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THE FRESHWATER DECAPOD CRUSTACEANS OF THE APALACHICOLA DRAINAGE SYSTEM IN FLORIDA, SOUTHERN ALABAMA, AND GEORGIA

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THE FRESHWATER DECAPOD CRUSTACEANS OF THE APALACHICOLA DRAINAGE SYSTEM IN FLORIDA, SOUTHERN ALABAMA, AND GEORGIA

HORTON H. HOBBS, JR., AND C. W. HART, JR.[1]

SYNOPSIS: Two families of freshwater decapod crustaceans frequent the lower Apalachicola drainage system. The family Palaemonidae is represented by 2 shrimps of the genus *Palaemonetes* and the Astacidae by 21 crayfishes belonging to the genera *Procambarus* (15 species), *Cambarus* (4), *Orconectes* (1), and *Cambarellus* (1). An illustrated key is provided for identifying these animals, and a tabular summary of their ecological distributions precedes an annotated list of species. The latter includes for each species a bibliographic synonomy, diagnostic characters, color notes, ecological data, range, life history notes, and a list of crayfish associates. Locality records in the area are indicated on appended maps. *Procambarus rogersi expletus*, new subspecies, is described from Calhoun County, Florida.

INTRODUCTION

The area treated in this study is bounded on the west by the Choctawhatchee River; on the north by Henry County, Alabama, Clay, Calhoun, and Dougherty counties, Georgia; on the east by Dougherty, Mitchell, and Grady counties, Georgia, and Leon and Wakulla counties, Florida; and on the south by the Gulf of Mexico.

Here occur almost half of the freshwater decapod crustaceans found within the political boundaries of the State of Florida—23 species and subspecies belonging to 5 genera. Some of the crayfish frequent the larger streams; others appear to be confined to a few small streams, while certain of them are apparently restricted to subsurface waters which they reach by burrowing, sometimes to a depth of more than 10 feet. The shrimp have invaded most of the permanent bodies of water except the smaller streams, and are frequently encountered in semipermanent aquatic environments.

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Within this area a wide diversity of habitats is available to the decapod stocks that have invaded it and, in spite of the slight variation in topography, the development of diverse soil types in relatively small areas has resulted in swamp and marsh areas partially or completely isolated by well-drained soils. Many of the streams flow through areas that, because of the nearly xeric conditions prevailing adjacent to them, are accessible only to those crayfishes and shrimps able to reach them by migrating upstream. Too, the lower Apalachicola River itself appears to have functioned as a barrier to certain species as effectively as xeric habitats. Thus it is apparent that barrier effects, insofar as these decapods are concerned, are just as efficient in a monotonous terrain as in regions with striking diversity of elevations. The importance of soil types becomes apparent when it is realized that in Florida the total variation in topographic relief ranges from sea level to approximately 500 feet, and the area of the State above 300 feet is small indeed. In Florida only along the Apalachicola River does one find a situation that recalls the deep shaded ravines so typical of the upper Piedmont and foothills of the Appalachian System, and it is of interest that only here are found a flora and fauna with so many upper Piedmont and southern Appalachian elements.

The senior author's interest in the Apalachicola drainage system began when he first collected in the area in 1934. Since then he has made many collections in the vicinity to ascertain its crayfish fauna. In September 1955 both of us spent 10 days in the area visiting as many localities as possible. This visit was initiated through the activities of a group of biologists associated with the Florida State Museum and the Department of Biology, University of Florida, and led by Dr. J. C. Dickinson, Jr. They became interested, upon learning of the proposed impoundment of the Flint and Chattahoochee rivers, in making a study of the flora and fauna that the lake resulting from the construction of the Jim Woodruff Dam would displace.

A number of important contributions have been made to our knowledge of the fauna and flora of the region, most of which have been cited in the excellent study by Hubbell, Laessle, and Dickinson (1956). They have presented a comprehensive treatment of the physical features and natural regions of the area together with a classification of the major habitats. Since then Clench and Turner (1956) completed a monographic study of the mollusks from the Escambia to the Suwannee River, and Berner (1958) has published a list of the mayflies of the lower Apalachicola River Drainage.

The history of work on the crayfishes of this area is indeed brief, dating back only to 1938 when the senior author described *Cambarus rogersi* (now *Procambarus rogersi*) from the Apalachicola flatwoods near Blountstown. The bibliography at the end of this paper cites all the subsequent work published on the subject to date.

The Origin of the Fauna

The region under consideration lies wholly within the Coastal Plain province, and although opinions differ as to how long it has been above sea level (c.f. Cook 1945 and Goin 1958), almost certainly some of it was inundated as recently as the latter part of the Pleistocene. With the retreat of the sea three principal highways seemed to have been opened to the decapods: (1) The confluence of the Flint and Chattahoochee rivers to form the Apalachicola provided a route for the Piedmont fauna to reach the Florida panhandle. (2) The second route from the northeast developed along the Ochlockonee drainage system and allowed the Coastal Plain fauna in southeastern Georgia to move into the coastal flatwoods of the panhandle. (3) The third route, from the northwest, provided a highway for stocks moving southeastward from Alabama into the panhandle. In spite of the fact that the molluscan fauna is apparently derived totally from a northwestern stock (Clench and Turner, 1958: 103), considerable interest and importance attaches to the role that these three routes have played in the population of the Apalachicola region, for not only does an examination of them shed light on the evolution of the several decapod stocks, but also should contribute to an understanding of the origin and evolution of much of the biota of the area.

The crayfishes and shrimps of the Apalachicola drainage system represent 10 somewhat closely related groups, and only 2 species are endemic to the region, the others being found in other drainage systems.

East of the developing Apalachicola River the Ochlockonee system paralleled to some degree the developing Flint River. This resulted in a well-drained area between the two and, except for the possibility of stream piracy developing in the intervening area, there could have been little opportunity for the faunas of the two systems to mix. Only in the continuous flatwoods between the lower reaches of these two streams could decapods have migrated from one stream to the other.

Immediately west of the Apalachicola River the land is drained chiefly by the Chipola River which rises in the southeastern part of

Alabama and joins the Apalachicola some 25 miles above its mouth. Between these two rivers, and particularly in Alabama and northern Florida, the land lies at a relatively high elevation with few streams. Even though the Chipola is a small stream it has undoubtedly facilitated the migrations of several stocks now found in the coastal flatwoods.

Of the 6 crayfishes that have apparently invaded the region from the north along the Flint and Chattahoochee rivers, 3 are primarily stream dwellers. One, *Procambarus paeninsulanus,* is somewhat ubiquitous [2] and two, *Cambarus floridanus* and *C. diogenes,* are burrowing species that excavate complex burrows in the immediate vicinity of streams. Of the stream-dwelling species, one representative, *C. latimanus,* typically a Piedmont form, is found in a few localities in the deep ravines along the east side of the Apalachicola River in Florida as well as in a few places in the Flint and Chattahoochee drainages below the Fall Line in Georgia and Alabama. Another, *P. spiculifer,* occurs in most of the major river systems in Alabama, Georgia, and northern Florida, both in the Piedmont and Coastal Plain provinces. The third, *P. versutus,* has been found in only a single locality in the area, a small brook in the Apalachicola Bluffs. It occurs abundantly in streams to the west and northwest, and the small population here is probably a relict one. It is so considered because it is known elsewhere in the drainage from only two localities near Phenix City, Alabama, and it is assumed that these are the only ones where the species, once widely dispersed in this drainage system, has survived to the present. Of the burrowing species, *C. diogenes* is found from New Jersey and the Great Lakes southwestward to Texas. The other, *C. floridanus,* appears to be confined to the Apalachicola and the Ochlockonee systems. *Procambarus paeninsulanus* frequents most aquatic habitats from the Choctawhatchee River eastward to the Atlantic Ocean.

Whereas representatives of only two crayfish genera entered the region from the north along the Apalachicola River, representatives of three appear to have arrived from the northwest. The only stream-dwelling species in this group is the pigmy crayfish, *Cambarellus schmitti,* which is found in springs and streams from southern Alabama to the northern part of the peninsula of Florida. In the flatwoods in temporary lentic and lotic situations occur five species that

[2] The word ubiquitous is here used to designate a broad ecological tolerance, and is applied to those species that frequent lentic and lotic habitats as well as burrows.

dig shallow burrows during seasons of drought. *Orconectes clypeatus* is found from Oklahoma to South Carolina, *C. fodiens* from Ontario southward and eastward through the upper Mississippi basin to Georgia, and the remaining three, *P. latipleurum, P. apalachicolae,* and *P. hubbelli,* have small ranges in the region, *latipleurum* being endemic to the Apalachicola drainage system. The remaining species that appears to have arrived in the area from the northwest is *P. pycnogonopodus,* another ubiquitous form found abundantly in the western drainage of the Apalachicola River in Florida.

Only one genus, *Procambarus,* is represented by the crayfish stocks that arrived in the Apalachicola region from the northeast. From one of them arose two burrowing species, *P. rogersi* and *P. pygmaeus.* The range of *rogersi* is largely restricted to this area; that of *pygmaeus* is apparently discontinuous, records having been established in isolated localities on both sides of the Apalachicola River and in the vicinity of the Okefenokee Swamp. Another northeastern stock is represented by *P. kilbyi,* a secondary burrower (see below) which ranges through the coastal flatwoods from the Apalachicola drainage system eastward to Levy County, Florida. From the other two stocks arose the ubiquitous *P. leonensis,* the range of which extends from the eastern tributaries of the Apalachicola River to the Suwannee River, and the stream-dwelling, endemic *P. youngi.*

Of the two species of shrimps in the area, *Palaemonetes kadiakensis* seems to have arrived from the northwest and *P. paludosus,* by far more abundant in the area, from the northeast.

The hypogean crayfishes, *Procambarus pallidus* (Hobbs, 1940: 394) and *Cambarus cryptodytes* Hobbs (1941: 110), known respectively from sinkholes in the Tallahassee region and from a well two miles south of Graceville, Jackson County, Florida may eventually be found within the area; however, they have not been included in this report.

Key to the Decapods of the Area

1 Rostrum compressed, with a row of spines above and at least one or two below (figs. 1, 3). Third pair of walking legs not chelate.....Palaemonidae (shrimp)

1′ Rostrum depressed, never with a row of spines above (fig. 5). Third pair of walking legs chelate.....Astacidae (crayfish)

Key to Palaemonidae

1 Branchiostegal spine located on anterior margin of carapace immediately below the branchiostegal groove (fig. 1). Posterior pair of dorsal spines

on telson lying midway between anterior pair and caudal margin of telson (fig. 4) ..... *Palaemonetes (Palaemonetes) paludosus*

1′ Branchiostegal spine lying behind anterior margin of carapace and below the branchiostegal groove (fig. 3). Posterior pair of dorsal spines on telson lying almost on caudal margin of telson, sometimes in a line with the terminal spines (fig. 2) ..... *Palaemonetes (Palaemonetes) kadiakensis*

The Shrimp

We have observed only two species of freshwater shrimp in the area and, while they are abundant in certain places, no systematic attempt has been made to record all the localities from which they have been collected. They cannot be separated reliably without some magnification to see the diagnostic characteristics given in the key. The number of spines on the rostrum varies, but the predominent numbers are indicated in figures 1 and 3.

Palaemonetes (Palaemonetes) paludosus (Gibbes)

(Figures 1 and 4)

Hippolyte paludosa Gibbes 1850, Proc. Amer. Ass. Adv. Sci., 3: 197.

Palaemonetes exilipes Stimpson 1871, Ann. Lyc. Nat. Hist., N. Y., 10: 130.

Palaemonetes (Palaemonetes) paludosus Holthuis 1949, Koninklijke Nederlandsche Akademie van Wetenschappen, 52 (1): 7.

