

A Report on the Crawfishes (Decapoda, Astacidae)¹ of Oklahoma

ROLLIN D. REIMER, Tulane University,
New Orleans, Louisiana²

Since the survey of the crawfishes of Oklahoma by Creaser and Ortenburger in 1933, there have been several changes in the taxonomy of the family Astacidae and the number of species and subspecies now known to occur within the state has increased to 19. Ten species were reported by Creaser and Ortenburger, one of which I consider erroneous.

The crawfishes in North America east of the Rocky Mountains are currently assigned to either Cambarinae (Hobbs, 1942) or Cambarellinae (Languarda, 1961). These two subfamilies are equivalent to the genus *Cambarus* used by most crawfish taxonomists prior to 1942. The subfamily Cambarellinae contains only one genus, *Cambarellus*, and is not known from within the boundaries of Oklahoma. The subfamily Cambarinae consists of seven genera, *Troglocambarus*, *Paracambarus*, *Procambarus*, *Cambarus*, *Orconectes*, *Hobbseus* (Joe F. Fitzpatrick, Jr., personal communication) and *Faxonella*, four of which are known to occur in the state. The genus *Troglocambarus* is confined to the subterranean waters of Florida, *Hobbseus* to the Pearl and Tombigbee drainages in Alabama and Mississippi and the upper part of the Pearl River in Mississippi, and *Paracambarus* to Mexico.

¹This research was supported in part by the Society of Sigma Xi with a Research Grant in Aid (1966-1967) and in part by an Environmental Sciences Training Grant (No. ST1-ES-27-62-S1).

²Present address: Department of Wildlife Sciences, Texas A&M University, College Station, Texas.

CHECK-LIST OF CRAWFISHES OCCURRING IN OKLAHOMA WITH
EQUIVALENT TAXONOMIC UNITS USED BY CREASEZ AND ORTENBURGER

Family Astacidae

Subfamily Cambarinae Hobbs, 1942

- | | |
|---|---|
| <i>Procambarus</i> Ortman, 1905 | Genus <i>Cambarus</i> (in part) |
| <i>Procambarus clarkii</i> (Girard, 1852) | Subgenus <i>Ortmanicus</i> Fowler, 1911 |
| <i>Procambarus acutus acutus</i> (Girard, 1852) | <i>Cambarus blandingi acutus</i> |
| <i>Procambarus simulans simulans</i> (Faxon, 1885) | <i>Cambarus simulans</i> |
| <i>Procambarus gracilis</i> (Bundy, 1876) | <i>Cambarus gracilis</i> |
| <i>Procambarus tensis</i> Hobbs, 1950 | |
| <i>Cambarus</i> Erichson, 1846 | Subgenus <i>Cambarus</i> |
| <i>Cambarus diogenes diogenes</i> Girard, 1852 | <i>Cambarus diogenes</i> |
| <i>Cambarus diogenes ludovicianus</i> Faxon, 1884 | |
| <i>Cambarus hedgpethi</i> Hobbs, 1948 | |
| <i>Cambarus setosus</i> Faxon, 1889 | <i>Cambarus setosus</i> (extralimital) |
| <i>Orconectes</i> Cope, 1872 | Subgenus <i>Faxonius</i> Ortman, 1905 (in part) |
| <i>Orconectes difficilis</i> (Faxon, 1898) | <i>Cambarus difficilis</i> |
| <i>Orconectes palmeri longimanus</i> (Faxon, 1898) | <i>Cambarus longimanus</i> |
| <i>Orconectes nats</i> (Faxon, 1885) | <i>Cambarus nats</i> |
| <i>Orconectes meeki brevis</i> Williams, 1952 | |
| <i>Orconectes causeyi</i> Jester, 1967 | |
| <i>Orconectes neglectus neglectus</i> (Faxon, 1885) | <i>Cambarus neglectus</i> |
| <i>Orconectes nana nana</i> Williams, 1952 | |
| <i>Orconectes menas</i> (Creaser, 1933) | |
| <i>Orconectes leptogonopodus leptogonopodus</i> Hobbs, 1948 | |
| <i>Faxonella</i> Creaser, 1933 | Subgenus <i>Faxonius</i> (in part) |
| <i>Faxonella clypeata</i> (Hay, 1899) | <i>Cambarus clypeatus</i> |

KEY TO THE CRAWFISHES OF OKLAHOMA AND EXTRALIMITAL SPECIES
SUSPECTED OF OCCURRING IN THE STATE

The following key is based on sexually active males, referred to as Form I or first form males. Form I males can be distinguished from Form II or second form males by a comparison of their first pair of pleopods, which are modified for copulation and are called gonopods (Figs. 18-32). The terminal elements of Form I gonopods are well defined and at least one is corneous. For identification of immature individuals, females and Form II males, one must consult the recognition characters (Figs. 1-46) given for each species.

