

***Caecidotea mackini*, new species, with a synopsis of the subterranean
asellids of Oklahoma (Crustacea: Isopoda: Asellidae)**

Julian J. Lewis*, G. O. Graening, Danté B. Fenolio, and Elizabeth A. Bergey

(JLL) Lewis & Associates LLC; Cave, Karst & Groundwater Biological Consulting,
17903 State Road 60, Borden, Indiana 47106-8608, U.S.A., e-mail: lewisbioconsult@aol.com;
(GOG, EAB) Oklahoma Biological Survey and Department of Zoology,
University of Oklahoma, Norman, Oklahoma 73019, U.S.A.;
(DBF) Department of Biology, University of Miami, Coral Gables, Florida 33124, U.S.A.

Abstract.—A survey of cave and spring fauna in Oklahoma resulted in the discovery of *Caecidotea mackini*, new species, which is described from specimens collected in Long's Cave, Delaware County. Within the *hobbsi* group of the genus *Caecidotea*, *C. mackini* belongs to a subset of nine species termed the *tridentata* assemblage. All nine are subterranean, but several retain vestigial eyes or pigmentation. Correlated with zoogeographic and climatic evidence, the invasion of groundwaters by an epigeal progenitor during the middle to late Tertiary is suggested. Besides *C. mackini*, new records for *C. macropropoda*, *C. acuticarpa*, *C. stiladactyla*, *C. steevesi*, *C. ancyla*, *C. antricola*, *C. adenta*, and *C. simulator* expand the known ranges of these cryptic species. With the recognition of two patterns of fourth pleopod morphology in *C. acuticarpa*, the species specificity of this character has become questionable. Although previously used to differentiate *C. simulator* and *C. steevesi*, further splitting or synonymy based on this pleopod anatomy is reserved until a better understanding of its differentiation is achieved.

Although Oklahoma is not known for possessing extensive karst areas, almost 2000 caves have been reported and numerous subterranean species are known from the state as summarized by Black (1971). In 2004, the Oklahoma Biological Survey continued a major faunal survey of caves and springs that built on work initiated by The Nature Conservancy in 2000. This recent sampling produced the material used herein for the description of the new species of *Caecidotea*, as well as expanding our knowledge of the ranges of species constituting the subterranean asellid isopod fauna of Oklahoma.

The Springfield Plateau section of the Ozark Plateaus physiographic province, occurring primarily in Missouri and Arkansas, barely extends into northeastern Oklahoma. Although perhaps not as cavernous as other parts of the Ozarks, many caves occur in this part of Oklahoma. A smaller area containing caves is the Arbuckle Mountains Uplift in the south-central part of the state. It is separated from the Springfield Plateau by the Arkoma Basin, a region of non-cavern forming strata. Other isolated caves are found in the western half of Oklahoma, where they have formed in Permian gypsum or Paleozoic limestone (Black 1971).

Black (1971) listed seven species of *Asellus* (= *Caecidotea* Packard, 1871) be-

* Corresponding author.

lieved to be cavernicoles and two spring-dwelling species of *Lirceus* (Rafinesque, 1820). Of the seven *Caecidotea*, only four were valid species or actually occurred in Oklahoma: *C. macropropoda*, *C. acuticarpa*, *C. stiladactyla* and *C. adenta*. Black (1971) included *C. tridentata* in his list, a species described by Hungerford (1922) from a cistern in eastern Kansas. Over the years, isopods collected from a variety of habitats across several states were mis-identified as *C. tridentata*, including caves in the Arbuckle Uplift (Harrel 1960, Black 1971, Fleming 1972a). Lewis & Bowman (1981) redescribed *C. tridentata* and restricted its range to east-central Kansas.

Other species included in the list of Black (1971) were *C. ozarkana* and *C. oculata*. Chase & Blair (1937) described *C. macropropoda* and *C. ozarkana* from a cave and spring five miles south of the town of Kansas, Adair County, Oklahoma. Lewis (1982) synonymized *C. ozarkana* with *C. macropropoda*. *Caecidotea oculata* remains somewhat of an enigma. Mackin & Hubricht (1940) reported this species only from surface streams in the Ouachita Mountains but described it as having reduced eyes. Until more can be learned of *C. oculata*, its ecological classification remains uncertain, but it remains unknown from subterranean waters.

Fleming (1972a) described *C. steevesi* from Carrico Cave (Dade County, Missouri), seeps at the town of Baxter Springs (Cherokee County, Kansas), and Gittin' Down Mountain Cave (Adair County, Oklahoma). Lewis (1999) examined these collections and discovered that the fourth pleopod exopod morphology of the Baxter Springs isopods was distinct from that of *C. steevesi* and described them as *C. simulator*. Fleming (1972a) also described *C. ancyla* from Brewer Cave, Boone County, Arkansas, and Three Forks Cave, Adair County, Oklahoma.

Thus, five obligate subterranean isopod species were previously known from Oklahoma. Herein is presented the description of a new species of *Caecidotea*, the first records of *C. antricola* and *C. simulator* from Oklahoma, and records of other collections examined that contribute to knowledge of the habitat and range of the subterranean asellid fauna of Oklahoma and adjacent states.

Names of collectors are abbreviated in the text: G. Graening (GG), D. Fenolio (DF), M. Slay (MS), J. Stout (JS). The taxonomy and identifications are that of the senior author, while the remainder of the paper was a collaborative effort of all the authors. The material examined for this project is deposited in the collection of the National Museum of Natural History, Smithsonian Institution (USNM). In the interest of cave conservation, specific locations are not given but can be obtained from the Oklahoma Biological Survey.

Systematics

Family Asellidae

Genus *Caecidotea* Packard, 1871

Caecidotea mackini Lewis, new species

Figs. 1, 2a–f, 3a–e, 4a, b

Material examined.—OKLAHOMA: Delaware Co., Long's Cave, ca. 7.5 mi (12 km) south of Jay, 31 Aug 2001, GG, MS, DF, S. McGinnis, 10.4 mm male paratype, (USNM 1087373); same locality, 26 Jul 2005, GG, MS, 11.5 mm male holotype (USNM 1087371), 9.5 mm male paratype, 6 female paratypes (USNM 1087372).