This species is abundant in the lower Piedmont and Coastal Plain provinces from New Jersey to Florida. It has also been reported from Mississippi, Louisiana, Oklahoma, and Texas.

Palaemonetes (Palaemonetes) kadiakensis Rathbun

(Figures 2 and 3)

Palaemonetes kadiakensis Rathbun 1902, Proc. U. S. Nat. Mus., 24: 903.

Palaemonetes (Palaemonetes) kadiakensis Holthuis 1949, Koninklijke Nederlandsche Akademie van Wetenschappen, 52 (1): 8.

According to Holthuis (*loc. cit.*) this species occurs in the "freshwaters of Central U.S.A. west of the Alleghenies from the Great Lakes to the Gulf coast, also in S. Ontario (Canada) and N. E. Mexico". Although it is not rare in this area, it is not so common as *P. paludosus*.

Key to Astacidae

1	Male	22
1′	Female	2
2(1′)	Annulus ventralis freely movable—not fused wih sternum anterior to it	6
2′	Annulus ventralis only slightly movable—fused with sternum anterior to it *Cambarus*	3
3(2′,23)	Areola linear or obliterated (fig. 35)	4
3′	Areola narrow or broad but never reduced to a line (fig. 6)	5
4(3)	Movable finger of chela with a distinct excision on opposable margin; fingers concolorous, not red-tipped (fig. 11) *C. fodiens*	
4′	Movable finger with no well-defined excision on opposable margin; fingers red-tipped (fig. 10) *C. diogenes*	
5(3′)	Areola with three or four punctations across narrowest part; color brownish or greenish gray *C. latimanus*	
5′	Areola with only one or two punctations across narrowest part; color reddish purple or red *C. floridanus*	
6(2)	Mesial surface of carpus (fig. 7) of cheliped without a prominent tubercle or spine, except sometimes on distal margin; rostrum without lateral spines or tubercles *Orconectes clypeatus*	
6′	Mesial surface of carpus of cheliped with a prominent tubercle or spine, or if without, then rostrum always bears lateral spines or tubercles	7
7(6′)	Sclerite between fifth walking legs in the form of an acute triangle; adult individuals never more than one inch in length *Cambarellus schmitti*	
7′	Sclerite between fifth walking legs variable in shape but never in the form of an acute triangle; adult individuals always more than one inch in length	8
8(7′)	Lateral surface of carapace with two spines on each side immediately behind cervical groove	9
8′	Lateral surface of carapace without or with only one spine on each side immediately behind cervical groove	10
9(8,31)	Spine present on mesial margin of basipodite of cheliped (fig. 9sb) *Procambarus versutus*	
9′	No spine present on mesial margin of basipodite of cheliped *P. spiculifer*	
10(8′)	Palm of chela flattened (depressed) with a cristiform row of tubercles on inner margin (fig. 30)	11
10′	Palm of chela not conspicuously depressed and never with a single cristiform row of tubercles on inner margin	15
11(10)	Annulus ventralis distinctly longer than wide *P. rogersi ochlocknensis*	
11′	Annulus ventralis either broader than long or with the two dimensions subequal in length	12

12(11′) Annulus ventralis distinctly broader than long and without conspicuous tubercles anteriorly ..... *P. rogersi rogersi*

12′ Annulus ventralis with length and width subequal or with conspicuous tubercles anteriorly 13

13(12′) Annulus ventralis without tubercles anteriorly; carapace green with scarlet markings ..... *P. pygmaeus*

13′ Annulus ventralis with tubercles anteriorly (fig. 37); carapace purplish red 14

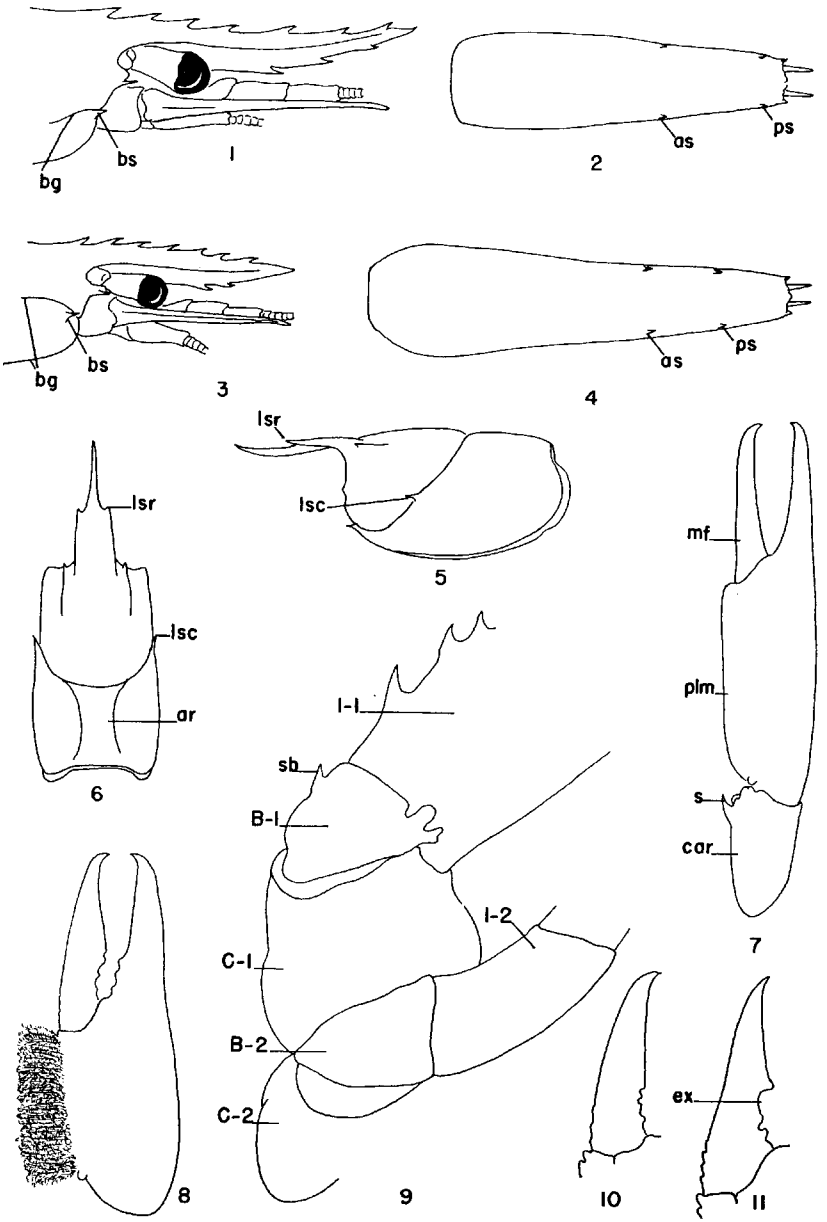
14(13′) Inner margin of antennal scale evenly rounded (fig. 39) ..... *P. rogersi expletus*

Explanation of Figures 1-11

Figure 1. Lateral view of anterior portion of *Palaemonetes paludosus.*
Figure 2. Dorsal view of telson of *Palaemonetes kadiakensis.*
Figure 3. Lateral view of anterior portion of *Palaemonetes kadiakensis.*
Figure 4. Dorsal view of telson of *Palaemonetes paludosus.*
Figure 5. Lateral view of carapace of *Procambarus youngi.*
Figure 6. Dorsal view of carapace of *Procambarus youngi.*
Figure 7. Dorsal view of distal three podomeres of cheliped of male of *Procambarus youngi.*
Figure 8. Dorsal view of chela of male of *Procambarus hubbelli.*
Figure 9. Ventral view of proximal podomeres of left cheliped and second walking leg of *Procambarus versutus.*
Figure 10. Movable finger of chela of *Cambarus diogenes diogenes.*
Figure 11. Movable finger of chela of *Cambarus fodiens.*

Abbreviations Used

ar—areola
as—anterior dorsal spine
B-1—basipodite of cheliped (first walking leg)
B-2—basipodite of second walking leg
bg—branchiostegal groove
bs—branchiostegal spine
C-1—coxopodite (coxa) of cheliped (first walking leg)
C-2—coxopodite of second walking leg
car—carpus
ex—excision
I-1—Ischiopodite of cheliped (first walking leg)
I-2—Ischiopodite of second walking leg
lsc—lateral spine on carapace
lsr—lateral spine on rostrum
mf—movable finger
plm—palm of chela
ps—posterior dorsal spine
s—spine
sb—spine on basipodite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14′	Anterior half of inner margin of antennal scale straight	*P. rogersi campestris*
15(10′)	Areola at least one-third as broad as long and acumen as long as remainder of rostrum (fig. 6)	*P. youngi*
15′	Areola always less than one-third as broad as long and acumen never as long as remainder of rostrum	16
16(15′)	Lateral spines present on carapace and usually on margins of rostrum (fig. 6)	17
16′	Lateral spines lacking on carapace and seldom present on rostrum	19
17(16)	Surface of annulus ventralis subplane except for sinuous sinus	*P. paeninsulanus*
17′	Surface of annulus ventralis not flat but bearing prominences or ridges	18
18(17′)	Annulus ventralis usually with a broad transverse furrow (east of the Apalachicola River)	*P. leonensis*
18′	Annulus ventralis usually with a median longitudinal elevation (west of the Apalachicola River)	*P. pycnogonopodus*
19(16′)	Anterolateral surfaces of annulus ventralis with spines or tubercles	20
19′	Anterolateral surfaces of annulus ventralis without spines or tubercles	21
20(19)	Rostrum acute lanceolate	*P. latipleurum*

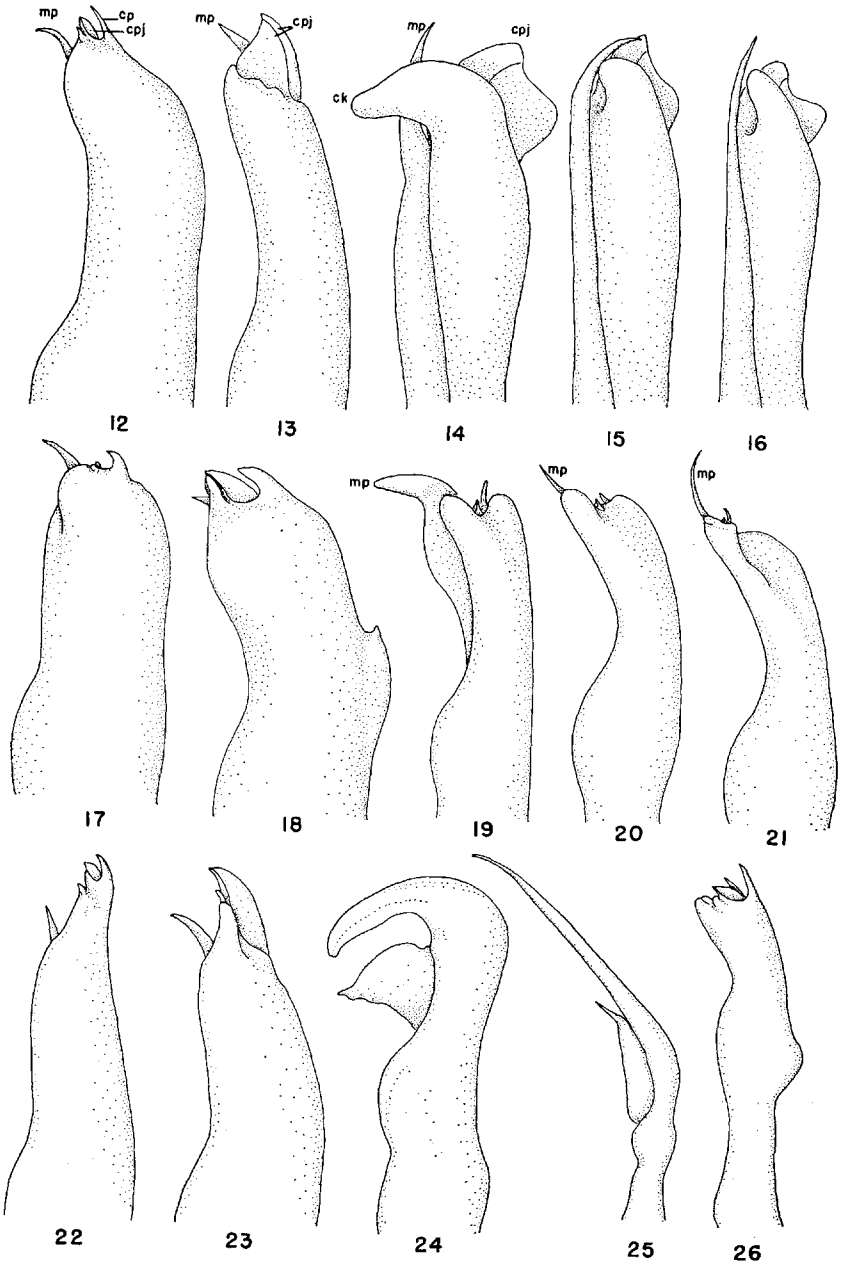
Explanation of Figures 12-26

First left pleopods of first form males. All are lateral views except figures 14-16 and 25 which are caudal views. Pubescence is not indicated in any of the pleopods illustrated.

