

DISTRIBUTION AND TAXONOMY OF THREE SPECIES
OF *ORCONECTES* (DECAPODA: CAMBARIDAE) IN ILLINOIS, U.S.A.

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A B S T R A C T

We examined Ohio and Mississippi River specimens of *Orconectes* that had been identified previously as *O. placidus* and collected new specimens or examined types of *Orconectes luteus*, *O. placidus*, *O. forceps*, *O. medius*, and *O. rusticus* from Illinois and other states. Our analyses revealed the presence of three species of *Orconectes* in the Ohio and Mississippi rivers, *Orconectes luteus*, *O. placidus*, and *O. sp.* (undescribed), based on chela morphometrics, gonopods, carpal spines, chela denticles, and life colors. All the Mississippi River records of *O. placidus* were *O. luteus*, and many of the Ohio River records of *O. placidus* were *O. n. sp.* Distinguishing characteristics for all three species, along with an addition to the dichotomous key to Illinois decapods, were included. The ranges of *O. luteus*, *O. placidus*, and *O. n. sp.* in Illinois were amended. Several problems were noted with the syntypes of *O. placidus* such as erroneous locality, misidentification, and mixing of specimens between localities. The ratio dactylus length/palm mesial margin length, which has been considered a distinguishing characteristic between *O. forceps* and *O. placidus*, was invalidated as a useful discriminator for these species, whereas presence or absence of a distomedian carpal spine was reliable. We consider *Orconectes luteus* and *O. n. sp.* native inhabitants of Illinois, and the latter species likely occurs in Kentucky portions of the Ohio River as well.

The placid crayfish (common name proposed herein), *Orconectes (Procericambarus) placidus* (Hagen, 1870), has a restricted distribution in southern Illinois, which is the northern extent of its range (Page, 1985). The placid crayfish also occurs in parts of Kentucky, Tennessee, and Alabama (Rhoades, 1944; Hobbs, 1989). The golden crayfish, *Orconectes (Procericambarus) luteus* (Creaser, 1933), occurs in Missouri, Kansas, Arkansas, and Illinois (Creaser, 1933; Williams, 1954; Pflieger, 1996; Minckley and Deacon, 1959; Metcalf and Distler, 1961; Ghedotti, 1998), but it was not included as part of the Illinois fauna until recently (Taylor, 1996; Wetzel and Poly, 2000). The placid crayfish is listed as an endangered species in Illinois, whereas the golden crayfish has no status because of its recent discovery (Illinois Endangered Species Protection Board, 1999). Little information on taxonomy or life history has been published about these species of crayfishes (Williams, 1954; Boyd and Page, 1978; Page, 1985; Pflieger, 1996; Muck *et al.*, 2002).

Page (1985) gave the Illinois distribution of *Orconectes placidus* as the lower Mississippi River, the Ohio River, and the Big Creek

drainage (Ohio R.) and noted that some Illinois specimens presented taxonomic difficulties. After we captured *O. luteus* at Grand Tower, Illinois, we questioned whether the Mississippi River specimens listed as *O. placidus* in Page (1985) might be *O. luteus* because of the proximity to the Mississippi River border in Missouri where *O. luteus* occurs (Pflieger, 1996). Also, several collection sites shown in Pflieger (1996) for *O. luteus* appeared to be in the mainstem of the Mississippi River, and one of the records of *O. placidus* in Page (1985) was on the West side of the main channel of the Mississippi River (on Kaskaskia Island). Hagen (1870) included specimens from Texas, Tennessee, and Illinois as syntypes of *O. placidus*, but the species does not occur in Texas (Penn and Hobbs, 1958; see also Results and Discussion sections). We borrowed museum specimens (including type specimens) and made recent collections of *O. luteus* and “*O. placidus*” in Illinois to compare their characteristics and to define their ranges in the state. Our study demonstrates that *O. luteus*, *O. placidus*, and an undescribed species of *Orconectes* (leopard crayfish) occur in Illinois, and we provide

distinguishing characteristics for the three species.

MATERIALS AND METHODS

Specimens of *Orconectes luteus*, *O. placidus*, *O. rusticus* (Girard, 1852), and *O. n. sp.* were collected from 20 sites in Illinois, Missouri, and Ohio during 1999–2002 and were preserved in 70–80% EtOH. We noted life colors of each species, and color photographs were taken of individuals of each species. Form (I or II) was noted for both male (M) and female (F) crayfishes (see Wetzel, 2002, for details of form alternation in females). Additional specimens from museums were studied (see Material Examined), including type specimens of *Orconectes (P.) forceps* (Faxon, 1884), *O. (P.) medius* (Faxon, 1884), *O. placidus*, and *O. luteus*. Museum names and acronyms were as follows: Illinois Natural History Survey, Champaign, Illinois (INHS); Monte L. Bean Museum (Brigham Young University) Crustacean Collection, Provo, Utah (MLBM BYUC); Museum of Comparative Zoology, Cambridge, Massachusetts (MCZ); Museum National d'Histoire Naturelle, Paris, France (MNHN); National Museum of Natural History, Washington, D.C. (USNM); North Carolina State Museum of Natural Sciences, Raleigh (NCSM); and Ohio State University Museum of Biological Diversity, Columbus (OSUMC). Carapace length (CL) and the following chela measurements were recorded to the nearest 0.1 mm using digital calipers: chela length, chela palm width, chela depth, propodus width (taken at middle of finger), dactylus width (taken at middle of finger), dactylus length, palm mesial margin length, and gap between fingers at widest point between closed fingers (the latter two characters for *O. placidus*, *O. forceps*, and *O. n. sp.* only). We measured 166 *Orconectes luteus* (59 MI, 17 MII, 75 FI, 15 FII), 91 *O. placidus* (38 MI, 12 MII, 32 FI, 9 FII), 169 *O. n. sp.* (9 MI, 81 MII, 7 FI, 72 FII), 7 *O. forceps* (3 MI, 4 FI), 2 *O. medius* (1 MI, 1 FI), and 4 *O. sp. indet.* (some *O. placidus* syntypes) (3 MI, 1 MII), excluding chelae that appeared to be regenerated. The number of rows of denticles were counted at the widest portion of the line of denticles.