Description.—Eyeless, unpigmented. Longest male 11.5 mm, female 12.5 mm, body slender, linear, approximately 5.8× as long as wide, coxae visible in dorsal view. Margins of head, pereonites and pleotelson lined with setae and spines. Head approximately 1.6× as wide as long, anterior margin concave, rostrum absent; post-mandibular lobes moderately



Fig. 1. *Caecidotea mackini*, Long's Cave, Delaware Co., Oklahoma: a-e, male: (a) habitus, (b) head, antenna 1, proximal articles antenna 2, (c) left mandible, incisor and lacinia mobilis, (d) right mandible incisor and palp, (e) maxilla 1, apices of inner and outer lobes; f, g, variation in proportions of pleotelson and uropods: (f) 8.3 mm female, (g) 11.4 mm female.

produced. Pleotelson approximately 1.4× as long as wide, sides subparallel, caudo-medial lobe slightly produced, broadly rounded.

Antenna 1 reaching middle of last article of antenna 2 peduncle, flagellum

of male approximately 14-16 articles, 7 or 8 distal articles each with an esthete, flagellum of female with approximately 12 articles, 6 distal articles with 1 esthete each. Antenna 2 of male last article of peduncle approximately 1.4× length of

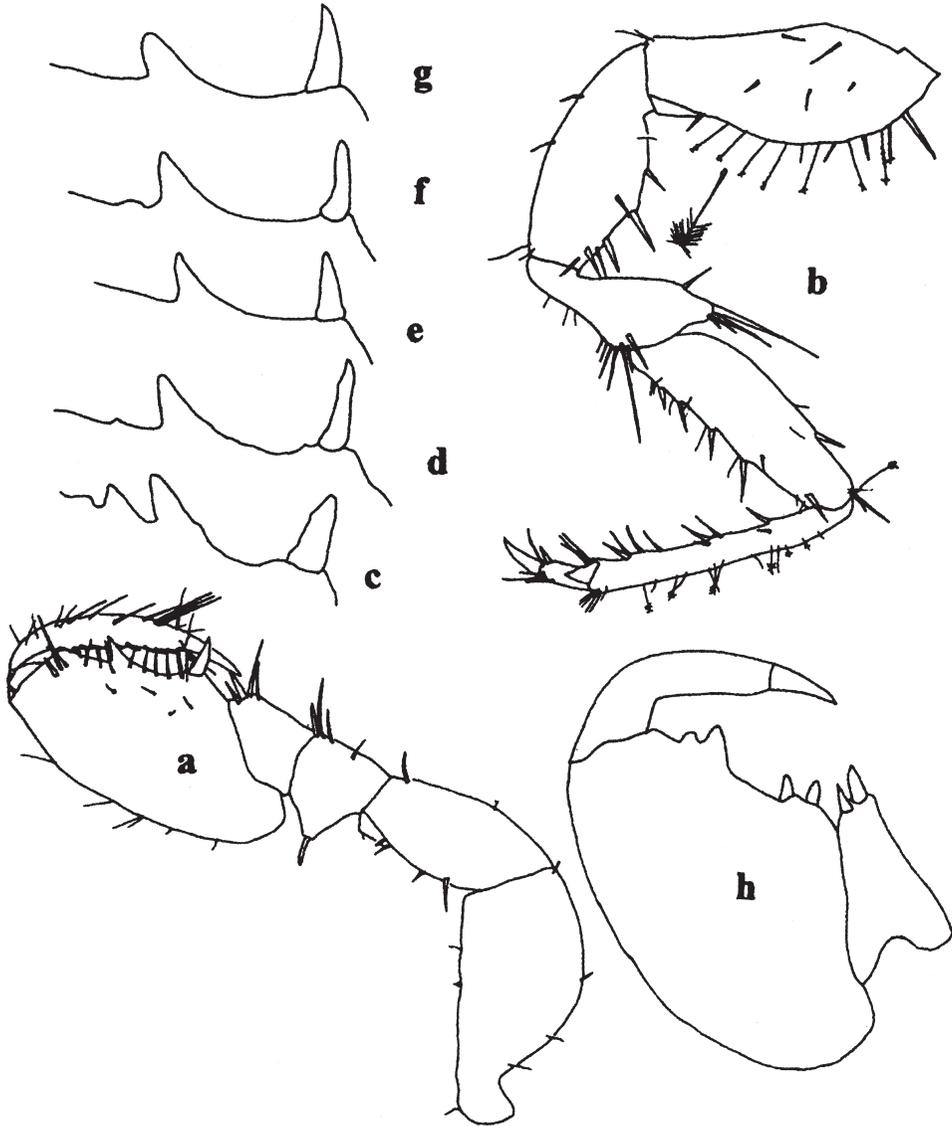


Fig. 2. *Caecidotea mackini*, Long's Cave, Delaware Co., Oklahoma: a, b, male: (a) pereopod 1, (b) pereopod 4; c-h, variation in pereopod 1 palmar margin of propodus: (c) 12.5 mm female, (d) 10.4 mm male, (e) 9.5 mm male, (f) 11.5 mm male, (g) 11.7 mm female. *Caecidotea acuticarpa*, Byrds Mill Cave, Pontotoc Co., Oklahoma: (h) pereopod 1, showing diagnostic carpus in relationship to propodus (setation omitted).

preceding article, flagellum with approximately 100–105 articles.

Mandibles with 4-cusped incisors and lacinia mobilis, adjacent rows of 12–14 plumose setae, palp with plumose setae on articles 2 and 3. Maxilla 1, outer lobe with 13 robust spines, inner lobe with 5

apical plumose setae. Maxilliped with 5 or 6 retinacula.

