

A new crayfish of the genus *Orconectes* from western Tennessee (Decapoda: Cambaridae)

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Abstract—A new crayfish, *Orconectes pagei*, is described from northern and eastern flowing tributaries of the Tennessee River in western Tennessee. The species occurs in small to medium streams with sand substrate. Form I males of *O. pagei* differ from all other members of the genus *Orconectes* in being both pigmented and possessing a first pleopod with a short, laterally flattened central projection and a short, dorsoventrally flattened mesial process.

Recent re-examination of crayfishes collected from western Tennessee in the late 1970's and early 1980's housed in the Illinois Natural History Survey's Crustacean Collection, revealed the presence of several unidentifiable form II males and females from two locations in the Big Sandy River drainage. Subsequent field work in that drainage in 1996 resulted in the collection of several form I males of that unidentifiable taxon. That species, described herein as *Orconectes pagei*, is assigned to the nonimate subgenus *Orconectes*. This subgeneric assignment is based on the overall similarity in the shape of the form I male pleopod of *O. pagei* to other members of the subgenus. *O. pagei* represents the only epigean member of this subgenus and raises the total number of taxa assigned to it to seven. The remaining members of *Orconectes* (*Orconectes*) are *Orconectes* (*O.*) *australis australis* (Rhoades, 1941), *O.* (*O.*) *australis packardi* Rhoades, 1944, *O.* (*O.*) *incomptus* Hobbs & Barr, 1972, *O.* (*O.*) *inermis inermis* Cope, 1872, *O.* (*O.*) *inermis testii* (Hay, 1891), and *O.* (*O.*) *pellucidus* (Tellkampf, 1844). A subgenus that contains both epigean and troglobitic members is not uncommon in the family Cambaridae. Other described subgenera with both ecotypes include *Cambarus* (*Erebicambarus*), *C.* (*Jug-*

icambarus), *Procambarus* (*Austrocambarus*), and *P.* (*Ortmannicus*).

Orconectes pagei, new species
Figs 1 & 2, Table 1

Diagnosis.—Body and eyes pigmented. Rostrum flat anteriorly, slightly concave posteriorly, terminating in long acumen; median carina absent. Rostral margins thickened, slightly converging distally; terminating in spines (see Variation). Areola 25.0–31.5% (\bar{X} = 28.3, n = 40, SD = 1.4) of total length of carapace. Narrowest part of areola just anterior of midpoint, 5.8–15.0 (\bar{X} = 9.2, n = 40, SD = 1.9) times as long as wide with 2 to 4 (mode = 3, n = 40, SD = 0.5) punctations across narrowest part. One large cervical spine on each side of carapace. Postorbital ridges well developed, terminating in large spines. Suborbital angle weakly developed. Antennal scale broadest slightly proximal to midlength. Ischia of third pereopods of form I and form II males with hooks; hooks overreaching basioischial articulation in form I males only. Chela with 3 rows of tubercles along mesial margin of palm; small tufts of setae over mesial margin of palm, fingers, and dorsomesial surface; dorsal surfaces of fingers with well defined longitudinal ridges. Ventral surface of chela with tubercle at

base of dactyl. First pleopods of form I male symmetrical, extending to bases of third pereopods when abdomen flexed. First pleopod of form I male without distinct shoulder on cephalic surface at base of central projection; central projection corneous, constituting 8.0–11.0% ($\bar{X} = 9.2$, $n = 4$, $SD = 1.3$) of total length of first pleopod, flattened laterally and bladelike, tapering rapidly to a sharply pointed tip; mesial process equal in length and corneous, flattened dorsoventally and bladelike, tapering to acute tip. Central projection and mesial process of form I first pleopod divergent, forming wide gap between distal tips. Annulus ventralis immovable, subrhomboidal; cephalic half with median trough, lateral prominences forming anterior margin of fossa; fossa shallow with narrow lateral width; sinuate sinus running from center of fossa to caudal edge.

