

THE CRAYFISH SUBGENUS *GIRARDIELLA*
(DECAPODA: CAMBARIDAE) IN ARKANSAS, WITH
THE DESCRIPTIONS OF TWO NEW SPECIES AND
A KEY TO THE MEMBERS OF THE *GRACILIS*
GROUP IN THE GENUS *PROCAMBARUS*

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Abstract.—The burrowing crayfish *Procambarus* (*Girardiella*) *ferrugineus* is described from two localities in the lower Arkansas River system, and *P. (G.) regalis*, from eight localities in the Ouachita and Red river basins of southwestern Arkansas. Their closest allies are *P. (G.) gracilis*, *P. (G.) liberorum*, and *P. (G.) reimeri*. *Procambarus (G.) regalis* may be distinguished from the others by possessing a rostrum with tapering, thickened lateral carinae and conspicuously thickened postorbital ridges; *P. (G.) ferrugineus* differs from all except *P. (G.) regalis* and *P. (G.) reimeri* in exhibiting chelae with tuberculate palms, and from the last named species in having a very narrow or obliterated areola. Notes on, and spot maps depicting, the distribution of the eight members of *Girardiella* occurring in Arkansas follow a key to all of the members of the *gracilis* Group of the subgenus.

At least four handsome crayfish, the adult males of which sport a purplish red to brownish dorsum that is sharply delimited from a cream-to-buff ventrolateral section of the carapace, are known to occur in the Mississippi River basin: *P. (G.) gracilis* (Bundy 1876), reportedly a wide ranging species occurring in the prairie from southeastern Wisconsin southwestward into northern Texas (Hobbs III & Rewolinski 1985:22); *P. (G.) liberorum* Fitzpatrick (1978b), known largely from the upper Arkansas River basin; *P. (G.) ferrugineus*, n. sp., occupying at least part of the lower segment of the same basin; *P. (G.) reimeri* Hobbs (1979), apparently restricted to the upper Ouachita River watershed; and *P. (G.) regalis*, described herein from the Ouachita and Red river basins in southwestern Arkansas. Following the descriptions of the two new species is a key to all of the members of the *gracilis* Group of the subgenus. The first couplet, which defines the two currently recognized "groups" of *Girardiella*,

provides a citation to the most recent key (Fitzpatrick 1978a) facilitating the recognition of the members of the *hagenianus* Group, one which is largely restricted to the prairie sections of western Alabama and eastern Mississippi. For each of the six additional species of the *gracilis* Group occurring in Arkansas, a summary statement of the range and a list of localities in the state are provided.

Procambarus (Girardiella) ferrugineus,
new species

Figs. 1, 2, 12, 15

Diagnosis.—Body pigmented, eyes well developed. Rostrum of adults lacking marginal spines, tubercles, and median carina. Carapace with row of small cervical tubercles. Areola 38 to more than 100 times longer than broad in adults (as broad as 36 in one juvenile) and constituting 38.0 to 39.4 (average 38.7) % of total length of carapace (44.6 to 45.8, average 45.2, % of postorbital carapace length). Suborbital angle weak and

obtuse. Hepatic area distinctly tuberculate; branchiostegal spine rudimentary. Antennal scale about 2.6 times as long as wide, widest distal to midlength. Ventral surface of chela strongly tuberculate, tubercles present along proximal fourth of ventral surface of dactyl. Ischium of third pereopod in first form male with simple strong hook overreaching basioischial articulation; hook not opposed by tubercle on corresponding basis; coxa of fourth pereopod lacking caudomesial boss. First pleopods of first form male reaching coxae of third pereopods, symmetrical, bearing proximomesial, sclerotized spur and truncate cephalic shoulder at base of terminal elements, lacking lateral subterminal setae; setae on caudoproximal ridge flared; terminal elements (all at least partly cornified) consisting of (1) straight, long, tapering (occasionally bifid or bearing small spur) distally-directed mesial process projecting beyond other terminal elements; (2) short, acute, corneous-tipped, cephalodistally-directed cephalic process at cephalic base of mesial process; (3) strong, cornified, acute, cephalocaudally flattened, and laterally curved central projection situated between cephalic process; and (4) conspicuous, corneous caudal element consisting of distally rounded, caudally-concave lamelliform lobe partly shielding small, erect, subacute digitiform prominence. Lamelliform lobe and central projection reaching almost same level distally. Female with annulus ventralis freely movable, about 1.2 times as long as broad, subsymmetrical in outline, with cephalomedian trough curved at about midlength where leading to tilted sigmoid sinus ending on caudal wall of annulus near median line; anterior three-fourths of annulus lateral to trough multituberculate. Preannular plate and first pleopod present although somewhat reduced.

Holotypic male, form I.—Cephalothorax (Figs. 1, 2a, 1) subovate, distinctly compressed laterally, even though greatest width of carapace only slightly less than height at caudodorsal margin of cervical groove (19.2

and 19.4 mm). Second segment of abdomen considerably narrower than thorax (13.8 and 19.2 mm). Areola almost linear, 54.3 times as long as broad, lacking punctations in narrowest part. Cephalic section of carapace 1.6 times as long as areola, latter comprising 39.1% of total length of carapace (45.8% of postorbital carapace length). Surface of carapace punctate dorsally, granulate laterally, tuberculate in hepatic region. Rostrum broad basally, tapering gradually anteriorly, but, approaching apex, margins contracting more rapidly, acumen not clearly defined basally; slightly upturned tip almost reaching base of ultimate podomere of antennular peduncle; margins slightly thickened, and dorsal surface rather deeply concave, lacking median carina, and with punctations scattered between those forming submarginal rows. Subrostral ridges moderately well developed and evident in dorsal aspect along basal two-fifths of rostrum. Postorbital ridges rather prominent, swollen caudally and merging gently with surface of carapace cephalically. Suborbital angle moderately prominent but obtuse. Branchiostegal spine absent; row of very small tubercles replacing cervical spine(s).

Abdomen distinctly shorter than carapace (35.5 and 42.7 mm). Pleura of third through fifth segments broadly rounded ventrally. Cephalic section of telson with 2 spines in each caudolateral corner, lateral ones fixed (Fig. 2m). Cephalic lobe of epistome (Fig. 2j) campanulate, thickened marginally and with low, irregular median carina; thickened marginal area bearing few setae; main body of epistome with spindle-shaped median depression exceeding dimensions of usual fovea; epistomal zygoma as illustrated. Ventral surface of proximal podomere of antennular peduncle with small spine near midlength. Antennal peduncle lacking spines on basis and ischium, but small lateral tubercle on lateral surface of latter in left member; flagellum broken, but in paratypic male, form I, reaching third abdominal tergum. Antennal scale (Fig. 2i)

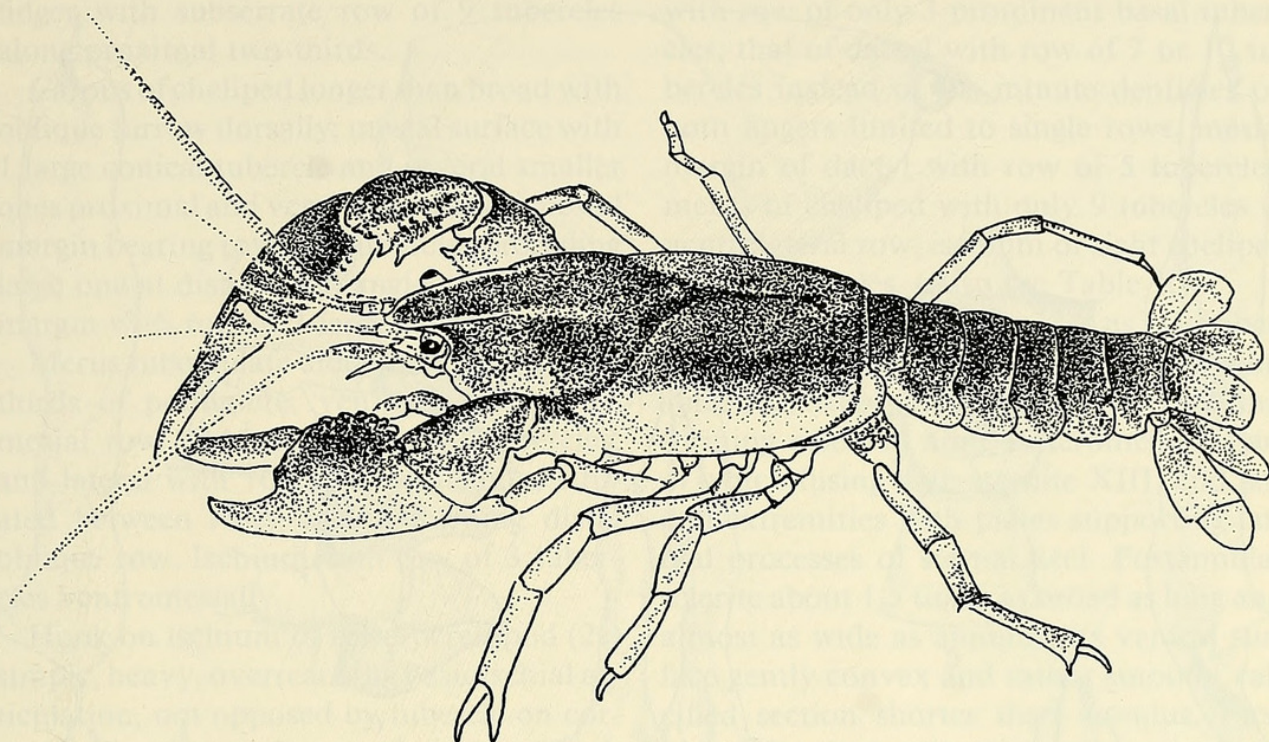


Fig. 1. *Procambarus* (G.) *ferrugineus*: dorsolateral view of holotypic male, form I.

about 2.5 times as long as broad, widest distal to midlength; greatest width of lamellar area about 1.5 times that of thickened lateral part.

Third maxilliped extending to level of ultimate podomere of antennule, ventral surface moderately setose, all conspicuous setae seemingly stiff some of which studded with short spiniform setules in area near midlength; merus not completely obscured in lateral aspect by long plumose setae extending distally from ischium and lateral surface of merus.