Figure 12. *Procambarus leonensis.*
Figure 13. *Procambarus pygmaeus.*
Figure 14. *Procambarus rogersi rogersi.*
Figure 15. *Procambarus rogersi ochlocknensis.*
Figure 16. *Procambarus rogersi campestris.*
Figure 17. *Procambarus pycnogonopodus.*
Figure 18. *Procambarus paeninsulanus.*
Figure 19. *Procambarus kilbyi.*
Figure 20. *Procambarus apalachicolae.*
Figure 21. *Procambarus latipleurum.*
Figure 22. *Procambarus versutus.*
Figure 23. *Procambarus spiculifer.*
Figure 24. *Cambarus floridanus.*
Figure 25. *Orconectes clypeatus.*
Figure 26. *Procambarus youngi.*

Abbreviations Used

ck—caudal knob
cp—cephalic process
cpj—central projection
mp—mesial process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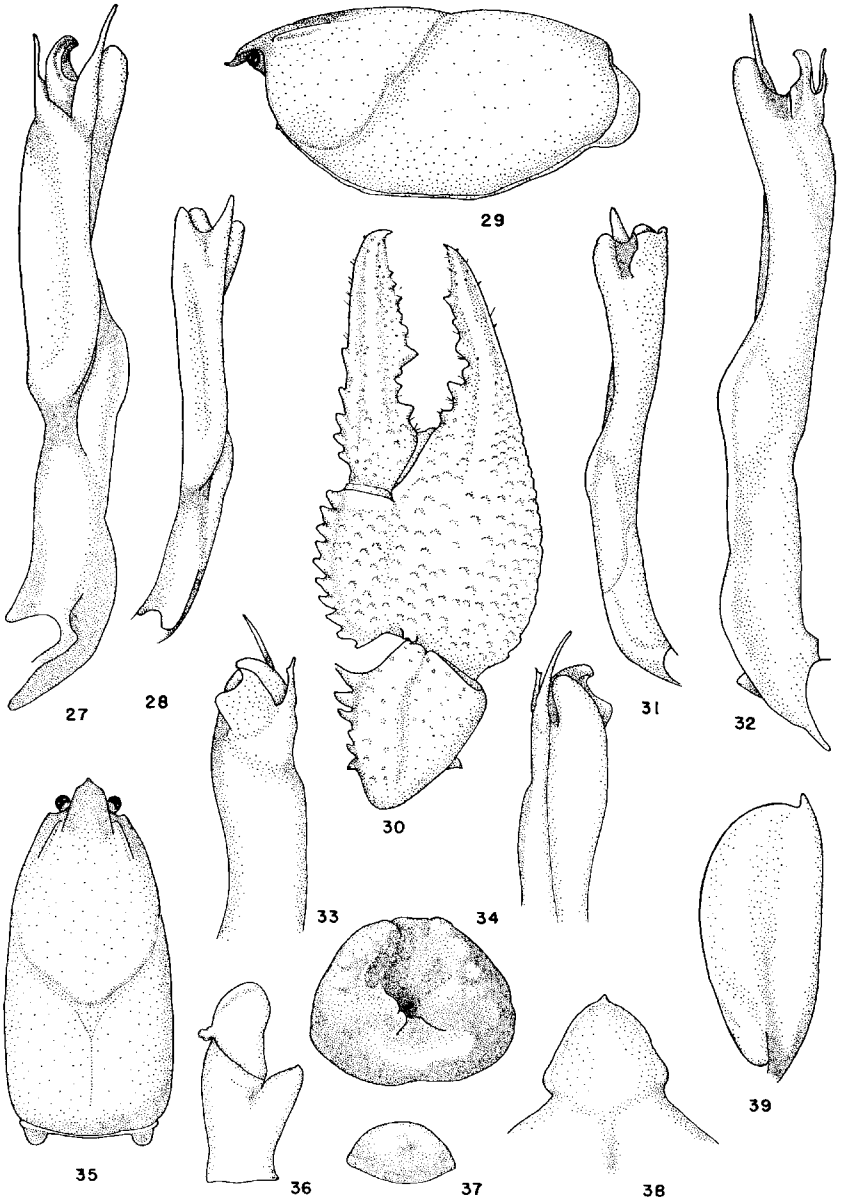
20′	Rostrum broadly ovate	*P. apalachicolae*
21(19′)	Dorsal surface of carapace and abdomen usually with a light median longitudinal band (Apalachicola drainage system and eastward)	*P. kilbyi*
21′	Dorsal surface of carapace and abdomen speckled; adults never with a light median longitudinal band (Choctawhatchee drainage system)	*P. hubbelli*
22(1)	First pleopod terminating in two parts that if not markedly unequal in length are bent posteriorly at at least right angles to the main shaft of the appendage (figs. 24, 25)	23
22′	First pleopod terminating in two or more conspicuous parts; if only two, then subequal in length and never bent posteriorly at as much as at right angles (figs. 12-23, 26)	24
23(22)	Tips of first pleopod consisting of one short and one long ramus (fig. 25)	*Orconectes clypeatus*
23′	Tips of first pleopod consisting of two rami of subequal length bent approximately at right angles to the main shaft of the appendage (fig. 24)	*Cambarus* 3
24(22′)	Hooks present on ischiopodites (third joint from base) of second and third pereiopods	*Cambarellus schmitti*
24′	Hooks present on ischiopodites of third (fig. 36) or third and fourth pereiopods	25
25(24′)	Hooks present on ischiopodites of third pereiopods only	26
25′	Hooks present on ischiopodites of third and fourth pereiopods	31
26(25)	Palm of chela flattened and with a cristiform row of tubercles along inner margin (fig. 30)	27
26′	Palm of chela not flatttened, never with a cristiform row of tubercles, and usually with a conspicuous tuft of plumose setae along inner margin (fig. 8)	*Procambarus hubbelli*
27(26)	Caudal knob of first pleopod conspicuous (figs. 14-16, 34)	28

Explanation of Figures 27-39

Procambarus rogersi expletus, subsp. nov.

Figure 27. Mesial view of first pleopod of holotype.
Figure 28. Mesial view of first pleopod of morphotype.
Figure 29. Lateral view of carapace of holotype.
Figure 30. Upper surface of distal three podomeres of cheliped of holotype.
Figure 31. Lateral view of first pleopod of morphotype.
Figure 32. Lateral view of first pleopod of holotype.
Figure 33. Cephalic view of distal portion of first pleopod of holotype.
Figure 34. Caudal view of distal portion of first pleopod of holotype.
Figure 35. Dorsal view of carapace of holotype.
Figure 36. Basipodite and Ischiopodite of third pereiopod of holotype.
Figure 37. Annulus ventralis of allotype.
Figure 38. Epistome of holotype.
Figure 39. Antennal scale of holotype.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27′	Caudal knob of first pleopod vestigial so that only two terminal elements are apparent (fig. 13)	*P. pygmaeus*
28(27)	Caudal knob bent mesially at a right angle to the main shaft of the appendage (fig. 14)	*P. rogersi rogersi*
28′	Caudal knob bent no more than at a 45 degree angle to the main shaft of the appendage (figs. 15, 16, 34)	29
29(28′)	Inner margin of antennal scale evenly rounded (fig. 39)	*P. rogersi expletus*
29′	Anterior half of inner margin of antennal scale straight	30
30(29′)	Plate-like central projection of first pleopod directed obliquely caudad across cephalic border of tip, cephalic process present (fig. 15)	*P. rogersi ochlocknensis*
30′	Plate-like central projection of first pleopod directed laterad across cephalic border of tip, cephalic process rudimentary or absent (fig. 16)	*P. rogersi campestris*
31(25′)	Lateral surface of carapace with two spines on each side	9
31′	Lateral surface of carapace with only one spine on each side (fig. 5)	32
32(31′)	Areola at least one-third as broad as long and acumen as long as remainder of rostrum (fig. 6)	*P. youngi*
32′	Areola always less than one-third as broad as long and acumen never as long as remainder of rostrum	33
33(32′)	Areola less than one-fifth as broad as long	34
33′	Areola at least one-fifth as broad as long	36
34(33)	First left pleopod with a conspicuous angular prominence on cephalic margin (fig. 18)	*P. paeninsulanus*
34′	First left pleopod without an angular prominence on cephalic margin (figs. 12, 17)	35
35(34′)	Distal portion of first pleopod somewhat tapering and directed caudodistad (fig. 12)	*P. leonensis*
35′	Distal portion of first pleopod not tapering, and directed distad (fig. 17)	*P. pycnogonopodus*
36(33′)	Mesial process of first pleopod heavy, subspatulate, and directed caudad (fig. 19)	*P. kilbyi*
36′	Mesial process slender and never directed caudad (figs. 20, 21)	37
37(36′)	Mesial process subspiculiform and curved cephalad (fig. 21)	*P. latipleurum*
37′	Mesial process slender, but not so spiculiform, and directed caudodistad (fig. 20)	*P. apalachicolae*

Summary of Ecological Habits and Habitats of the Crayfishes

A—Species that Occur in Burrows

The burrowing forms show three somewhat different relationships to the burrowing habit, indicated by: P—primary (restricted to burrows); S—secondary (generally occupying burrows but wandering into open water during rainy seasons); and T—tertiary (burrowing only when the aquatic basin becomes dry, or occasionally, but not necessarily, as its breeding period approaches).

I. Burrowing in Seepage Areas [Bayheads and Bogs, Hubbell et al., 1956: 34, 36]

P. rogersi rogersi P
P. rogersi expletus P
P. rogersi ochlocknensis P
C. latimanus S
C. floridanus P
C. diogenes P or S
P. rogersi campestris P

II. Burrowing in Flatwoods [Slash Pine Flatwoods—Marginal thicket type and Pitcher-plant type, Hubbell et al., 1956: 35]

P. rogersi rogersi P
P. rogersi expletus P
P. rogersi ochlocknensis P
P. rogersi campestris P
P. paeninsulanus T
P. pycnogonopodus T
P. hubbelli S
P. apalachicolae S
P. latipleurum S
P. kilbyi S
P. leonensis T
P. pygmaeus P or S
O. clypeatus S or T

III. Burrowing in Floodplains of Large Streams [Alluvial Swamps, Hubbell et al., 1956: 33]

C. diogenes P-S
C. floridanus P

IV. Burrowing in Banks of Streams

P. hubbelli S
P. paeninsulanus T
P. kilbyi S
P. spiculifer T
P. versutus T
C. diogenes P-S
C. latimanus S
C. fodiens S
C. floridanus P

V. Burrowing in Drying Ponds or Ditches [Cypress Ponds, Hubbell et al., 1956: 33]

P. hubbelli S
P. kilbyi S
P. apalachicolae S
P. latipleurum S
P. paeninsulanus T
P. pycnogonopodus T
P. leonensis T
P. pygmaeus P or S
O. clypeatus S or T
C. fodiens S

B—Species Occasionally or Usually Found Outside of Burrows

I. Inhabiting Ponds, Lakes, and Ditches. L—permanent lakes or ponds; T—temporary or fluctuating ponds or ditches [Including Cypress Ponds, Hubbell et al., 1956: 33]

P. hubbelli T
P. kilbyi T
P. leonensis L-T
O. clypeatus T
P. apalachicolae T
P. pycnogonopodus L-T
P. paeninsulanus L-T
P. paludosus L (shrimp)

II. Inhabiting Lotic Situations. A—ravine brooks; I—intermittent streams; B—rivers, creeks, and brooks not in deep ravines.

