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NEW SPECIES AND RECORDS OF *KLEPTOCHTHONIUS* FROM INDIANA (PSEUDOSCORPIONIDA, CHTHONIIDAE)

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ABSTRACT. New records and supplemental data are given for the troglobitic species *Kleptochthonius packardi*; and two new epigean or troglophilic species are described, *K. griseomanus* and *K. lewisorum*. Some comments are made on the status of the genus.

Keywords: Pseudoscorpionida, *Kleptochthonius*, cavernicoles, Indiana

In 1879, H. Hagen described *Blothrus packardi* from Wyandotte Cave in Crawford County, Indiana. This was the first cavernicolous pseudoscorpion known in North America. Restudy of the type collection (Muchmore 1963) revealed that the species belongs in the genus *Kleptochthonius* Chamberlin 1949. In 1994 I reported an isolated *Kleptochthonius* palp from Wilson's Cave in Jefferson County, Indiana. No other material pertaining to the genus has been reported from the state until recently. Over the past several years, intensive search by J.J. Lewis and his colleagues in caves of southern Indiana has turned up new material of *K. packardi*, together with several other species of pseudoscorpions. The present paper reexamines *Kleptochthonius packardi* and describes two new species in the genus.

METHODS

Most of the specimens studied here were dissected, cleared, and mounted on microscope slides for detailed examination. Specimens are deposited in the Florida State Collection of Arthropods, Gainesville, Florida (FSCA) and the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (MCZ). Some abbreviations are used in the text: L = length; L/B = ratio, length/breadth; L/D = ratio, length/depth; T = tactile seta.

SYSTEMATICS

Genus *Kleptochthonius* Chamberlin

Apochthonius (*Heterochthonius*) Chamberlin 1929: 153; Beier 1932:42.

Heterochthonius Chamberlin: Hoff 1945:313; Hoff 1949:434.

Kleptochthonius Chamberlin 1949:4; Hoff 1958:7; Malcolm & Chamberlin 1961:2–3; Muchmore 1965:1; Muchmore 1990:510; Harvey 1991:177; Muchmore 1994a:13.

Chamberlinochthonius Vachon 1952:105; Hoff 1958:7.

Kleptochthonius (Chamberlinochthonius) Vachon: Malcolm & Chamberlin 1961:16; Muchmore 1965:1; Muchmore 1990:510; Harvey 1991:179.

Kleptochthonius was described originally by J.C. Chamberlin (1929) as *Heterochthonius*, a subgenus of *Apochthonius* Chamberlin. The name *Kleptochthonius* was first applied by Chamberlin (1949), after he discovered that the name *Heterochthonius* had been used previously by Berlese (1910) for a genus of Acarina. At that time, only two species were known, *K. crosbyi* (Chamberlin 1929) and *K. multispinosus* (Hoff 1945), both epigean forms from North Carolina. In 1952, M. Vachon erected a new, allied genus, *Chamberlinochthonius*, the type species, *C. henroti*, being a troglobitic form from a cave in West Virginia. Malcolm & Chamberlin (1961) described two new epigean species of *Kleptochthonius* from Oregon and eight new troglomorphic species from caves in eastern states; the latter they placed in *Chamberlinochthonius*, which they regarded as an ''artificial but convenient'' subgenus of *Kleptochthonius*. Subsequently, Muchmore (1963, 1965, 1976, 1994a, 1994b) and other authors (e.g., Harvey 1991) followed Malcolm & Chamberlin in assigning species to the subgenera *Kleptochthonius* or *Chamberlinochthonius*. However, subgeneric designations are not used in the present report, because they are currently undergoing reevaluation (see Discussion).

The genus *Kleptochthonius* was well defined by Malcolm & Chamberlin (1961). Supplementary discussions of specialized sensory setae on the palpal chela and of the dorsal process of the movable chelal finger were given by Muchmore (1965, 1976, 1994a).