Right chela (left probably regenerated) (Fig. 2n) subovate in cross section, not strongly depressed; palm about 1.3 times as broad as length of mesial margin; latter about one-third total length of chela; entire palm except for proximolateral, lateral, and ventrolateral area studded with tubercles, those on dorsal surface becoming weaker and more withdrawn laterally. Mesial surface of palm with row of 7 tubercles (one reduced in earlier premolt injury) flanked dorso- and ventrolaterally by several sublinear rows of smaller ones; distalmost row of tubercles on

ventral surface of palm extending, while diminishing in size, onto basal part of fixed finger. Both fingers with low median ridges dorsally and ventrally; ridges flanked proximally by squamous tubercles and along most of their lengths by setiferous punctations. Opposable margin of fixed finger with row of 4 prominent tubercles (fourth from base decidedly largest) along proximal fourth of finger followed by row of 8 smaller ones (several too small to be included in illustration) reaching level of large, more ventrally situated tubercle near base of distal fourth of finger; row of minute denticles extending between tubercles and forming narrow band between large distalmost tubercle and corneous tip of finger; lateral surface of finger rounded and bearing longitudinal row of setiferous punctations. Opposable margin of dactyl with conspicuous excision in basal third bearing row of 3 tubercles followed distally in same alignment by row of 8 of which proximalmost much larger than others (3 distalmost members too small to include in illustration); minute denticles arranged as on fixed finger; mesial surface of

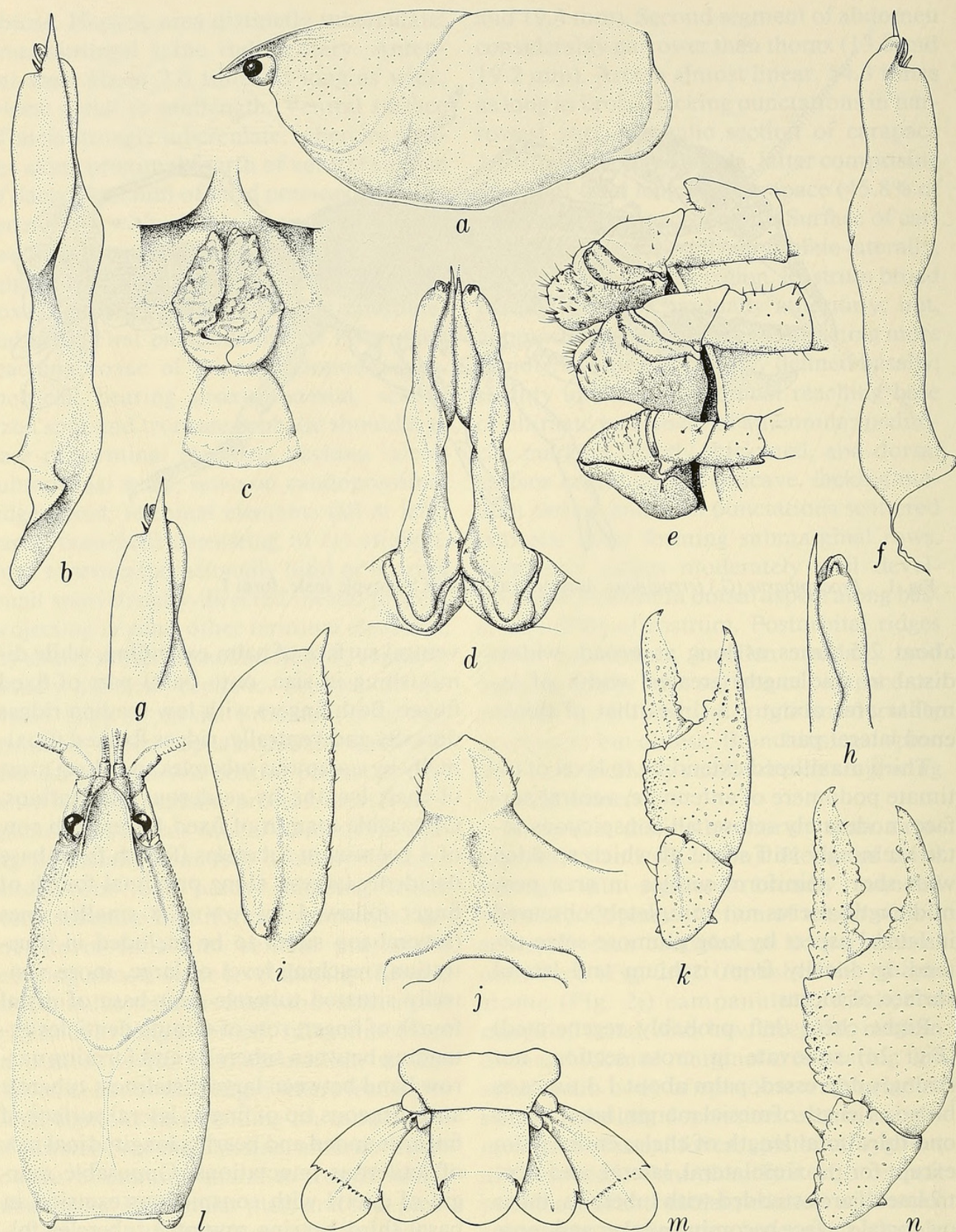


Fig. 2. *Procambarus* (G.) *ferrugineus* (all from holotype except c and k from allotype, and b and f-h from paratype male, form I): a, Lateral view of carapace; b, Submesial view of first pleopod; c, Annulus ventralis and associated sclerites; d, Caudal view of first pleopods; e, Ventral view of basal podomeres of third, fourth, and fifth pereopods; f, Sublateral view of first pleopod; g, Submesial view of distal part of first pleopod; h, Caudal view of same; i, Dorsal view of antennal scale; j, Epistome; k, Dorsal view of distal podomeres of cheliped; l, Dorsal view of carapace; m, Dorsal view of telson and uropods; n, Dorsal view of distal podomeres of cheliped.

finger with subserrate row of 9 tubercles along proximal two-thirds.

Carpus of cheliped longer than broad with oblique furrow dorsally; mesial surface with 1 large conical tubercle and several smaller ones proximal and ventral to it; dorsomesial margin bearing row of 8 tubercles preceding large one at distomesial angle; distoventral margin with row of 3 large tubercles.

Merus tuberculate along dorsodistal two-thirds of podomere; ventral surface with mesial row of 16 (left with 14) tubercles, and lateral with 10; several tubercles situated between rows, and 3 forming distal oblique row. Ischium with row of 3 tubercles ventromesially.

Hook on ischium of third pereopod (2e) simple, heavy, overreaching basioischial articulation, not opposed by tubercle on corresponding basis. Coxae of neither fourth nor fifth pereopods with caudomesial boss.

Sternum between third, fourth, and fifth pereopods rather shallow; ventrolateral margins with plumose setae but obscuring only distal part of first pleopods.

First pleopods of paratypic first form male (Fig. 2b, d, f, g, h) as described in "Diagnosis." Left member in holotype with mesial process bifurcate, and right member of one paratypic male with same process bearing short acute spur.

Uropods (Fig. 2m) with neither lobe of basal podomere bearing spines; mesial ramus with distomedian spine small and situated proximal to distal margin.

Allotypic female.—Differing from holotype, other than in secondary sexual features, in following respects: second segment of abdomen proportionately broader (15.6 and 19.1 mm); right suborbital angle with acute, corneous apex; branchiostegal spine rudimentary, represented by very small obtuse angle; cephalic section of telson with single spine in right caudolateral corner; flagellum of antennae broken but probably reaching second abdominal tergum; chela (Fig. 2k) proportionately much smaller, mesial surface of palm with row of 7 or 8 (left) tubercles, opposable margin of fixed finger

with row of only 3 prominent basal tubercles, that of dactyl with row of 7 or 10 tubercles instead of 11, minute denticles on both fingers limited to single rows, mesial margin of dactyl with row of 5 tubercles; merus of cheliped with only 9 tubercles in ventrolateral row, ischium of right cheliped with 4 tubercles. (Also see Table 1.)

Annulus ventralis (Fig. 2c) as described in "Diagnosis." Preannular plate inconspicuous, deeply embedded in sternum but forming calcified arch, anteromedian part of which fusing with sternite XIII, and lateral extremities with plates supporting lateral processes of sternal keel. Postannular sclerite about 1.5 times as broad as long and almost as wide as annulus, its ventral surface gently convex and rather smooth; calcified section shorter than annulus. First pleopod well developed, reaching cephalic margin of annulus when abdomen flexed.

In the allotype and one of the paratypes collected on 16 April, the cement glands were very well developed, suggesting that ovulation in these females would have occurred in the near future; thus females are likely to become ovigerous in late spring or early summer.

Color notes.—Holotype (Fig. 1): Dorsum of carapace basically brick red. Dorsal surface of rostrum and gastric region slightly paler than remainder; anterior flank of cervical groove very dark red. Rostral carinae and postorbital ridges orange; hepatic region dark red dorsally, fading ventrally, and bearing orange tubercles. Antennal and mandibular areas also fading ventrally, and entire lateral branchiostegal region cream suffused with pink. First abdominal tergum darker red than remaining terga which almost same hue as dorsum of thorax; red coloration fading across pleura. Telson dark red basally becoming paler to transverse suture; posterior section with basal dark brownish patches. Uropods reddish tan; mesial part of proximal section of lateral ramus and most of mesial ramus mottled with dark brown on reddish tan background. Antennules and antennae with

Table 1.—Measurements of adults of *Procambarus* (*G.*) *ferrugineus*.

	Holotype	Allotype	♂I	♀	♀	♀
Carapace:						
Entire length	41.7	42.1	38.1	38.7	38.1	30.3
Postorbital length	35.6	36.1	32.5	33.3	32.1	25.8
Width	19.2	19.1	17.6	17.7	17.5	14.3
Height	19.4	18.1	17.2	17.2	17.2	13.4
Areola:						
Width	0.3	0.2	0.1	0.3	0.2	0.1
Length	16.3	16.2	14.9	15.0	14.5	11.5
Rostrum:						
Width	5.8	5.9	5.3	5.4	5.6	4.4
Length	7.7	8.2	7.1	7.4	7.2	6.0
Chela:						
Length, palm mesial margin	11.2	7.6	9.2	7.1	7.4	5.1
Palm width	14.5	9.9	12.8	10.2	10.1	6.7
Length, lateral margin	32.9	23.2	28.8	21.8	22.4	15.7
Dactyl length	20.0	14.1	17.8	14.2	14.1	10.2
Abdomen:						
Width, second segment	13.8	15.6	12.5	14.7	14.8	10.7
Length, total	35.5	39.7	33.0	36.5	35.6	29.0

mottled peduncles, brown on greenish tan, and greenish brown flagella. Dorsal surface of distal podomeres of third maxilliped greenish brown with pink suffusion. Merus of cheliped pink mesially and laterally with triangular olive dorsal area bearing pinkish orange tubercles; carpus pink laterally, pinkish olive dorsally and mesially, also with pinkish orange tubercles; propodus mostly red dorsally but fading laterally to pink and darkest mesially where studded with very dark red (almost black) tubercles, but those forming mesialmost row with pinkish tips; finger becoming pale distally to base of dark, corneous tip; dactyl darker than fixed finger, with very dark tubercles proximally, but becoming lighter toward dark corneous tip; tubercles on opposable margins of fingers cream to white except for corneous tips. Remaining pereopods pinkish tan, slightly darker on distal part of merus and over carpus and dorsal margin of propodus. Sternal area and basal parts of appendages grayish cream, ventral surface of more distal podomeres pink to orange.