Gonopods, chela denticles, and carpal spines of MI were examined with light (LM) and scanning electron microscopy (SEM) ($n = 2$ *O. luteus*, 2 *O. placidus*, and 1 *O. n. sp.* with SEM). For SEM, body parts were washed with detergent, sonicated, critical point dried, sputter coated with gold/palladium, and examined with a Hitachi S-570 SEM at 20 kV.

We compared means of several ratios for differences among species. Dactylus length/dactylus width was compared between *O. luteus* and *O. placidus* using the Mann-Whitney *U* test because of unequal variances, and the same test was used to compare dactylus length/chela gap width between *O. placidus* and *O. n. sp.* Chela length/chela width was compared among *O. luteus*, *O. placidus*, and *O. n. sp.* using one-way ANOVA and the Scheffé multiple comparisons procedure. Results were considered significant at $\alpha = 0.05$ (adjusted for number of comparisons with the Scheffé test ($\alpha = 0.0167$) and Mann-Whitney *U* test ($\alpha = 0.025$)). All statistics were performed with StatView 5.0 (SAS Institute, Inc., 1999).

RESULTS

We found three crayfish species, including an undescribed species, present among the specimens formerly identified as *Orconectes placidus*

in Illinois. *Orconectes luteus* occurred in the Mississippi River mainstem from Kaskaskia Island downstream to southern Alexander County as well as in Apple Creek in the Illinois River drainage. *Orconectes placidus* occurred in the Big Creek drainage (Hardin County) and Ohio River downstream to Joppa. *Orconectes n. sp.* was distributed from 5.5 km upstream of Joppa to Cairo in the lower Ohio River (Fig. 1).

The ratio dactylus length/dactylus width differed significantly between *O. luteus* and *O. placidus* (Mann-Whitney *U*, $P < 0.0001$), and this ratio provided good separation when displayed graphically (Fig. 2 A, B). A significant difference was found between *O. placidus* and *O. n. sp.* in mean dactylus length/chela gap width (Mann-Whitney *U*, $P < 0.0001$; Fig. 3), and mean chela length/chela width differed significantly among *O. luteus*, *O. placidus*, and *O. n. sp.* (ANOVA, $P < 0.0001$; Table 1). Dactylus length/palm mesial margin length was compared among *O. forceps*, *O. placidus*, and *O. n. sp.*; only 22% (14 M, 5 F of 87) of *O. placidus*, mostly larger males, had a ratio greater than or equal to 2.5, and the three species could not be distinguished with this ratio (Fig. 4, see Discussion for additional comments). However, *O. n. sp.* and *O. forceps* lacked a distomedian spine on the ventral surface of the carpus, whereas on *O. placidus* the spine is usually well developed and on *O. luteus* it is usually moderately developed (Fig. 5 A–C). The overall shape of the chelae of *O. n. sp.* differentiated it from the other species (Fig. 6D). The denticles on the inner margins of the dactylus and propodus of the cheliped were 3–6 rows wide in *O. luteus* compared to 1 or 2 rows wide in *O. placidus*, *O. forceps*, and *O. n. sp.* (Fig. 5 D–F).

Gonopod structure was diagnostic between form I male *O. luteus* and both taxa that occur in the Ohio River. The gonopod of *O. luteus* had a definite cephalic shoulder, whereas gonopods of *O. placidus*, *O. forceps*, and *O. n. sp.* did not have the shoulder. In addition, the shape of the tip of the central projection differed between *O. luteus* and the other species in that the tip was about half the width in *O. luteus* compared with similar-sized individuals of the other species (Fig. 5 G–I). However, *O. n. sp.*, *O. forceps*, and *O. placidus* could not be distinguished by the shape of the central projection tip (Fig. 5 H, I). Although the gonopods were shown as SEM images for clarity, the overall differences and similarities in shape among gonopods were