Description of holotypic male, form I.—Body slightly compressed laterally, thorax slightly wider than abdomen (16.3 and 14.8 mm, respectively). Greatest width of carapace slightly larger than height at caudo-dorsal margin of cervical groove (16.3 and 14.4 mm respectively). Postorbital carapace length 91.0% of length of carapace. Areola 9.7 times longer (10.7 mm) than wide (1.1 mm) with 2 punctations across narrowest part: length of areola 30.9% of length of carapace. Rostrum with scattered punctations and setae, posterior half slightly excavated; margins slightly converging anteriorly, fringed with setae and terminating in small rounded tubercles. Acumen terminating in corneous spine reaching nearly to end of antennular peduncle. Postorbital ridges well developed, terminating in corneous spines. Suborbital angle poorly developed. Cervical spine large and corneous; dorsal and branchiostegal areas of carapace punctate.

Abdomen longer than carapace (40.5 and 34.6 mm, respectively). Cephalic section of telson with 1 movable and 1 immovable spine in each caudolateral corner. Protopodite of uropod with spine extending over en-

dopodite and spine in caudolateral corner extending over exopodite. Caudal margin of cephalic section of exopodite with numerous spines (15) and 1 movable spine in caudolateral corner. Lateral margin of endopodite terminating in spine; endopodite with prominent median ridge terminating in premarginal spine. Dorsal surfaces of telson and uropods setiferous.

Antennal scale broadest slightly proximal to midlength; thickened lateral margin terminating in large corneous spine. Left antennal scale 8.5 mm long, 3.7 mm wide.

Mesial surface of palm of left chela with 3 rows of tubercles, 10 tubercles in middle row, 6 in dorsal-most row, and 4 in ventral-most row; dorsal and lateral surfaces of palm covered with many small setiferous punctations. Ventral surface of palm of chela with corneous spine at base of dactyl. Dorsal and ventral surfaces of finger of propodus with submedian longitudinal ridges flanked by setiferous punctations, small tuft of setae at base; basal half of opposable margin with 5 weakly developed tubercles. Dorsal and ventral surfaces of dactyl with submedian longitudinal ridges flanked by setiferous punctations. Fingers with subterminal corneous tips.

Carpus with deep oblique furrow dorsally; mesial surface with 1 tubercle at distal end, large corneous procurved spine just distal to midlength, small corneous spine at midlength; ventral surface with 2 corneous spines at midlength of distal margin. Dorsodistal surface of merus with 2 large corneous spines; ventral surface with 2 large corneous spines just distal to midlength of ventrolateral margin and mesial row of 9 tubercles, some corneous; row terminating in large corneous spine. Ischium with 2 small corneous spines on mesial margin.

Hook on ischium of third pereopod only; hook simple, overreaching basioischial articulation and not opposed by tubercle on basis. Right fifth pereopod absent. First pleopod as in Diagnosis, reaching just cephalic to bases of third pair of pereopods when abdomen flexed.