Female differing from male chiefly in

suppression of red coloration: dorsum basically brown with lavender suffusion and anterior flank of cervical groove very dark brown. Rostral carinae and postorbital ridges pinkish cream; hepatic region, dark and mottled with almost black splotches, fading ventrally and bearing pinkish cream tubercles; antennal area almost cream and mandibular area only slightly darker; entire branchiostegal region lavender cream. First abdominal tergum dark reddish purple suffused with tan; terga of second through fifth segments with reddish brown background on which are comparatively inconspicuous, slightly darker spots arranged in two paired rows: dorsolateral row of slightly obliquely placed rectangles, and lateral row, at base of pleura, of semicircular spots with dorsal side convex; tergum of sixth abdominal segment also reddish brown with pair of pinkish tan spots posteriorly; pleura of second through sixth segments paler reddish brown with cream submarginal slash and small dark spot caudodorsal to it. Telson with antero-median subovate, transverse reddish brown spot and pair of rectangular ones immedi-

ately posterior to it; caudal section of telson and uropods paler than remainder of dorsal surface of abdomen and inconspicuously mottled, but no markings prominent. Fringe on pleura cream. Color pattern of chelipeds not differing from male, but reddish coloration reduced to pale pinkish orange. Antennae and antennules as in male. Third maxilliped and pereopods similar but lacking pinkish suffusion, thus predominantly olive and cream.

Type locality.—Roadside ditch 10 miles (16 km) south of Lonoke on State Route 31, Lonoke County, Arkansas (T.1S, R. 8W, Sec. 6). There was no standing water in the ditch, and the burrows of this crayfish were marked by crude chimneys as much as 15 cm high. The simple or bifid galleries, with surface diameters no more than 8 cm, penetrated the watertable some 20 to 25 cm below the surface, and descended to depths of about 1 m. The soil consisted of a sandy clay over clay. Occurring in fewer numbers, but occupying adjacent burrows, in the ditch were members of *Cambarus* (*Lacunicambarus*) *diogenes* Girard (1852). Cultivated fields were adjacent to the grass-covered ditch, and members of the genera *Juglans*, *Prunus*, and *Quercus* were scattered along the fence rows.

Disposition of types.—The holotype and allotype are deposited in the National Museum of Natural History (Smithsonian Institution) (USNM), USNM 218841 and 218842 respectively, as are the paratypes consisting of 2 ♂I, 3 ♀, and 3 j♀.

Size.—The largest specimen available is the allotypic female which has a carapace length of 42.1 (postorbital carapace length 36.1) mm. The smaller of the two first form males has corresponding lengths of 38.1 and 32.5 mm. Ovigerous females or ones carrying young have not been collected.

Range and specimens examined.—Known from only two localities in Lonoke County, Arkansas; type locality, 2 ♂I, 4 ♀, 3 j♀, 16 Apr 1985, R. H. Gilpin and HHH, coll.; and roadside ditch 2.9 mi (4.6 km) S of Lonoke on St Rte 31 (T. 1N, R. 9W, Sec.

36), 1 ♂I, 11 Apr 1987, G. B. Hobbs and HHH.

Variations.—Noteworthy variations are few: the rostrum in all of the specimens, even in juveniles, reaches or almost reaches the base of the ultimate podomere of the antennule; none of the spines or tubercles, including the branchiostegal, is any better developed in the juvenile than in the adults; in none of the specimens does the antenna reach farther caudally than the tergum of the third abdominal segment. Even the areolae of the young are not appreciably wider than those of mature individuals; moreover, there is little variation in the number of tubercles adorning the several podomeres of the chelipeds of the adults: 3 or 4 on the ventromesial surface of the ischium; 12 to 16 in the ventromesial row on the merus and 8 or 9 in the lateral row; 6 to 8 present on the mesial margin of the palm, 7 to 9 on the opposable margin of the fixed finger, and 6 to 10 on the corresponding margin of the dactyl. Insofar as the secondary sexual characteristics are concerned, except for the variation noted above in the mesial process of the first pleopod in the holotype and one of the paratypic males, virtually no noteworthy variation exists; in one of the females, however, the annulus ventralis lies so close to sternite XIII that the preannular plate is scarcely visible.

Relationships.—In his study of *Procambarus* (*G.*) *hagenianus* and its allies, Fitzpatrick (1978a) recognized two species groups in the subgenus *Girardiella*: *gracilis* Group and *hagenianus* Group. Members of the former are readily recognized by lacking spines projecting from the caudal margin of the mesial ramus of the uropods, but possessing a cephalic process on the first pleopod of the male; they occur west and north of the Mississippi River. The members of the *hagenianus* Group, which Fitzpatrick treated in detail, possess two spines projecting from the caudal margin of the mesial ramus of the uropods and lack a cephalic process on the first pleopod of the male; all of them occur east of the Mississippi River

in and near the prairie sections of Mississippi and Alabama. With the descriptions of *P. (G.) ferrugineus* and *P. (G.) regalis*, the *gracilis* Group, still poorly understood and the range of not one of its members clearly defined, encompasses ten species ranging from northeastern Mexico to Wisconsin. This new crayfish is similar to *P. (G.) gracilis*, *P. (G.) liberorum*, and *P. (G.) regalis* in color and in possessing a very narrow areola. It also shares much in common with *P. (G.) reimeri*. Its chela, with a tuberculate palm, is unlike that of two of the species just mentioned but in this respect similar to that of *P. (G.) regalis* and *P. (G.) reimeri*. Noteworthy is the presence of what is interpreted to be a preannular plate in the female, a character which, until discovered in the last-mentioned species, was thought to be a unique feature of the members of the subgenus *Austrocambarus*. Features that serve to distinguish *P. (G.) ferrugineus* from these and other close relatives are noted in the key herein.

Remarks.—In re-examining the species related to *P. (G.) ferrugineus*, we are unable to recognize any material between the range of typical *P. (G.) simulans* and that of the Mexican subspecies, described by Villalobos, from Nuevo León that might be interpreted as intergrades between them. In view of our lack of knowledge of such populations, we propose that *Procambarus (Girardiella) regiomontanus* Villalobos (1954) be accorded specific rank and are so treating it in the key that follows.

Procambarus (Girardiella) regalis,
new species

Figs. 3, 4, 14, 15

Diagnosis.—Body pigmented, eyes well developed. Rostrum lacking marginal spines, tubercles, and median carina. Carapace with 1 or row of up to 6 small cervical tubercles. Areola linear to 31 times as long as wide and constituting 38.2 to 43.6 (avg. 40.4) % of total length of carapace (44.9 to

49.0, avg. 46.2, % of postorbital carapace length). Suborbital angle weak and obtuse. Hepatic and mandibular areas strongly tuberculate; branchiostegal spine rudimentary to moderately well developed. Antennal scale about 2.4 times as long as wide, widest distal to midlength. Ventral surface of chela tuberculate mesially, punctate laterally, 0 to 2 tubercles on ventral surface of dactyl. Ischium of third pereopod of first form male with simple strong hook overreaching basis-ischial articulation; hook not opposed by tubercle on corresponding basis; coxa of fourth pereopod lacking caudomesial boss. First pleopods of first form male reaching coxae of third pereopods, symmetrical, bearing rudiment of proximomesial spur, angular shoulder at base of terminal elements, and lacking lateral subterminal setae; terminal elements (all at least partly sclerotized) consisting of (1) almost straight, long, tapering, distally directed mesial process projecting beyond other terminal elements; (2) short, acute, cephalodistally directed cephalic process situated at cephalolateral base of mesial process; (3) strong, cornified, obliquely flattened, and caudolaterally curved central projection situated between cephalic process; and (4) caudal element, most conspicuous of four, consisting of distally rounded, lamelliform lobe disposed in same plane as central projection, and digitiform prominence on caudomesial angle adnate from base almost, or quite, to tip. Central projection and lamelliform lobe of caudal element reaching almost same level distally. Female with annulus ventralis freely movable, about 1.3 times as long as broad, subsymmetrical in outline, with cephalomedian trough leading to tilted sigmoid sinus ending on caudal wall of annulus near median line, anterolateral prominences smooth or comparatively weakly tuberculate. Preannular plate and first pleopod present; long postannular sclerite tapering anteriorly.

Holotypic male, form I.—Cephalothorax (Figs. 1, 4a, 1) subovate, distinctly compressed laterally even though greatest width

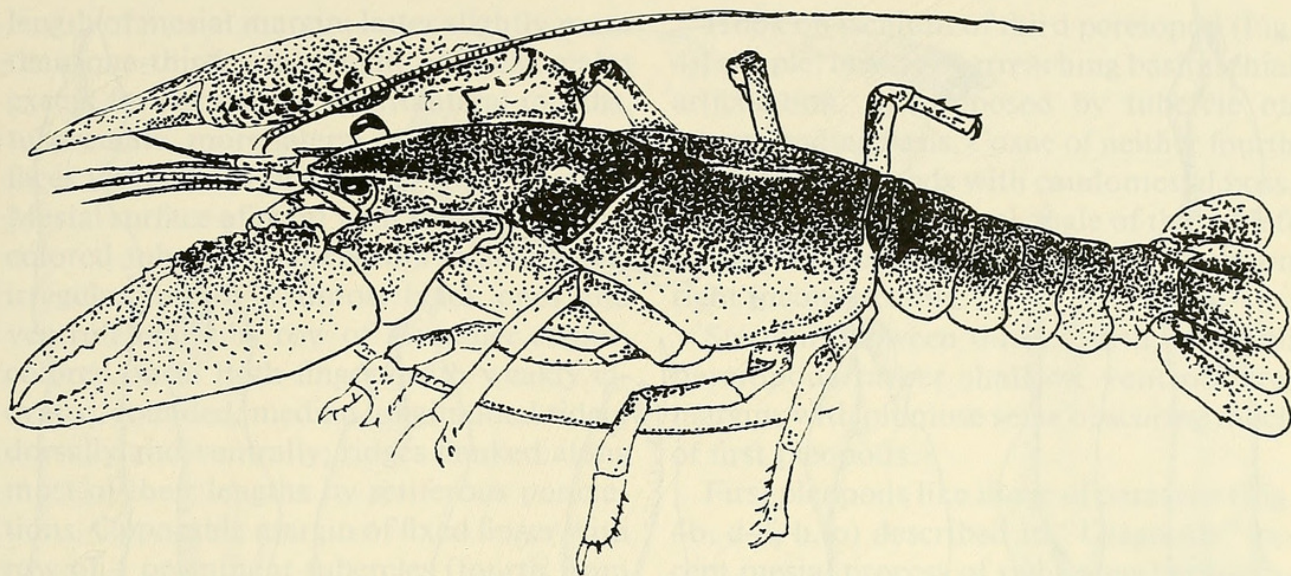


Fig. 3. *Procambarus* (G.) *regalis*: dorsolateral view of morphotypic male, form II.

of carapace slightly greater than height at caudodorsal margin of cervical groove (18.3 and 17.9 mm). Second segment of abdomen considerably narrower than thorax (13.2 and 18.3 mm). Areola very narrow, about 80 times as long as broad, lacking punctations in narrowest part. Cephalic section of carapace 1.4 times as long as areola, latter comprising 41.3% of total length of carapace (46.9% of postorbital carapace length). Surface of carapace punctate dorsally, granulate laterally, strongly tuberculate in hepatic and mandibular regions. Rostrum broad basally, gradually tapering anteriorly from base, margins contracting more rapidly toward apex; acumen, however, not clearly delimited basally; rostral tip slightly upturned, reaching midlength of penultimate podomere of antennular peduncle; margins distinctly thickened, particularly basally, and dorsal surface concave, lacking median carina, and with punctations scattered between those forming submarginal rows. Subrostral ridges rather weak and barely evident in dorsal aspect to base of acumen. Postorbital ridges very prominent, swollen caudally, and merging abruptly with surface of carapace cephalically, but lacking spines or apical tubercles. Paired posterior gastric prominences conspicuous. Suborbital angle obtuse. Branchiostegal spine rudimentary;

row of 4 (left) or 5 (right) tubercles representing cervical spines.