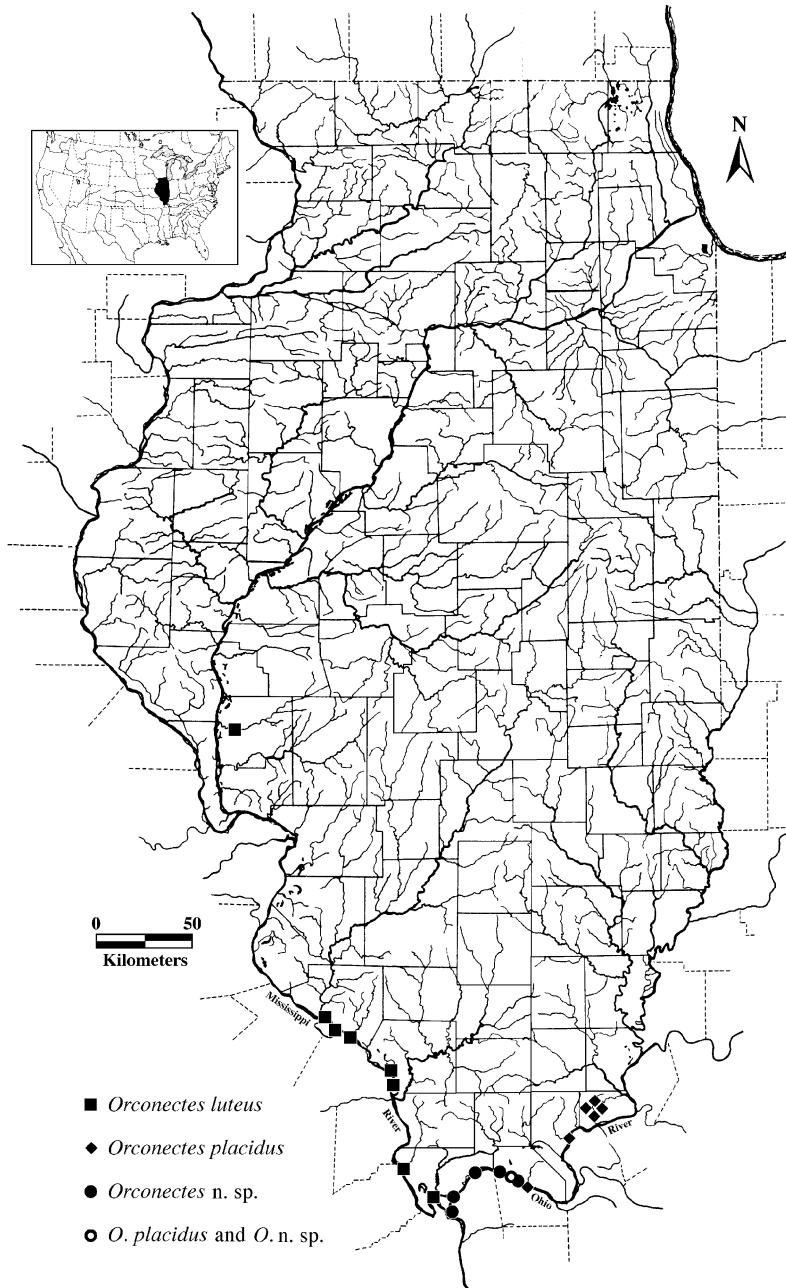


Fig. 1. Distribution of three species of *Orconectes* in Illinois that were collectively referred to as *O. placidus* in Page (1985). The third square (top to bottom) in the Mississippi River denotes two collection sites for *O. luteus* (Chester and mouth of Marys River), and the most upstream location (solid circle) for *O. n. sp.* in the Ohio River represents two collection sites.

readily apparent with light microscopy, and gonopod shape was consistent within species regardless of differences in CL.

Life colors were distinctive among *O. luteus*, *O. placidus*, and *O. n. sp.* (Fig. 6). *Orconectes*

placidus usually had prominent, wide, black bands on the tips of the dactylus and propodus of the cheliped (Fig. 6C), whereas shorter, dark bands may or may not be present on *O. luteus* and *O. n. sp.* A broad, black stripe spanned the length

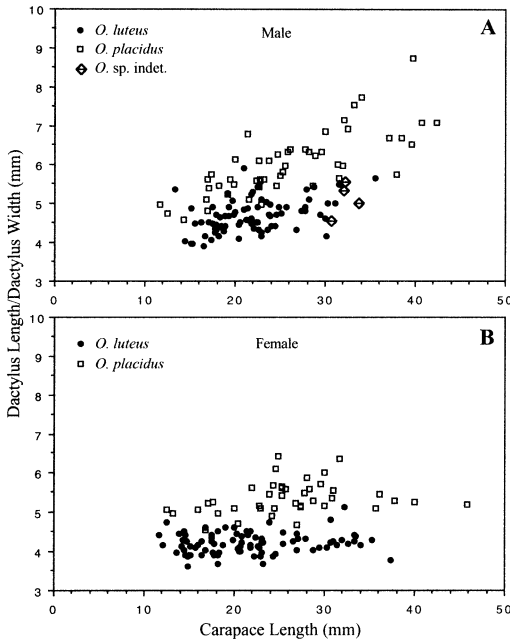


Fig. 2. Scatterplots of the ratio dactylus length/dactylus width (mean \pm SD) for male and female *Orconectes luteus* (4.454 ± 0.418 , $n = 166$) and *O. placidus* (5.759 ± 0.741 , $n = 91$). Means differed significantly between species with both sexes included (Mann-Whitney U , $P < 0.0001$). *Orconectes* sp. indet. (MCZ 170, $n = 3$ [of 4] and MCZ 289, $n = 1$ [of 7]) were included to show differences in ratio for these syntypes.

of the lateral margin of the cheliped propodus of *O. placidus*. The anterior black saddle on the carapace extended posterior to the cervical groove in *O. placidus*, whereas the black saddle was restricted to the area anterior to and including the cervical groove in *O. luteus* (Fig. 6B, C). The chelipeds of *O. placidus* also had a prominent black tubercle on the propodus at the base of the dactylus, unlike *O. luteus*, which had an orange-red tubercle, and other body spines and dactyls of walking legs of *O. luteus* were orange-red as well. The color of *O. n. sp.* was quite unlike the other species in being a base color of brown, with varying degrees of speckling or blotching on the chelae, carapace, and abdomen (Fig. 6D). There were no black bands across the carapace of *O. n. sp.* as those found on *O. luteus* and *O. placidus*. *Orconectes luteus* from Apple Creek (not shown) were not as vibrantly colored as specimens from the Mississippi River or other rivers in southern Missouri. *Orconectes placidus* from the Big Creek drainage had the boldest markings (Fig. 6C), whereas those from the Ohio River (not shown) were dull, and some specimens from