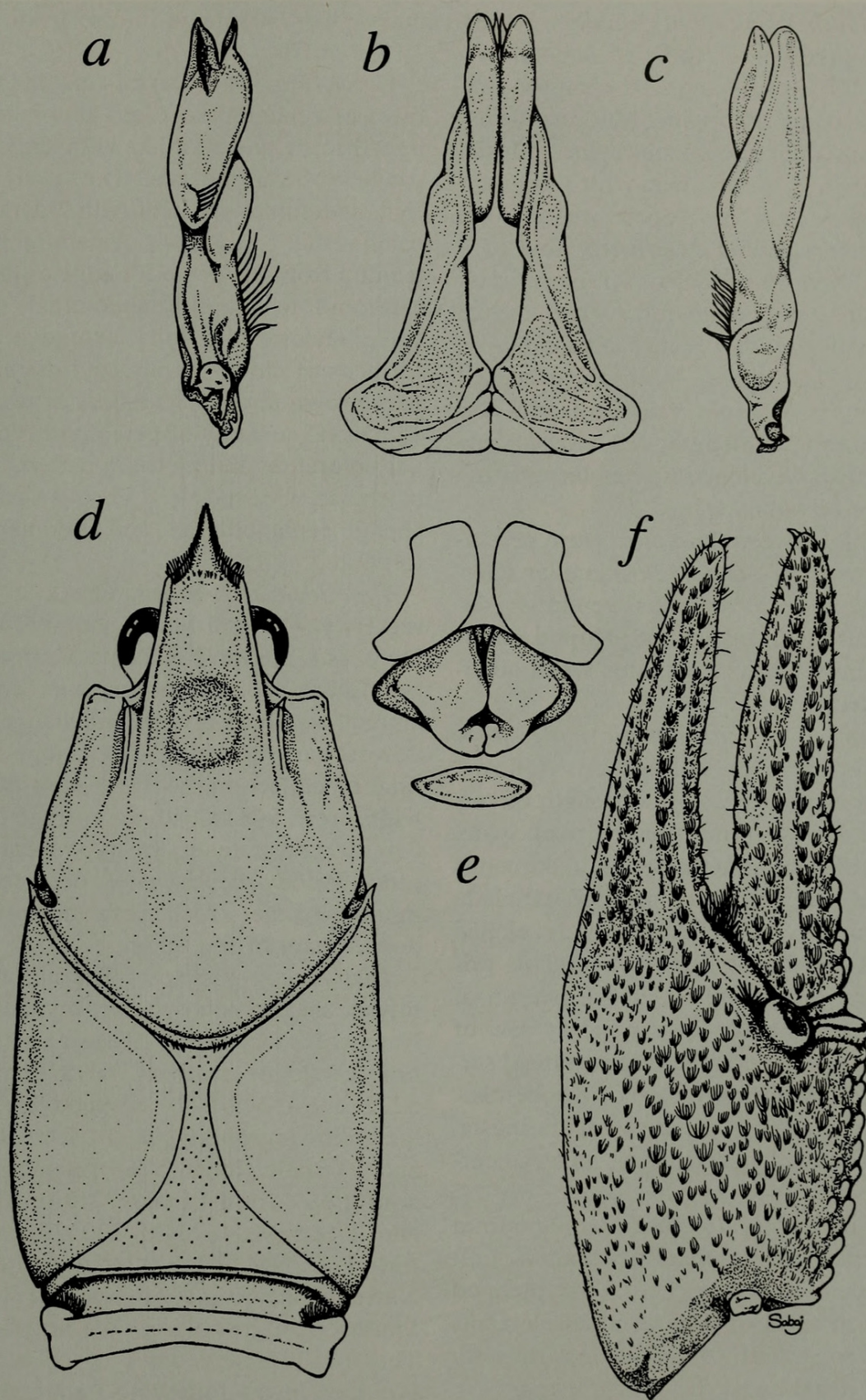


Fig. 1. *Orconectes pagei*, new species: a, Mesial view of first pleopod of form I male; b, Caudal view of first pleopods of form I male; c, Lateral view of first pleopod of form II male; d, Dorsal view of carapace; e, Annulus ventralis; f, Dorsal view of left chela. Figures 1a, 1b, 1d, and 1f are of holotype (INHS 5785); figure 1c is of morphotype (INHS 5777); figure 1e is of allotype (INHS 5772).

Description of allotypic female.—Differing from holotype as follows. Areola constituting 28.5% of length of carapace and 8.7 times longer than wide. Margins of rostrum terminating in corneous spines. Mesial margin of palm of left chela with secondary row of 5 weakly developed tubercles on dorsal surface lateral to primary row of 7 tubercles. Ventral surface of left merus with large spine in distolateral corner, mesial margin with row of 7 spines terminating in large corneous spine. Ventral surface of right merus with 2 spines in distolateral corner, 2 spines at midlength, and a mesial row of 4 weakly developed spines terminating in 2 large corneous spines.