1. Gonopod ending in two distinct processes 2
1. Gonopod ending in three or more distinct processes 19
2. Both processes of gonopod bent caudally at approximately a 90° angle to axis of shaft *Cambarus* 3
2. Both processes of gonopod not bent caudally at a 90° angle to axis of shaft 6
3. Areola open *Cambarus setosus*
3. Areola obliterated 4
4. Suborbital angle absent *Cambarus hedgpethi*
4. Suborbital angle present and well developed 5
5. Rostrum and epistome narrow; three red bands of pigment running down dorsum of abdomen *Cambarus diogenes ludovicianus*
5. Rostrum and epistome broad; red bands of pigment on abdomen absent *Cambarus diogenes diogenes*
6. Central projection of gonopod at least twice length of mesial process *Faxonella clypeata*
6. Central projection less than twice length of mesial process *Orconectes* 7
7. Areola obliterated 8
7. Areola open 10
8. Rostrum, acumen and antennal scale extremely elongate; acumen over ½ length of rostrum (Figs. 22, 35) *Orconectes lancifer*
8. Rostrum, acumen and antennal scale not as above; acumen less than ½ length of rostrum 9
9. Processes of gonopod short, mesial process curved caudad at approximately a 90° angle to axis of shaft *Orconectes difficilis*
9. Processes of gonopod long, mesial process never curved so strongly caudad *Orconectes palmeri longimanus*
10. Areola narrow, lacking punctae at narrowest point or with only one row 11
10. Areola narrow or broad, with two, three or more rows of punctae at narrowest point 12
11. Areola open but lacking punctae at narrowest point; tips of fingers of chelae bright red, followed proximally by band of deep blue pigment *Orconectes palmeri longimanus*
11. Areola almost always with one row of punctae at narrowest point; chelae not so colored *Orconectes nais*
12. Rostrum very narrow 13
12. Rostrum broad 14
13. Central projection of gonopod reaching to base of second pair of pereopods *Orconectes nana nana*

13. Central projection of gonopod reaching to base of first pair of pereopods *Orconectes nana macrum*
14. Both terminal processes of gonopod curved gently caudad, along entire length 15
14. Central projection curved caudad, mesial process straight or bent in opposition to central projection 11
15. Antennal scale evenly rounded mesially, broadest at mid-length..... *Orconectes causey*
15. Antennal scale abruptly rounded mesially, broadest anterior to mid-length 11
16. Rostrum with sides concave, acumen long *Orconectes meeki meeki*
16. Rostrum with sides not concave, often with sides converging anteriorly, acumen short *Orconectes meeki brevis*
17. Central projection much longer than mesial process, mesial process making up approximately 67% of central projection; central projection reaching at least to tip of first pair of pereopods *Orconectes leptogonopodus leptogonopodus*
17. Central projection only slightly longer than mesial process and never reaching beyond second pair of pereopods 14
18. Rostrum with carina; tips of chelae red, followed proximally by black ring of pigment *Orconectes neglectus neglectus*
18. Rostrum without carina; tips of chelae light orange but without conspicuous black marking *Orconectes menona*
19. Hooks present on ischia of second and third pairs of pereopods..... (figs. 11, 32)..... *Cambararellus puer*
19. Hooks present on ischia of third or third and fourth pairs of pereopods *Procambarus* 2
20. Two cervical spines on each side of cephalothorax *Procambarus dupratii*
20. Cephalothorax with one lateral spine on each side or spine entirely lacking 21
21. Males with hooks on ischia of third pair of pereopods only..... (Fig. 15) 2
21. Males with hooks on ischia of third and fourth pairs of pereopods 2
22. Antennal scale widest anterior to mid-length; areola obliterated or extremely narrow, never with punctae at narrowest point *Procambarus gracilis*
22. Antennal scale widest posterior to mid-length; areola narrow to broad, always with at least one row of punctae at narrowest point *Procambarus simulans simulans*
23. Gonopod ending in three terminal processes; marginal rostral spines and cervical spines absent *Procambarus tenuis*
23. Gonopod ending in four terminal processes; marginal rostral spines and cervical spines on cephalothorax present but often reduced 2
24. Areola obliterated in middle *Procambarus clarkii*
24. Areola narrow but never obliterated *Procambarus acutus acutus*

ANNOTATED LIST OF SPECIES AND SUBSPECIES

A detailed list of the localities for the crawfishes in Oklahoma will be supplied by the author upon request.

Cambarus Erichson, 1846

The species of this genus occurring within the state are, for the most

part, burrowing species. They build neat and often quite high chimneys (10 to 12 inches). *Cambarus setosus* is a troglobitic form known only from subterranean waters and does not burrow. Hobbs and Barr (1960) summarized the data on this species. Data regarding *Cambarus diogenes diogenes* and *Cambarus diogenes ludovicianus* were summarized by Marlow (1960); additional data were supplied by Reimer (1964). Life history and ecological data were reported for *Cambarus hedgpethi* by Penn and Marlow (1959), Penn and Hobbs (1958) and Reimer (loc. cit.).

Cambarus diogenes diogenes Girard, 1852

Figs. 1, 18, 38; Map 1

Body pigmented; rostrum without marginal spines; areola obliterated; suborbital angle prominent; rostrum and epistome broader than in *Cambarus diogenes ludovicianus*; dorsum of abdomen without stripes characteristic of *Cambarus diogenes ludovicianus*.

Distribution: From Alabama to Michigan and Atlantic Coast to Rocky Mountains in Colorado and Wyoming (Williams, 1954a).