Pereopod 1 of male, propodus approximately $1.9\times$ as long as wide, palmar margin with large proximal spine, subequal triangular median process, distal process absent; dactyl flexor margin with

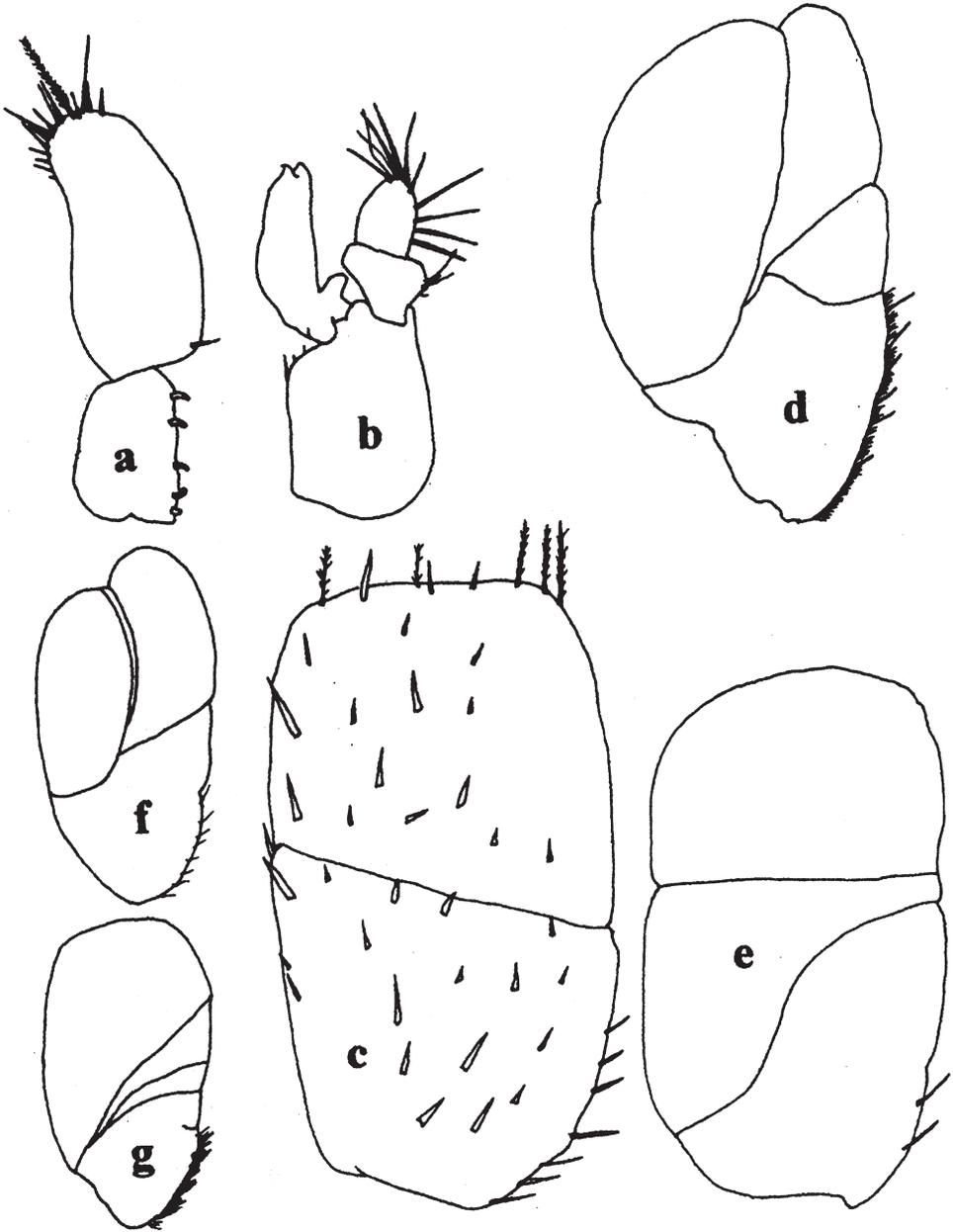


Fig. 3. *Caecidotea mackini*, Long's Cave, Delaware Co., Oklahoma: a-e, 12.4 mm male: (a) pleopod 1, (b) pleopod 2, (c) pleopod 3 exopod, (d) pleopod 4 exopod, (e) pleopod 5 exopod. *Caecidotea acuticarpa*, Byrds Mill Cave, Pontotoc Co., Oklahoma: (f) pleopod 4 exopod. *Caecidotea adenta*, deep limestone sink cave, Kiowa Co., Oklahoma: (g) pleopod 4 exopod.

spines; distal margin of carpus blunt, lower than base of proximal spine on palmar margin of propodus, with 2 robust spines. Pereopod 1 of female, palmar margin propodus of largest spec-

imen with large proximal spine, subequal triangular median process, lower triangular distal process; other females without distal process. Pereopod 4 sexual dimorphism minimal or absent, basis with row