Kleptochthonius packardi (Hagen)
Figs. 1, 4

Blothrus packardi Hagen 1879:399.
Chthonius packardi (Hagen): Hagen 1880:83–84; Hubbard 1880:37, 79, 84 (in part); Banks 1895: 13 (in part); Blatchley 1897:170; Coolidge 1908: 114 (in part); Vachon 1952:111 (in part).
Chthonius packardii Hagen: Packard 1888:43–48, figs. 12a-g, Pl. XI figs. 3, 3a-j (in part).
Chtonius [sic] *packardii* Hagen: Blatchley 1897: 205 (in part).
Cthonius [sic] packardi Hagen: Blatchley 1897:171.
Chthonius(?) *packardi* (Hagen): Beier 1932:61 (in part); Roewer 1937:240 (in part); Hoff 1958:4 (in part).
Genus? *packardi* Hagen: Hoff 1949:443 (in part).
''*Chthonius*'' *packardi* (Hagen): Malcolm & Chamberlin 1961:1.
Kleptochthonius (*Chamberlinochthonius*) *packardi* (Hagen): Muchmore 1963:2–5, figs. 1–2; Muchmore 1965:2, 7; Muchmore 1976:211; Harvey 1991:181 (in part); Muchmore 1994b:319–320.
Not *Chthonius packardii* Hagan [sic]: Giovannoli 1933:604 (misidentification).

Type material examined.—Lectotype male (No. 1), allotype female (No. 2), and 4 paralectotype males of *Blothrus packardi* Hagen [also labeled ''*Chamberlinochthonius packardi* (Hagen), det. W.B. Muchmore''], on slides, in MCZ.

Type locality.—Wyandotte Cave, Crawford County, Indiana. [*Note:* Harvey (1991: 181) erroneously gives ''Mammoth Cave, Kentucky, U.S.A.'' as the type locality of *K.*(*C.*) *packardi*].

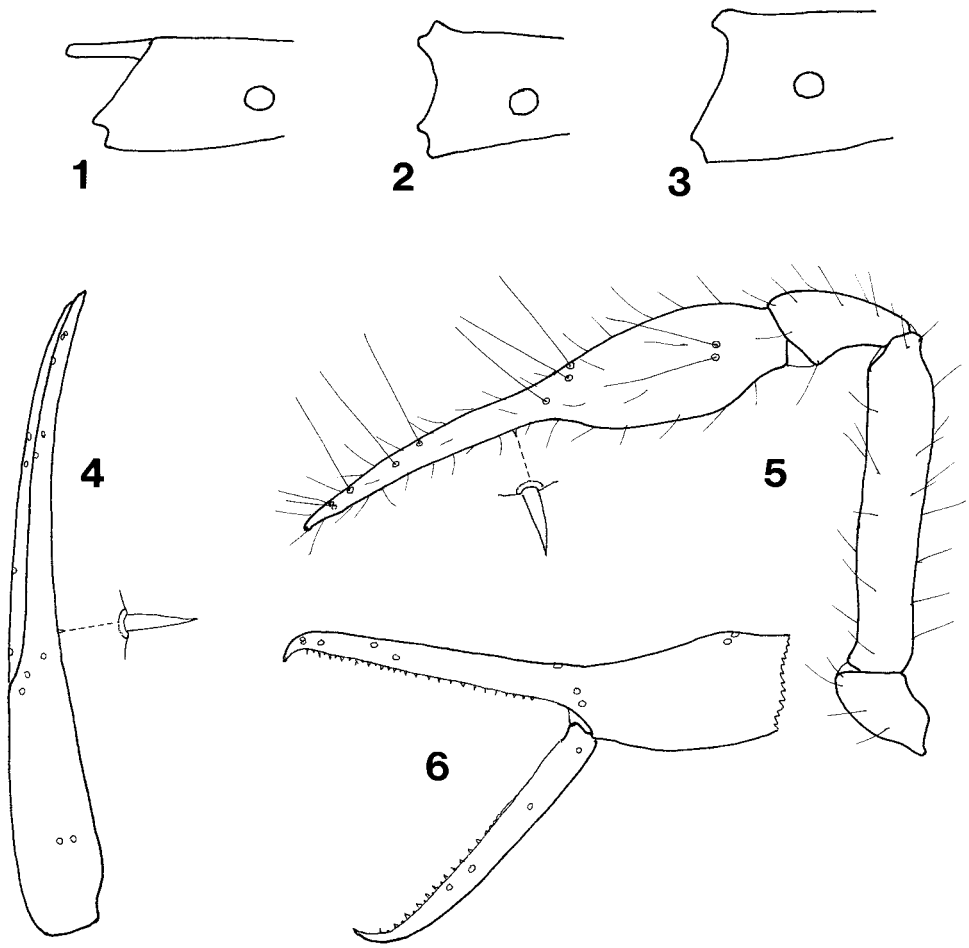
Diagnosis.—A large, eyeless species of *Kleptochthonius* with very slender appendages (length of palpal chela 1.3 mm or greater, chela usually 7.0 or more times as long as broad); all parts light brown or lighter; dorsal process on proximal end of movable chelal finger long, cylindrical; a short, stout sensory seta on medial side of fixed finger near base.