Cambarus diogenes ludovicianus Faxon, 1884

Body pigmented; rostrum without lateral spines; areola obliterated; suborbital angle prominent; rostrum and epistome narrower than in *Cambarus diogenes diogenes*; dorsum of abdomen with three longitudinal bands of pigment. In another paper I shall raise *Cambarus diogenes ludovicianus* to a species based on a narrower rostrum, narrower epistome, color pattern and range. However, since this change is unpublished, the trinomen is retained here.

Distribution: Previously this subspecies was thought to be confined to the "Alluvial Fault Basin in Louisiana" (Penn and Marlow, 1959; Marlow, 1960). My collections indicate that this form is much more widespread. Reimer (1964) reported it from throughout the Gulf Coastal Plains in Arkansas. OKLAHOMA: Glover River at Glover, McCurtain County.

Cambarus hedgpethi Hobbs, 1948

Figs. 2, 39

Body pigmented; rostrum without marginal spines; areola obliterated; suborbital angle absent or only slightly evident, never as prominent as in *Cambarus diogenes*.

Distribution: Texas, Louisiana, Mississippi, Arkansas and Oklahoma. OKLAHOMA: Three miles south of Tom, McCurtain County (U.S.N.M. No. 96157).

Cambarus setosus Faxon, 1889

Figs. 3, 19, 33 Map 1

Albinistic; eyes reduced and without pigment; rostrum with distinct shoulders at base of acumen and often with small marginal spines; areola open, but narrow.

Distribution: Southwestern Missouri and northeastern Oklahoma (Hobbs and Barr, 1960).

Orconectes Cope, 1872

The species of this genus occurring in Oklahoma are usually found in clear, permanent, flowing bodies of water. They can usually be found

under rocks or other debris in the streams. Many of these crawfishes have been reported from burrows; however, burrowing usually occurs only during periods of drouth and never reaches the degree of refinement found in *Cambarus*. Almost all species herein reported were reviewed by Williams (1954a). Additional data were reported by Penn (1952, 1957), Williams (1954b), Penn and Hobbs (1958), Reimer (1964), Fitzpatrick (1965), Mornot (1966) and Jester (1967).

Orconectes difficilis (Faxon, 1898)

Fig. 20. Map 2

Rostrum with lateral spines; areola obliterated; one cervical spine on each side; antennal scale widest at mid-length.

Distribution: Oklahoma, Louisiana and Texas.

Orconectes palmeri longimanus (Faxon, 1898)

Map 1

Rostrum with marginal spines; areola obliterated in most specimens; one cervical spine on each side; antennal scale widest at midlength; fingers of chelae with conspicuous red tips followed proximally by a deep blue pigment band. Individuals with an open areola can be distinguished from *Orconectes nais* in northeastern Oklahoma by the color pattern on the fingers of the chelae.

Distribution: "All western tributaries of the Mississippi River from the Arkansas River to the Gulf and Gulf drainage streams from the Mississippi River to the Guadalupe River in Texas" (Penn, 1957).

Orconectes nais (Faxon, 1885)

Figs. 9, 23, 36. Map 3

Rostrum with marginal spines areola narrow usually with only one row of punctae at narrowest point; one cervical spine on each side; antennal scale widest at mid-length.

Distribution: Oklahoma, Kansas and Arkansas.

Orconectes meeki brevis Williams, 1952

Fig. 5. Map 4

Rostrum with marginal spines; areola narrow usually with two or three rows of punctae at narrowest point; cervical spine on each side of cephalothorax present, but reduced; antennal scale widest anterior to mid-length.

Distribution: Oklahoma and Arkansas.

Orconectes causeyi Jester, 1967

Figs. 4, 10, 24, 37. Map 2

Rostrum with lateral spines; areola narrow to broad; one cervical spine on each side; antennal scale widest at mid-length.

There seems to be an east to west cline in regard to the width of the areola in this species. Specimens from the western part of the state, as well as New Mexico and western Kansas, have a very narrow areola while those in extreme northeastern Oklahoma, Arkansas, Kansas and Missouri have a much broader one. Subspecific designations may be warranted; however, other complications concerning this species prevent such designations.

Orconectes causeyi has been confused with *O. nais*, but is much more closely related to *O. virilis* and may be only one of its subspecies. *Orconectes nais* shows closest affinities to *O. palmeri longimanus* and *O. meeki meeki*. The taxonomy of *Orconectes causeyi*, and its relationship to *O. virilis*, will be treated in my forthcoming paper on the genus *Orconectes* in western North America. For present purposes, the name, *Orconectes causeyi*, is retained for those *virilis*-like crawfish occurring in Oklahoma.

Distribution: New Mexico, Texas, Arkansas, Oklahoma, Missouri, and Kansas.

Orconectes neglectus neglectus (Faxon, 1885)

Figs. 14, 41. Map 3

Rostrum broad and carinate; marginal rostral spines small; areola broad; cervical spine on each side present but reduced; antennal scale widest distal to mid-length; tips of fingers of chelae orange or red, followed proximally by ring of black pigment.

Distribution: Northeastern Colorado, extreme southern Nebraska, Kansas, northeastern Oklahoma and northwestern Arkansas (Williams, 1954b).

Orconectes nana nana Williams, 1952

Figs. 6, 25, 40. Map 2

Rostrum very narrow; marginal rostral spines small; areola broad; cervical spine absent; antennal scale widest anterior to mid-length.