Abdomen distinctly shorter than carapace (35.7 and 39.7 mm). Pleura of third through fifth segments broadly rounded ventrally. Cephalic section of telson with 2 spines in each caudolateral corner, lateral ones fixed. Cephalic lobe of epistome (Fig. 4i) thickened marginally and with median elevated area basally; main body of epistome lacking fovea; epistomal zygoma arched. Ventral surface of proximal podomere of antennular peduncle with strong spine near midlength. Antennal peduncle lacking spines and prominent tubercles on proximal three podomeres; flagellum reaching first abdominal tergum. Antennal scale (Fig. 4k) about 2.4 times as long as broad, widest distal to midlength; greatest width of lamellar area about 1.7 times that of thickened lateral part.

Third maxilliped extending to level of ultimate podomere of antennule, ventral surface moderately setose, conspicuous setae with short, densely set branches; merus not completely obscured in lateral aspect by long, plumose setae extending distally from ischium and lateral surface of merus.

Right chela (left regenerated) (Fig. 4m) subovate in cross section, rather strongly depressed; width of palm about 1.2 times

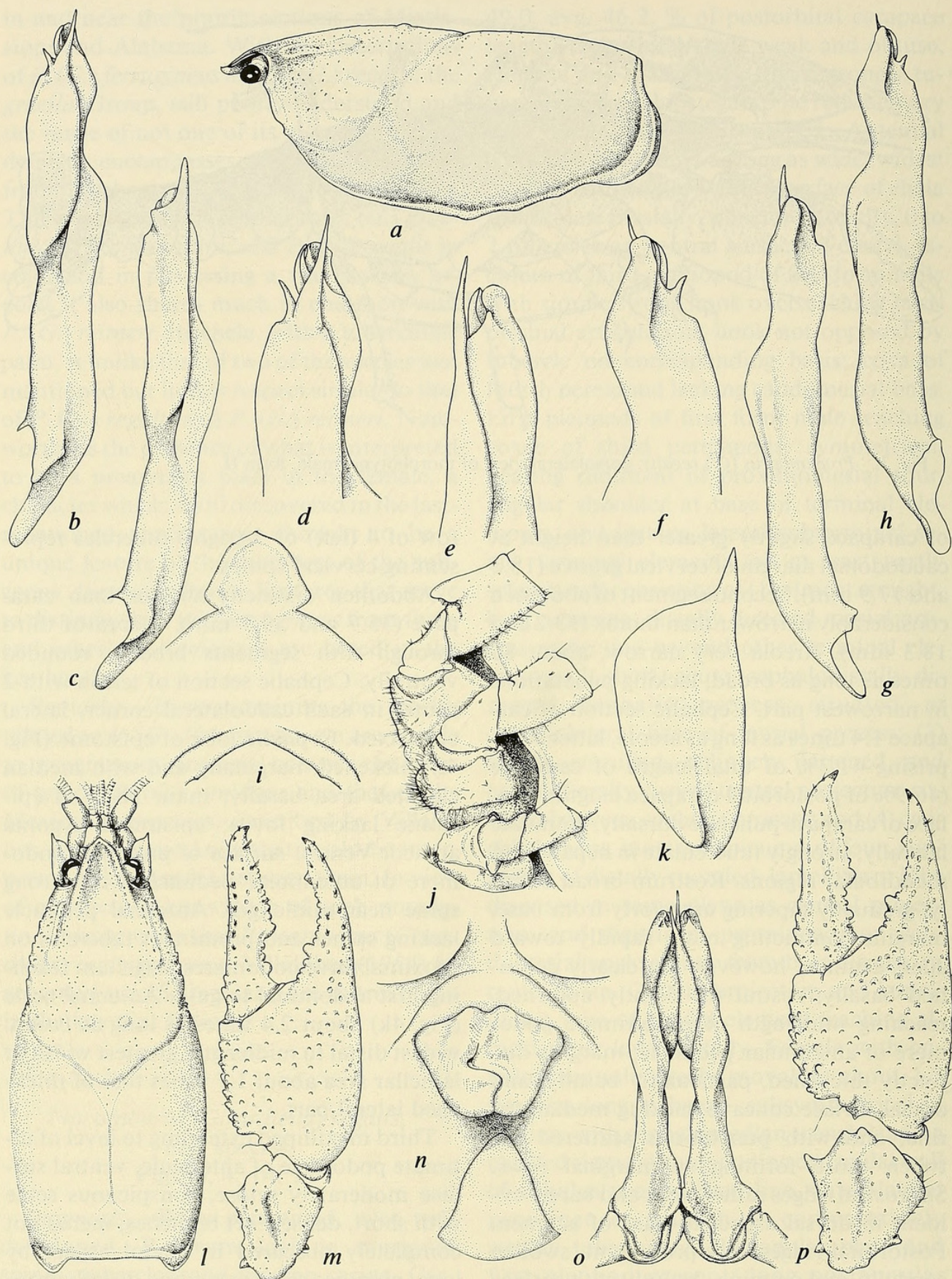


Fig. 4. *Procambarus* (G.) *regalis* (all from holotype except n and p from allotype, and c and g from morphotype): a, Lateral view of carapace; b-d, Mesial view of first pleopod; e, Caudal view of distal part of first pleopod; f-h, Lateral view of first pleopod; i, Epistome; j, Ventral view of basal podomeres of third, fourth, fifth pereiopods; k, Dorsal view of antennal scale; l, Dorsal view of carapace; m, p, Dorsal view of distal podomeres of cheliped; n, Annulus ventralis and associated sclerites; o, Caudal view of first pleopods.

length of mesial margin; latter slightly more than one-third total length of chela; palm except for dorso- and ventrolateral fourths, tuberculate, more lateral ones on both surfaces weaker and progressively withdrawn. Mesial surface of palm with row of 8 cream-colored tubercles flanked dorsolaterally by irregular row of 7 almost black ones and ventrolaterally by row of 7 smaller cream-colored ones. Both fingers with weakly elevated, rounded, median longitudinal ridges dorsally and ventrally; ridges flanked along most of their lengths by setiferous punctations. Opposable margin of fixed finger with row of 4 prominent tubercles (fourth from base decidedly largest) along proximal fourth of finger, followed by row of 7 smaller ones almost reaching level of large more ventral tubercle near base of distal fourth of finger; single row of minute denticles extending between 7 more distal tubercles and continuing, dorsal to distalmost tubercle, to corneous tip of finger; lateral surface of finger rounded and bearing row of widely spaced setiferous punctations. Opposable margin of dactyl with conspicuous excision in basal third bearing row of 3 tubercles followed distally in same alignment by row of 8, of which proximalmost much larger than others; single row of minute denticles extending distally from distal base of second tubercle in excised area; mesial surface of finger with 2 tubercles at base followed by row of setiferous punctations.

Carpus of cheliped longer than broad with oblique furrow dorsally; mesial surface with 1 large conical tubercle and 4 smaller ones proximal to it; dorsomesial surface with irregular row of 3 small, withdrawn tubercles; ventral surface with arc of 6 tubercles leading to more mesial one of 2 situated on ventrodistal margin of podomere.

Merus of cheliped with dorsal row of 9 tubercles of increasing size distally, all except 2 distalmost subsquamous; ventral surface with mesial row of 14 tubercles and lateral one of 9; several tubercles situated between rows. Ischium with row of 3 tubercles ventromesially.

Hook on ischium of third pereopod (Fig. 4j) simple, heavy, overreaching basioischial articulation, not opposed by tubercle on corresponding basis. Coxae of neither fourth nor fifth pereopods with caudomesial boss, but mesial caudoventral angle of that of left fifth with prominent tubercle; tubercle on right inconspicuous.

Sternum between third, fourth, and fifth pereopods rather shallow; ventrolateral margins with plumose setae obscuring much of first pleopods.

First pleopods like those of paratype (Fig. 4b, d-f, h, o) described in "Diagnosis" except mesial process of right member regenerated: shorter and bifid. In addition, unlike arrangement of setae at caudal base of these appendages in many, if not most, crayfishes, setae of both pleopods splayed, disposed both distomesially and distolaterally, reminding one of caudal aspect of spread tail of fantail pigeon.

Uropods with mesial lobe of basal podomere produced in distally projecting spine; mesial ramus with distomedian spine small and situated much proximal to distal margin; lateral spine present on both mesial and lateral rami.

Allotypic female.—Differing from holotype, other than in secondary sexual features, in following respects: areola linear, even narrower than in holotype; tip of rostrum almost reaching base of ultimate podomere of antennular peduncle; rostral margins and postorbital ridges less conspicuously thickened; left branchiostegal spine absent, right one better developed than those in holotype; cervical spines represented by row of 6 minute tubercles on left and 5 on right; small lateral tubercle present on ischium of antennal peduncle; width of palm of chela (Fig. 4p) about 1.3 times length of mesial margin; mesial margin of left chela with row of only 7 cream-colored tubercles; ridges on fingers more distinctly elevated; more distal row of tubercles on opposable margin of fixed finger consisting of only 5 on both chelae; dactyl of right chela with row of 5 tubercles distal to excision, left with

Table 2.—Measurements of the primary types of *Procambarus (G.) regalis*.

	Holotype	Allotype	Mor- photype
Carapace:			
Entire length	39.7	33.1	35.3
Postorbital length	35.0	28.8	30.9
Width	18.3	15.1	14.7
Height	17.9	14.5	15.5
Areola:			
Width	0.2	0.1	0.4
Height	16.4	14.5	14.3
Rostrum:			
Width	5.9	5.1	5.1
Length	6.2	5.5	5.8
Chela:			
Length, palm mesial margin	12.0	7.8	10.6
Palm width	14.9	10.2	12.7
Length, lateral margin	35.2	21.8	29.5
Dactyl length	21.2	13.7	18.0
Abdomen:			
Width, second segment	13.2	12.7	11.3
Length, total	35.7	31.4	29.7

4; mesial surface of dactyl with row of 4 tubercles extending along basal two-fifths; ventral surface of carpus of cheliped with arc of 5 tubercles leading to 2 on ventrodistal margin; tubercles on dorsal margin of merus of cheliped forming single row proximally but more scattered distally, row of 9 on left but fewer, 7 or 8, on right; ventral surface of merus with mesial row of 13 tubercles, lateral rows of 10 on right and 8 on left. For measurements, see Table 2.

