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A SECOND TROGLOBITIC SPECIES OF THE GENUS *LIRCEUS* (ISOPODA, ASELLIDAE) FROM SOUTHWESTERN VIRGINIA

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Introduction

The first known troglobitic species (i.e., obligatory cavernicole) of *Lirceus*, *L. usdagalun*, was described by Holsinger and Bowman (1973) from three caves in Lee County, Virginia. Prior to that time, 13 species of *Lirceus* had been described, all of which were primarily epigean forms (Williams, 1972). The genus occurs in parts of the eastern and middle-western United States and the Great Lakes region of southern Ontario, Canada, where it is represented in a variety of aquatic habitats, including springs, seeps, streams, ponds, sloughs, woodland pools, lakes and drain outlets (Williams, 1972). Several species of *Lirceus*, other than *L. usdagalun*, also have been reported from cave stream habitats (see Holsinger and Bowman, 1973, for a summary), but all have pigment and small eyes and are considered troglophiles and/or trogloxenes.

In August 1974, while doing field work in the caves of southwestern Virginia, Dr. David C. Culver and one of us (J. R. H.) discovered another population of eyeless, unpigmented *Lirceus* in a stream in McDavids Cave, Scott County, Virginia. A second trip to this cave in November 1975 resulted in the collection of additional specimens from the population. Surface habitats in Lee and Scott counties also were sampled for the presence of *Lirceus* to determine the taxonomic relationship between epigean and hypogean species. On initial inspec-

tion the material from McDavids Cave appeared similar to *L. usdagalun*, but after closer study it proved to differ consistently in a number of morphological characters and is described below. The description of this new species brings the total number of described species in the genus to 15 and the number of troglobites to two.

All of the material examined in this study is deposited in the National Museum of Natural History, Smithsonian Institution (USNM), or in the collection of the junior author (JRH).

Lirceus culveri, new species

Figures 1–4

Material examined: Virginia. Scott Co.: McDavids Cave, holotype male (USNM 156148), 21 paratypes (USNM 156149) and 4 slide-mounted paratypes (JRH collection), J. A. Estes et al., 28 Nov. 1975; 10 paratypes (2 partly on slide mounts) (USNM 152631), J. R. Holsinger and D. C. Culver, 3 Aug. 1974.

Diagnosis: An eyeless, unpigmented species closely allied morphologically with *Lirceus usdagalun* but distinguished from that species as follows: presence of only 1 heavy spine on small proximal process of gnathopod palm in both sexes; median process of palm of gnathopod small to prominent in mature male; spur of endopodite tip of male second pleopod slightly longer; distomedial margin of peduncle of male second pleopod without small spine and more weakly serrulate; uropod less setose, approximaltely 20 percent length of pleotelson, exopod only about ⅓ length of endopod. Largest male, 6.2 mm; largest female, 6.8 mm.

Description: Body about 64 percent longer than wide, with subparallel sides, not widening posteriorly. Head about 60 percent wider than long; lateral margin narrowly and deeply incised, anterior lobe about twice as wide as posterior lobe. Pereonites subequal, margins covered with fine setae. Pleotelson subtriangular, about 28 percent length of body, only slightly broader than long, narrowing posteriorly; median posterior process poorly delimited. Antenna 1: flagellum 5-segmented, last 2 to 4 segments bearing aesthetascs; first 2 peduncular segments with tufted setae (not shown in Fig. 2A). Antenna 2 relatively long but variable in length, 60 to 90 percent length of body; first peduncular segment with single stiff seta; peduncular segment 6 about 33 percent longer than 5, longer than combined length of first 4 peduncular segments; flagellum with up to 37 segments in largest specimen. Mandible without palp; incisor and lacinia mobilis 4-cuspidate (lacinia mobilis absent from right, present on left); spine row with 11 to 13 plumose spines on left, 15 on right; molar bearing clusters of subapical setae. Maxilla 1: outer plate with 12–13 apical spines, outermost 4 longer than inner ones; inner plate with 5 apical, plumose setae. Maxilliped: inner