Distribution: Northeastern Oklahoma and northwestern Arkansas.

Orconectes menae (Creaser, 1933)

Fig. 26.

Rostrum wide; marginal rostral spines reduced; areola moderately broad; cervical spine absent; antennal scale widest anterior to mid-length.

Distribution: Ouachita Mountain Province of Oklahoma and Arkansas. OKLAHOMA: Little Eagle Creek, west of Octavia, LeFlore County (U.S.N.M. No. 114315).

Orconectes leptogonopodus leptogonopodus Hobbs, 1948

Fig. 27.

Rostrum with reduced lateral spines; areola broad; lateral spine on cephalothorax absent; antennal scale widest anterior to mid-length.

Distribution: Ouachita Mountain Province of Oklahoma and Arkansas. OKLAHOMA: Eagle Creek n.w. of Smithville, McCurtain County; 6 mi. n.ne. of Broken Bow, McCurtain County.

Faxonella Creaser, 1933

Faxonella was elevated from a subgenus of *Orconectes* by Fitzpatrick in 1963. *Faxonella clypeata*, one of the two species belonging to this genus, has been taken from several different types of aquatic habitats, including roadside ditches, creeks, ponds and burrows. The life history of this species was worked out by Smith (1953). Since Fitzpatrick's study of *Faxonella*, additional data were presented by Reimer (1964) based on material from Arkansas.

Faxonella clypeata (Hay, 1899)

Figs. 21, 34. Map 1

Rostrum broad and lacking marginal spines; areola broad; cervical spine absent; central projection of gonopod three times longer than mesial process; tips of central projection overlap in normal position.

Distribution: Oklahoma, Arkansas, Louisiana, Mississippi, Florida, Georgia, South Carolina, Alabama and Texas (Fitzpatrick, 1963).

Procambarus Ortmann, 1905

With the exception of *Procambarus gracilis* and *Procambarus tenuis*, the species of this genus in the state, are found about as often in burrows as in roadside ditches, ponds and other permanent and semipermanent aquatic habitats. *Procambarus gracilis* is a primary burrower and may be found far from any surface water. Adults are almost always taken from burrows. *Procambarus tenuis* shares basically the same type of habitat as the members of the genus *Orconectes* and has been taken only in the clear, rocky streams of the Ouachita Mountains.

Various aspects of the biology of the following species were reviewed by Penn (1943, 1956), Williams (1954a), Penn and Hobbs (1958), Hobbs (1962, 1967), and Reimer (1964).

Procambarus clarkii (Girard, 1852)

Figs. 13, 28, 43.

Rostrum tapering to small marginal spines; areola obliterated in middle; one cervical spine on each side; antennal scale widest proximal to mid-length; hooks on ischia of third and fourth pair of pereopods.

Distribution: "From eastern Alabama to western Texas and up the Mississippi Valley to Dunklin County, Missouri, and Hickman County, Kentucky. (Introductions: Calif., Fla., Nev., Va., Hawaii and Japan.)" (Hobbs, 1962). OKLAHOMA: Stream 2.8 miles north of Harris on U.S. Highway 259, McCurtain County.

Procambarus acutus acutus (Girard, 1852)

Figs. 12, 29, 44. Map 3

Rostrum triangular, with minute marginal spines; areola narrow; one cervical spine on each side; antennal scale widest proximal to mid-length; hooks on ischia of third and fourth pair of pereopods.

Distribution: Coastal plain and piedmont from Massachusetts to Georgia, from Florida to panhandle to Texas and Minnesota to Ohio (Hobbs, personal communication).

Procambarus simulans simulans (Faxon, 1885)

Figs. 7, 30, 42. Map 4

Rostrum with sides convex; marginal rostral spines absent; areola narrow; one cervical spine on each side; antennal scale widest proximal to mid-length; hooks on ischia of third pair of pereopods.

Distribution: Texas, Louisiana, Arkansas, Oklahoma, New Mexico, Kansas and Colorado.

Procambarus gracilis (Bundy, 1876)

Figs. 8, 46. Map 1

Rostrum with sides nearly parallel; marginal rostral spines absent; areola obliterated or extremely narrow, never with punctae at narrowest point; antennal scale widest slightly distal to mid-length; hooks present on ischia of third pair of pereopods.

Distribution: Texas, Oklahoma, Kansas, Missouri, Iowa, Illinois and Wisconsin.

Procambarus tenuis Hobbs, 1950

Figs. 31, 45. Map 1

Rostrum with sides converging; marginal rostral spines absent; cervical spine on each side absent; areola narrow; antennal scale widest distal to mid-length; hooks on ischia of third and fourth pair of pereopods.

Distribution: Ouachita Mountain Province of Oklahoma and Arkansas.