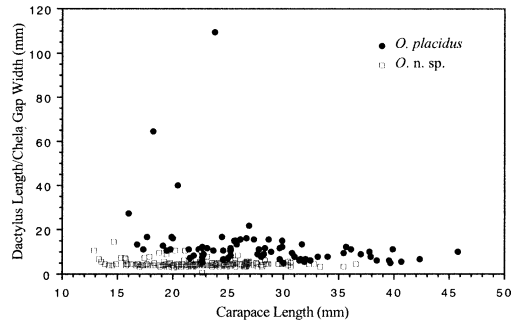


Fig. 3. Scatterplot of the ratio dactylus length/chela gap width (mean \pm SD) for *Orconectes placidus* (13.766 ± 14.132 , $n = 72$) and *O. n. sp.* (5.135 ± 1.568 , $n = 169$). Means differed significantly between species with both sexes included (Mann-Whitney U , $P < 0.0001$).

Joppa were pale green with subdued bands on the chelae and little trace of the black saddles on the carapace. *Orconectes rusticus* was included because of its placement in the dichotomous key relative to other species included herein and because it could be confused with *O. luteus*. With life colors, *O. rusticus* could be distinguished from the other three by the prominent rusty spot on each side of the posterior lateral margins of the carapace (Fig. 6A). The following couplets can be substituted for couplet 17 of the dichotomous key in Page (1985):

- 17a. Dorsal (cephalic when lifted from body) surface of gonopod with shoulder (Fig. 42), central projection tapers to narrow tip; three or more rows of denticles on inner margins of propodus and dactylus of cheliped 17b
- 17a. Dorsal surface of gonopod without shoulder (Fig. 43), central projection with broader, spatulate tip; one or two rows of denticles on inner margins of propodus and dactylus of cheliped 17c
- 17b. Cephalic shoulder of gonopod well-developed; prominent rusty spot posterior and lateral on carapace *Orconectes rusticus* (p. 412; Fig. 6A in Poly and Wetzel, 2003 [present paper])
- 17b. Cephalic shoulder of gonopod not well-developed; orange-red tubercle at base of dactylus of cheliped; spines on body and dactyls of walking legs often orange-red *Orconectes luteus* (see Pflieger, 1996, p. 92; Fig. 6B in Poly and Wetzel, 2003 [present paper])
- 17c. Distomedian spine present on ventral surface of carpus; prominent black band on tips of dactylus and propodus of cheliped and black tubercle at base of dactylus of cheliped *Orconectes placidus* (p. 404; Fig. 6C in Poly and Wetzel, 2003 [present paper])
- 17c. Distomedian spine absent on ventral surface of carpus; chelae, carapace, and abdomen often with

Table 1. One-way ANOVA results for the ratio chela length/chela width (mean \pm SD mm) of *Orconectes luteus* (2.378 ± 0.154 , $n = 166$), *O. placidus* (2.670 ± 0.173 , $n = 91$), and *O. n. sp.* (2.462 ± 0.144 , $n = 169$). All pairwise comparisons differed significantly (Scheffé multiple comparisons procedure, all $P < 0.0001$, adjusted $\alpha = 0.0167$).

Source of variation	df	SS	MS	F	P	α
Species	2	5.052	2.526	105.705	<0.0001	0.05
Error	423	10.108	0.024			
Total	425	15.160	2.550			

speckles or irregular blotches of dark pigment

..... *Orconectes*
n. sp. (undescribed) (Fig. 6D in Poly and Wetzel,
 2003 [present paper])

Based on our determinations, three of four specimens in MCZ 170 and one specimen in MCZ 289 (the largest male) were not *O. placidus* (both lots contain syntypes). The largest specimen (MII) in MCZ 289 had denticle patterns, chela dimensions, and overall appearance of those in MCZ 170. All three MI specimens in MCZ 170 possessed a definite shoulder on the gonopods, whereas *O. placidus* did not have a cephalic shoulder on the gonopods (MCZ 296). In addition, three MI specimens in MCZ 170 and the largest MII specimen in MCZ 289 were similar in chela dimensions and did not agree with *O. placidus* (Fig. 2). One MII specimen in MCZ 170 was *O. placidus* (see Discussion).

The specimens of *Orconectes placidus* in the "Würzburg Museum" (Institut für Zoologie, Universität Würzburg) cited by Faxon (1914: 418) and Hobbs (1989: 48) were no longer extant (much of that collection was destroyed during World War II, personal communication from Drs. Erhard Strohm and Peter Wolbert, 20 June 2000). The same authors reported type specimens were at the Australian Museum, Sydney, but types of *O. placidus* were not found in that collection (Penny Berents, personal communication, 14 June 2000).

DISCUSSION

Based on our analyses, recent collections, and reidentifications of specimens, the present range of *Orconectes luteus* in Illinois is from Apple Creek (a tributary of the lower Illinois River) to south of Horseshoe Lake in the Mississippi River, whereas *O. placidus* occurs in the lower Ohio River and Big Creek drainage and *O. n. sp.* in the lower Ohio River of Illinois (Fig. 1).