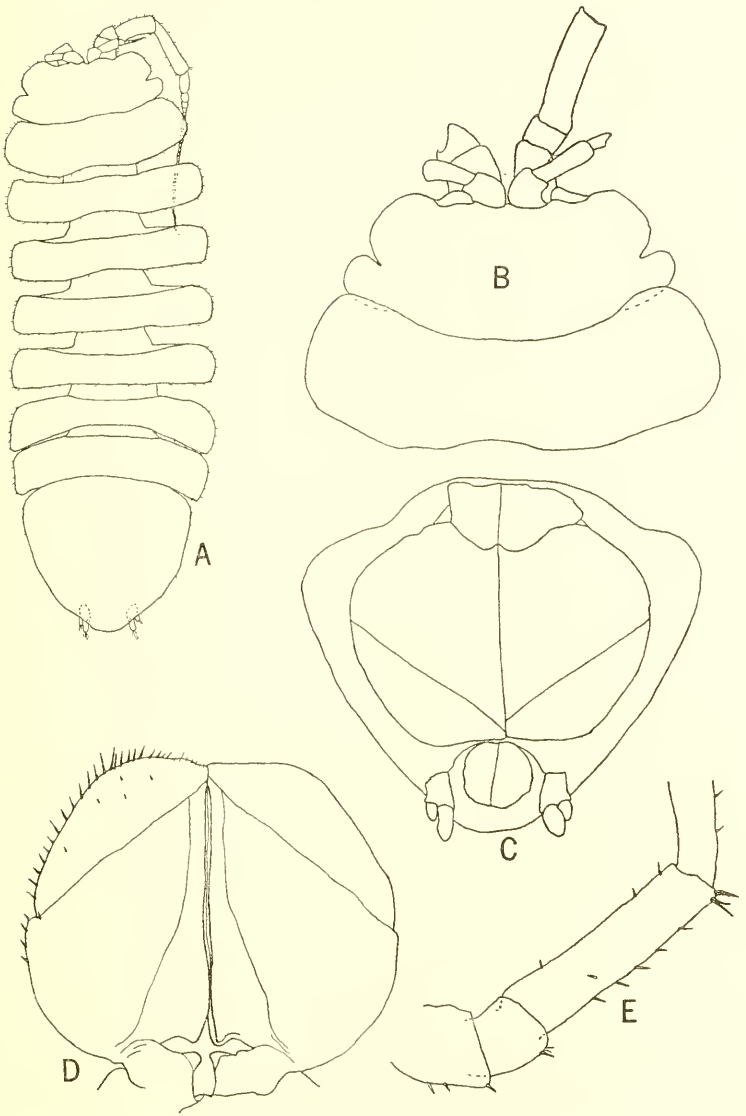

Fig. 1. *Lirceus culveri*, new species. Female paratype (5.9 mm): A, Dorsal view; B, Head and pereonite (setation omitted); C, Pleotelson and uropods, ventral (setation omitted). Male paratype (6.2 mm): D, Pleopod 3, anterior (setation shown only on one side); E, Left antenna 2, in part.