P. kilbyi I
P. leonensis I-B
P. pycnogonopodus I-B
P. paeninsulanus I-B
P. spiculifer A-B
C. latimanus A
P. versutus A
P. youngi B
P. pygmaeus I
C. schmitti B
O. clypeatus I
P. paludosus I-B (shrimp)
P. kadiakensis B (shrimp)

III. Inhabiting Sluggish Streams and Sloughs.

P. kilbyi
P. hubbelli
P. leonensis
P. pycnogonopodus
P. paeninsulanus
O. clypeatus
C. schmitti
P. paludosus (shrimp)
P. kadiakensis (shrimp)

Annotated List

Both the keys and the diagnostic characters have been designed for the recognition of the crayfishes and shrimps of this area, and should not be utilized to identify or to confirm an identification of specimens collected outside of the region. Notes on color and references to the habits of the several species are, insofar as we are aware, applicable to any localities where the animals are found.

Life history notes and the list of crayfish associates apply only to the crayfishes collected in the general region and not throughout the range of each species or subspecies.

The maps indicate the distribution of each of the crayfishes in the area; exact locality data are given only for those species that are known from only a few localities.

In the Life History Notes reference is made to "first form males". These are breeding males as opposed to "second form males" which are adult but apparently incapable of transferring sperm to the female. The first form male may be distinguished from the second by the presence of at least one corneous apical process on the first abdominal appendage, pleopod, whereas none of them is corneous in the second form male.

Those species, some of the habitats of which have been or probably will be affected by the impoundment of the Jim Woodruff Dam are *P. spiculifer, P. paeninsulanus, O. clypeatus, C. latimanus, C. floridanus, C. fodiens,* and *C. diogenes.*

Procambarus youngi Hobbs
(Figures 5, 6, 7, 26; Map 6)

Procambarus youngi Hobbs 1942, Univ. Fla. Pub., Biol. Sci. Ser., 3 (2): 131, 15 figs.

This species is known from only three localities, one each in the drainage systems of the Chipola River, St. Marks River, and Wetappo Creek (see below). Further collecting in the permanent streams in the Apalachicola flatwoods and bordering uplands should be undertaken to determine whether or not this species is as limited in its distribution as it appears to be.

Diagnostic Characters.—A combination of the acumen of the rostrum being subequal in length to the remainder of the rostrum, the areola comprising one-third of the length of the carapace, and, in the male, the length of the inner margin of the palm of the chela being longer than that of the movable finger is sufficient to distinguish this crayfish from any other.

Color Notes.—Not available.

Ecological Observations.—The type locality, Guard House Branch, is a small clear stream flowing through gently sloping flatwoods. Wetappo Creek is a somewhat larger stream that is frequently coffee-colored, and the St. Marks River is a large spring-fed stream, crystal-clear except during periods of heavy rains when it,

too, becomes somewhat coffee colored. In the larger streams *P. youngi* was found only in the littoral areas among the vegetation and debris.

KNOWN LOCALITIES.—Florida, Gulf County: Guard House Branch, 1 mile west of Weewahitchka, on State Highway 22 (old no. 52); 6.4 miles east of Bay County line on State Highway 22. Wakulla County: St. Marks River, 6.3 miles east of Woodville.

LIFE HISTORY NOTES.—First form males have been collected in April, September, and November. No females with eggs or young have been observed.

CRAYFISH ASSOCIATES.—*P. paeninsulanus, P. spiculifer,* and *C. schmitti.*

Procambarus spiculifer (LeConte)

(Figure 23; Map 2)

Astacus spiculifer LeConte 1856, Proc. Acad. Nat. Sci., Philad., 7: 401.

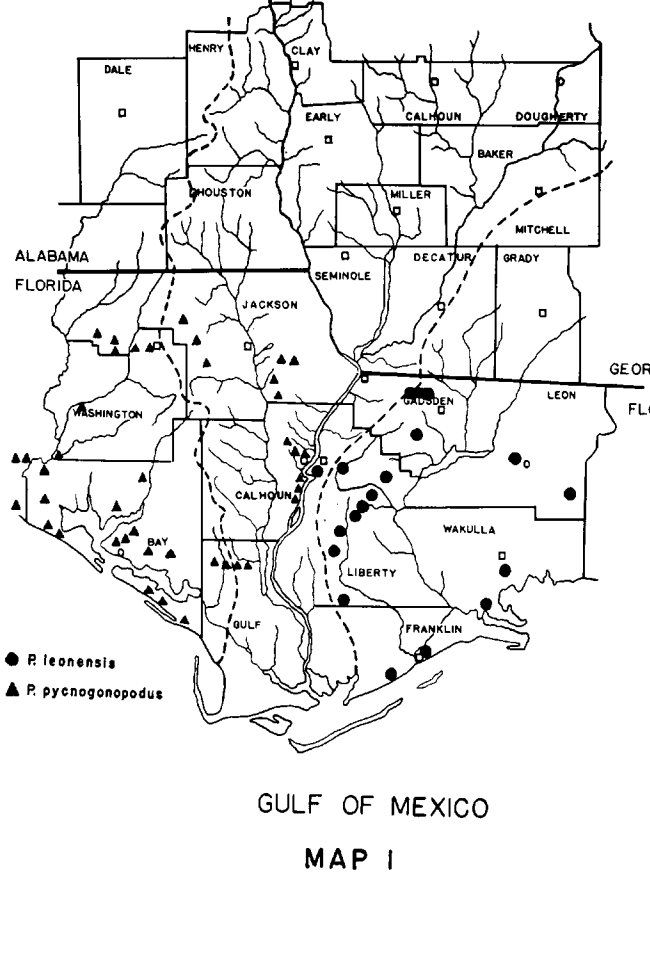
Cambarus spiculifer Hagen 1870, Illus. Cat. Mus. Comp. Zool., Harvard Coll., (3): 9.

Procambarus spiculifer Hobbs 1942, Amer. Midl. Nat., 28 (2): 342 (by implication).

Procambarus spiculifer is the largest and one of the most abundant species in the area. Its range has been recently reviewed by Hobbs (1953: 416) who reported it to inhabit streams from the headwaters of the Chattahoochee River south to the Suwannee River in Florida and west to Mobile County, Alabama. In Alabama it is not known to occur north of a line drawn from Washington County to Lee County.

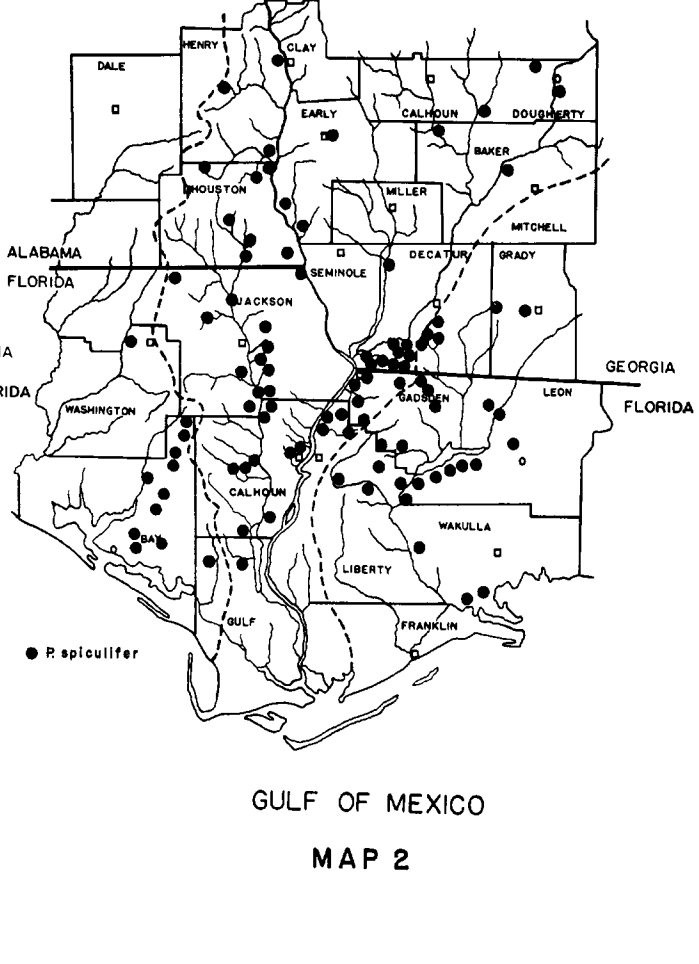
DIAGNOSTIC CHARACTERS.—The presence of two lateral spines on each side of the carapace and the absence of a spine from the mesial margin of the basipodite of the cheliped will distinguish this crayfish from any other in the area under consideration.

COLOR NOTES.—This is the most strikingly marked species in the area, and while the actual colors vary considerably, the patterns of the markings are remarkably constant in those individuals that frequent the Apalachicola drainage system. The most conspicuous of these markings is a dark longitudinal band on each side of the carapace which extends dorsally at the posterior margin of the carapace toward the corresponding band on the opposite side; a conspicuous gap separates the two bands. In addition other dark patches and bands are symmetrically arranged on the carapace. The ground color varies from light tan and dark brown to bluish green; the chelae



GULF OF MEXICO

MAP 1



GULF OF MEXICO

MAP 2

are usually dark with red-tipped fingers and with cream-colored tubercles. Red splotches are present on the epimera of the abdominal segments.

Ecological Observations.—*Procambarus spiculifer* appears to be confined to lotic habitats and is the only crayfish that has been taken from the rivers in the area. "The size of the stream is not of primary importance—almost any well areated, lotic situation which the crayfish can reach by suitable highways is likely to be occupied. *P. spiculifer* has never been collected in standing water, and only rarely have I taken it from the still reaches of a stream. . . . In the ravines along the Apalachicola and Ochlocknee rivers where small springs and seepage areas combine their waters to form small creeks, *spiculifer* is abundant, although it does not seem to invade the shallow headwaters. In these streams the water is very clear and cool, and usually flows with a moderate current over a sand or clay bottom" Hobbs 1942b: 123, 124). While this species does not appear to penetrate the headwaters of the small creeks in the ravines south of Chattahoochee, it is found in the small headwater brooks to the north as well as in those streams flowing into the Ochlockonee River in Decatur County, Georgia and Gadsden County, Florida. The presence or absence of vegetation in the stream appears to have little effect on the population. Frequently specimens are more easily obtainable where aquatic vegetation is abundant, but some of the largest populations were encountered in streams totally devoid of aquatic vascular plants. Some kind of cover, whether it be an undercut bank, vegetation, or debris, is always associated with a sizable population. In streams affording few places for concealment the population is always small.

Whereas *P. spiculifer* does not burrow to the extent that many of the species in the area do, it does dig shallow horizontal tunnels into the banks of streams, and many of the larger specimens have been taken from such tunnels during the day. In most places larger series of specimens may be obtained from the open water at night when the animals leave their places of concealment.