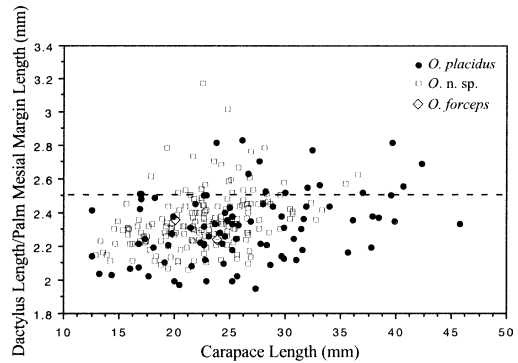


Fig. 4. Scatterplot of the ratio dactylus length/palm mesial margin length (mean \pm SD) for *Orconectes placidus* (2.326 ± 0.206 , $n = 87$), *O. forceps* (2.310 ± 0.085 , $n = 2$), and *O. n. sp.* (2.361 ± 0.171 , $n = 169$).

Orconectes n. sp. and *O. placidus* have been collected sympatrically and syntopically only at Joppa, Illinois.

Orconectes luteus was considered an introduced species by Taylor (1996) when discovered in Apple Creek, Greene County, Illinois. However, it is clear now that the species is native to Illinois when considering its distribution in Missouri. Genetic affinities of *O. luteus* from Apple Creek to populations in northeastern Missouri and direct tributaries of the Mississippi River in southeastern Missouri also support this contention (J. W. Fetzner, Jr., personal communication). Color variations occur among different populations of *O. luteus* (Pflieger, 1996; J. W. Fetzner, Jr., personal communication), and the Illinois River drainage population differed in color from those in the Mississippi River (authors, personal observation). However, we did not collect any recently molted (i.e., "clean") specimens from Apple Creek; thus, their dull coloration could have been due to accumulated debris on the exoskeleton. Even though life colors can be variable, color should be noted or documented with a photograph whenever crayfishes are collected because it is a valuable taxonomic character. We have been unable to distinguish among *O. luteus* populations in Missouri and Illinois using morphological characters (chelae, gonopods). However, the taxonomic status of *O. luteus* as presently defined might change after further study of the species across its range. Fetzner and Crandall (1999) performed genetic analyses to determine relationships among populations of *Orconectes luteus* in Missouri, and additional samples from Missouri and Illinois were

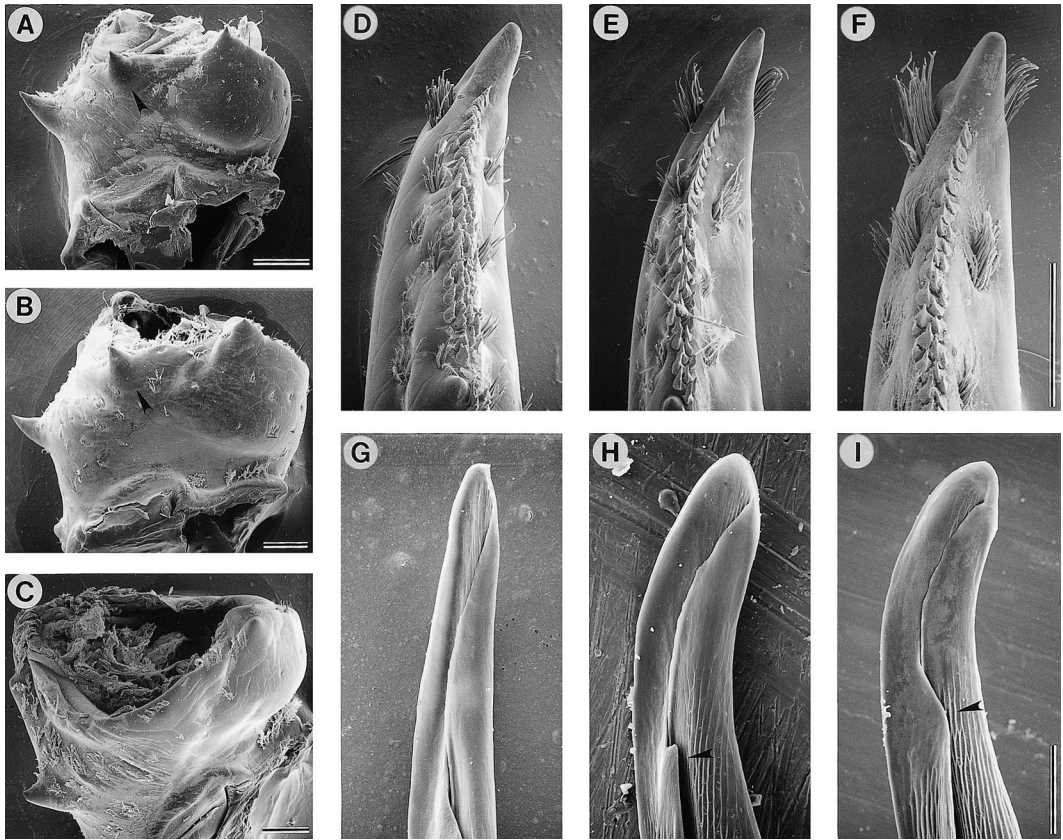


Fig. 5. Carpal spines of (A) *Orconectes luteus*, (B) *O. placidus*, and (C) *O. n. sp.* (ventral view of carpus; arrows indicate distomedian carpal spine, if present). Denticles on dactylus of (D) *O. luteus*, (E) *O. placidus*, and (F) *O. n. sp.* (denticle patterns of *O. forceps* (not shown) are the same as those in E and F). Tips of MI gonopods (mesial view) of (G) *O. luteus*, (H) *O. placidus*, and (I) *O. n. sp.* (arrows indicate differences in sculpturing between the species [H, I]) (A, D: 21.1 mm CL, Mississippi R., INHS 9104); (G: 24.7 mm CL, Apple Cr., MCZ 47134); (B, H: 24.6 mm CL, Ohio R., INHS 9112); (E: 21.3 mm CL, Big Creek, MCZ 47137); (C, F, I: 26.1 mm CL, Ohio R., MCZ uncat.). Scale bars = 1 mm (A–F [bar on F also for D, E]); 100 μ m (G–I [bar on I also for G, H]).

examined for a more comprehensive study of population genetic structure of *O. luteus* (J. W. Fetzner, Jr., personal communication).