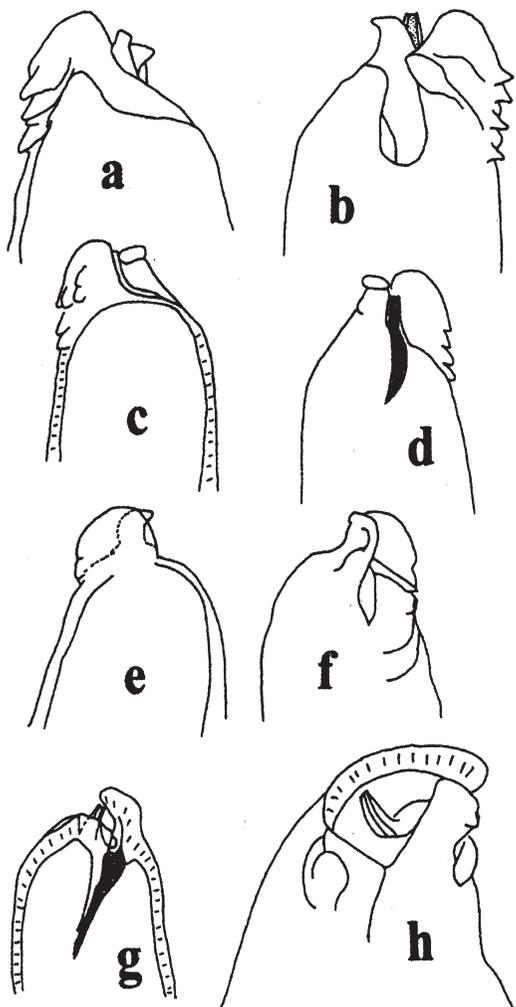


Fig. 4. The male pleopod 2 endopodite tips of selected Oklahoma asellids. *Caecidotea mackini*, Long's Cave, Delaware Co., Oklahoma: (a) posterior, (b) anterior. *Caecidotea acuticarpa*, Byrds Mill Cave, Pontotoc Co., Oklahoma: (c) posterior, (d) anterior. *Caecidotea adenta*, deep limestone sink cave, Kiowa Co., Oklahoma: (e) posterior, (f) anterior. *Caecidotea ancyla*, Dressler Cave, Cherokee Co., Oklahoma: (g) anterior. *Lirceus garmani*, Locust Grove Spring, Delaware Co., Oklahoma: (h) anterior.

of 9 distally plumose setae along margin, carpus approximately $3\times$ as long as wide, propodus with row of 6 distally plumose setae along margin.

Male pleopod 1 longer than pleopod 2, protopod approximately $0.6\times$ length of exopod, with approximately 5 retinacula.

Exopods approximately $0.5\times$ as wide as long, lateral margin slightly concave, with elongate plumose seta on distal margin. Female pleopod 2 subtriangular with approximately 11 or 12 elongate plumose setae along distal and lateral margins. Male pleopod 2, distal segment of exopod with approximately 12 elongate plumose setae along margin. Endopod with distinct basal apophysis; tip in anterior aspect with cannula subtrapezoidal; mesial side of U-shaped endopodial groove forming a low knob-like shoulder leading up to the pronounced mesial process, which is approximately equal in extent to cannula, curved mesiad; lateral side of endopodial groove forming a second knob-like shoulder leading up to the caudal process, slightly higher than other processes, distinctly scalloped laterally. Tip of endopod in posterior aspect with prominent scalloped caudal process partially obscuring cannula, tip of mesial process visible. Pleopod 3 exopod, suture approximately equidistant between proximal and distal parts, proximolateral setae present, approximately 5 apical plumose setae. Pleopod 4 exopod, proximolateral setae present, false suture trifurcating. Pleopod 5 exopod with proximal sigmoid false suture and transverse false suture.

Uropods subcylindrical, to approximately $2\times$ length of pleotelson, endopod approximately $0.75\times$ length of protopod, sexual dimorphism not apparent.

Etymology.—This species is named for J. G. Mackin, in honor of his pioneering work on the asellid fauna of Oklahoma (Mackin 1940, Mackin & Hubricht 1938, 1940; Hubricht & Mackin 1949).

Ecology.—Long's Cave is a proto-dendritic, phreatic conduit 350 m in length, with some secondary vadose development. It was dissolved from the Reed Springs member of the Mississippian Boone Formation limestone. This karst complex concentrates and discharges a subterranean stream of approximately 0.1 cubic meter per minute. The recharge

area is 313 hectares (Aley & Aley 1999) to which, as presently known, *C. mackini* is endemic. Human entry into the system requires snorkeling gear at low base-flow conditions. The Nature Conservancy owns Long's Cave and manages it within the Eucha Nature Preserve.

Caecidotea mackini coexists with another stygobitic isopod, *C. ancyla*. Other notable aquatic fauna found in Long's Cave include the Ozark cavefish *Amblyopsis rosae* (Eigenmann, 1898), Oklahoma cave crayfish *Cambarus tartarus* (Hobbs & Cooper, 1972), and a cave amphipod *Stygobromus* sp.

Relationships.—Within the *hobbsi* species group there are several taxa, called here the *tridentata* assemblage, in which the structures of the taxonomically important male pleopod 2 endopod tip are nearly indistinguishable (Fig. 4a–f). Besides *C. mackini*, these include *C. tridentata* (Kansas, Lewis & Bowman, 1981), *C. acuticarpa* (Oklahoma, Mackin & Hubricht, 1940), *C. adenta* (Oklahoma, Mackin & Hubricht, 1940), *C. reddelli* (Texas, Lewis & Bowman, 1996), *C. salemensis* (Missouri, Lewis, 1981), *C. spatulata* (Illinois, Missouri, Lewis & Bowman, 1981) and *C. teresae* (Indiana, Lewis, 1982). In each of these, the endopod tip comprises a low, conical cannula surrounded by a scalloped, broadly rounded caudal process and a mesial process that hooks mesiad apically. To these might be added *C. lesliei* (Illinois, Lewis & Bowman, 1981) that is clearly a closely related derivative, lacking only the mesial process hook (it is blunter apically). The male first pleopod is so similar in these and other members of the *hobbsi* group that it is of little help in separating the species. These species (Fig. 4d, f, g) mostly possess a type A pleopod 4 exopod suture pattern (2 false sutures with apical incision, per Lewis & Bowman 1981) that is frequently correlated with *Caecidotea* inhabiting saturated soil interstitial habitats rather than

caves. Only *C. salemensis* and some populations of *C. acuticarpa* (see below) have a type B pleopod 4 and are primarily cavernicoles. *Caecidotea mackini* is separated from all species in the assemblage by the sculptured appearance of the male pleopod 2 endopod tip (Fig. 4a, b) that has proximal ledges leading up to the mesial and caudal processes. Of the species with adjacent ranges, it is separated from *C. tridentata* by the absence of the prominent proximal process on the gnathopod (Fig. 2a), from *C. acuticarpa* by the broader, shorter carpus (Fig. 2h), and from *C. salemensis* by the type B pleopod 4 (Fig. 3d) and elongate, cylindrical uropods (Fig. 1a).