Sternum between third and fourth pereopods narrowly V-shaped. Postannular sclerite $\frac{1}{2}$ as wide as annulus ventralis (described in Diagnosis). First pleopod uniramous, barely reaching annulus when abdomen flexed.

Description of morphotypic male, form II.—Differing from holotype as follows. Areola constituting 28.0% of length of carapace and 14.8 times longer than wide. Margins of rostrum terminating in corneous spines. Mesial margin of palm of left chela with secondary row of 6 weakly developed tubercles on dorsal surface lateral to primary row of 6 tubercles, mesial margin of palm of right chela with secondary row of 6 weakly developed tubercles on dorsal surface lateral to primary row of 8 tubercles. Ventral surfaces of meruses with mesial row of 7 tubercles terminating in large corneous spines.

Hook on ischium of third pereopod not overreaching basioischial articulation. Left second pereopod detached. First pleopod of uniform texture; both terminal elements noncorneous and of equal length with rounded distal ends.

Size.—The largest specimen examined is the holotype, a 34.6 mm CL form I male. Females ($n = 6$) range in size from 20.0 to 27.4 mm CL. Form I males ($n = 4$) range in size from 16.3 to 34.6 mm CL. Form II

males ($n = 30$) range in size from 15.6 to 29.8 mm CL.

Color.(Fig. 2).—Dorsal and lateral surfaces of cephalothorax and abdomen tan to light brown and mottled with dark brown patches of varying size. Dorsal surface of each abdominal segment with 2 dark brown patches that form a pair of parallel bars extending from the posterior edge of the cephalothorax to the 5th abdominal segment when abdomen is fully extended. Dorsal surfaces of chela, carpus, and merus tan to light brown in color with dark brown patches. Dorsal surfaces of pereopods with similar coloration and mottling pattern. Fingers of chelae with red tips. Ventral surfaces of chelae, cephalothorax, and abdomen cream to white.

Type locality.—Morris Creek at Tennessee Hwy. 424, 0.5 km W jct. W/Tennessee Hwy. 114, 1.6 km NE Yuma, Carroll County, Tennessee. Holotype was collected among woody debris in midchannel, 25 m downstream of Hwy. 424 bridge. At the time of collection, Morris Creek ranged in width from 5–8 m with an average depth of 0.4 m. Substrate at the type-locality was sand. Woody debris piles occurred commonly in the creek both upstream and downstream of the bridge.

Disposition of types.—The holotype, allotype, and morphotype are in the Illinois Natural History Survey Crustacean Collection (catalogue numbers INHS 5785, INHS 5772, and INHS 5777, respectively), as are the following paratypes: 14 form II males and 1 female (INHS 5764); paratypes consisting of 2 form I males, 2 form II males, and 2 females (USNM 130530), and one form I (USNM 284135) are deposited at the National Museum of Natural History, Smithsonian Institution, Washington, D.C. The localities and dates of collection are provided in the following Range and specimens examined section.

Range and specimens examined.—*Orconectes pagei* is confined to streams draining the Cretaceous McNairy Sand and Coon Creek formations which occur as a



Fig. 2. A 25.7 mm carapace length ♂ II *Orconectes pagei* collected from Hunting Creek, 1.6 km E Bruceton, Carroll Co., Tennessee on 9 May 1996.

Table 1.—Measurements (mm) of *Orconectes pagei*, new species.