Two additional native species of *Orconectes* are now known to occur in Illinois waters, and within the state, the range of *O. placidus* is restricted to the Ohio River and Big Creek drainage in southeastern Illinois. *Orconectes placidus* usually is abundant where it occurs in the Big Creek drainage and in the Ohio River mainstem. The taxonomic status of some syntype specimens may be doubtful, but we know that some specimens clearly are not *O. placidus*. Long ago, Ortmann (1931: 80) indicated that specimens in MCZ 170 were not *O. placidus*, and he cited the presence of the cephalic shoulder on MI gonopods as his evidence. That the MCZ lots contain mixtures

of species has not been noted before. We believe that specimens may have been transposed between MCZ 170 and MCZ 289. We consider the locality information (“Quincy, Illinois”) for MCZ 296 erroneous because it is the only isolated record of the species from a point far outside its present range. The designation of the type locality for *O. placidus* as “Lebanon, Wilson County, Tennessee” by Hobbs (1989: 48) is not accurate because a lectotype has not been selected from the syntypes, and such action is needed to restrict the type locality (ICZN, 1999). We leave any lectotype designation to future workers who study taxonomy of the species across its entire range.

Hobbs (1972: 98) distinguished *O. placidus* from *O. forceps* and *O. n. neglectus* (Faxon,



1885) by the ratio dactylus length/palm mesial margin length, which was reported to be greater than 2.5 for *O. placidus* and less than 2.5 for *O. forceps* and *O. n. neglectus*. We found this ratio was of little value in separating *O. placidus* and *O. forceps*. Ortmann (1931: 78) indicated that large male *O. placidus* had a ratio of 2.5 to 3, but in the present study, not even all large males had a value above 2.5 (see Fig. 4). The presence or absence of the distomedian carpal spine separated every specimen of *O. placidus* (well-developed spine) from both *O. forceps* syntypes and *O. n. sp.* (spine absent).

Details of the sculpturing on the central projection might be useful to distinguish between *O. placidus* and *O. n. sp.* (Fig. 5 H, I). Line drawings of the gonopods often do not supply sufficient detail of the shape of the tip of the central projection. A more detailed examination of all crayfish gonopods with LM and SEM might provide additional taxonomic characters.

Orconectes n. sp. is an undescribed taxon for which we are preparing a description. In several characters, *Orconectes n. sp.* is similar to Faxon's crayfish, *Orconectes forceps*, reported in the Tennessee River drainage of southwestern Virginia and Tennessee, Alabama, and Georgia (Faxon, 1884; Hobbs, 1981). Although the leopard crayfish, *O. n. sp.*, has been collected at seven locations in the Ohio River of Illinois, the species undoubtedly occurs in Kentucky portions of the Ohio River and with further effort might also be found in the Mississippi River bordering Kentucky or Missouri.

MATERIAL EXAMINED

Orconectes luteus.—ILLINOIS: INHS 2302 ($n = 1$), Mississippi River, Grand Tower, Jackson Co., T10S, R4W, Sec. 25, NW 1/4, 13 June 1981, M. Klutho *et al.* INHS 2303 ($n = 1$), Mississippi River, Grand Tower, Jackson Co., T10S, R4W, Sec. 25, NW 1/4, 19 September 1981, M. Klutho *et al.* INHS 2381 ($n = 1$), Mississippi River, 0.5 mi S Grand Tower, Jackson Co., T10S, R4W, Sec. 36, NW 1/4, 24 October 1985, W. Dimmick and B. R. Kuhajda. INHS 3582 ($n = 10$), pool, 3 mi SE