Additional material examined.—INDIANA: *Crawford County:* Route 66 Cave, 6 km S of Hardinsburg, ''hand-collected from raccoon scat (with Collembola) on mudbank, end of main passage of cave about 60 meters from entrance, dry upper level'', 26 October 1996 (J.J. Lewis, James Lewis, V. Lewis), 1♀. *Harrison County:* Binkley Cave, about 1.5 km S of Corydon, in pitfall trap about 300 m into dark zone, 16 November 1997 (J.J. Lewis, T. Sollman), 1 tritonymph; Coon Cave, 6.5 km SW of Corydon, ''from rock on top of baited (cheese) pitfall trap, dark zone'', 17 May 1997 (J.J. Lewis, S. Rafail), 1♂; Maucks Cave, Harrison-Crawford State Forest, ''from flowstone in lower level of cave'', 14 September 1996 (J.J. Lewis, James Lewis, V. Lewis), 1 tritonymph; Twin Domes Cave, Twin Domes Nature Preserve, in pitfall traps, 31 May 1998 (J.J. Lewis), 2♀. *Orange County:* Murray Spring Cave, Paoli Country Club, in pitfall trap, 30 April 1998 (J.J. Lewis, S. Rafail), 1♀; Saltpeter Cave, 6 km NNE of Marengo, 2 March 1997 (J.J. Lewis, James Lewis, V. Lewis), 2♀. (All on slides, in FSCA.)

Supplemental data.—All parts of animals pale in color. Eyes absent in all. Chaetotaxy of carapace 4-4-4-2-4 = 18, except in one female where there are 3, rather than 4, setae on posterior margin. Tergal chaetotaxy somewhat variable, but usually much like the types, i.e., 2-3:2-3:2-3:2-4:4:4:5-6:6:-. Internal genitalia of male similar to those of *K. crosbyi* (see Malcolm & Chamberlin 1961: fig. 3A). Appendages of adults very long and slender. Palpal femur 1.55–1.65× and chela 2.3–2.45× as long as carapace; L/B of femur 6.85–7.15, patella 2.35–2.55, chela 7.1–7.9; L/D of hand 2.75–3.05; movable finger 1.55–1.7× as long as hand. Leg I: femur 2.25–2.5× as long as patella. Leg IV: L/D of femur + patella 3.45–3.85, tibia 5.25–5.7. The dorsal process on the proximal end of movable finger of chela is long, cylindrical (Fig. 1). There is a short sensory seta on the medial side of the fixed finger of the palpal chela, at or just distad of level of trichobothrium *ist* (Fig. 4).

Tritonymph much like adult but smaller and with slightly less slender appendages; with only 7 trichobothria on hand and fixed chelal finger and 3 on movable finger. Short sensory seta on fixed chelal finger as in adult.