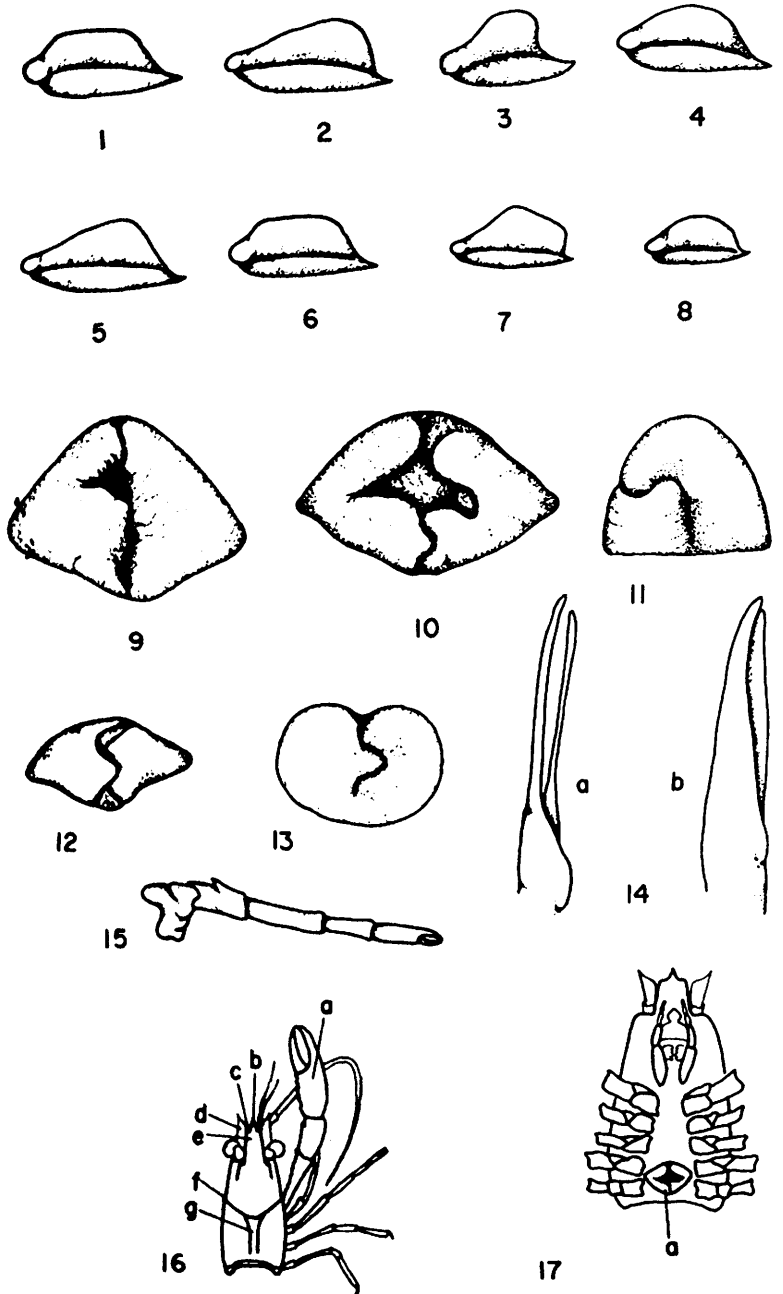
ERRONEOUS AND EXTRALIMITAL SPECIES

Cambarus immunis Hagen (= *Orconectes immunis*) was reported by Creaser and Ortenburger (1933) from Okfuskee County. Surveys made since their report (Williams and Leonard, 1952; Williams, 1954a) indicate that the range of this species does not extend farther south than northern Missouri and northeastern Kansas. Therefore, I consider the locality in Oklahoma to be in error.

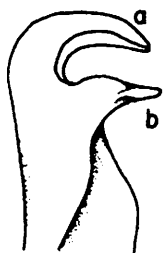
Several species have been reported from neighboring states, in drainages extending into Oklahoma. Reimer (1964) reported *Procambarus dupratzi* Penn from the Little River drainage in Sevier and Little River counties, Arkansas. *Orconectes lancifer* (Hagen) was reported from the Red River drainage in Red River County, Texas (Penn and Hobbs, 1958) and Hempstead County, Arkansas (Reimer, loc. cit.). *Orconectes nana macrus* Williams and *Orconectes meeki meeki* (Faxon) were reported from northwestern Arkansas by Williams (1954a) and Reimer (loc. cit.). *Cambarellus puer* Hobbs, a member of the subfamily Cambarellinae, was taken from the Little River drainage in Little River County, Arkansas by Reimer (loc. cit.).

ACKNOWLEDGEMENTS

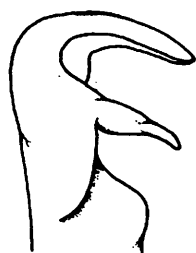
I wish to express my appreciation to Dr. Horton H. Hobbs, Jr. for allowing me to use data from his personal crawfish collection as well as from the collections housed in the United States National Museum. I would also like to thank Dr. Alfred E. Smalley and Dr. Joe F. Fitzpatrick, Jr. for reading and criticizing this manuscript. I am also indebted to Dr. Fitzpatrick, Dr. Smalley and Mr. Thomas M. Gray, for additional data on crawfishes in Oklahoma.