Kaskaskia, Randolph Co., T7S, R7W, Sec. 22, NW 1/4, 24 March 1975. INHS 3593 ($n = 5$), Mississippi River, mouth, Marys River, Randolph Co., T7S, R6W, Sec. 33, SW 1/4, 19 March 1981, L. M. Page. INHS 3595 ($n = 1$), Mississippi River, River Mile (RM) 118.0–115.8, 2 mi NE Kaskaskia, Randolph Co., T6S, R7W, 13 July 1973, U.S. Army Corps of Engineers. INHS 7255 ($n = 2$), Mississippi River at Grand Tower (Devils Backbone Park), among rocks around old concrete boat ramp extending onto large sandy area, Jackson Co., T10S, R4W, Sec. 23, 7 October 1999, J. E. Wetzel, W. J. Poly, A. Miller, E. Poynter, and J. Rush. INHS 7256 ($n = 2$), [same locality as INHS 7255], 31 October 1999, W. J. Poly and F. Kanekawa [one with a zebra mussel, *Dreissena polymorpha*, attached when collected]. MCZ uncat. ($n = 1$), [same locality as INHS 7255], 13 April 2000, W. J. Poly. INHS 5181 ($n = 19$), Apple Creek, 3 mi E Haypress, Co. Rd. 1850N, Greene Co., T11N, R13W, Section 36, NE 1/4, 10 October 1995, C. A. Taylor and M. Pyron. MCZ 47134 ($n = 49$ [of 61]), Apple Creek, approximately 10 km NW of Carrollton, Illinois, Bluffdale Township, Greene Co., T11N, R13W, Sec. 36, NE 1/4, 6 November 1999, J. E. Wetzel and W. J. Poly. MLBM BYUC uncat. ($n = 21$), [same locality as MCZ 47134 above], 21 November 1999, W. J. Poly and F. Kanekawa. INHS 9106 ($n = 1$), Mississippi River along riprap-covered bank near boat ramp, approximately 1 km downstream of State Route 51/150 bridge (and River Mile 109.5), Randolph Co., T7S, R7W, Sec. 24, SW 1/4, 13 November 1999, J. E. Wetzel and W. J. Poly. INHS 9104 ($n = 1$), [same locality as INHS 9106 above], 27 November 1999, W. J. Poly and F. Kanekawa [with 4 zebra mussels, *Dreissena polymorpha*, attached when collected]. MCZ 47144 ($n = 1$), [same locality as INHS 9106 above], 13 April 2000, W. J. Poly. MCZ 47145 ($n = 1$), [same locality as INHS 9106 above], 6 October 2001, J. E. Wetzel and W. J. Poly. MCZ 47142 ($n = 1$), Mississippi River near mouth of Marys River, along upstream side of first wingdam below mouth of Marys River, Randolph Co., T7S, R6W, Sec.

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Fig. 6. Dorsal views of four species of *Orconectes* that occur in Illinois, illustrating the differences in their color patterns (all MI). (A) *O. rusticus* (37.4 mm CL, MCZ 47141); (B) *O. luteus* (31.0 mm CL, MCZ 47145); (C) *O. placidus* (39.4 mm CL, MCZ 47135); (D) *O. n. sp.* (33.2 mm CL, MCZ uncat.).

32, NE 1/4, 13 November 1999, J. E. Wetzel and W. J. Poly. MCZ 47131 ($n = 4$), Mississippi River adjacent wingdam 200 m upstream of confluence with tributary stream, 7.5 km N of Grand Tower, Fountain Bluff Township, Jackson Co., T9S, R4W, Sec. 34, 9 December 2000, J. E. Wetzel and W. J. Poly [one with a zebra mussel, *Dreissena polymorpha*, attached]. INHS 9100 ($n = 4$), Mississippi River, wingdam adjacent to Miller City Road, Alexander Co., T16S, R2W, Sec. 25, 12 August 2001, J. E. Wetzel and W. J. Poly. INHS 9103 ($n = 2$), Mississippi River, 1.2 km N of Thebes, Alexander Co. T15S, R3W, Sec. 8, 6 January 2002, W. J. Poly and J. E. Wetzel. Uncat. ($n = 2$ juv., no voucher, specimens died in captivity), [same locality as INHS 9103 above], 20 May 2000, J. E. Wetzel and W. J. Poly. MISSOURI: INHS 9105 ($n = 5$), Big River at State Route 8 bridge, approximately 5 km NE of Irondale, St. Francois Co., T36N, R4E, Sec. 6, NW 1/4, 8 October 1999, J. E. Wetzel and W. J. Poly. MLBM BYUC 02-08 ($n = 26$), INHS uncat. ($n = 21$), Whitewater River at K Road bridge, 2.5 km NNW of Sedgewickville, Bollinger Co., T33N, R10E, near Sec. 22, 16 December 1999, J. E. Wetzel and W. J. Poly. USNM 98344 ($n = 1$, holotype), USNM 98345 ($n = 1$, allotype), Niangua River at mouth of Greasy Creek, 5 mi SE Buffalo, Dallas Co., 28 August 1931, J. C. Saylor. USNM 69347 ($n = 3$, paratypes), Rubidoux Creek, Waynesville, Pulaski Co., 22 August 1929, E. P. Creaser and E. B. Williamson. USNM 117130 ($n = 43$, paratypes), Johnson Creek near Halltown, Laurence Co., 31 August 1930, E. P. Creaser. USNM 117137 ($n = 7$, paratypes), Roubidoux Creek, Pulaski Co., 22 August 1929, E. B. Williamson. USNM 117138 ($n = 3$, paratypes), headwaters of Niangua River near Marshfield, Webster Co., no date, J. C. Saylor.

Orconectes placidus.—ILLINOIS: INHS 3064 ($n = 2$), Ohio River, Fort Massac State Park, Massac Co., 12 August 1976, M. A. Morris and L. M. Page. INHS 3066 ($n = 4$), Ohio River, Fort Massac State Park, Metropolis, Massac Co., 17 June 1976, M. A. Morris and J. A. Boyd. INHS 6869 ($n = 1$), Ohio River, Fort Massac State Park, Massac Co., T16S, R5E, Sec. 7, SW 1/4, 29 August 1998, L. M. Page *et al.* INHS 9101 ($n = 7$), Big Creek at County Road 400 E bridge, 5 km South of Karbers Ridge, Illinois, Hardin Co., T11S, R8E, Sec. 28, 12 October 1999, J. E. Wetzel and E. C.