Measurements (mm).—*Adult:* Figures given first for the single male, followed in parentheses by ranges for 6 females. Body L 1.90 (1.81–2.63). Carapace L 0.605 (0.59–0.695). Chelicera L 0.53 (0.51–0.57). Palp: trochanter 0.30 (0.28–0.32) / 0.155 (0.13–0.17); femur 1.00 (0.97–1.11) / 0.14 (0.14–0.155); patella 0.36 (0.355–0.39) / 0.15 (0.15–0.16); chela 1.50 (1.42–1.60) / 0.19 (0.19–0.22); hand 0.60 (0.55–0.63) / 0.195 (0.19–0.22); movable finger L 0.94 (0.89–1.04). Leg



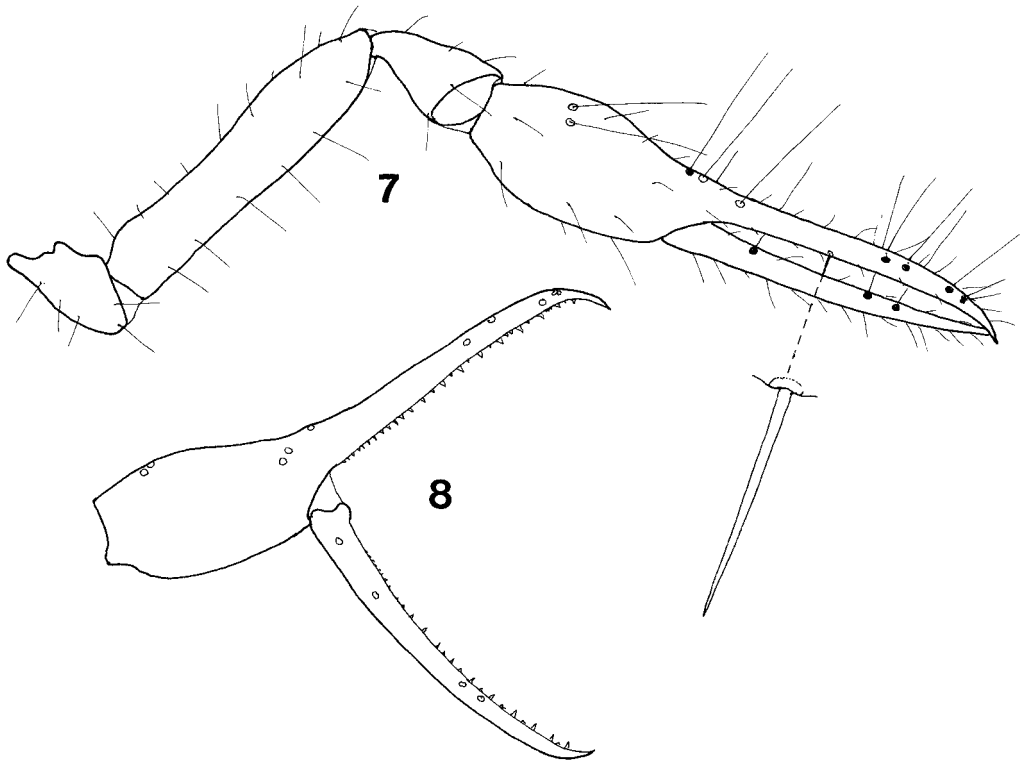
Figures 1–6.—Species of *Kleptochthonius*. 1–3. Proximal end of movable finger of palpal chela, lateral view, showing dorsal process (dorsal at top; areole is that of trichobothrium *b*). 1. *Kleptochthonius packardi*, lectotype male; 2. ***Kleptochthonius griseomanus*** new species, holotype female; 3. ***Kleptochthonius lewisorum*** new species, holotype female. 4. *Kleptochthonius packardi*, lectotype male: Left palpal chela, dorsal view, with enlargement of sensory seta on fixed finger (other setae omitted). 5, 6. ***Kleptochthonius griseomanus*** new species, holotype female. 5. Right palp, dorsal view, with enlargement of sensory seta on fixed finger; 6. Left chela, lateral view (base broken; setae omitted).

