4 miles west of Mobile. In the Carnegie Museum there is a single male specimen of this species labeled: "Wister, Choctaw Nat., Oklahoma." This is now in Le Flore County, Oklahoma. I have collected in the vicinity of Wister, Oklahoma, without obtaining this species; however, at that time I was unacquainted with its ecological peculiarities.

RELATIONSHIPS.—In the original description Hay suggested that the species, when the male was discovered, would probably prove to be a form related to *Cambarellus cubensis*. Faxon (1914, p. 401) felt inclined to group it with *Cambarus* (*Bartonius*). This crayfish can now be correctly assigned to the genus *Faxonius*, but it is certainly an orphan among this group of crayfishes. In view of the peculiarities of the sexual appendage with one long ramus and one short one, I deem this species worthy of subgeneric ranking and designate it *Faxonella*, new subgenus of *Faxonius*.

PLATE I

FIG. 1. First form male sexual appendage of *Faxonius creolanus.*
FIG. 2. Second form male sexual appendage of *Faxonius creolanus.*
FIG. 3. First form male sexual appendage of *Faxonius luteus.*
FIG. 4. Second form male sexual appendage of *Faxonius luteus.*
FIG. 5. First form male sexual appendage of *Faxonius punctimanus.*
FIG. 6. Second form male sexual appendage of *Faxonius punctimanus.*
FIG. 7. First form male sexual appendage of *Faxonius clypeatus.*
FIG. 8. Second form male sexual appendage of *Faxonius clypeatus.*
FIG. 9. First form male sexual appendage of *Faxonius menae.*
FIG. 10. Second form male sexual appendage of *Faxonius menae.*
FIG. 11. First form male sexual appendage of *Faxonius quadruncus.*
FIG. 12. Second form male sexual appendage of *Faxonius quadruncus.*

PLATE I

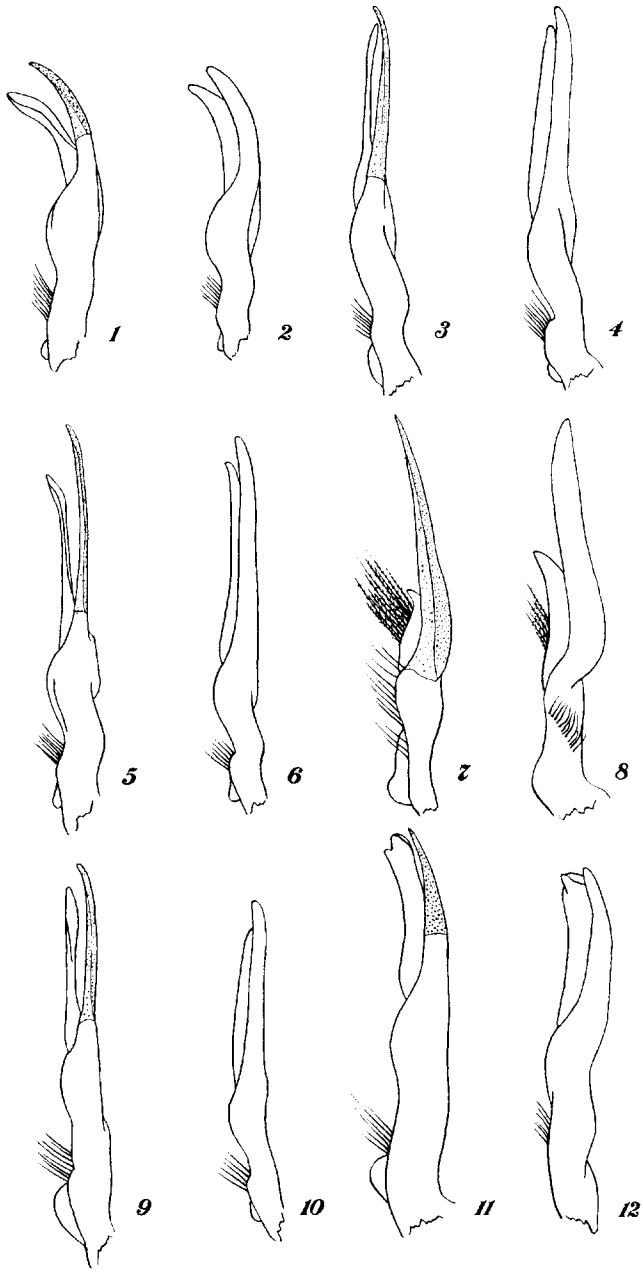

PLATE II

FIG. 1. Ventral view of *Faxonius clypeatus*.
FIG. 2. Dorsal view of *Faxonius clypeatus*.

PLATE II

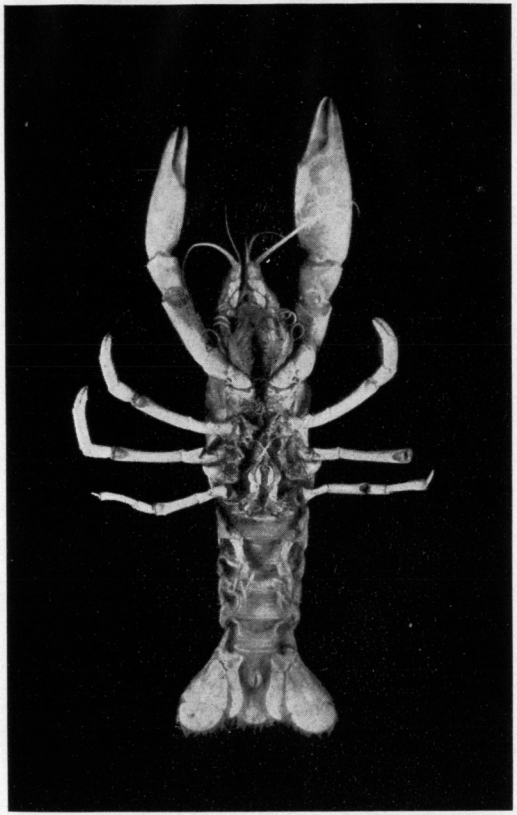

FIG. 1

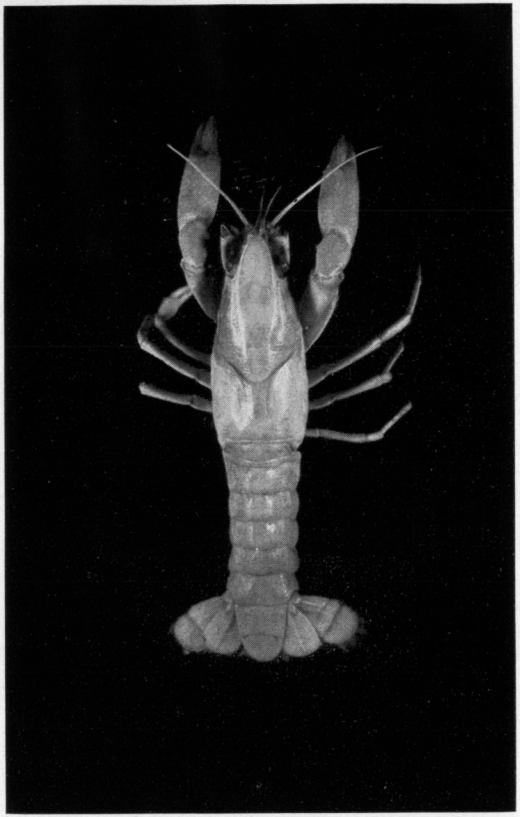

FIG. 2