Poynter. MCZ 47135 ($n = 10$), [same locality as INHS 9101 above], 28 October 2001, W. J. Poly and J. E. Wetzel. INHS 9112 ($n = 21$), Ohio River at Golconda, along rocky area of shoreline near concrete boat ramp, Pope Co., T13S, R7E, Sec. 30, 31 October 1999, J. E. Wetzel and W. J. Poly. INHS 9108 ($n = 5$), Ohio River at Joppa boat ramp, Massac Co., T15S, R3E, Sec. 23, NE 1/4, 25 July 2001, J. E. Wetzel and W. J. Poly. MCZ 47132 ($n = 4$ [of 17]), [same locality as INHS 9108 above], 10 August 2001, J. E. Wetzel and W. J. Poly. MCZ 296 ($n = 1$, syntype), Quincy [locality considered erroneous by WJP and JEW]. MCZ 47137 ($n = 34$), Big Creek at Iron Furnace, approximately 7 km NNE of Rosiclare, Illinois, Hardin Co., T12S, R8E, Sec. 4, SE 1/4, 31 October 1999, J. E. Wetzel and W. J. Poly. MCZ 47148 ($n = 1$), Ohio River at Fort Massac State Park near boat ramp, Metropolis, Massac Co., T16S, R4E, Sec. 7, 8 February 2000, W. J. Poly and J. E. Wetzel. TENNESSEE: MCZ 289 [part] ($n = 6$, syntypes), Lebanon, Wilson Co. MNHN-As 117 ($n = 4$, syntypes?), Lebanon, Wilson Co. [possibly a subset of MCZ 289]. TEXAS: MCZ 170 ($n = 1$ [of 4]), *O. placidus* syntypes).

Orconectes sp. indet. (reidentified specimens).—TEXAS: MCZ 170 ($n = 3$ [of 4]), *O. placidus* syntypes) [these are not *O. placidus*]. TENNESSEE (?): MCZ 289 [part] ($n = 1$ [of 7], syntype), Lebanon, Wilson Co. [this specimen is not *O. placidus*, refer to text for explanation].

Orconectes n. sp. (reidentified specimens).—ILLINOIS: INHS 3075 ($n = 6$), Ohio River, 2 miles S of Hillerman, Massac Co., 12 August 1976, L. M. Page and M. A. Morris. INHS 3516 ($n = 12$), Ohio River, 2.5 miles NE of Olmsted, Pulaski Co., 16 July 1975, L. M. Page and M. A. Morris. INHS 4434 ($n = 2$), Ohio River, 1 mile S of Hillerman, Massac Co., T15S, R3E, Sec. 16, SW 1/4, 18 August 1994, K. S. Cummings and C. A. Mayer. INHS 6778 ($n = 1$), Ohio River, Joppa, Massac Co., T15S, R3E, Sec. 24, SE 1/4, 28 August 1998, L. M. Page *et al.* INHS 7278 ($n = 2$), Ohio River, S of Hillerman, Massac Co., 6 October 1988, K. S. Cummings, C. A. Mayer, and R. E. Caldwell.

Orconectes n. sp.—ILLINOIS: MCZ 47138 ($n = 2$), Ohio River at Joppa boat ramp, Massac Co., T15S, R3E, Sec. 23, NE 1/4, 25 July 2001, J. E. Wetzel and W. J. Poly. MCZ 47133 ($n = 11$), [same locality as MCZ 47138 above], 10

August 2001, J. E. Wetzel and W. J. Poly. MCZ 47139 ($n = 15$), [same locality as MCZ 47138 above], 12 August 2001, W. J. Poly and J. E. Wetzel. MCZ 47140 ($n = 39$), INHS 9109 ($n = 19$), OSUMC 4252 ($n = 19$), Ohio River at Lock and Dam 53, 5 km NE of Olmsted, Pulaski Co., T15S, R2E, Sec. 18, NW 1/4, 12 August 2001, W. J. Poly and J. E. Wetzel. INHS 9110 ($n = 9$), Ohio River at Mound City boatramp, Pulaski Co., T16S, R1W, Sec. 25, SE 1/4, 12 August 2001, J. E. Wetzel and W. J. Poly. MCZ 47136 ($n = 28$), Ohio River at Cairo boatramp (East side), Alexander Co., T17S, R1W, Sec. 25, SE 1/4, 12 August 2001, W. J. Poly and J. E. Wetzel. NCSM 23769 ($n = 1$), Ohio River, 5.5 km ESE of Joppa near coal conveyors, River Mile 947.8, Massac Co., T15S, R4E, Sec. 29, 15 September 2001, J. E. Schwegman. INHS 9102 ($n = 1$), [same locality as MCZ 47136 above], 30 September 2001, J. E. Wetzel and W. J. Poly. NCSM 23770 ($n = 1$), Ohio River, 4 km ESE of Joppa, River Mile 949, Massac Co., T15S, R4E, Sec. 30, 17 November 2001, J. E. Schwegman.

Orconectes forceps.—ALABAMA: MCZ 3582 ($n = 2$, syntypes), Cypress Creek, Lauderdale Co., October 1882, C. L. Herrick. USNM 4880 ($n = 7$, syntypes), Cypress Creek, Lauderdale Co., October 1882, C. L. Herrick.

Orconectes rusticus.—OHIO: MCZ 47141 ($n = 2$), Stillwater River, 100 m upstream of State Route 185 bridge at Webster, 4 km South of Versailles, Darke Co., T10N, R4E, Sec. 31, NE 1/4, 3 September 2001, W. J. Poly and A. J. Paulus.

Orconectes medius.—MISSOURI: MCZ 3585 ($n = 2$, syntypes), Irondale, Washington Co., E. Harrison, 1 October 1868.

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