Annulus ventralis (Fig. 4n) as described in "Diagnosis." Moderately well developed calcified preannular plate present; postanular sclerite subtriangular, tapering anteriorly, slightly longer than broad, longer than annulus, and completely calcified. First pleopods comparatively well developed, almost reaching cephalic margin of annulus when abdomen flexed.

Morphotypic male, form II.—Differing

from holotype in following respects: areola about 40 times as long as broad, and with 1 punctation in narrowest part; branchios-tegal spine better developed and more acute than in holotype; 5 very weak cervical tubercles on each side; spine on ventral surface of proximal podomere of antennular peduncle smaller; palm of chela lacking ventrolateral row of tubercles flanking mesial row; opposable margin of fixed finger with row of 5 tubercles (fifth from base largest) along proximal fourth of finger followed by row of 7 (right) or 8 (left); dactyl of chela with 4 tubercles in excised area and 5 (left) or 6 (right) in row beyond excision; mesial surface of dactyl with row of 3 (left) or 4 (right) tubercles at base; other than large conical tubercle, those on mesial and dorsomesial surfaces of carpus quite inconspicuous; ventral surface of podomere with 3 (right) or 5 (left) tubercles forming arc leading to 2 larger tubercles on ventrodistal margin of palm; except for 1 (right) or 2 (left) tubercles on dorsal surface of merus, all much smaller than those of holotype; ventral surface of merus of left cheliped with mesial row of 13 tubercles and lateral one of 6, right with 14 and 7, respectively; hook on ischium of third pereopod not reaching basioischial articulation. Proximal podomere of uropod with spine on mesial lobe less strongly produced.

First pleopod (Fig. 4c, g) differing from that of first form male described in "Diagnosis" in exhibiting more robust, less acute mesial process, rudimentary cephalic process, and more inflated, shorter central projection, none of terminal elements corneous; in spite of differences, lateral aspect markedly similar to that of first form male.

Color notes (based on morphotype).—Dorsum of carapace (Fig. 3) predominately brownish red; lateral rostral ridges and postorbital ridges, in striking contrast, orange to cream orange; mandibular adductor, extreme posterior gastric areas, and anterior areolar triangle dark reddish brown. Orbital region adjacent to postorbital ridges dark

brown fading rapidly ventrally over remainder of orbital and hepatic regions to pale pink with cream tubercles; ventral half of branchiostegites, including anteroventral branchiostegal region and caudal ridge, pale tannish cream. First abdominal segment dark reddish brown, remainder of abdomen with broad brownish red, laterally undulating stripe terminating caudally at transverse suture of telson; stripe fading laterally on each segment with margins of pleura matching ventral halves of branchiostegites; caudal section of telson and both rami of uropods similarly pale tannish cream, latter with red median longitudinal ridges. Antennules and antennae (including flagella) pale olive green; setal clusters at apices of podomeres of peduncle grayish cream; third maxillipeds similarly olive with pale orange blush. Dorsum of merus and carpus of chelipeds reddish to olive brown with cream-tipped tubercles; chela tannish orange laterally, gradually increasingly tinged with olive toward mesial margin, most mesial row of tubercles pinkish cream and two parallel, more dorsolateral rows very dark blue, almost black; fixed finger lateral to median longitudinal ridge pinkish orange; more mesial part and entire dorsum of dactyl olive; ventral surface of chela pinkish orange. Basal podomeres of cheliped and remaining pereopods, including most surfaces of ischia, very pale pinkish to lavender cream; dorsal surfaces of more distal podomeres with very pale bluish olive suffusion.

Dorsal surface of abdomen of juveniles and of some adult females with pale median longitudinal stripe flanked by pair of dark greenish gray or greenish brown ones.

Size.—The largest specimen available is a first form male having a carapace length of 40.8 mm (postorbital length 36.3 mm). The smallest first form male has corresponding lengths of 31.7 and 27.6 mm. Measurements are not available for either ovigerous females or ones carrying young; for those of the primary types, see Table 2.

Type locality.—De Ann Cemetery, about

1 mile (1.6 km) west of the junction of State Routes 19 and 24 on latter at western city limit of Prescott, Nevada County, Arkansas (T. 11S, R. 22W, Sec. 8). Specimens were collected from simple burrows which descended to a depth of approximately 1 m and were topped by chimneys from 8 to 12 cm high. Soils in the grass-covered, treeless field consisted of sandy clay, and no standing water was in the area inhabited by the crayfish.

Disposition of types.—The holotypic male, form I, allotype, and morphotypic male, form II, are deposited in the National Museum of Natural History, USNM 219244, 219245, and 219246, respectively, as are the paratypes consisting of 4 ♂I, 3 ♂II, 11 ♀, 3 j♂, and 1 j♀.

Range and specimens examined.—All of the specimens available were collected in southwestern Arkansas as follows (Those lots or specimens noted by an asterisk are excluded from the type series.). Ouachita River Basin: Nevada County; (1) type locality, 3 ♂I, 5 ♀, 16 Mar 1982, Elaine Laird, 1 ♀, 6 May 1979, EL; *65 very small juveniles, 28 Feb 1981, HWR. Red River Basin: Howard County; (2) Mineral Springs, 2 ♂I, May 1986, Kyle Erwin, Jason Erwin, 1 ♀, L. Tate, 1985. (3) 2 mi S of Mineral Springs, 1 ♂II, LT, 1985. (4) 1.4 mi S of St Rte 27 on 317, *1 j♀, 2 May 1986, HWR. Sevier County; (5) roadside wet area 5.1 mi E of Oklahoma state line on US Hwy 70, 21 Apr 1973, J. E. Pugh, G. B. Hobbs, HHH., 2j ♂, *5 j♀, 9 Apr 1982, HWR and D. Koym (6) field 1.5 mi N of Paraloma (T. 11S, R. 28W, Sec. 8), 1 ♀, 1 Apr 1987, Eddie Daniels, KE, JE, HWR. (7) seepage area 1.6 mi S.W. of jct. on St Rtes 27 and 234, 1 ♂II, 3 ♀, 2 j♂, 1 j♀, 20 Apr 1987, GBH, HHH. (8) roadside ditch 0.4 mi E of Oklahoma state line, *1 ♂I, *1 ♂II, *2 ♀, *10 j♂, *12 j♀, 21 Apr 1973, JEP, GBH, HHH.

Variations.—Most conspicuous among the variations noted are those in specimens from localities 5 and 8, both in the Little River basin. They exhibit features that set

them distinctly apart from specimens from the more eastern localities. Whereas most features of the first pleopod of the single first form male and the general mien are not conspicuously unlike those of males from the other localities, the shoulder on the pleopod is much more prominent and produced distally; in all of the specimens, the rostrum has weaker and decidedly less strongly convergent lateral ridges. Moreover in the first form male, there exists a weak, but distinct beard on the mesial surface of the palm of the chela similar to, but much less conspicuous than, that in *P. (G.) tulanei*. The crayfish from these localities are tentatively assigned to *P. (G.) regalis*, but further study of more material from the Little River basin will be required to ascertain their status.

Relationships.—*Procambarus (Girardiella) regalis* has its closest affinities with *P. (G.) gracilis* and *P. (G.) liberorum*, living specimens of the three resembling one another not only in their coloration, but also in most morphological features. The comparatively short (not overreaching the caudal process) central projection of the first pleopod of first form males differs from that of *P. gracilis*, and the more slender rostrum with thickened lateral carinae, more prominent postorbital ridges, and obliquely oriented caudal process of the first pleopod are among the features that distinguish it from members of *P. liberorum*. The rather smooth anterolateral prominences of the annulus ventralis and the long subtriangular postannular sclerite serve to separate the female from those of the other two species.

Key to the Members of the *gracilis* Group
of the Subgenus *Girardiella*
(Based on First Form Males)

1. Mesial ramus of uropod with 2 spines projecting from distal margin; cephalic process of first pleopod lacking *hagenianus* Group
... (See Fitzpatrick, 1978a:95, for key to members.)

- Mesial ramus of uropod without spines projecting from distal margin; cephalic process of first pleopod present ... *gracilis* Group ... 2
- 2. Opposable margin of dactyl of chela with prominent angular excision in basal third; dorsolateral surface of palm punctate; color of first form male mostly red 3
- Opposable margin of dactyl of chela lacking or with weak excision in basal third; dorsolateral surface of palm tuberculate; color of first form male brown, tan or greenish. 6
- 3. First pleopod with central projection clearly overreaching caudal element (Fig. 5) *gracilis*
- First pleopod with central projection not overreaching distal extremity of caudal element (Figs. 11, 13) 4
- 4. Areola less than 30 times as long as broad *reimeri*
- Areola at least 38 times as long as broad, sometimes linear 5
- 5. Palm of chela punctate except for tubercles along and adjacent to mesial surface; setae on caudoproximal ridge of first pleopod directed caudolaterally *liberorum*
- Palm of chela mostly tuberculate, especially on mesial halves of dorsal and ventral surfaces; setae on caudoproximal ridge of first pleopod splayed, directed distomesially and distolaterally 7
- 6. Rostral margins conspicuously thickened and tapering from base; ratio of length to width of rostrum never more than 1.2 *regalis*
- Rostral margins not thickened and subparallel to ill-defined base of acumen; ratio of length to width of rostrum greater than 1.2 *ferrugineus*
- 7. Central projection of first pleopod clearly overreaching distal ex-

- tremity of caudal element (Figs. 6, 7) 8

- Central projection not, or rarely barely, overreaching distal extremity of caudal element (Figs. 8, 9, 10) 9

8. Mesial surface of palm of chela bearded; blade of caudal element of first pleopod broadly rounded to truncate distally (Fig. 7) .. *tulane*

- Mesial surface of palm of chela never bearded; blade of caudal element of first pleopod tapering distally (Fig. 6) *regiomontanus*

9. Blade of central projection of first pleopod directed distolaterally, and in caudal aspect extending lateral to caudal element (Fig. 10b) *curdi*

- Blade of central projection of first pleopod directed distally, and, in caudal aspect, situated mesial to caudal element (Figs. 8, 9) 10

10. Areola no more than 14 times as long as broad; blade of caudal element of first pleopod with broadest plane almost transversely oriented; in mesial view, caudodistal end of shaft of pleopod subtruncate, almost forming angle with caudal element (Fig. 8) *parasimulans*

- Areola more than 14 times as long as broad; blade of caudal element of first pleopod with broadest plane obliquely oriented; in mesial view, caudodistal end of shaft of pleopod tapering, lacking even suggestion of angle of base of caudal element (Fig. 9) *simulans*

Notes on the Ranges of Other Members
of the Subgenus *Girardiella*
Occurring in Arkansas

In addition to the new species described above, five other members of the subgenus

Girardiella occur in Arkansas. They are listed below, and for each of them a statement of its range is followed by a list of locality records within the state; those localities from which specimens have not been examined by one or both of us are noted by an asterisk. As nearly complete synonymies as we have been able to amass are provided for all of the species except *P. (G.) simulans*. Many of the references in the literature are almost certainly based on erroneous determinations, and the reported range (Hobbs 1974: 48, one of the more recent) must be recognized as possibly, if not likely, encompassing that of several taxa (including *P. (G.) parasimulans*, see below).