I: femur 0.62 (0.585–0.665) / 0.095 (0.08–0.11); patella 0.265 (0.235–0.295) / 0.09 (0.08–0.09). Leg IV: femur + patella 0.865 (0.86–0.955) / 0.245 (0.23–0.26); tibia 0.60 (0.555–0.63) / 0.105 (0.105–0.12).

Tritonymph: Two specimens. Body L 1.45, 1.68. Carapace L 0.49, 0.495. Chelicera L 0.40, 0.40. Palp: femur 0.75, 0.76 / 0.125, 0.125; patella 0.28, 0.29 / 0.125, 0.13; chela 1.13, 1.14 / 0.17, 0.17; hand 0.46, 0.45 / 0.17, 0.17; movable finger L 0.69, 0.71. Leg IV: femur + patella 0.605, 0.64 / 0.16, 0.18; tibia 0.42, 0.45 / 0.09, 0.09.

Remarks.—The newly collected specimens appear to be slightly larger than the types from Wyandotte Cave, as reported in 1963. However, these differences are probably due in part to changes in measuring techniques between that time and the present. In any event, the species, as here recognized, is rather variable in size and chaetotaxy. Further collecting and study may reveal that more than one species is represented.

In addition to the type locality, Wyandotte Cave, *Kleptochthonius packardi* has been found in several caves in neighboring Craw-



Figures 7, 8.—***Kleptochthonius lewisorum*** new species, holotype female. 7. Left palp, dorsal view but chela twisted showing medial surface, with enlargement of sensory seta on fixed finger (darkened areoles are underneath, i.e., on lateral side of chela); 8. Right chela, lateral view (setae omitted).

ford, Harrison, and Orange Counties, Indiana. Two females were collected within Twin Domes Cave, Harrison County, where *K. griseomanus* new species is also present at the entrance. A tritonymph, apparently belonging to *K. packardi*, was taken some 300 m into the eastern end of the Binkley Cave System, the largest known cave in Indiana, while the holotype of *K. lewisorum* new species (see below) was found in the Baelz Cave section at the western end of the system (about 5.5 km away, straight-line distance) (see Lewis & Sollman 1998).

Kleptochthonius(?) sp.

A single, detached, left palp of an adult pseudoscorpion was collected in Wilsons Cave, Jefferson County, Indiana; it has been tentatively identified as belonging to an unknown species of *Kleptochthonius* (Muchmore 1994b). If it is indeed a *Kleptochthonius*, it appears most closely related to *K. sheari* Muchmore (1994a), with a relatively long, sensory seta at the base of the fixed chelal finger. From the attenuation of the palp, it appears to be a troglomorphic species. No other representative of the genus has been found in this part of Indiana.

Kleptochthonius griseomanus new species
Figs. 2, 5, 6

Type material.—Holotype female (WM8208.01001) from Indian Cave, (a sandstone cave in the Hemlock Cliffs area of Hoosier National Forest), about 6.5 km SSE of Taswell, Crawford County, Indiana, 5 July 1997 (J.J. Lewis, S. Rafail); allotype male (WM8240.02001) from leaf litter at base of entrance pit, Twin Domes Cave, Twin Domes Nature Preserve, Harrison County, Indiana, 31 May 1998 (J.J. Lewis, R. Burns, E. Burns, H. Huffman, E. Jacquart) (mounted on slides, in FSCA).

Diagnosis.—A smaller, less slender species, with palpal chela 1.05 mm long, 4.7–5.05× as long as broad; 4 corneate eyes;

mostly light brown, but hand of chela distinctly gray; dorsal process on proximal end of movable chelal finger small, roughly bilobed; a short, stout sensory seta on medial side of fixed finger near base. *Kleptochthonius griseomanus* appears most closely related to *K. inusitatus* Muchmore (1994a) from eastern Ohio. The two are similar in size and proportions, but *K. griseomanus* differs in having a distinctly gray palpal chela, fewer setae on the terga, a smaller, less strongly bilobed process on the base of the movable finger of the chela, and the small sensory seta on the fixed finger closer to the level of trichobothrium *ist*.