For Legend, see P. 61



18



19



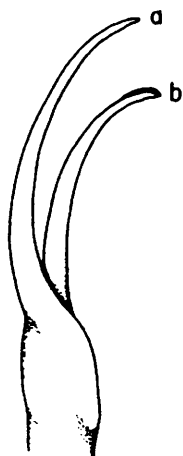
20



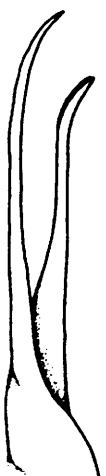
21



22



23



24



25



26



27



28



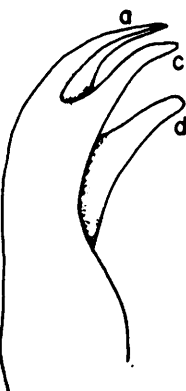
29



30

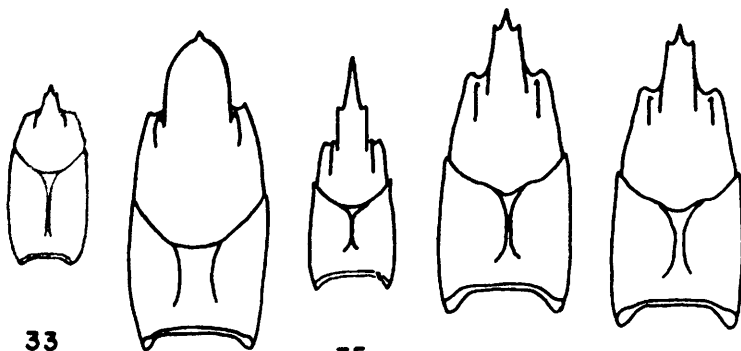


31



32

For Legend, see P. 61



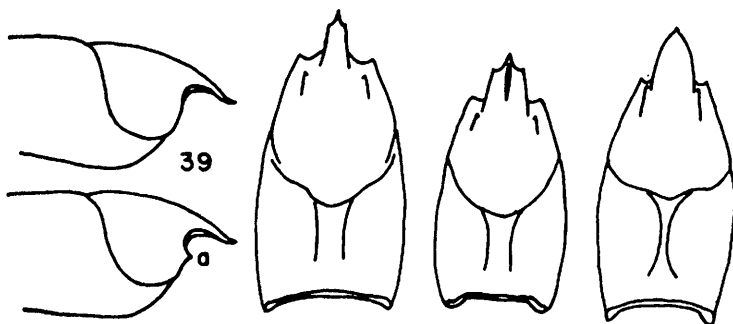
33

34

35

36

37



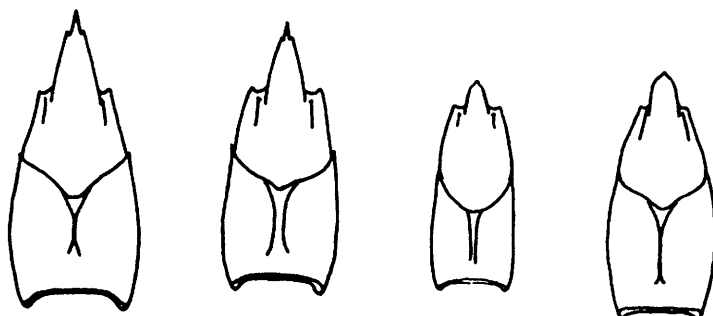
39

38

40

41

42



43

44

45

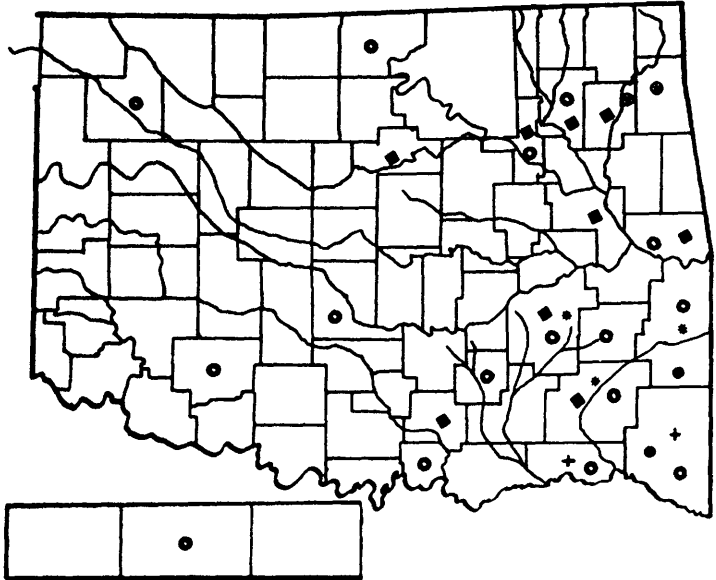
46

For Legend, see P. 61

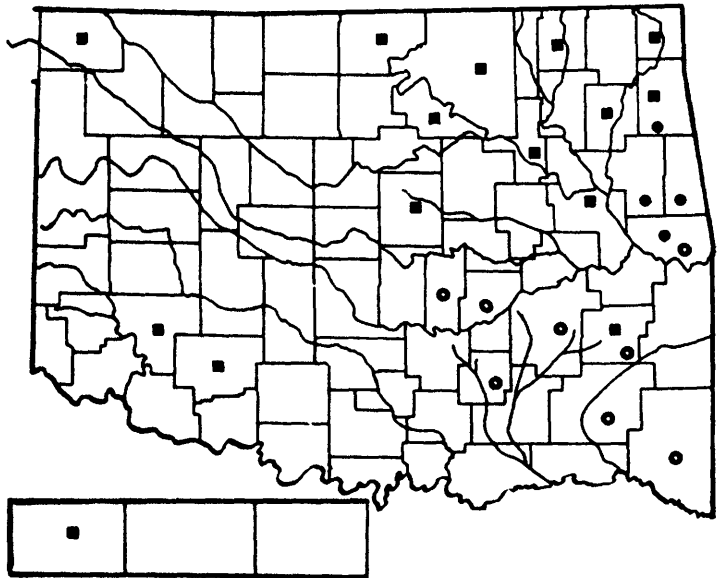
FIGURES 1-17. Antennal scales (1-8); not drawn to scale. 1. *Cambarus diogenes diogenes*. 2. *Cambarus hedgpethi*. 3. *Cambarus setosus*. 4. *Orconectes causeyi*. 5. *Orconectes meeki brevis*. 6. *Orconectes nana nana*. 7. *Procambarus simulans simulans*. 8. *Procambarus gracilis*. Annuli ventrales (9-13); not drawn to scale. 9. *Orconectes nais*. 10. *Orconectes causeyi*. 11. *Cambarellus puer*. 12. *Procambarus acutus acutus*. 13. *Procambarus clarkii*. 14. Gonopod of *Orconectes neglectus neglectus*; a. Form I male, b. Form II male. 15. Pereiopod of Form I male showing location of hook. 16. Dorsal aspect of cephalothorax showing important taxonomic characters; a. chela, b. acumen, c. marginal rostral spines, d. antennal scale, e. rostrum, f. cervical spine, g. areola. 17. Ventral aspect of cephalothorax showing location of annulus ventralis; a. Annulus ventralis.