Life History Notes.—First form males have been collected in every month of the year, and while there are few records of females with eggs, they have been observed in January, March, and August.

Crayfish Associates.—*P. youngi, P. paeninsulanus, P. leonensis, P. pycnogonopodus, P. kilbyi, O. clypeatus, C. schmitti, C. diogenes, C. floridanus, C. latimanus,* and *C. fodiens.*

Procambarus versutus (Hagen)

(Figures 9, 22; Map 5)

Cambarus versutus Hagen 1870, Illus. Cat. Mus. Comp. Zool., Harvard Coll., (3): 51.

Procambarus versutus Hobbs 1942, Amer. Midl. Nat., 28 (2): 342 (by implication).

The easternmost limit of the range of this species occurs in the Apalachicola drainage system, and in its lower reaches is known from a single stream, Little Sweetwater Creek in Liberty County, Florida. Its range extends from Mississippi eastward to the Apalachicola drainage system.

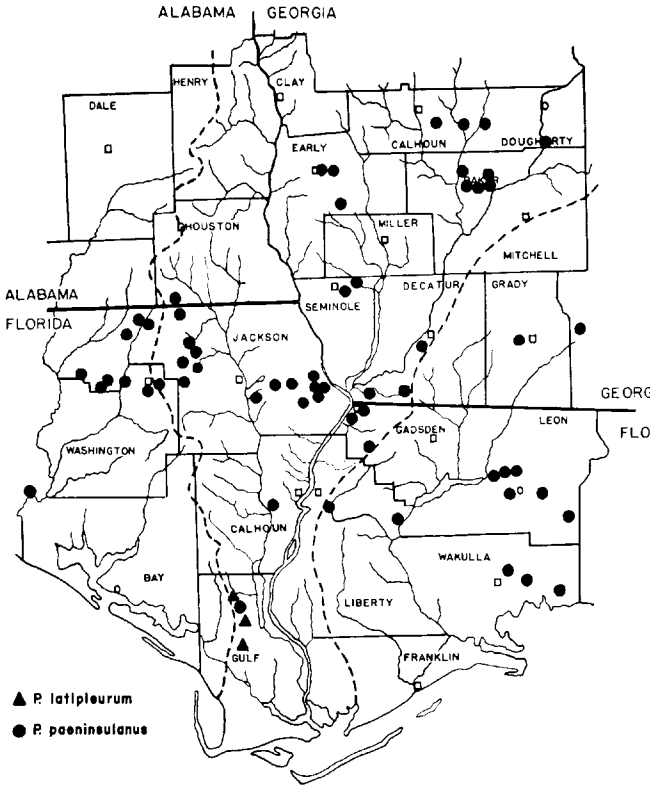
Diagnostic Characters.—The presence of two lateral spines on each side of the carapace and the presence of a spine on the mesial margin of the basipodite of the cheliped will distinguish this crayfish from any other in the region.

Color Notes.—Like its close relative, *P. spiculifer*, this crayfish is strikingly colored. The most conspicuous markings are found on the carapace; on its tan background a brick-red longitudinal band on each side extends dorsally from the posterior margin of the carapace toward the corresponding band on the opposite side. Another brick-red longitudinal stripe extends along each side just ventral to this one, separated from it by a cream stripe. Additional red and cream markings are symmetrically arranged. The chelipeds are reddish brown with black tubercles.

Ecological Observations.—*P. versutus*, insofar as known, has never been found in lentic situations, and it appears to be most abundant in small, sand-bottomed, spring-fed streams. In such habitats it occurs under the undercut banks or in clumps of debris. In streams containing *Vallesneria*, *Potomageton*, and other aquatic plants *P. versutus* may occur in large numbers. In Little Sweetwater Creek it was taken near the headwaters where the depth of the water was no more than 3 inches. Although efforts were made to locate this species in other ravine streams in the Apalachicola Bluff area, this is the only place it was found.

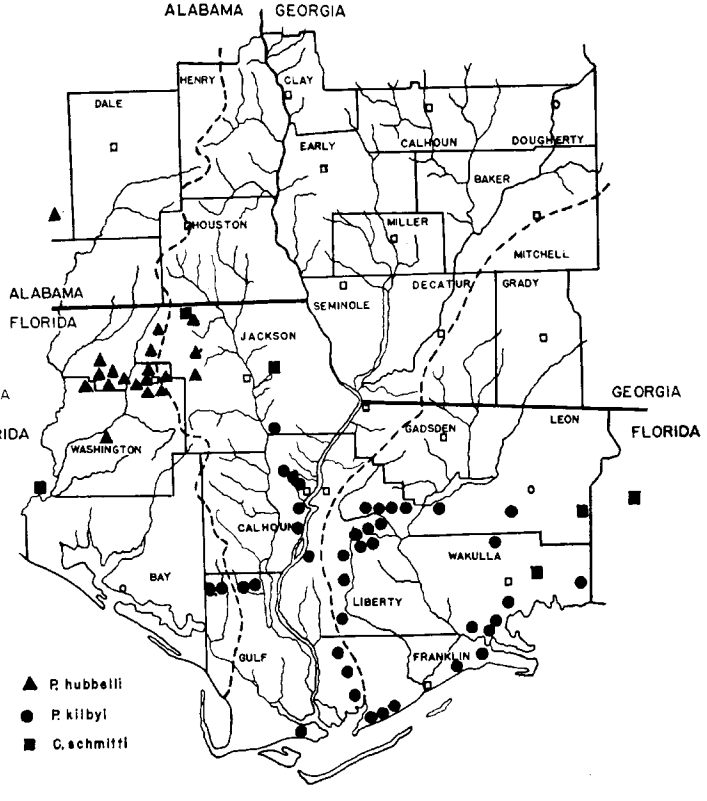
Known Localities.—Headwater ravine tributary to Little Sweetwater Creek near Rock Bluff, Liberty County, Florida, and several localities in Washington County.

Life History Notes.—First form males have been collected every month of the year except January, February, July, and November.



GULF OF MEXICO

MAP 3



GULF OF MEXICO

MAP 4

Only in April and June have females with eggs been found, and the single female that was found with young attached to the pleopods was collected in April.

CRAYFISH ASSOCIATES.—No other crayfishes were collected in the single locality where *P. versutus* is known to occur in this region. In the Choctawhatchee drainage system in the southwestern part of Washington County it was associated with *C. diogenes.*

Procambarus leonensis Hobbs

(Figure 12; Map 1)

Procambarus leonensis Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 114, figs. 121-125; Hobbs 1943, Proc. Fla. Acad. Sci., 6 (1): 49, 12 figs.

Procambarus leonensis frequents both lentic and lotic habitats between the Apalachicola and Suwannee rivers in Florida; however it does not appear to be abundant in the Apalachicola drainage system. Perhaps this is not actually true, for very little collecting has been done in the southern part of Liberty and the western part of Franklin counties, Florida.

DIAGNOSTIC CHARACTERS.—The only reliable criterion for recognizing this species is the structure of the terminal elements of the first pleopod of the male. A single small lateral spine or tubercle is present on both sides of the carapace and the pleopod tapers distally, is somewhat recurved, and bears four terminal "teeth", two of which are spine-like, one subspatulate and corneous (in the first form male), and the fourth vestigial in the form of a small tooth lying caudal to the subspatulate element. Hooks are present on the ischiopodites of the third and fourth walking legs of the male.

COLOR NOTES.—*P. leonensis* is rather drab when compared with *P. spiculifer* or *P. versutus;* its greenish brown background shows darker irregular markings dorsally and lighter markings laterally, and usually two pairs of black spots on the dorsolateral surfaces of the branchiostegites. The legs are usually bluish green and in mature specimens the chelipeds are often conspicuously brownish orange on the lower surface.

ECOLOGICAL OBSERVATIONS.—*Procambarus leonensis* is the sole inhabitant of many of the sinkhole ponds in the limestone sections of its range, and is the only species known to inhabit many of the larger lakes in the Tallahassee region. It has also invaded most of

the streams, roadside ditches, and swamps throughout the extent of its range. Individuals living in temporary bodies of water construct during dry seasons simple burrows, which may or may not reach the water table, and where they remain until the ground water rises once again to fill the ditches or ponds.

LIFE HISTORY NOTES.—First form males have been collected in January, April, May, June, August, September, November, and December. Females with eggs were found in April, May, August, and September.

CRAYFISH ASSOCIATES.—*P. kilbyi, P. rogersi campestris* (and intergrades), *P. pygmaeus, P. spiculifer, P. paeninsulanus,* and *O. clypeatus.*

Procambarus pycnogonopodus Hobbs
(Figure 17; Map 1)

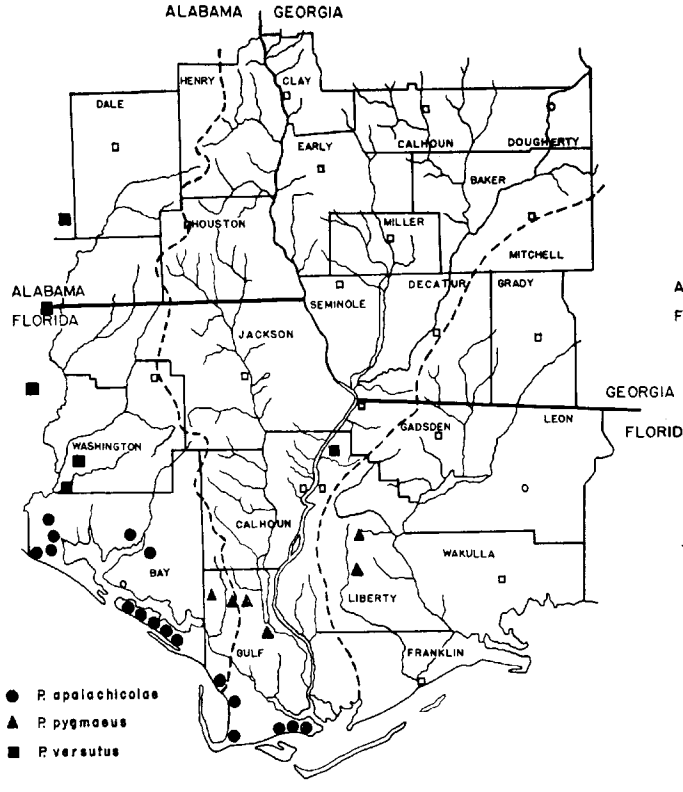
Procambarus pycnogonopodus Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 117, figs. 126-130; Hobbs 1943, Proc. Fla. Acad. Sci., 6 (1): 53, 15 figs.

This species occurs in most bodies of water in which collections have been made between the Apalachicola and Yellow rivers in Florida and, while it has not been encountered in the Flint-Chattahoochee region, it is abundant in streams flowing into the Apalachicola in Calhoun County, Florida. It has not been reported from the Yellow River system.

DIAGNOSTIC CHARACTERS.—A single small lateral spine or tubercle is present on each side of the carapace, and the first pleopod of the male is of almost uniform thickness up to the tip. Projecting from the latter are only three small elements: one that is spiniform, a hooklike one, and (in the first form male) a very small corneous tooth that, in lateral aspect, lies between the two. Hooks are present on the ischiopodites of the third and fourth walking legs in the male.