Description.—Representative of *Kleptochthonius* as discussed above, and with the following particular features. Male and female much alike. Hand of palpal chela gray; chelal fingers and other palpal segments, carapace and chelicera tan; other parts lighter. Carapace about as long as broad; epistome barely perceptible; 4 corneate eyes; chaetotaxy 6-4-4-2-4 = 20. Coxal area typical; each coxa I with 5 coxal spines. Tergal chaetotaxy of holotype 4:4:7:6:8:9:10:9:?:?:T2T:0, allotype similar. Sternal chaetotaxy of holotype (female) 8:(3)8(3):(3)8(3):12:14:14:13:13:11:0:2; sternites 2–5 of male 13:11-10 / (3)6(3):(3)9(3):11. Internal genitalia of male similar to those of *K. crosbyi* (see Malcolm & Chamberlin 1961: fig. 3A). Chelicera 0.8 as long as carapace; hand with 7 setae; flagellum of about 7 setae; galea a very low elevation. Palp (Fig. 5) long and slender; femur 1.3–1.35× and chela 1.9-1.95× as long as carapace. L/B of trochanter 1.8–1.85, femur 5.5–5.85, patella 2.1–2.15, and chela 4.7–5.05; L/D of hand 1.95–2.05; movable finger 1.5× as long as hand. Trichobothria as shown in Fig. 6. A short, sensory seta is present distad of trichobothrium *ist* on medial side of fixed finger (Fig. 5). Dorsal process on base of movable finger small, roughly bilobed (Fig. 2). Fixed finger of holotype with 21 tall, spaced macrodenticles and 10 very small, rounded microdenticles alternating distally; movable finger with 11 tall, spaced macrodenticles, 6 very small alternating microdenticles, and 10 low, rounded teeth proximally. Legs rather long and slender. Leg I with femur 2.1–2.2× as long as patella. Leg IV: L/D of femur + patella 2.9–3.0, tibia 4.9–5.1.

Measurements (mm).—Figures given first for holotype female, followed in parentheses by those for allotype male. Body L 2.11 (1.87). Carapace L 0.555 (0.54). Chelicera L 0.45 (0.42). Palp: trochanter 0.235 (0.23) / 0.13 (0.125); femur 0.725 (0.73) / 0.13 (0.125); patella 0.32 (0.295) / 0.15 (0.14); chela 1.04 (1.06) / 0.22 (0.21); hand 0.43 (0.435) / 0.22 (0.21); movable finger L 0.64 (0.66). Leg I: femur 0.39 (0.415) / 0.075 (0.075); patella 0.185 (0.185) / 0.075 (0.075). Leg IV: femur + patella 0.615 (0.66) / 0.20 (0.23); tibia 0.435 (0.46) / 0.09 (0.09); basitarsus 0.245 (0.235) / 0.075 (0.065); telotarsus 0.415 (0.445) / 0.05 (0.05).

Etymology.—The species is named *griseomanus* in reference to the distinctly gray hand of the palpal chela.

Remarks.—Two specimens of *K. packardi* were collected within Twin Domes Cave, in the entrance pit of which the allotype of *K. griseomanus* was found (see above). The former is certainly a troglobite, whereas the latter is at best a troglophile, or an epigean species only accidentally associated with the cave.

Kleptochthonius lewisorum new species
Figs. 3, 7, 8

Type material.—Holotype female (WM8207.01001) from the ''underside of a stone lying in leaf litter with some raccoon droppings, in the company of some troglobitic *Sinella alata* Christiansen (Collembola), twilight zone,'' Baelz Cave, Binkley Cave System, Harrison County, Indiana, 28 June 1997 (J.J. Lewis, F.A. Pursell) (mounted on slide, in FSCA).

Diagnosis.—A medium-sized species (palpal chela 1.15 mm long), with moderately slender palps (chela 4.6× as long as broad); 4 eyes, posterior pair smaller than anterior pair; all parts, including palps, light brown or lighter; process on proximal end of movable finger of palpal chela small, irregularly rounded; a moderately long sensory seta on medial side of fixed finger near middle.