Peck & Lewis (1978) presented a correlation between the distribution of subterranean invertebrates in the middle western United States with the geological, climatic and vegetational history of the region. Although all members of the *tridentata* assemblage are subterranean species, *C. tridentata*, *C. acuticarpa*, *C. spatulata*, *C. salemensis*, and *C. teresae* (and perhaps others) retain vestiges of pigmentation. *Caecidotea spatulata* has small eyes and has been collected from questionably epigeal habitats – it is difficult to know if the report of this species from temporary surface waters (Mackin & Hubricht 1940) is a matter of preference or accidental discharge from groundwaters. The retention of vestigial eyes or pigment points to an epigeal ancestor, in this case one that invaded groundwater habitats over a relatively wide area (Lewis 1982). The range of this assemblage of species, from Texas north into Oklahoma and Kansas then east to central Indiana (Fig. 5), corresponds to the Great Plains region of central North America. After the uplift of the Rocky Mountains, during the mid-Tertiary cooling and drying resulted in a shift in fragmentation of the forests and the creation of the Great Plains grasslands (Peck & Lewis 1978). The western part of

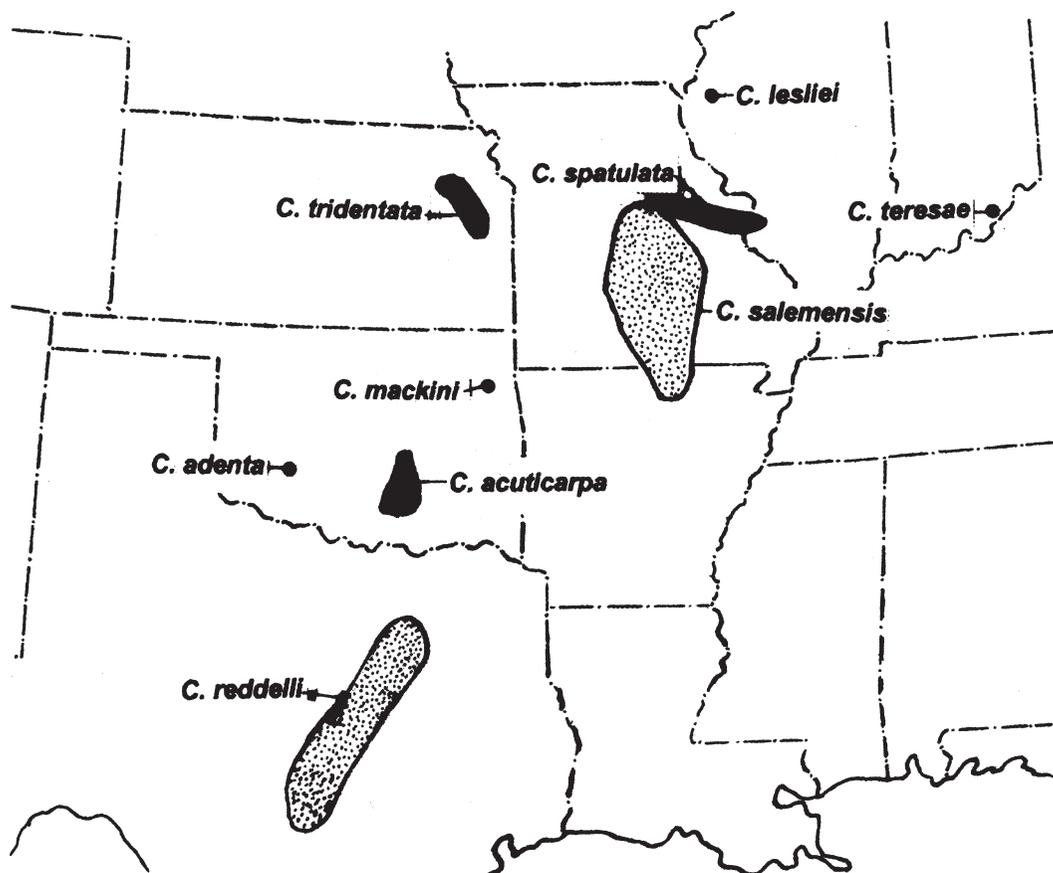


Fig. 5. Map of the south-central United States showing the approximate ranges of nine species of the *Caecidotea tridentata* species assemblage.

this area became the most arid and no subterranean asellids have been discovered there. Thus, morphologic, zoogeographic and climatic evidence correlate to suggest that an epigeic ancestor of the *tridentata* assemblage invaded groundwaters as surface habitats became scarcer during the middle to late Tertiary. Today only a cluster of subterranean species remain.

Caecidotea acuticarpa Mackin & Hubricht, 1940
Figs. 2h, 3f, 4c, d

Material examined.—OKLAHOMA: Type A: Johnston Co.: Twin Vulture Cave, 5 Aug 2005, GG, DF, 2 males, 1

juv; Pontotoc Co.: Byrds Mill Spring, 2 Dec 1930, J. G. Mackin, 4 males, 3 females; 10 Nov 2005, S. Wallace, 1 male, 1 female; Deadman's Spring, 30 Mar 2006, GG, DF, 2 males, 4 females.