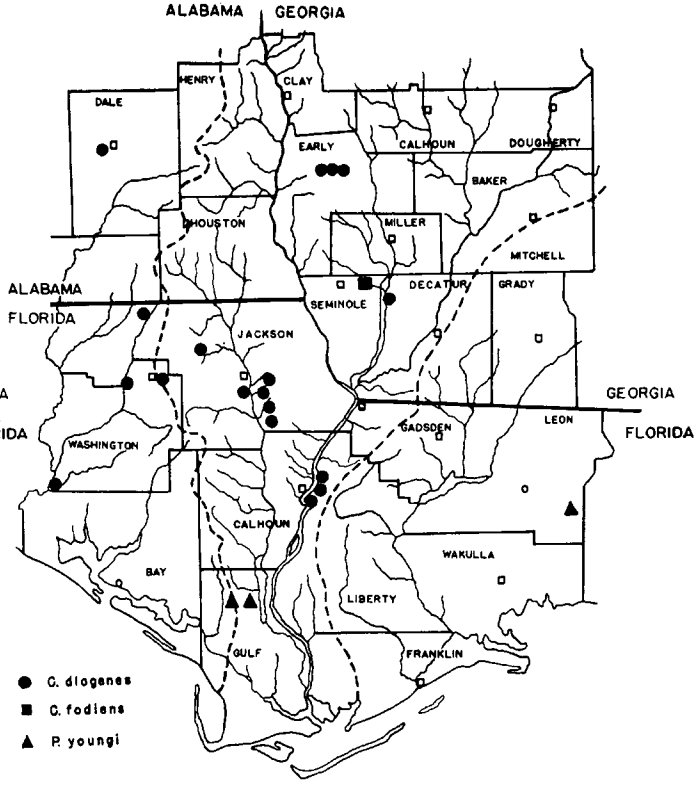
COLOR NOTES.—Ground color reddish brown with a greenish cast. Lateral portion of carapace lighter with more tan, becoming cream to light green along ventral margins of branchiostegites. Dorsolateral portion of branchiostegites with a pair of black spots, one just posterior to the cervical groove and the other just anterior to caudal margin of carapace, both on a level with the eyes. Legs olive green above and greenish cream below. Cheliped dark orange brown with black tubercles above, orange below with black and cream tubercles.

ECOLOGICAL OBSERVATIONS.—*P. pycnogonopodus* has an ecological tolerance as wide as that of any of the crayfishes in the region, and



GULF OF MEXICO

MAP 5



GULF OF MEXICO

MAP 6

is the only one that has been found in brackish water. Wherever epigean water occurs within its range, with the possible exception of the larger rivers, this species is usually present. Even in temporary bodies of water, such as pools, ditches, and some streams, it is usually present; and when the water disappears, it constructs simple burrows as much as 3 feet in depth. The presence or absence of vegetation in the water appears not to restrict it, but it seems to be more abundant in habitats rich in aquatic plants.

Life History Notes.—First form males have been collected in April, May, June, October, and November. Females with eggs have been observed in April, May, and October.

Crayfish Associates.—*P. spiculifer, P. kilbyi, P. rogersi rogersi, P. latipleurum, P. pygmaeus, P. hubbelli, P. paeninsulanus, P. apalachicolae,* and *Cambarellus schmitti.*

Procambarus paeninsulanus (Faxon)
(Figure 18; Map 3)

Cambarus clarkii paeninsulanus Faxon 1914, Mem. Mus. Comp. Zool., 40 (8): 369.

Procambarus clarkii paeninsulanus Hobbs 1942, Amer. Midl. Nat., 28 (2): 342 (by implication).

Procambarus paeninsulanus Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 104, 5 figs.

Procambarus paeninsulanus is not only relatively abundant in the area, but is common throughout its range, which extends from the Choctawhatchee River system in Florida eastward to the Atlantic Ocean and from southeastern Alabama and southern Georgia southward to Hillsborough County, Florida.

Diagnostic Characters.—The purplish red color of the adults of this species coupled with an almost flat annulus ventralis in the female and a distinct angular prominence on the cephalic surface of the first left pleopod of the male will readily separate this species from others in the area.

Color Notes.—Ground color purplish red with purplish to black markings. Lateral surface of carapace lighter in color ventrally, passing from pink to pinkish cream. Branchiostegites with a dark band running longitudinally from almost the caudal margin of the carapace to the cervical groove on a level with the eyes. Chelipeds red or reddish orange with black or cream tubercles; lower surface more brillantly colored than upper surface.

ECOLOGICAL OBSERVATIONS.—This species, like *P. pycnogonopodus* and *P. leonensis*, is not limited to one or two types of ecological situations but is found in almost all aquatic habitats in its range. Like the two previous species it constructs simple burrows, and almost all the females carrying eggs have been collected from the straight or gently sloping tunnels. Although there is no evidence that these animals undergo mass migrations overland as do their close relative *P. clarkii* (see Penn 1943: 15), specimens have been collected at least ½ mile from the nearest body of water. It was formerly quite abundant in several localities now inundated by the impounded waters of the Jim Woodruff Dam, both along the western border of the Chattahoochee in Florida and in the lower Flint in Georgia.

LIFE HISTORY NOTES.—First form males have been collected in every month of the year except January and December, and females with eggs in March, May, and August through November. Females with young were also collected from August through November.

CRAYFISH ASSOCIATES.—*P. kilbyi, P. spiculifer, P. pygmaeus, P. pycnogonopodus, P. hubbelli, P. youngi, P. leonensis, Orconectes clypeatus, Cambarellus schmitti, Cambarus diogenes,* and *C. fodiens.*

Procambarus apalachicolae Hobbs

(Figure 20; Map 5)

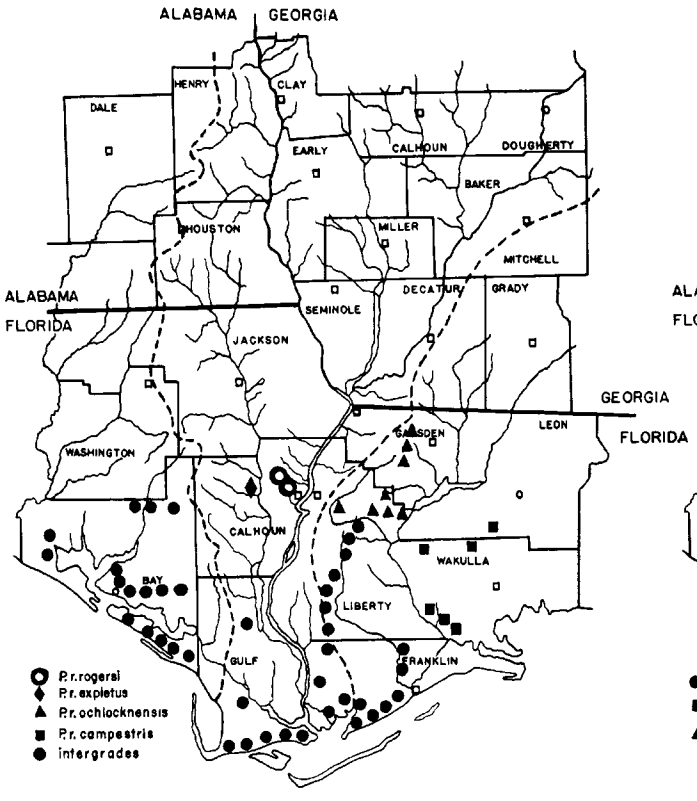
Procambarus apalachicolae Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2) 55, 15 figs.

This species, although abundant in its relatively small range, is apparently confined to the Apalachicola flatwoods in southern Bay and Gulf counties, Florida. Its range in relation to those of *P. latipleurum* and *P. econfinae* (Hobbs 1942: 49) is discussed by Hobbs (idem, pp. 57-58).

DIAGNOSTIC CHARACTERS.—The absence of spines on the rostrum and on the lateral surfaces of the carapace together with the relatively broad areola (approximately three times as long as wide), hooks on the ischiopodites of the third and fourth pereiopods of the male, prominent tubercles on the cephalolateral borders of the annulus ventralis of the female, and a caudodistally directed spine on the first pleopod of the male serve to identify this species.

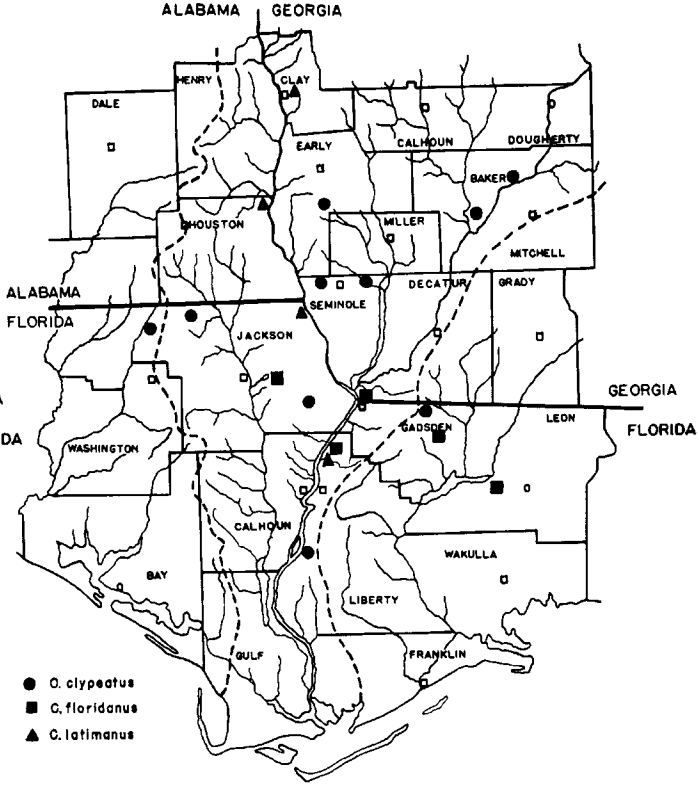
COLOR NOTES.—None available.

ECOLOGICAL OBSERVATIONS.—*P. apalachicolae* is a secondary burrower and typically inhabits depressions in the Apalachicola flatwoods where water stands during some period each year. When the de-



GULF OF MEXICO

MAP 7



GULF OF MEXICO

MAP 8

pressions become dry the crayfish construct simple burrows with entrances marked by small chimneys. Burrows to a depth of 3 feet are not unusual.

LIFE HISTORY NOTES.—First form males have been collected in April, May, June, and October and females with eggs in May and June. A single female with young was collected in June.

CRAYFISH ASSOCIATES.—*P. pycnogonopodus, P. rogersi rogersi* (and intergrades).

Procambarus latipleurum Hobbs

(Figure 21; Map 3)

Procambarus latipleurum Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 52, 15 figs.

This species is known only from a small area in Gulf County, Florida, within a 13-mile radius of Weewahitchka. Because the closely related *P. apalachicolae* is abundant to the south and west of its range and well drained areas lie to the north and east of it, it seems probable that the species does have a limited range.

DIAGNOSTIC CHARACTERS.—The acute lanceolate rostrum, the absence of spines or tubercles on the lateral surfaces of the carapace, the spiniform tubercles on the cephalolateral borders of the annulus ventralis of the female, and the subspiculiform cephalically-curved spine on the first pleopod of the male readily distinguish this crayfish from any others in the region.

COLOR NOTES.—None available.

ECOLOGICAL OBSERVATIONS.—This species is known from only four localities in the vicinity of Weewahitchka where it was collected from pools in roadside ditches and borrow pits, sluggish streams, and simple burrows. It is almost certainly a secondary burrower.

KNOWN LOCALITIES.—Florida, Gulf County: 5.8 miles west of Weewahitchka on State Highway 22 (old no. 52); 6.1 miles south of Weewahitchka on State Highway 71 (old no. 6); and 12.6 miles south of Weewahitchka on State Highway 71.

LIFE HISTORY NOTES.—First form males were collected in October, and no females with eggs or young have been reported.

CRAYFISH ASSCIATES.—*P. pycnogonopodus, P. kilbyi,* and *P. pygmaeus.*

Procambarus kilbyi (Hobbs)

(Figure 19; Map 4)

Cambarus kilbyi Hobbs 1940, Proc. U. S. Nat. Mus., 89 (3097): 410, fig. 20.

Procambarus kilbyi Hobbs 1942, Amer. Midl. Nat., 28 (2): 343.