Description of female.—(Male unknown). Representative of the genus *Kleptochthonius* as discussed above, and with the following particular features. Palps very light brown, carapace and chelicerae tan, other parts lighter. Carapace with epistome very small; 4 corneate eyes, posterior pair smaller; chaetotaxy 9-4-4-2-4 = 23. Coxal area typical of the genus; each coxa I with 3 coxal spines. Tergal chaetotaxy 4:4:4:6:7:9:9:9:9:7:T2T:0.; sternal

chaetotaxy 8:(4)6(4):—?—T1T2T1T:2. Chelicera 0.75 as long as carapace; hand with 7 setae; flagellum of 7–8 setae; galea a low elevation. Palp (Fig. 7) long, slender: femur 1.3× and chela 1.95× as long as carapace. L/B of trochanter 1.9, femur 5.05, patella 1.75, and chela 4.6; L/D of hand 1.6; movable finger 1.85× as long as hand. Trichobothria as shown in Fig. 8. A sensory seta of moderate length on fixed finger near middle of medial side (Fig. 7). Dorsal process on base of movable finger small, irregularly rounded (Fig. 3). Fixed finger with about 20 tall, spaced macrodenticles, decreasing in size to very small proximally, and 10 moderately large microdenticles alternating distally (in two of the intervals between macrodenticles there are two microdenticles rather than one); movable finger with 10 tall, spaced macrodenticles, 6 moderately large alternating microdenticles, and 10 low, rounded teeth proximally. Legs moderately slender: leg I with femur 2.1× as long as patella; leg IV with L/D of femur + patella 2.95, of tibia 4.5.

Measurements (mm).—Body L 2.47. Carapace L 0.54. Chelicera L 0.445. Palp: trochanter 0.265/0.14; femur 0.755/0.15; patella 0.295/0.17; chela 1.15/0.25; hand 0.42/0.265; movable finger L 0.78. Leg I: femur 0.39/0.08; patella 0.185/0.08. Leg IV: femur + patella 0.615/0.21; tibia 0.43/0.095; basitarsus 0.235/0.08; telotarsus 0.43/0.045.

Etymology.—The species is named for Julian J. Lewis and his sons, James J. Lewis and Victor M. Lewis, who for the past several years have been leading the way in studies of the invertebrate faunas in Indiana caves.

Remarks.—Because of the moderately long sensory seta near the middle of the fixed chelal finger, *Kleptochthonius lewisorum* appears related to one or more, as yet unidentified, species from the southeastern states. It differs from them in size, proportions, and body chaetotaxy.

Baelz Cave, the type locality, consists of a short passage in the bluff of Indian Creek near the Seven Springs resurgence of Binkley River; it is a route for floodwater overflow out of the Binkley Cave System. This is about 6 km from the site of capture of a specimen of *K. packardi* in the eastern end of the system (see above).

DISCUSSION

Like *Tyrannochthonius* Chamberlin 1929 (see Muchmore & Chamberlin 1995; Muchmore 1996) the genus *Kleptochthonius* contains species with quite varied morphologies. On the one hand, *Kleptochthonius crosbyi* (type species of the genus) is a small, four-eyed, epigean chthoniid, with moderately slender palps, while *K. henroti* (Vachon) (type species of *Chamberlinochthonius* Vachon) is a large, blind, troglobitic species with very attenuated palps. In their revision of *Kleptochthonius*, Malcolm & Chamberlin (1961) recognized the close relationship of these varied species by ''considering *Chamberlinochthonius* Vachon as an artificial but convenient subgenus comprising essentially the cavernicolously modified forms of *Kleptochthonius*.'' (p. 3). Now, when there are some 10 epigean species and over 30 cavernicolous species known in the genus, it is perfectly clear that a generic or subgeneric distinction based on size, eyes, coloration, or slenderness of appendages is not warranted. However, it does appear possible that the nature and number of special sensory setae on the fixed finger of the palpal chela (Muchmore 1976, 1994a), and perhaps some other characters (Muchmore 1965), will provide evidence of separate evolutionary lines within the genus. Restudy of all species in the genus is in progress.

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