Type B: Johnston Co.: Bruno's Spring 2, 30 Mar 2006, GG, DF, 6 males, 4 females; Martin Spring, 30 Mar 2006, GG, DF, male, 2 females; Mystic Cave, 18 Dec 2004, GG, DF, 2 males, 1 female; spring upstream of Tishomingo National Fish Hatchery, 5 Aug 2005, GG, DF, 1 male, 1 female; spring box upstream of Tishomingo National Fish Hatchery, 31 Mar 2006, GG, DF, 4 males, 4 females; Murray Co.: spring on Hickory Creek,

29 Mar 2006, GG, DF, 5 males, 2 females; Pontotoc Co.: Coal Creek Cave, 19 Dec 2005, GG, DF, 3 males, 2 females.

Remarks.—Fleming (1972b) synonymized *C. acuticarpa* with *C. tridentata*, but Lewis & Bowman (1981) rejected this synonymy after examination of the type specimens of *C. acuticarpa* and the re-description of *C. tridentata*. Although described as unpigmented by Mackin & Hubricht (1940), a diffuse granular magenta pigment is visible in some specimens, similar to that seen in other *tridentata* assemblage species.

Lewis & Bowman (1981) noticed in their analysis of the subterranean *Caecidotea* in Illinois that the fourth pleopod exopods had two basic patterns. These were termed: (1) type A (Fig. 3d, f) with a false suture pattern in which the distal part of the exopod was divided into two roughly oval parts, and (2) type B (Fig. 3g) possessing a single sigmoid suture. These were believed to be species-specific and considered useful taxonomic characters. Examination of the fourth pleopod exopods of specimens of *C. acuticarpa* revealed that both type A and B were present. This presented a dilemma if this morphology is in fact species specific. Although the male pleopod 2 endopod tip of *C. acuticarpa* is very similar to that of other *tridentata* assemblage species, the unique shape of the carpus in *C. acuticarpa* is distinctive even under low magnification (Fig. 2a, h). Until it can be established whether pleopod 4 morphology is species-specific, a manifestation of polytypic species, or perhaps even eco-phenotypic, it is not desirable to split *C. acuticarpa* based only on this character. In the material examined, the collections are separated into type A and B populations for future reference.

Distribution.—*Caecidotea acuticarpa* is endemic to groundwater habitats in the Arbuckle Uplift, where it has been collected from caves, springs and a well.

It has been reported from Johnston, Murray, Pontotoc and Seminole counties (Mackin & Hubricht 1940, Harrel 1963, Black 1971, Fleming 1972a).

Caecidotea adenta Mackin & Hubricht, 1940

Figs. 3g, 4e, f

Material examined.—OKLAHOMA: Kiowa Co.: deep limestone sink cave 15 mi south of Mountain View, Nov 1936, J. G. Mackin, 5 males, 5 females.

Remarks.—Specimens of an asellid from a small cave near Turner Falls, Murray County were collected by J. Holsinger and R. Norton on 24 June 1964 and identified by Fleming (1972b) as *Asellus adentus*. This is believed to be a misidentification of *C. acuticarpa*. Murray County is within the known range of *C. acuticarpa*, whereas *C. adenta* is known only from the type-locality in the Wichita Mountains. A single female specimen of a subterranean *Caecidotea* was collected by Graening and Fenolio from a well in Comanche County, Oklahoma, also in the Wichita Mountains. The slender gnathopod of this specimen suggests that it is *C. adenta*, but collection of a male is necessary to confirm this suspicion.

Caecidotea ancyla (Fleming, 1972a)

Fig. 4g

Material examined.—ARKANSAS: Boone Co.: Brewer Cave, 26 Jun 1964, J. R. Holsinger, 1 male; Major's Cave, Jul 1977, N. Youngsteadt, J. Youngsteadt, 1 male. MADISON Co.: Denny-Horsethief Cave, 4 Jun 1977, M. D. Schram, 22 males, 12 females, Withrow Springs Cave, 6 Aug 1978, M. D. Schram, 5 males, 3 females. MISSOURI: Camden Co.: Ozark Caverns, 17 Mar 1982, J. E. Gardner, 1 male, 4 females; River Cave, Hahatonka State Park, 4 Aug 1940, L. Hubricht, 15 females. OKLAHOMA: Adair Co.: Three Forks Cave, 1 Aug 1970, J. Black, 2 males; Cherokee Co.: Dressler Cave, 28 Jul 2005, GG, MS, 2 males, 5 females; Delaware

Co.: East Hollow Cave, 26 Jul 2005, GG, MS, 1 male; Engelbrecht Cave, 8 Dec 2004, GG, DF, 1 male; Long's Cave, 26 Jul 2005, GG, MS; Peach Tree Cave, 27 Jul 2005, GG, MS, 7 males/females; Spider Cave, 3 May 2005, GG, DF, 3 males, 2 females; Stansbury-January Cave, J. Lewis, 2 Jun 1981, 4 males, 4 females; 1 Jan 2001, E. Bergey, 1 male, 1 female.

Remarks.—The description of *Caecidotea ancyla* by Fleming (1972a) was sufficient to identify the species. However, the appearance of the male second pleopod endopod tip shown in fig. 4g is provided as it more typically portrays the structure than that shown in Fleming's illustration. This species co-occurs with other, usually larger species (e.g., *C. antricola*, *C. stiladactyla*, *C. mackini*). Its relatively diminutive size may cause it to be overlooked or mistaken for juveniles of the larger species with which it is syntopic. Culver & Ehlinger (1980) and Lewis (1988) documented habitat partitioning by similar species pairs of subterranean *Caecidotea* inhabiting the same cave.

Distribution.—*Caecidotea ancyla* is endemic to the Ozarks, where most collections have been made from within the Springfield Plateau, although this species is also known from the western part of the Salem Plateau.

Caecidotea antricola Creaser, 1931

Material examined.—OKLAHOMA: Delaware Co.: January-Stansbury Cave, 9 Oct 2001, SH, DF, E. Bergey, 1 male, 1 female; Star Cave, 1 Aug 2005, GG, DF, 2 males, 1 female.

Remarks.—This is the most widespread and common of the subterranean isopods of the Ozarks. Lewis & Bowman (1981) and Lewis (1988) reported *C. antricola* from 14 counties in Missouri and three counties in Arkansas, spanning both the Salem Plateau and Springfield Plateau. These are the first records from Oklahoma.