This species ranges throughout the Florida coastal flatwoods from Jackson, Calhoun, and Gulf counties eastward to Levy County. It is the only member of the Barbatus Group in the region (*P. apalachicolae, P. latipleurum, P. hubbelli,* and *P. kilbyi*) that occurs on both sides of the Apalachicola River.

Diagnostic Characters.—The absence of spines on the rostrum and on the lateral surfaces of the carapace, the relatively broad areola (approximately four times as long as wide), the absence of tubercles on the cephalolateral borders of the annulus ventralis of the female, hooks on the ischiopodites of the third and fourth pereiopods of the male, and a large, subspatulate, caudally projecting process on the tip of the first pleopod distinguish this crayfish from all others in the region.

Color Notes.—The ground color varies from straw brown to olive green, and a cream or gray stripe, about the width of the areola, extends from the tip of the rostrum to the tip of the telson. Laterally a pair of narrow, similarly colored stripes extend almost the entire length of the animal but are most prominent on the branchiostegites and along the bases of the epimera of the abdominal segments. Chelipeds dark brown or green with darker tubercles, a few of them with cream tips.

Ecological Observations.—*P. kilbyi,* although a secondary burrower frequenting temporary pools, borrow pits, and roadside ditches, also occurs in small temporary streams. It is apparently just as well suited to life in open water as it is to burrows; however at all localities in which it was collected from open water the water table at times drops below the level of the basin and forces the crayfish to burrow.

Life History Notes.—First form males have been collected from February to June and from September to November. Females with eggs and others with young were found in May and June.

Crayfish Associates.—*P. pycnogonopodus, P. paeninsulanus, P. latipleurum, P. leonensis, P. pygmaeus, P. rogersi campestris, P. rogersi rogersi,* and *P. spiculifer.*

Procambarus hubbelli (Hobbs)
(Figure 8; Map 4)

Cambarus hubbelli Hobbs 1938 (*nomen nudum*), Proc. Fla. Acad. Sci., 2: 90.

Cambarus hubbelli Hobbs 1940, Proc. U. S. Nat. Mus., 89 (3097): 406, fig. 19.

Procambarus hubbelli Hobbs 1942, Amer. Midl. Nat., 28 (2): 342.

This species appears to be confined to the flatwoods adjacent to the Choctawhatchee River and its tributaries in Alabama and Florida.

DIAGNOSTIC CHARACTERS.—The absence of spines on the rostrum and on the lateral surfaces of the carapace, the relatively broad areola, hooks on the ischiopodites of the third pereiopods only of the male, and the tuft of plumose setae along the inner margin of the palm of the chela of the male distinguish this species from any other crayfish in the area.

COLOR NOTES.—The ground color varies from straw brown to olive green with darker brown or greenish black flecks over the entire dorsal surface including the chelipeds. Young specimens are frequently colored like the adults of *P. kilbyi*, but the adults have never been observed to exhibit the distinct stripes so characteristic of *P. kilbyi*.

ECOLOGICAL OBSERVATIONS.—The habits of this species appear not to differ from those of *P. kilbyi* except that it has been taken from permanent sluggish streams.

LIFE HISTORY NOTES.—First form males have been collected from February through July, and females with eggs in April and May.

CRAYFISH ASSOCIATES.—*P. pycnogonopodus*, *P. paeninsulanus*, and *O. clypeatus*.

Procambarus pygmaeus Hobbs

Procambarus pygmaeus Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 83, 14 figs.

The range of this species appears to be discontinuous. It is known from Clinch and Wayne counties, Georgia, and from Gulf and Liberty counties, Florida.

DIAGNOSTIC CHARACTERS.—Its bright green color set off by scarlet tubercles, ridges, and terminal margins of joints readily distinguishes this crayfish from any other known. Its rostrum and lateral carapace surfaces are without spines, its areola is very narrow (more than 20 times longer than broad), the annulus ventralis of the female is oval

with a longitudinal oval depression, and the first pleopod of the male terminates in two conspicuous teeth with a corneous ridge along the base of the lateral one in the first form male.

COLOR NOTES.—The ground color varies from olive to forest green, and practically all ridges, tubercles, and rims of joints are scarlet red. Red markings are also present on the epimera of the abdominal segments.

ECOLOGICAL OBSERVATIONS.—*P. pygmaeus* should probably be classified as a secondary burrower. Wherever it has been collected *Juncus repens*, a red and green semiaquatic plant, has also been present. Many specimens were collected at night and occasional ones by day by pushing a dipnet through beds of *Juncus*. The burrows this crayfish constructs are as complex as those of *P. rogersi rogersi* and, except for the smaller size of the tunnels, similar to them in every way. This species, like its relatives, the several subspecies of *P. rogersi*, is associated primarily with a flatwoods terrain.

KNOWN LOCALITIES.—Florida, Gulf County: 11.7 miles west of Weewahitchka on State Highway 22 (old no. 52); 6.6 miles east of Bay Co. line on State Highway 22; 1.7 miles east of Bay Co. line on State Highway 22; 6.1 miles south of Weewahitchka on State Highway 71 (old no. 6). Liberty County: 11.3 miles south of Telogia on State Highway 65 (old no. 135); 5.4 miles south of Telogia on State Highway 65. The remaining known localities are in Clinch and Wayne counties, Georgia.

LIFE HISTORY NOTES.—First form males have been collected in April, May, and October, and a female with eggs was found in May.

CRAYFISH ASSOCIATES.—*P. kilbyi, P. pycnogonopodus, P. latipleurum, P. paeninsulanus,* and *P. leonensis.*

Procambarus rogersi rogersi (Hobbs)

(Figure 14; Map 7)

Cambarus rogersi Hobbs 1938, Jour. Wash. Acad. Sci., 28 (2): 62, 11 figs.

Procambarus rogersi Hobbs 1942, Amer. Midl. Nat., 28 (2): 344.

Procambarus rogersi rogersi Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2) 89, 5 figs.; Hobbs 1945, Jour. Wash. Acad. Sci., 35 (8): 248, 5 figs.

This subspecies occupies a narrow strip of flatwoods between the Chipola and Apalachicola rivers in Gulf (?) and Calhoun counties, Florida. To the south it intergrades with the other three subspecies,

P. r. ochlocknensis, P. r. campestris, and probably with *P. r. expletus* (see below).

DIAGNOSTIC CHARACTERS.—The absence of spines on the rostrum and lateral surfaces of the carapace, the linear areola, an annulus ventralis in the female that is distinctly broader than long, and the first pleopod of the male terminating in three parts with the caudal knob bent mesiad at a right angle to its main shaft are diagnostic for this subspecies.

COLOR NOTES.—Ground color pinkish lavender to lavender red with the colors fading ventrally on the branchiostegites to a pinkish or lavender cream. Legs pinkish to cream and chelipeds lavender red above with light tubercles and pinkish or lavender cream below. No striking markings are present.

ECOLOGICAL OBSERVATIONS.—This species is a primary burrower, spending practically its entire life in complex tunnels underground. It has never been collected outside of burrows. It is abundant in seepage areas and in flatwoods where the water table is near the ground surface. In most places within its range where pitcher plants (*Sarracenia*), sundews (*Drosera*), club mosses (*Lycopodium*), and hatpins (*Ericaulon*) occur, one is likely to find this crayfish. The burrows may extend horizontally 5 feet or more with tunnels extending in several directions. One spiral or vertical passage always reaches below the water table and in many burrows more than one. Each burrow usually has two or more chimneys that range from 4 to 8 inches in height. The soil in which the burrows are constructed may be a mucky sand or a mixture of sand and clay, both types usually underlain by clay.

LIFE HISTORY NOTES.—First form males have been found in April, May, and December, and a single female with eggs in April.

CRAYFISH ASSOCIATES.—*P. kilbyi, P. apalachicolae,* and *P. pycnogonopodus.*

Procambarus rogersi campestris Hobbs

(Figure 16; Map 7)

Procambarus rogersi campestris Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 90, 5 figs.; Hobbs 1945, Jour. Wash. Acad. Sci., 35 (8): 255, 7 figs.

This subspecies appears to be confined to southwestern Leon County and western Wakulla County, Florida. It intergrades with the other subspecies of *P. rogersi* in Franklin and Liberty counties.

DIAGNOSTIC CHARACTERS.—The absence of spines on the rostrum and lateral surfaces of the carapace, the obliterated areola, the antennal scale with a straight anteromesial margin, the subcylindrical annulus ventralis with a deep troughlike opening anteriorly in the female, and the first pleopod of the male terminating in four parts, the cephalic one of which is vestigial and the caudal knob bent mesiad at less than a right angle are typical of this subspecies.

COLOR NOTES.—Essentially identical to *P. rogersi rogersi.*

ECOLOGICAL OBSERVATIONS.—Habits the same as those of *P. rogersi rogersi.*

LIFE HISTORY NOTES.—First form males were collected in June and November; no females with eggs have been observed.

CRAYFISH ASSOCIATES.—*P. kilbyi* and *P. leonensis.*

Procambarus rogersi ochlocknensis Hobbs
(Figure 15; Map 7)

Procambarus rogersi ochlocknensis Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 89, 5 figs.; Hobbs 1945, Jour. Wash. Acad. Sci., 35 (8): 252, 8 figs.

This subspecies is known only from Gadsden and northern Liberty counties, Florida. To the south it intergrades with *P. r. campestris* and *P. r. rogersi* (See Hobbs 1945: 257-260).

DIAGNOSTIC CHARACTERS.—The absence of spines on the rostrum and lateral surfaces of the carapace, the obliterated areola, the antennal scale with a straight anteromesial margin, an annulus ventralis in the female that is longer than broad, and the first pleopod of the male terminating in four parts, the caudal knob of which is bent mesiad at less than a right angle to the main shaft of the appendage, and the well developed cephalic process not visible in caudal aspect characterize this subspecies.

COLOR NOTES.—Essentially identical to *P. rogersi rogersi.*

ECOLOGICAL OBSERVATIONS.—Habits the same as those of *P. rogersi rogersi.*

LIFE HISTORY NOTES.—First form males were collected in March, April, and December, and females with eggs were taken in March and April.

CRAYFISH ASSOCIATES.—*P. kilbyi, P. leonensis, P. paeninsulanus,* and *O. clypeatus.*

Procambarus rogersi expletus,[3] new subspecies
(Figures 27-39; Map 7)

This new crayfish is known only from a single locality in Calhoun County, Florida. Because of its obvious close relationship with the three recognized subspecies of *P. rogersi*, it is also designated a subspecies. The recognition of this crayfish as a distinct race seems justified because it is so markedly different from *P. rogersi rogersi*, the subspecies that occurs just across the Chipola River to the east. It is relatively distantly removed geographically from its apparent closest relative, *P. rogersi campestris*, and it is distinct from any of the available specimens of the intergrade population from the area to the south. At the same time it is no more different from *P. r. campestris* than the other three races, and is apparently allopatric to all the other forms of *rogersi*.

DIAGNOSIS.—Rostrum without marginal spines; areola obliterated; males with hooks on ischiopodites of third pereiopods only; chela depressed and bearing a cristiform row of tubercles along inner margin of palm; postorbital ridges without spines or tubercles; no lateral spines present on carapace; inner margin of antennal scale evenly rounded. First pleopod terminating in four parts; mesial process subspiculiform and extending laterodistally beyond the tips of the other terminal elements; cephalic process considerably better developed than in the other three subspecies, an irregular elongate process visible in caudal aspect (that in *campestris* and *ochlocknensis* not visible in caudal aspect); caudal process thumb-like and directed mesially at about a 20 degree angle to the main shaft of the appendage; central projection forming a large corneous fan across the cephalic side of the tip and bent laterodistad at about a 70 degree angle to the main shaft of the appendage. Annulus ventralis subcylindrical with the cephalolateral surfaces tuberculate.