FIGURES 18-32. Apices of gonopods of Form I males; not drawn to scale. a. Central projection, b. mesial process, c. caudal process, d. cephalic process. Mesial view (18, 19, 20, 22, 28, 29, 31, 32). Lateral view (21, 23-27, 30). 18. *Cambarus diogenes diogenes*. 19. *Cambarus setosus*. 20. *Orconectes difficilis*. 21. *Faxonella clypeata*. 22. *Orconectes lancifer*. 23. *Orconectes nais*. 24. *Orconectes causeyi*. 25. *Orconectes nana nana*. 26. *Orconectes menae*. 27. *Orconectes leptogonopodus leptogonopodus*. 28. *Procambarus clarkii*. 29. *Procambarus acutus acutus*. 30. *Procambarus simulans simulans*. 31. *Procambarus tenuis*. 32. *Cambarellus puer*.

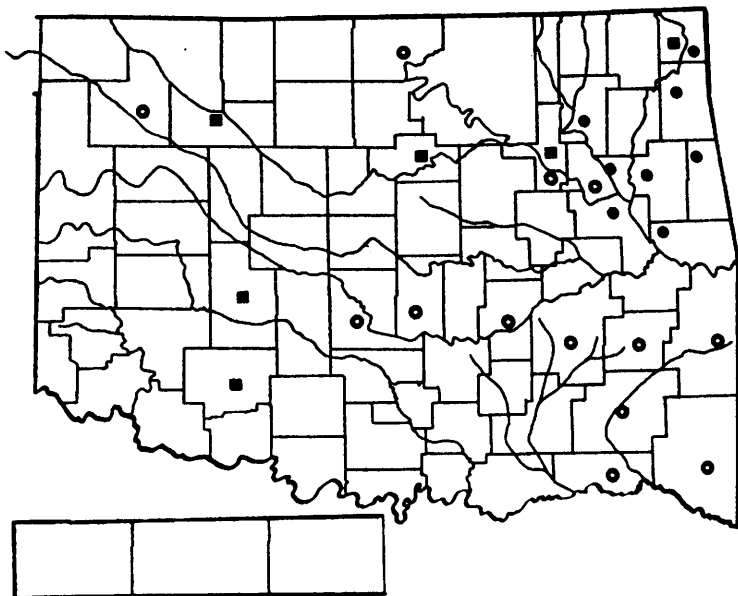
FIGURES 33-46. Cephalothoraxes of Form I males; not drawn to scale. 33. *Cambarus setosus*. 34. *Faxonella clypeata*. 35. *Orconectes lancifer*. 36. *Orconectes nais*. 37. *Orconectes causeyi*. 38. *Cambarus diogenes diogenes*; a. showing suborbital angle. 39. *Cambarus hedgpethi*, suborbital angle absent. 40. *Orconectes nana nana*. 41. *Orconectes neglectus neglectus*. 42. *Procambarus simulans simulans*. 43. *Procambarus clarkii*. 44. *Procambarus acutus acutus*. 45. *Procambarus tenuis*. 46. *Procambarus gracilis*.