Caecidotea macropropoda Chase & Blair, 1937

Material examined.—ARKANSAS: Washington Co.: Spring at Bradley Shelter, MS, 7 males, 5 females; Snyder Cave, MS, 4 males, 2 females; Storm Drain Spring, 28 Nov 2000, MS, 3 males. OKLAHOMA: Sequoyah Co.: Gum Spring, 12 Jul 2001, E. Bergey, 3 males.

Remarks.—Dearolf (1953) reported *C. macropropoda* from northwestern Arkansas. Lewis (1982) synonymized *C. ozarkana* with *C. macropropoda* and redescribed the species. Similar to the situation with *C. stiladactyla*, this species can be difficult to identify because of seeming differences in the orientation of the cannula from specimen to specimen. The cannula in some specimens appears to be a decurved tubular structure, while in others it appears more recumbent (per *C. stiladactyla* Mackin & Hubricht, 1940). The positioning and general shape of the accessory processes of the male second pleopod endopod tip are in general the same as that figured by Lewis (1982) but are more pronounced in some specimens. In one specimen the distal process on the palmar margin of the male gnathopod was bicusate rather than rounded. The suture patterns of the fourth pleopod exopod and the proximal setation was similar in all specimens examined, as were the elongate uropods. Due to the complexities of the morphology of asellids (in particular *C. macropropoda*, *C. stiladactyla*, *C. steevesi*, and *C. simulator*) inhabiting groundwaters of the Springfield Plateau, it is necessary to dissect and slide-mount multiple appendages from multiple specimens to make accurate identifications.

Lewis (1999) recorded localities in Carroll and Washington counties, to which the sites above are added. This species is endemic to the Springfield Plateau in Arkansas and Oklahoma, where it is found in caves and their spring outlets.

Caecidotea steevesi (Fleming, 1972a)

Material examined.—ARKANSAS: Madison Co.: War Eagle Cave, 21 Jun 1981, M. D. Schram, 2 males; Withrow Springs Cave, 16 Sep 1979, M. D. Schram, 4 males, 7 females; MISSOURI: Dade Co.: Carrico Cave, 20 Aug 1968, J. R. Holsinger, R. Norton, 5 males, 4 females; OKLAHOMA: Adair Co.: Gallcatcher Cave, 2 May 2005, GG, DF, 1 male, 2 females; Delaware Co.: Nickel Preserve Cave #4, 1 Jun 2001, S. Hensley, 1 male.

Remarks.—As noted by Lewis (1999), the primary difference between *C. steevesi* and *C. simulator* is in the morphology of the fourth pleopods. With the significance of this pleopod as a taxonomic character in question (see discussion of *C. acuticarpa* above), it may be necessary to synonymize *simulator* with *steevesi* at some point. Until such time that a definitive answer becomes available, no action is being taken to split or synonymize species based on the fourth pleopod morphology.

Distribution.—*Caecidotea steevesi* is endemic to the Springfield Plateau, where it occurs in caves in northwestern Arkansas, southwestern Missouri, and northeastern Oklahoma (Fleming 1972a, Lewis 1999).

Caecidotea simulator Lewis, 1999

Material examined.—OKLAHOMA: Cherokee Co.: Single Barrel Cave, 28 Jul 2005, GG, MS, 4 males, 3 females; Delaware Co.: Carroll's Cenote, 3 May 2004, GG, DF, 1 male, 2 females; Ottawa Co.: cave near Klugf's Spring, 28 Jun 2001, J. Waterbury, 6 males/females; cave on Tripoli land, 14 Dec 2004, GG, DF, MS, 1 male, 1 female; Schifleff Cave, 6 Dec 2004, GG, DF, 1 male, 1 female.

Remarks.—This species was described by Lewis (1999) from southeastern Kansas and northwestern Arkansas. With the addition of the first records from Oklahoma, the range of *C. simulator*

spans the western part of the Springfield Plateau.

Caecidotea stiladactyla Mackin & Hubricht, 1940

Material examined.—OKLAHOMA: Adair Co.: Duncan Field Cave, 29 Oct 1996, B. Howard, 1 male; 1 May 2004, GG, DF, 1 male, 3 females; Delaware Co.: Anticline Cave, 17 Jan 2006, DF, JS, 4 males; Bolton Cave, 5 mi S Jay, 29 Nov 1970, J. Black, 3 males, 1 female; cave at Brush Creek bridge, 15 Dec 2004, GG, MS, DF, 7 males/females; Peach Tree Cave, 27 Jul 2005, GG, MS, 1 male; Rock Quarry Cave, 25 Jul 2005, GG, MS, 2 males, 2 females; Spavinaw Bat Cave, 18 Jan 2006, DF, JS, 5 males, 7 females; spring on Brush Creek, 3 May 2004, GG, DF, 2 males; Surprise Cave, 27 Jul 2005, GG, MS, 3 males, 7 females; seep, 6.4 mi S. Jay, 24 May 1940, L. Hubricht, 8 males, 13 females.

Remarks.—Mackin & Hubricht (1940) described *C. stiladactyla* from springs and seeps in Newton and Boone counties, Arkansas. Black (1971) listed the first locality in Oklahoma (Delaware County), to which several more are added here. This species is endemic to the Ozark Springfield Plateau.

Lirceus garmani Mackin & Hubricht, 1949

Fig. 4h

Material examined.—OKLAHOMA: Delaware Co.: spring at roadside park 1 mi east of Locust Grove, 21 Jan 2006, DF, JS, 4 males, 3 females.

Remarks.—Hubricht & Mackin (1949) asserted that the tip elements of the male pleopod 2 endopod were of little diagnostic use. New material collected from the roadside park spring cited by Hubricht & Mackin (1949) as a locality for *L. garmani* was examined. The endopod tip appeared to be distinctive and a figure is presented for future comparisons.