HOLOTYPIC MALE, FORM I.—Body subovate, slightly compressed laterally. Width of carapace in region of caudodorsal margin of cervical groove slightly less than height (13.9 and 14.2 mm.). Greatest width of carapace (14.5 mm.) about midway between cervical groove and caudal margin of carapace.

Areola obliterated and constituting 40 percent of the entire length of carapace (12.0 and 30.0 mm.).

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[3] Expletus L.—perfect or complete. Name chosen because of the well developed cephalic process of the first pleopod of the male, giving it a complete complement of terminal elements.

Rostrum short (4.0 mm.) with converging margins and a short, poorly delimited, triangular acumen that is slightly upturned distally. Upper surface excavate with a row of fine setiferous punctations just mesial to margins; no marginal spines present. Subrostral ridges evident in dorsal aspect for a short distance anterior to posterior margin of orbit. Postorbital ridges, although not prominent, are long and terminate anteriorly without spines or tubercles.

Surface of carapace punctate dorsally and granulate laterally with a small, inconspicuous tubercle on lateral surface just posterior to cervical groove. Branchiostegal spines very small.

Abdomen shorter and narrower than carapace (see measurements). Anterior section of telson with 1 spine in the right and 2 in the left posterolateral angles.

Epistome (Fig. 38) broadly subtriangular and terminating cephalically in a small cephalomedian tubercle.

Antennules of the usual form with a small spine on ventral side of basal segment. Antennae reaching cephalic margin of third abdominal segment. Antennal scale (Fig. 39) small with inner margin evenly rounded; spine on outer distal extremity moderately strong and incurved.

Cheliped (Fig. 30) with a broad flattened palm tuberculate above and below, and with setiferous punctations on the lower lateral surface. A row of large punctations with conspicuously long setae extends from lower articular knob of propus almost to tip of immovable finger. A prominent ridge marks the articulation with the dactyl and with a prominent tubercle on lower surface. Outer margin of hand costate, and both fingers with distinct ridges above and below; that on lower surface of immovable finger with a row of tubercles proximally and a single tubercle on its mesial side just distal to fourth tubercle (counting from base). Inner margin of palm with a cristiform row of 10 tubercles. Opposable margin of immovable finger with a row of 6 tubercles (second from base largest), the distal one of which passes under the dactyl when the fingers are closed. Opposable margin of movable finger with a row of 9 tubercles, the fourth from base largest and marking a distinct excision in the margin at its base. A single row of minute denticles on opposable margins of both fingers between and distal to the large tubercle marking the excision. Mesial margin with a row of 5 tubercles along its proximal half and setiferous punctations distally. Upper and lateral surfaces of carpus with setiferous punctations, lower surface polished, and mesial one with spikelike tubercles. Groove on upper surface of carpus

moderately deep. Merus with polished mesial surface, sparsely punctate lateral surface, scattered tubercles on upper margin, only one of which is conspicuous, and with a lower surface bearing 2 well defined rows of tubercles; mesial row consists of 12 or 13 tubercles and lateral one of 11 or 12; those in the mesial row much more prominent than those in the lateral one. Ischiopodite with a row of 4 or 5 tubercles on lower margin.

Ischiopodites of third pereiopods with hooks. Coxa of fifth pereiopods with a prominent tubercle on caudomesial margin just below opening of vas deferens.

First pleopods asymmetrical and extending cephalad to base of second pereiopod. See DIAGNOSIS for description.

MORPHOTYPIC MALE, FORM II.—This specimen is smaller than the holotype and is probably juvenile. Most of the differences are probably to be associated with age. The areola is linear, not quite obliterated. The anterior section of the telson bears 2 spines in each caudolateral corner, and all of the podomeres bear 1 or 2 fewer tubercles than appear in the holotype. The first pleopods exhibit a transverse suture line (Fig. 31), but all the terminal elements are present although reduced in size and, as usual, none are corneous.

ALLOTYPIC FEMALE.—Differs from the holotype in the following respects: No tubercle larger than surrounding granulations on lateral surface of carapace immediately posterior to cervical groove. Branchiostegal spine represented by a small angular prominence. Anterior section of telson with 2 spines in each posterolateral angle. Epistome slightly more subquadrangular and without a small cephalomedian tubercle. The row of conspicuous long setae on lower surface of propus of cheliped is augmented by others lateral and mesial to it. Inner margin of palm with cristiform row of 6 tubercles on left, and 9 on right chela. Opposable margin of right immovable finger with a row of 5 tubercles. Opposable margin of right dactyl with only 3 tubercles. No one of the tubercles on upper distal surface of merus larger than others; mesial row of tubercles on lower surface of merus consists of 10 on right and 12 on left merus, corresponding lateral rows with 9 and 7. Ischiopodite with 3 tubercles on lower margin of right cheliped and 2 on left. Annulus ventralis (Fig. 37) subcylindrical with high cephalolateral walls bearing tubercles and cephalomedian trough leading to a deep centrally located depression. Sternite between fifth pereiopods a small conical plate.

Measurements.—(In. mm.)

		Holotype	Allotype	Morphotype
Carapace:	height	14.2	12.0	10.1
	width	13.9	12.5	10.6
	length	30.0	25.9	22.0
Areola:	width	0	0	0
	length	12.0	10.0	8.7
Rostrum:	width	4.0	4.0	2.9
	length	4.0	3.7	3.1
Abdomen:	width	10.0	8.9	6.8
	length	26.1	20.8	18.7
Chela:	length of inner margin of palm	7.5	5.6	4.3
	width of palm	11.4	9.3	6.7
	length of outer margin of hand	21.2	16.1	12.9
	length of dactyl	13.3	10.2	8.2

COLOR NOTES.—Almost identical to *P. rogersi rogersi* (see above).

TYPE LOCALITY.—A seepage slope, 0.9 mile north of Clarksville, Calhoun County, Florida on State Highway 73. This slope lies in a cleared area with a few scattered pines. Common in the area are *Sarracenia, Drosera, Lycopodium*, and wiregrass. The soil is a sandy clay, and at the time of collecting the water was not more than 1 or 2 inches below the surface. Here a large colony of crayfishes has constructed a maze of complex burrows, in some places so interwoven that it was difficult to determine, after using a shovel, which tunnel we had been following.

Disposition of Types.—The holotype, allotype, and morphotype are in the collection of the U. S. National Museum (nos. 102125, 102127, and 102126 respectively). Four female paratypes are in my personal collection at the University of Virginia.

SPECIMENS EXAMINED.—Only the seven specimens collected in the type locality in September 1955 have been assigned to this subspecies; however, it is possible that two collections from Bay County, 3 miles west of Youngstown and from a flatwoods west of the Econfina River west of Bennett, should also be assigned to it. Until first form males from these localities become available it seems advisable to refrain from making a subspecific determination of these specimens.

VARIATIONS.—The series available shows relatively few variations. The rostra in some of the specimens have more nearly broad lanceolate outlines; the maximum number of tubercles along the inner mar-

gin of the palm is 11, and the areola ranges from 37.9 to 41.7 percent of the entire length of the carapace (it appears to be proportionally longer in the larger specimens). The largest specimen in the collection is a female with a carapace length of 35.5 mm.

RELATIONSHIPS.—As indicated above, this subspecies probably has more in common with *campestris* than with either of the other two subspecies. The antennal scale is more similar to that of typical *rogersi;* the cephalic process of the first pleopod of *ochlocknensis* is more similar, but the caudal knob is more like that of *campestris,* as is the annulus ventralis. The combination of the rounded antennal scale, a well developed cephalic process, and the caudal knob directed at about a 20 degree angle to the main shaft of the pleopod serves to distinguish this crayfish from any of its near relatives.

CRAYFISH ASSOCIATES.—None.

Cambarellus schmitti Hobbs

(Map 4)

Cambarellus schmitti Hobbs 1942, Univ. Fla. Publ., Biol. Sci. Ser., 3 (2): 149, 15 figs.

This pigmy crayfish occurs in the lower Coastal Plain from Mobile County, Alabama eastward to the Santa Fe River in Columbia and Gilchrist counties, Florida.

DIAGNOSTIC CHARACTERS.—The adults of this species never attain a total length greater than 1 inch. The females may be recognized by the acute angular sternite between the bases of the fifth walking legs, and the males by the presence of bituberculate hooks on the ischiopodites of the second and third walking legs.

COLOR NOTES.—A dimorphic color pattern exists in this species as it does in *Cambarellus shufeldtii* (see Penn 1942, Hobbs and Marchand 1943, Penn 1950, and Volpe and Penn 1957). The ground color in both patterns varies from light tan to bluish gray, and the darker colors of brick red or steel blue are arranged either in spots or in stripes, the spots generally following the stripe pattern. Two pairs of stripes are present: the more median pair, starting just below the postorbital ridges, extends caudally just lateral to the areola to the base of the telson, and the lateral pair extends the same distance on a level with the bases of the epimera of the abdominal segments. In *C. shufeldtii,* Volpe and Penn demonstrated that the striped pattern is dominant to the spotted one.

a narrow swampy area. Both the seine and dipnet were used in the creek and its backwaters and the only other burrows located were opened in an effort to secure additional specimens, but none was found. If its habits here are as they are elsewhere, this crayfish should be abundant in small ponds, roadside ditches, and other shallow fluctuating bodies of water.

LIFE HISTORY NOTES.—The single collection made on 9 September 1955 contains a first form male.

CRAYFISH ASSOCIATES.—*P. paeninsulanus* and *O. clypeatus*.

Cambarus diogenes diogenes Girard
(Figure 10; Map 6)

Cambarus diogenes Girard 1852, Proc. Acad. Nat. Sci., Philad., 6: 88.

Cambarus nebrascensis Girard 1852, Proc. Acad. Nat. Sci., Philad., 6: 91.

Cambarus obesus Hagen 1870, Illus. Cat. Mus. Comp. Zool., Harvard Coll., 3: 81.

Cambarus diogenes diogenes Faxon 1884, Proc. Amer. Acad. Arts and Sci., 20: 144 (by implication).

While the ranges of its two subspecies have never been clearly delineated, the range of the species extends from Minnesota to Texas and New Jersey to the panhandle of Florida, except in the mountains. *C. d. ludovicianus* Faxon is apparently restricted to the lower Mississippi Valley region, occupying a V-shaped wedge with the apex reaching into Tennessee and Arkansas. Though relatively few specimens have been collected, the nominate subspecies is apparently common along most of the creeks and rivers of the Apalachicola region.

DIAGNOSTIC CHARACTERS.—In this area *C. diogenes diogenes* may be recognized by its obliterated areola and the absence of a distinct excision on the opposable margin of the movable finger of the chela. Both fingers of the chela are scarlet red at the tips.

COLOR NOTES.—The somewhat variable ground color ranges from a creamy yellow to a bluish green. In nearly all instances the margins of the rostrum, postorbital ridges, and tubercles on the chelipeds are red, and there are frequently red markings on the abdomen. The tips of the fingers of the cheliped are invariably red.

ECOLOGICAL OBSERVATIONS.—Although this crayfish is primarily a burrowing species, it is occasionally taken in open water. In this

streams, and occasionally in seepage areas in the headwaters of small streams. In many instances the burrows have at least two openings, one below water level and the other above it, and in such situations seldom have more than two or three passageways. In seepage areas the burrows may branch in several directions and have several chimneys. The chimneys are usually neatly constructed and often attain a height up to at least 1 foot. Burrows along the banks of the Apalachicola River with openings 10 to 15 feet above the water level are almost certainly excavated by this species.

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Manuscripts should be typewritten with double spacing, with ample margins, and on only one side of the paper. The author should keep a copy; the copy submitted must be the original. Tables, legends of figures, and all footnotes should be assembled separate from the text. Several legends or footnotes may be placed on a single sheet.

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