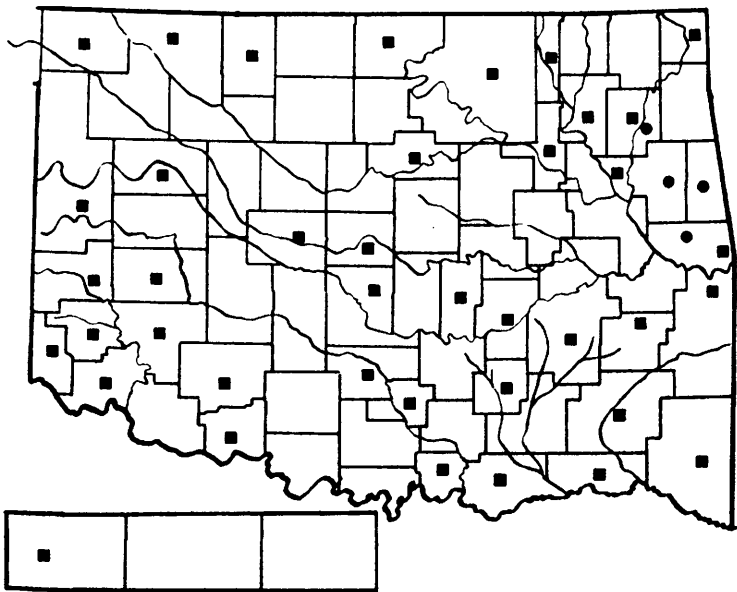
Map 1. *G. f. flavipes* +; *G. setosus* ○; *Q. palmeri longimanus* ●;
P. strimoli ●; *P. tenuis* ○; *P. gracilis* ■.



Map 2. *Q. saundersi* ■; *Q. affinis* ●; *Q. n. nana* ●.



Map 3. *Q. naia* ■; *Q. b. neglectus* ●; *F. s. acutus* ●



Map 4. *Q. meski brevis* ●; *F. s. similans* ■.

REFERENCES CITED

- Creaser, E. P., and A. I. Ortenburger. 1933. The decapod crustaceans of Oklahoma. Pub. Univ. Okla. Biol. Surv. 5(2):13-47.
- Fitzpatrick, J. F., Jr. 1963. Geographic variation in the crawfish *Faxonella clypeata* (Hay) with the definition and defense of the genus *Faxonella* Creaser (Decapoda, Astacidae). Tulane Stud. Zool. 10(1):57-79.
- 1965. A new subspecies of the crawfish *Orconectes leptogonopodus* from the Ouachita River drainage in Arkansas. Tulane Stud. Zool. 12(3):87-91.
- Hobbs, Horton H., Jr. 1942. A generic revision of the crayfishes of the subfamily Cambarinae (Decapoda, Astacidae) with the description of a new genus and species. Amer. Midland Natur. 28(2):334-357.
- 1962. Notes on the affinities of the members of the *Blandingii* section of the crayfish genus *Procambarus* (Decapoda, Astacidae). Tulane Stud. Zool. 9(5):273-293.
- 1967. The current status of the crayfishes listed by Girard (1852) in his "A revision of the North American Astaci. . ." (Decapoda, Astacidae). Crustaceana 12(2):124-132.
- and Thomas C. Barr, Jr. 1960. The origins and affinities of the troglolithic crayfishes of North America (Decapoda, Astacidae) I. The genus *Cambarus*. Amer. Midland Natur. 64(1):12-33.
- Jester, Douglas B. 1967. A new crawfish of the genus *Orconectes* from New Mexico (Decapoda, Astacidae). Amer. Midl. Natur. 77(2):518-524.
- Laguarda, F. Alfredo. 1961. Contribucion al estudio comparative de la formula branquial en la familia Astacidae (Crustacea; Decapoda). Tesis, Facultad de Ciencias. Univ. Nacl. A. de Mexico, p. 1-75.
- Marlow, Guy. 1960. The subspecies of *Cambarus diogenes*. Amer. Midland Natur. 64(1):229-250.
- Momot, W. T. 1966. Upstream movement of crayfish in an intermittent Oklahoma stream. Amer. Midland Natur. 75(1):150-160.
- Penn, George Henry. 1943. A study of the life cycle of Louisiana red-crawfish, *Cambarus clarkii* Girard. Ecology 24(1):1-18.
- 1952. The genus *Orconectes* in Louisiana. Amer. Midland Natur. 47(3):743-748.
- 1956. The genus *Procambarus* in Louisiana. Amer. Midland Natur. 56(2):406-422.
- 1957. Variation and subspecies of the crawfish *Orconectes palmeri* (Faxon). Tulane Stud. Zool. 5(10):229-262.
- and Horton H. Hobbs, Jr. 1958. A contribution toward a knowledge of the crayfishes of Texas. Texas J. Sci. 10(4):452-483.
- and Guy Marlow. 1959. The genus *Cambarus* in Louisiana. Amer. Midland Natur. 61(1):191-203.
- Reimer, Rollin D. 1964. The crawfish of Arkansas. Master's Thesis. Unpublished. University of Arkansas, Fayetteville, Arkansas.
- Smith, Elsie Wayne. 1953. The life history of the crawfish *Orconectes (Faxonella) clypeatus* (Hay). Tulane Stud. Zool. 1(7):77-96.

Williams, Austin B. 1954a. Speciation and distribution of the crayfishes of the Ozark Plateaus and Ouachita Provinces. Univ. Kans. Sci. Bull. 36(12):803-918.

..... 1954b. An explanation of the distribution of a North American crayfish. Ecology 33(4):573-575.

..... and A. Byron Leonard. 1952. The crayfishes of Kansas. Univ. Kans. Sci. Bull. 34(15):961-1012.