- Procambarus (Girardiella) curdi* Reimer
Figs. 10, 16

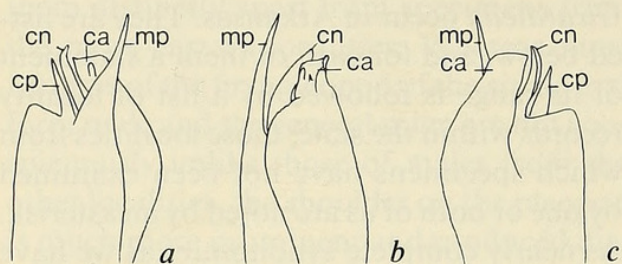
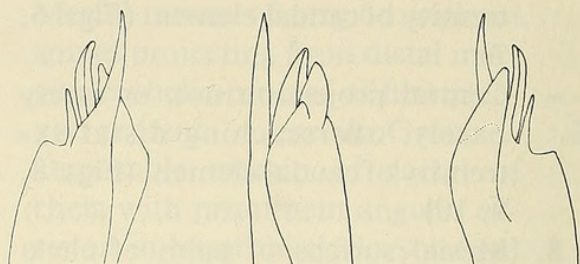
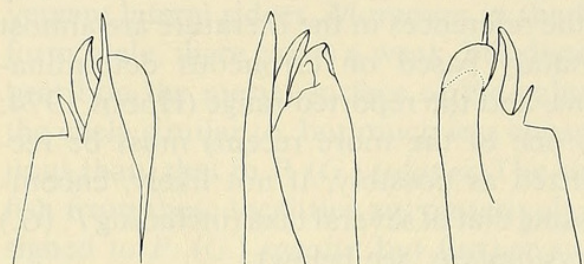
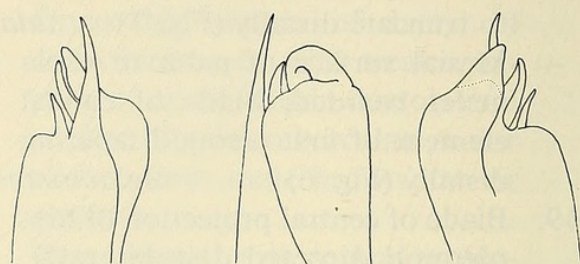
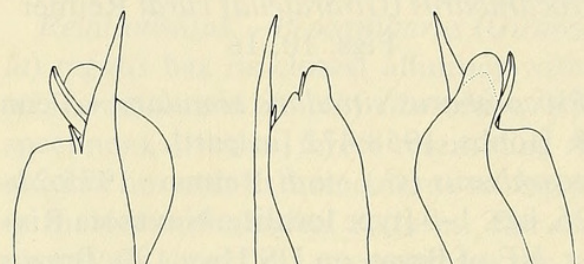
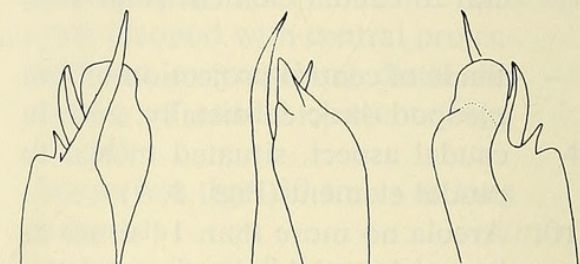
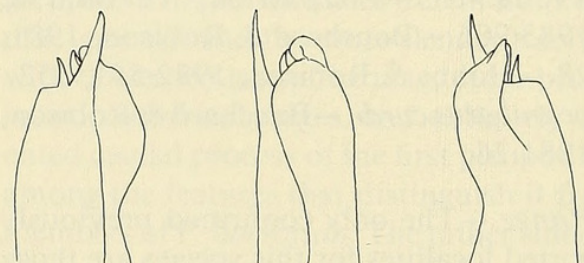
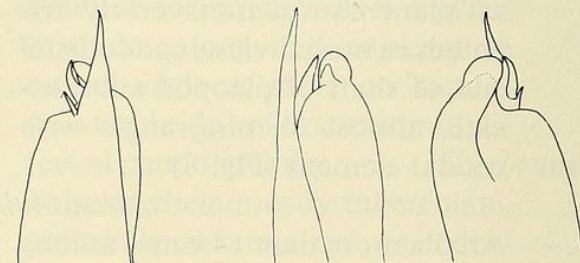
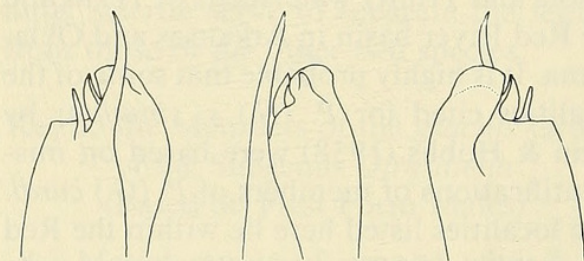
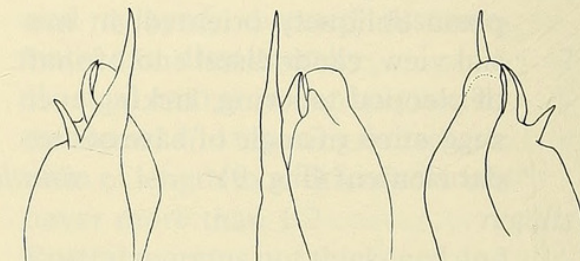
(?)*Procambarus simulans simulans*. — Penn & Hobbs, 1958:472 [in part].

Procambarus (G.) curdi Reimer, 1975:22–25, figs. 1–9 [type locality: Navasota River, NE of Bryan on US Hwy 190, Brazos County, Texas]. — Bouchard, 1978a:451; 1980a:451. — Fitzpatrick, 1978b:538; 1983:206. — Bouchard & Robison, 1981: 28. — Hobbs & Robison, 1982:551, 552.

Procambarus curdi. — Bouchard & Robison, 1981:26.

Range. — The only confirmed previously reported localities for this species are those of Reimer (1975:25) which lie in the Navasota and Trinity watersheds of Texas and the Red River basin in Arkansas and Oklahoma. It is highly probable that some of the localities cited for *P. (G.) s. simulans* by Penn & Hobbs (1958) were based on misidentifications of members of *P. (G.) curdi*. The localities listed here lie within the Red River basin of Arkansas and represent only minor extensions of the range of the species.

Arkansas records. — Little River County: (1*) 12.5 mi W of Ashdown (Reimer 1975: 25); (2) 4 mi N of cross roads, S of Little River Bridge on St Rte 41, 11 j♂, 20 j♀, 11 Apr 1982, B. Boyd, coll; (3) roadside ditch

5. *P. (G.) gracilis*6. *P. (G.) regiomontanus*7. *P. (G.) tulanei*8. *P. (G.) parasimulans*9. *P. (G.) simulans*10. *P. (G.) curdi*11. *P. (G.) reimeri*12. *P. (G.) ferrugineus*13. *P. (G.) liberorum*14. *P. (G.) regalis*

Figs. 5–14. Distal part of first pleopods of first form males: a, Mesial view; b, Caudal view; c, Lateral view. (ca, caudal element; cn, central projection; cp, cephalic process; mp, mesial process.)

4.3 mi S of Ashdown, 1 ♂II, 25 j♂, 25 j♀, 11 Apr 1982, Boyd; (4) roadside ditch 1.9 mi W of Ashdown on St Rte 32, 1 ♂II, 14 j♂, 12 j♀, 27 Apr 1976, M. T. Kearney, HHH; 3 j♂, 3 j♀, 10 Apr 1982, HWR, D. Koym. (5) roadside ditch 7 mi N of Miller Co line on US Hwy 71, 1 ♀, 26 Apr 1976, MTK & HHH. Miller County: (6) 8.5 mi SW of Fouke, near Sulphur River, 1 ♀, 8 j♂, 8 j♀, 26 Mar 1982, C. Johnson; (7) 3 mi E of Fouke on St Rte 134, 2 j♂, 1 j♀, 28 Mar 1982, Thomason.

Procambarus (Girardiella) liberorum
Fitzpatrick
Figs. 13, 15

Procambarus (Girardiella) gracilis.—Hobbs, 1974:47 [in part; and previous authors listing Arkansas within the range of the species].—Hobbs III & Rewolenski, 1985: fig. 1 [in part].—Page, 1985, fig. 99 [in part].

Procambarus (G.) liberorum Fitzpatrick, 1978b:533–538, figs. 1–14 [type locality: yard at 206 SW Seventh Street, Bentonville, Benton County, Arkansas]; 1983:206.—Bouchard, 1978b:14.—Hobbs, 1979:804, 810.—Bouchard & Robison, 1981:28.—Hobbs & Robison, 1982:552.

Procambarus liberorum.—Bouchard & Robison, 1981:28, 29.—Robison & Smith, 1982:54.—Mayden, 1985:200.—Page, 1985:371.

Range.—This crayfish is an inhabitant of the Arkansas River basin, occurring from Benton and Washington counties to Pope and Yell counties in Arkansas, and presumably will be found in the Oklahoma segment of the watershed.