Distribution.—This isopod is an inhabitant of springs, small creeks, ponds and occasionally cave streams in Arkansas, Kansas, Oklahoma, and Missouri (Hubricht & Mackin 1949). In Oklahoma, Hubricht & Mackin (1949) reported it from springs in Mayes and Okfuskee counties as well as creeks or ponds in Johnston, Pontotoc, Seminole, Wagoner, and Woods counties. Black (1971) reported *L. garmani* from January-Stansbury Cave, in Delaware County and Locust Grove Spring Cave in Mayes County. This species is a spring-dweller with prominent eyes and pigmentation.

Acknowledgments

Funding for the preparation of this manuscript was provided by the Oklahoma Department of Wildlife Conservation (State Wildlife Grant Program grant number T-16-P) to E. A. Bergey, D. Fenolio and G. O. Graening. Field assistance with sampling is gratefully acknowledged to M. Slay and J. Stout. Loan of type-material of Oklahoma asellids from the collections of the Smithsonian Institution was kindly facilitated by M. Schotte. J. R. Holsinger, M. Slay and M. Schotte kindly reviewed the manuscript and made suggestions for its improvement.

Literature Cited

- Aley, T., & Aley, C. 1999. Recharge area delineation and hazard area mapping for Long and McGee's caves in the Eucha Nature Preserve and for Twin Cave in the Twin Cave Preserve, Delaware County, Oklahoma. Final report to The Nature Conservancy. Ozark Underground Laboratory, Protom, Missouri.
- Black, J. H. 1971. The cave life of Oklahoma, a preliminary study (excluding Chiroptera).—*Oklahoma Underground* 4(172):2–53.
- Chase, H. D., & A. P. Blair. 1937. Two new blind isopods from northeastern Oklahoma.—*American Midland Naturalist* 18:220–224.
- Creaser, E. P. 1931. A new blind isopod of the genus *Caecidotea*, from a Missouri cave.—*Occasional Papers of the Museum of Zoology, University of Michigan* 222:1–7.
- Culver, D., & T. J. Ehlinger. 1980. The effects of microhabitat size and competition on two cave isopods.—*Brimleyana* 4:103–114.
- Dearolf, K. 1953. The invertebrates of 75 caves in the United States.—*Proceedings of the Pennsylvania Academy of Science* 27:225–241.
- Eigenmann, C. H. 1898. A new blind fish (*Typhlichthys rosae*).—*Proceedings of the Indiana Academy of Science for 1897*:231.
- Fleming, L. E. 1972a. Four new species of troglobitic asellids (Crustacea: Isopoda) from the United States.—*Proceedings of the Biological Society of Washington* 84:489–500.
- . 1972b. The evolution of the eastern North American isopods of the genus *Asellus* (Crustacea: Asellidae) Part I.—*International Journal of Speleology* 4:221–256.
- Harrel, R. C. 1960. A preliminary report on the invertebrate animals of Wild Woman Cave.—*Proceedings of the Oklahoma Academy of Science* 40:29–34.
- . 1963. Further notes on the invertebrate animals of Wild Woman Cave.—*Proceedings of the Oklahoma Academy of Science* 43:129–131.
- Hobbs, H. H. Jr., & M. R. Cooper. 1972. A new troglobitic crayfish from Oklahoma.—*Proceedings of the Biological Society of Washington* 85:49–56.
- Hubricht, L., & J. G. Mackin. 1949. The freshwater isopods of the genus *Lirceus* (Asellota, Asellidae).—*American Midland Naturalist* 42:334–349.
- Hungerford, H. B. 1922. A new subterranean isopod.—*Kansas University Science Bulletin* 14:175–181.
- Lewis, J. J. 1981. *Caecidotea salemensis* and *C. fustis*, new subterranean asellids from the Salem Plateau (Crustacea: Isopoda: Asellidae).—*Proceedings of the Biological Society of Washington* 94:579–590.
- . 1982. A diagnosis of the *hobbsi* group, with descriptions of *Caecidotea teresae*, n. sp., and *C. macropoda* Chase and Blair (Crustacea: Isopoda: Asellidae).—*Proceedings of the Biological Society of Washington* 95:338–346.
- . 1988. The systematics, zoogeography and life history of the troglobitic isopods of the Interior Plateaus of the eastern United States. Unpublished Ph.D. dissertation, University of Louisville, Kentucky, 281 pp.

- . 1999. *Caecidotea simulator*, a new subterranean isopod from the Ozark Springfield Plateau (Crustacea: Isopoda: Asellidae).—Proceedings of the Biological Society of Washington 112:175–180.
- , & T. E. Bowman. 1981. The subterranean asellids (*Caecidotea*) of Illinois (Crustacea: Isopoda: Asellidae).—Smithsonian Contributions to Zoology 335:1–66.
- , & ———. 1996. The subterranean asellids of Texas.—Proceedings of the Biological Society of Washington 109:482–500.
- Mackin, J. G. 1940. A key to the Oklahoma species of the family Asellidae.—Proceedings of the Oklahoma Academy of Science 20:17–18.
- , & L. Hubricht. 1938. Records of distribution of species of isopods in central and southern United States, with descriptions of four new species of *Mancasellus* and *Asellus* (Asellota, Asellidae).—American Midland Naturalist 19:628–637.
- , & ———. 1940. Descriptions of seven new species of *Caecidotea* (Isopoda, Asellidae) from central United States.—Transactions of the American Microscopical Society 59:383–397.
- Packard, A. S. 1871. On the crustaceans and insects. Pp. 739–761 in Putnam, F. W. & A. S. Packard, eds., The Mammoth Cave and its inhabitants. American Naturalist vol. 5.
- Peck, S. B., & J. J. Lewis. 1978. Zoogeography and evolution of the subterranean invertebrate faunas of Illinois and southeastern Missouri.—National Speleological Society Bulletin 40(2):39–63.
- Rafinesque, C. 1820. Annual synopsis of new genera and species of animals, plants and c. discovered in North America.—Annals of Nature, 16 pp.

Associate Editor: Christopher B. Boyko