	Holotype	Allotype	Morpho- type
Carapace:			
Total length	28.8	27.4	21.1
Postorbital length	26.1	20.7	15.5
Width	16.3	13.2	9.6
Height	14.4	13.1	8.9
Areola:			
Width	1.1	0.9	0.4
Length	10.7	7.8	5.9
Rostrum:			
Width	5.3	4.4	3.3
Length	9.2	7.6	6.0
Chela, left:			
Length, palm mesial margin	10.1	5.2	4.4
Palm width	11.0	5.9	4.6
Length, lateral margin	30.5	14.9	13.6
Dactyl length	16.9	7.5	7.2
Abdomen:			
Width	14.8	13.5	9.1
Length	40.5	33.8	25.0

narrow north-south band along the eastern edge of the crest of the Coastal Plain in Henry, Benton, Carroll, and Henderson counties, Tennessee (Fig. 3). The northernmost record for this species is Eagle Creek, a tributary of the Tennessee River in Henry County; the southernmost record being from Middleton Creek, a tributary of White Oak Creek in Henderson County. *Orconectes pagei* is most common in tributaries of the northern flowing Big Sandy River. Its propensity for streams with pure sand substrate of the McNairy Sand and Coon Creek formations most likely restricts its distribution to headwater streams of the Beech River and White Oak Creek drainages. Downstream portions of both of these drainages, and drainages south of White Oak Creek (e.g. Beason, Snake, Lick, and Chambers creeks), flow through high level alluvial deposits and are characterized by predominantly gravel substrates. In eastward flowing drainages of the Tennessee River south of White Oak Creek, *O. pagei*

is replaced by *Orconectes (Faxonius) wrighti* Hobbs, 1948.

A total of 81 specimens from 14 localities have been examined from the following Tennessee counties: Benton County: 1) INHS 780, Big Sandy River at TN Hwy. 69, 3.2 km W Big Sandy, 26 Apr 1978 (2 ♂ II, 1 ♀); Carroll County: 2) USNM 148879, Hollow Rock Branch at Bruceton, 7 Jun 1978 (1 ♂ II); 3) INHS 5764, Morris Creek at TN Hwy. 424, 1.6 km NE Yuma (type locality), 9 May 1996 (14 ♂ II, 1 ♀, all paratypes); INHS 5785, INHS 5784, 15 Jul 1996 (holotype and 1 ♂ I, 8 ♂ II, 3 ♀,); 4) INHS 5772, INHS 5771, Hunting Creek at Old S.R. 1, 1.6 km E Bruceton, 9 May 1996 (allotype and 4 ♂ II,); Henderson County: 5) USNM 130530, Owl Creek at Rt. 20, 1 km E Lexington, 16 Apr 1969 (2 ♂ I, 2 ♂ II, 2 ♀, all paratypes); 6) INHS 5641, Haley Creek at Davis Rd., 8 km E Lexington, 11 Jun 1996 (1 ♂ I, 3 juvenile ♂, 2 ♀, 3 juvenile ♀); 7) INHS 5781, Middleton Creek at TN Hwy. 100, 3.4 km NNE Roby, 11 Jun 1996 (5 ♂ II, 5 ♀); Henry County: 8) INHS 5766, McGowen Branch at India Rd., 1.6 km NE Paris, 8 May 1996 (2 ♂ II); 9) INHS 5777, INHS 5776, Barnes Fork Creek at Reynoldsburg Rd., 7.2 km SSE Paris, 8 May 1996 (morphotype and 2 ♂ II, 2 ♀); 10) INHS 5778, USNM 284135, Gin Creek at Copper Springs Rd., 6 km WSW Big Sandy, 16 Apr 1996 (1 ♂ I, 1 ♂ I paratype to UNSM); 11) INHS 778, trib. Barnes Fork Creek 0.5 km downstream TN Hwy. 77, 1.6 km N Van Dyke, 4 May 1981 (1 ♂ II); 12) INHS 5634, West Sandy Creek at TN Hwy. 641/69, 4.2 km S Oakwood, 16 Oct 1996 (8 ♂ I, 4 ♂ I, 2 juvenile ♀); 13) INHS 5626, Holly Fork Creek at TN Hwy. 79, 1.2 km SW Nobles, 17 Oct 1996 (3 ♂ I, 3 ♂ II); 14) INHS 5637, Eagle Creek at TN Hwy. 79, 4 km SW Oak Hill, 17 Oct 1996 (1 ♂ I).