Arkansas records.—Benton County: (1) type locality, 2 ♂I, 3 ♀, summer, 1976, Fitzpatrick family. Franklin County: (2) pond 8.3 mi S of Coombs, 1 ♂I, 1 ♀, 26 Feb 1955, E. Whatley. (3) 0.2 mi E of Branch on St Rte 22, 1 j♂, 15 Mar 1981, HWR. (4) seepage

area 0.4 mi E of Branch on St Rte 22, 1 ♀, 7 j♂, 6 j♀, 16 Apr 1982, HWR, DK. (5) Prairie Creek, 2 mi N of Charleston on St Rte 217, 1 ♂I, 24 May 1980, G. L. Harp. Johnson County: (6) P. L. Hill Work Center on St Rte 21, N of Clarksville, 1 j♀, 1 Feb 1986, D. Ebert. Logan County: (7) 0.8 mi E of Midway city limits on St Rte 22, 1 ♂I, 1 j♂, 15 Mar 1981, HWR; 1 ♂I, 1 ♀, 1 j♀, 16 Apr 1982, HWR, DK. Pope County: (8) roadside ditch 1.3 mi N of Hector on St Rte 105, 1 ♂I, 2 ♀, 17 Apr 1973, JEP, GBH, HHH. (9) stream 2.6 mi NW of St Rte 7 on St Rte 164, 4 ♂II, 4 j♂, 8 j♀, 16 Apr 1973, JEP, GBH, HHH. (10) dry stream-bed 1.8 mi N of Hector on St Rte 105, 1 ♀, 42 j, 16 Apr 1982, HWR, DK. (11) 2 mi E of Scottsville on St Rte 27, 1 j♂, 20 Mar 1986, (molted to first form in September 1987) HWR; 2 ♂II, 1 ♀, 20 Mar 1987 (one of the males molted to first form in September 1987), HWR. Scott County: (12) roadside ditch 5 mi E of Waldron on St Rte 80, 1 ♂II, 3 ♀, 8 j♂, 6 j♀, 18 Apr 1973, JEP, GBH, HHH. Sebastian County: (13) seepage area 3 mi E of Central City on St Rte 22, 7 j♂, 9 j♀, 15 Mar 1981, HWR; 5 j♂, 7 j♀, 16 Apr 1982, HWR, DK; 3 ♀, 2 j♂, 16 Mar 1986, HWR. Washington County: (14) low area near University of Arkansas campus, Fayetteville, 1 ♂I, 1 ♀, 11 May 1949, D. W. Gray. Yell County: (15) roadside ditch 5.8 mi SW of St Rte 7 on Rte 27, 1 ♂I, 4 ♀, 3 j♂, 9 j♀, 17 Apr 1973, JEP, GBH, HHH. (16) roadside ditch 1.7 mi SW of St Rte 154 on St Rte 27, 1 j♂, 2 j♀, 17 Apr 1973, JEP, GBH, HHH. (17) roadside ditch 32 mi N of Story on St Rte 27, 1 ♀, 15 Mar 1981, HWR.

Procambarus (Girardiella) parasimulans
Hobbs & Robison
Figs. 8, 16

Procambarus (Girardiella) simulans simulans.—Hobbs, 1974:48 [in part].

Procambarus (G.) parasimulans Hobbs & Robison, 1982:545–533, fig. 1 [type lo-

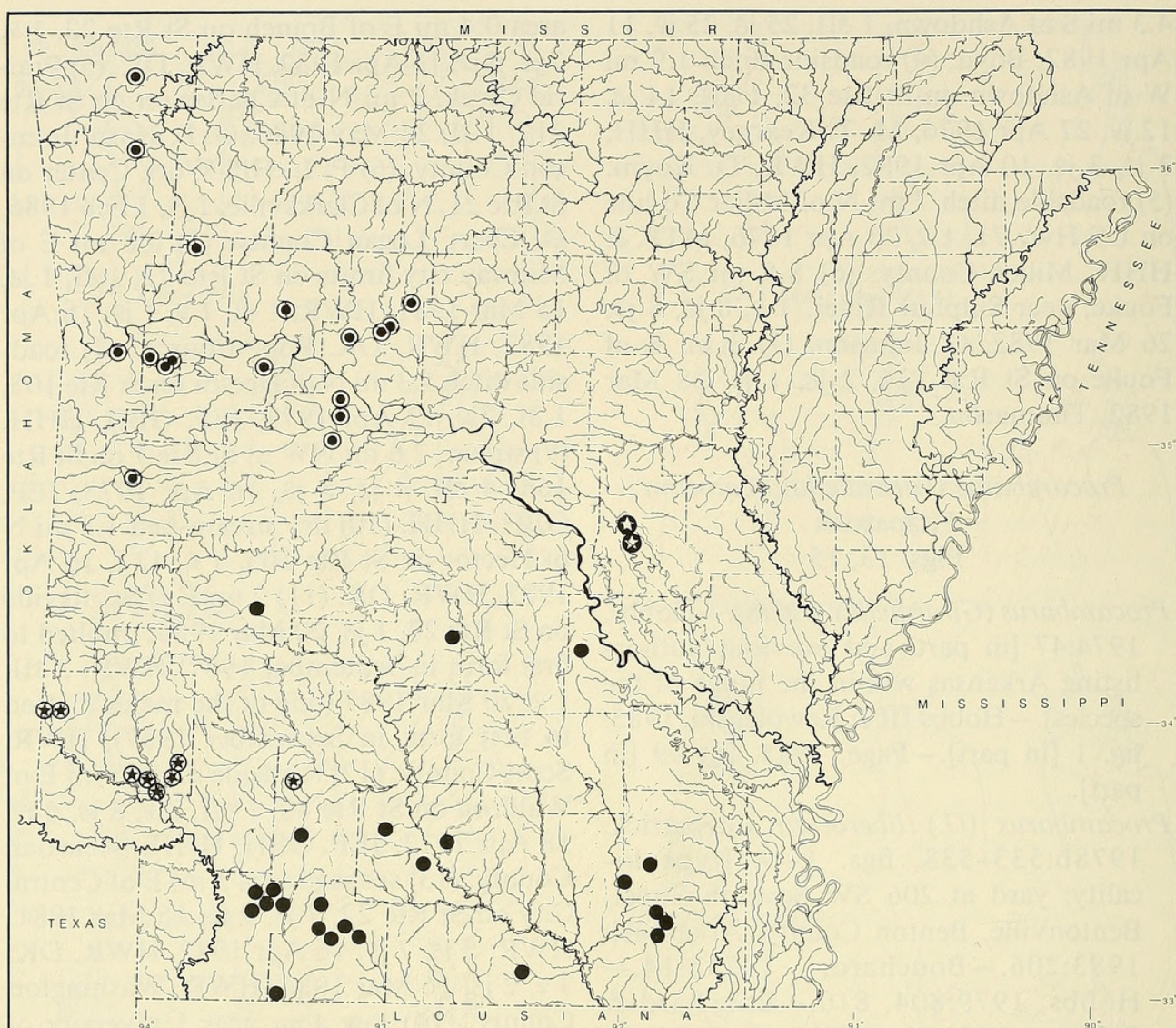


Fig. 15. Distribution of the members of the subgenus *Girardiella* in Arkansas: *P. (G.) ferrugineus* (white star on black background); *P. (G.) liberorum* (encircled dots); *P. (G.) regalis* (encircled black stars); and *P. (G.) tulaneii* (black dots).

cality: tributary to Prairie Bayou, 10.2 miles E of Bismarck on St Rte 84, Hot Spring County, Arkansas (Sec. 35, R. 19W, T. 48)].

Procambarus parasimulans. —Mayden, 1985:196, 207.

Range. —This crayfish is one of the more common inhabitants of pools (largely juveniles) and burrows in the southwestern part of Arkansas where it has been found in the Red and Ouachita river basins and in three localities in the Arkansas watershed.

Arkansas records. —It was reported by Hobbs & Robison (1982:551) from 12 localities in the Red and Ouachita river basins in Clark, Grant, Hot Spring, Nevada, Ouachita, Pike, and Sevier counties, Arkansas. Additional localities are as follows: Clark County: (1) roadside ditch, 7.4 mi E of Amity Courthouse on St Rte 84, 1 j♀, 30 Apr 1976, MTK, HHH. Franklin County: (2) 0.2 mi E of Branch on St Rte 22, 1 ♂II, 7 j♂, 6 j♀, 15 Mar 1981, HWR; 1 ♂II, 1 j♂, 16 Apr 1982, HWR, DK. (3) roadside ditch 3.1 mi E of Charleston on St Rte 22, 28 j♂, 20 j♀, 15 Mar 1981, HWR. Hempstead

County: (4) Blevins, 1 ♂II, 20 Apr 1982, E. Laird; 1 j♂, 20 May 1983, EL. Hot Spring County: (5) roadside ditch 5.2 mi E of Clark Co line on St Rte 84, 1 j♀, MTK, HHH. (6) unnamed creek on Hwy 84, 2.1 mi W of Bismarck, 6 j♂, 8 j♀, 13 Mar 1981, HWR. Howard County: (7) several creeks in or near Nashville, 1 ♂II, 1 ♀, 10 Mar 1986, R. Smith; 1 ♂II, 2 ♀, 13 Mar 1986, RS; 2 j♂, 17 Mar 1986, A. Brown, D. Byers; 1 j♂, 1 j♀, 17 Mar 1986, B. Evans, T. Crabtree; 1 j♂, 1 j♀, 19 Mar 1986, BE, TC; 1 ♀, 20 Mar 1986, C. Farr; 8 j♂, 5 j♀, 2 Apr 1986, C. King; 1 ♀, 9 Apr 1986, B. Cooper; 1 ♀, 14 Apr 1985, L. Tate, B. Wallis; 1 ♀, 2 May 1986, W. Johnson. (8) Mineral Springs, 1 ♀, 1985, L. Newton; 1 ♂I, 1 ♀, 1985, LT; 2 ♀, 1985, LT; 1 ♀, 8 Nov 1986, M. Fox; 1 ♂II, 9 Nov 1985, D. Batson. (9) Blue Bayou Creek W of Nashville (T. 9S, R. 26W, Sec. 15), 1 j♂, 14 Apr 1985, LT, BW. (10) about 3 mi N of Nashville on Pump Springs Road, 1 ♂I, 2 ♂II, 2 ♀, 5 j♂, 4 j♀, 2 Apr 1986, D. Howard. (11) small creek 7.5 mi SW of Newhope, 3 j♂, 2 j♀, 11 May 1963, A. P. Blair. (12) stream and seepage area 1.8 mi E of Sevier Co line on St Rte 4, 4 j♂, 1 j♀, 29 Apr 1976, MTK, HHH. Montgomery County: (13) 0.9 mi W of Caddo Gap, 1 ♀, 23 Nov 1962, A. P. Blair. Nevada County: (14) Outskirts of Willisville, 6 j♂, 8 j♀, 11 Sep 1985, DK. Pike County: (15) Antoine Creek, 2.5 mi N of Kirby, 1 ♀, 21 Apr 1952, E. Lachner. (16) roadside ditch 2 mi NE of Daisy on US Hwy 70, 9 j♂, 6 j♀, 21 Apr 1973, JEP, GBH, HHH. (17) roadside ditch 2.6 mi W of St Rte 8 on Rte 84, 1 ♂II, 11 j♂, 11 j♀, 17 Mar 1980, HWR. Polk County: (18) West Creek 3.5 mi E of Wicks (T. 5S, R. 32W, Sec. 27), 1 j♀, 27 Sep 1975, HWR. Saline County: (19) Saline River at Benton, 1 ♂II, 28 Sep 1985, HWR. (20) flooded field just W of Saline River, S side of St Rte 291, 1 j♂, 19 Mar 1980, HWR. Sebastian County: (21) 3 mi E of Central City on St Rte 22, 1 ♀, 10 j♂, 6 j♀, 16 Apr 1982, HWR, DK.

Remarks.—We have found that many young males, particularly those with regen-

erated chelae (which cannot always be recognized as such in smaller individuals), and almost all females of this crayfish are virtually indistinguishable from those of *P. (G.) tulaneii*. Therefore, many of the above localities and a few of those listed by Hobbs & Robison (1982:551) must be accepted provisionally.

Procambarus (Girardiella) reimeri Hobbs
Figs. 11, 16

Procambarus (Girardiella) reimeri Hobbs, 1979:804–811, 1 fig. [type locality: roadside ditch about 5 mi (8 km) NE of Mena on unnumbered road to Irons Fork River, Polk County, Arkansas].—Bouchard & Robison, 1981:28.—Fitzpatrick, 1983:206.—Hobbs & Robison, 1982:552.—Robison & Smith, 1982:53.

Procambarus reimeri.—Bouchard & Robison, 1981:26.—Mayden, 1985:196, 200.—Page, 1985:371.

Arkansas records.—The only localities in which this species is known to occur are the six in Polk County, Arkansas, cited by Hobbs, 1979:810.

Procambarus (Girardiella) simulans
(Faxon)
Figs. 9, 16

Procambarus (Girardiella) simulans (Faxon, 1884:112–113) [type locality, Dallas, Texas].

Range.—Reported to occur in the following states: New Mexico, Texas, Louisiana, Oklahoma, Kansas, Arkansas, and Colorado; the limits of its range in them, however, have not been determined.

Arkansas records.—We have examined only one specimen referable to this species in Arkansas, that collected along with *P. (G.) regalis* in a pasture 1.5 mi (2.4 km) N of Paraloma, Sevier County. (See locality 6 under *P. (G.) regalis*.)

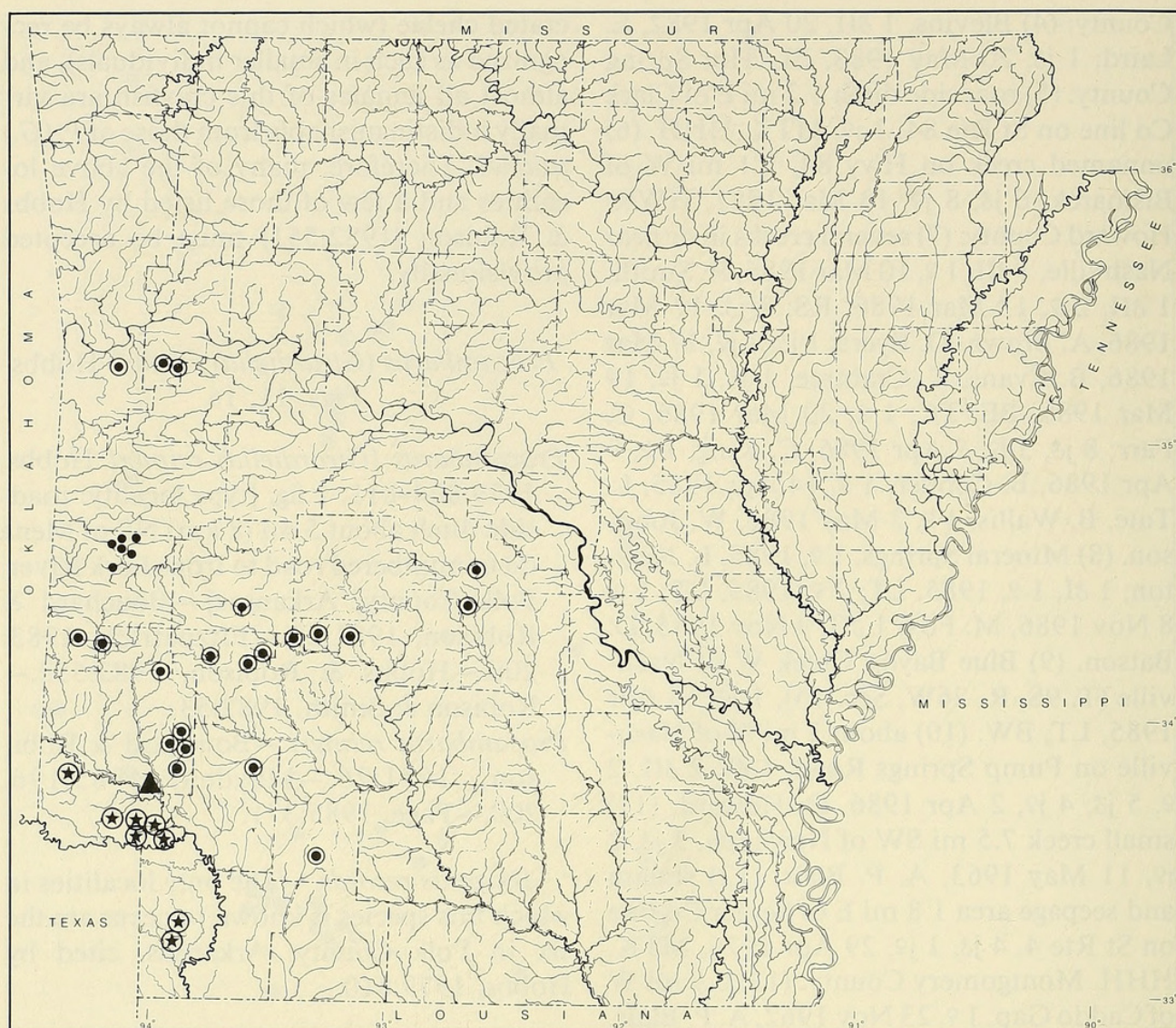


Fig. 16. Distribution of the members of the subgenus *Girardiella* in Arkansas: *P. (G.) reimeri* (small black dots); *P. (G.) parasimulans* (encircled dots); *P. (G.) simulans* (black triangle); *P. (G.) curdi* (encircled black stars).

Procambarus (Girardiella) tulane Penn
Figs. 7, 15

Procambarus tulane Penn, 1953a:163–166, 12 figs. [type locality: tributary of Bayou D'Arbonne, 4 mi W of Dubach on St Rte 288, Lincoln Parish, Louisiana]; 1953b: 6; 1956:420; 1959:5, 6, 12, 13, 17, figs. 11, 41.—Hobbs, 1959:887; 1968:K11, K25; 1971:466.—Walls, 1968:417.—Hart & Hart, 1974:30.—Bouchard, 1978b:fig. 2g.—Bouchard & Robison, 1981:26, fig. 2g.

Procambarus (Girardiella) tulane.—Hobbs, 1972a:7; 1972b:45, 152, figs. 38a, 39e;

1974b:48, 127, fig. 189.—Fitzpatrick, 1975:53; 1976:384; 1978a:57, 59, 93, 95, fig. 121; 1978b:538; 1983:206.—Reimer, 1975:25.—Bouchard & Robison, 1981: 28.—Hobbs & Robison, 1982:552.

Range.—Previously known only from the Red and Ouachita river basins in southern Arkansas and Louisiana, it is reported below from the lower Arkansas River basin in Jefferson County, Arkansas.

Arkansas records.—Ashley County: (1) Fountain Creek, 8 mi N of Hamburg on St Rte 81, 15 j♂, 21 j♀, 16 Mar 1967, J. E. & M. R. Cooper. (2) North Fork of Fountain

Creek at St Rte 81, 5 j♂, 3 j♀, 16 Mar, 1967, JEC & MRC. (3) 8 mi N of Hamburg on St Rte 81, 15 j♂, 21 j♀, 16 Mar 1967, JEC & MRC. Columbia County: (4) 3.8 mi E of Magnolia on US Hwy 82, 6 j♂, 5 j♀, 23 Apr 1965, W. J. Harman & HHH. (5) Big Creek, 2 mi E of Lamartine on St Rte 98, 1 j♂, 14 Jun 1974, HWR. (6) Big Creek at US Hwy 82 bypass, 1 ♂II, 11 Jul 1974, L. Weaver, L. Calhoun; (7) Magnolia city limits, 1 ♂II, 2 Jun 1974, HWR. (8) Cornie Creek, 6 mi SE of Magnolia, 2 ♂II, 1 ♀, 1 Nov 1974, S. Pelt. (9) roadside ditch 2.3 mi N of Louisiana state line on St Rte 132, 1 ♂II, 25 Apr 1976 [molted to form I, 20 Sept 1976] MTK, HHH. (10) Magnolia, 2 j♂, 2 j♀, 12 Apr 1974, HWR, Patrick Robison; 1 ♂II, 19 Sep 1979, M. A. Bryan, Montgomery. Drew County: (1) north of county line [on St Rte 81 ?], 8 j♂, 4 j♀, 16 Mar 1967, JEC & MRC. (12) Saline River about 13 mi SE of Monticello at end of St Rte 172, 1 j♂, 26 Oct 1974, HWR. Hot Spring County: (13) roadside ditch 3.5 mi W of Poyen on US Hwy 270, 1 ♂II, 1 ♀, 17 Mar 1980, HWR. Jefferson County: (14) ditch on Holland Rd off US Hwy 270 W of White Hall, 2 ♀, 1 j♂, 22 Apr 1979, B. Lovorn; 9 j♂, 6 j♀, 25 Apr 1982, BL. Lafayette County: (15) Bodcaw Creek, 10 mi N of Stamps on Hope Rd, 1 ♀, 5 May 1975, M. Foster. (16) Creek in Stamps, 2 ♀, 13 j♂, 5 j♀, 3 May 1975, J. Turnage. (17) backwaters of Bayou Bodcaw 4 mi N of Lewisville on Sunray Rd off St Rte 29, 3 j♂, 26 Apr 1976, MTK, HHH. (18) Lewisville, 2 ♂II, 13 Jun 1974, C. Lathan. Montgomery County: (19) Trib. to Collier Creek 1 mi W of Caddo Gap, 1 j♂, 2 j♀, 11 May 1963, A. P. Blair. Nevada County: (20) Whitten Branch 0.75 mi S of Bodcaw, 1 ♀, 7 Dec 1974, P. Ross. Ouachita County: (21) Larkin Bayou 3 mi N of St Rte 4 on Co Rd near Camden, 1 j♂, 1 j♀, 6 May 1975, SP, J. Stephens. (22) Larkin Bayou 1 mi E of St Rte 57, 4 mi N of jct with Rte 4, 1 j♀, 25 May 1975, SP, J. Wilson. (23) trib to Two Bayou between St Rtes 4 and 24, 1 ♂II, 1 j♂, 4 j♀, 30 Mar 1975, SP. (24) trib to Little

Bayou just off US Hwy 79 on Co Rd near Camden, 1 ♂II, 8 j♂, 8 j♀, 10 May 1975, SP. Union County: (25) roadside ditch 3 mi W of Strong on US Hwy 82, 1 ♂II, 1 ♀, 25 Apr 1986, HWR.

Remarks.—See “Remarks” under *Procambarus (G.) parasimulans*.

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