Etymology.—Named in honor of Dr. Lawrence M. Page, Principal Scientist and Curator of Fishes at the Illinois Natural History Survey. Dr. Page has contributed greatly to our knowledge of midwestern cray-



Fig. 3. Known range of *Orconectes pagei*. Type locality denoted by star. 1 = Mississippi River, 2 = Tennessee River, 3 = Big Sandy River.

fishes and continues to show an intense interest in the conservation and systematics of all aquatic organisms. This broad interest has been inherited by many of his co-workers and students.

Habitat and life-history notes.—During field sampling, all individuals were collect-

ed from small to medium-sized streams with sand substrate. Within these creeks, the species occurred exclusively in woody debris piles composed primarily of fallen tree limbs and bark in midchannel and along stream banks in areas with slow to moderate current. *Orconectes pagei* is

strongly associated with sand substrate; the species was never collected from streams within its range with even the smallest amount of gravel or cobble substrate.

Form I males have been collected in the months of April, July, and October. Field collection efforts from April through July 1996 revealed form I males to be uncommon, accounting for only four of the 51 specimens collected. In October, form I males were much more common, accounting for 12 of the 21 specimens collected. Juveniles were observed in June and October. Ovigerous females were collected in the months of April and May. Two ovigerous females collected on 8 May 1996 measured 18.5 and 14.5 mm CL and carried 101 and 43 eggs, respectively. Eggs were spherical and ranged from 1.7 to 1.8 mm in diameter.

Crayfish associates.—The following species were collected from habitats containing *O. pagei*: *Cambarus* (*Depressicambarus*) *striatus* Hay, 1902, *Orconectes* (*Trisellescens*) *validus* (Faxon, 1914), *Procambarus* (*Ortmannicus*) *viaeviridis* (Faxon, 1914), and *P. (O.) acutus* (Girard, 1852).

Variation.—Size of spines on rostral margins appears to be inversely proportional to carapace length. Juveniles and small individuals (ca. <25 mm CL) have large, well developed spines while larger individuals, such as the holotype, have margins that terminate in rounded tubercles.

Comparisons.—*Orconectes pagei* differs from all other members of *Orconectes* in the shape of the form I male gonopod and by being pigmented. The gonopod of *O. pagei* is unique to pigmented members of the genus in possessing all of the following characteristics: terminal elements short, central projection comprising less than 12% of total length of gonopod; elements divergent; central projection laterally flattened, tapering rapidly to acute tip distally; mesial process flattened dorsoventrally and blade-like.

Relationships.—In his subgeneric reorganization of the genus *Orconectes*, Fitz-

patrick (1987) stated that in crayfishes, most external morphological features are difficult to use for inferring intergroup relationships because they are readily modified to adapt to environmental conditions. While still variable, Fitzpatrick (1987) suggests that structures associated with amplexus are less susceptible to environmental modification and offer reliable characters for subgeneric classification. Since the form I male gonopod of *Orconectes pagei* is most similar to those of members of the subgenus *Orconectes*, we follow Fitzpatrick's contention and tentatively assign *O. pagei* to this subgenus. Within the subgenus *Orconectes* the form I gonopod of *O. pagei* is most similar to *Orconectes inermis testii*, a troglobitic species that occurs in south-central Indiana. *Orconectes pagei* presents somewhat of a dilemma in that it is pigmented, has developed eyes, possesses hooks on ischia of the third pereopods only, and occurs in epigean habitats roughly 230 miles south of the known range of *O. inermis testii*. Future genetic analysis planned for *O. pagei* and other members of the genus will shed new light on interspecific and intersubgeneric relationships within *Orconectes* and possibly determine whether this unique species deserves its own subgeneric status.

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