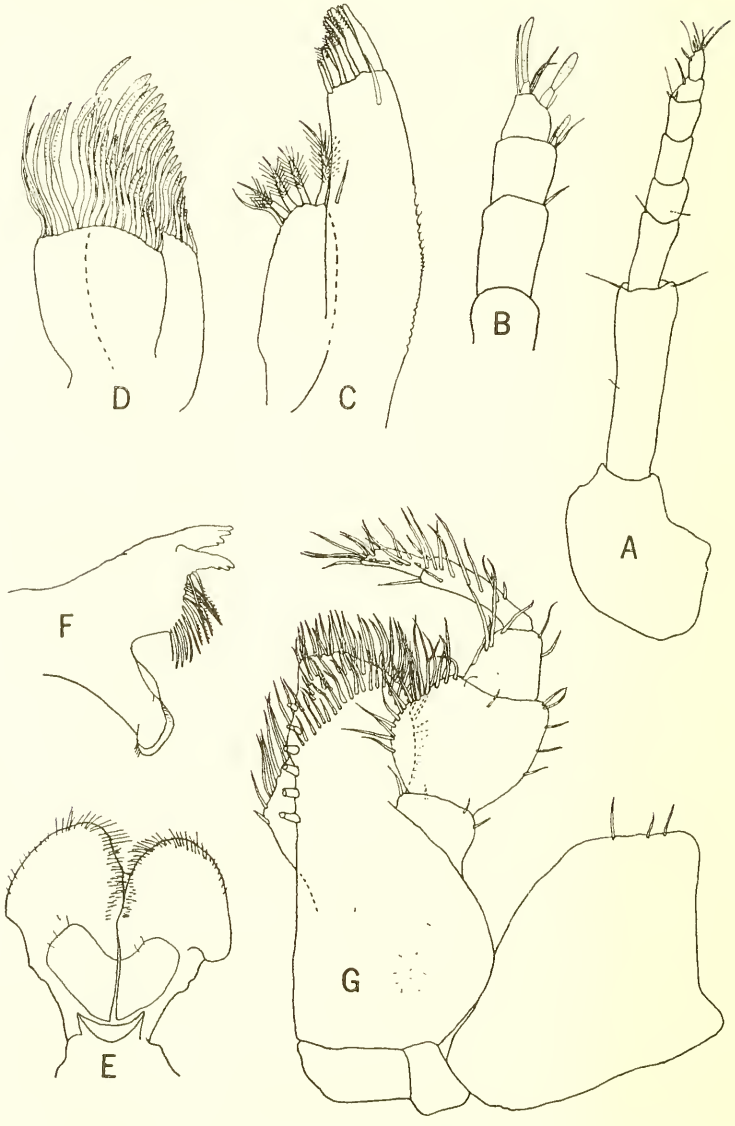

Fig. 2. *Lirceus culveri*, new species. Male paratype (6.0 mm): A, Right antenna 1, dorsal. Male paratype (6.2 mm): B, Terminal segments of antenna 1, dorsal (enlarged); C, Maxilla 1; D, Maxilla 2 (laminae of outer plate); E, Lower lip. Male paratype (5.2 mm): F, Left mandible; G, Left maxilliped, posterior.

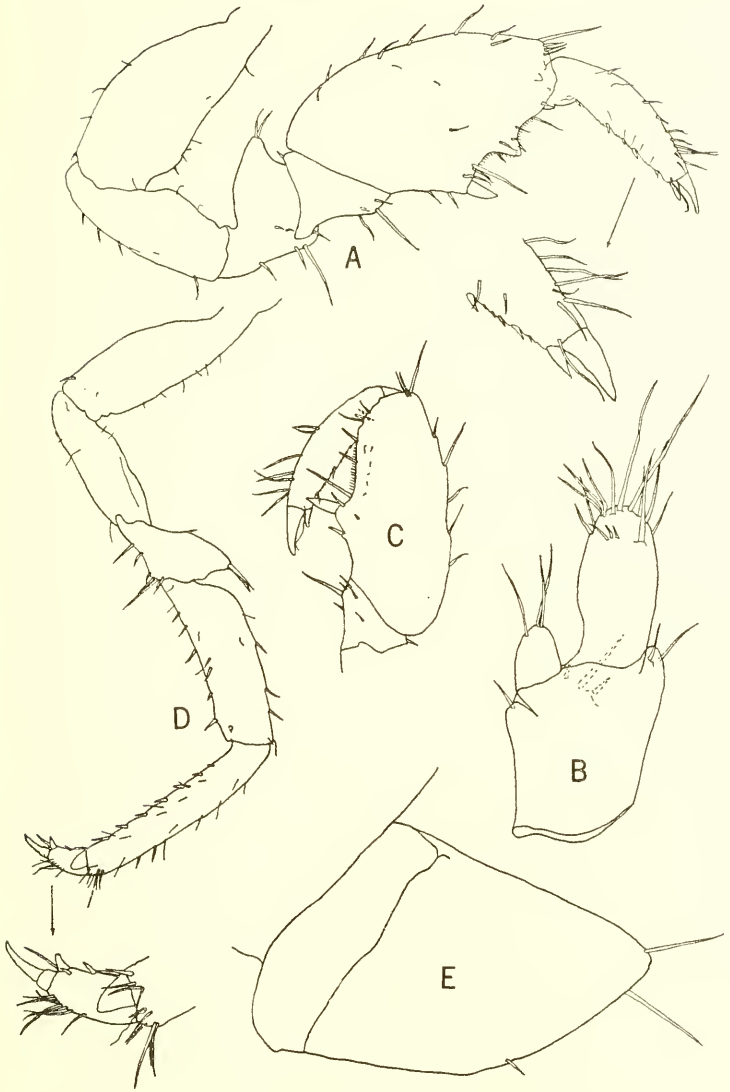

Fig. 3. *Lirceus culveri*, new species. Male paratype (5.2 mm): A, Left gnathopod, medial; B, Left uropod, dorsal. Female paratype (5.2 mm): C, Right gnathopod, medial. Male paratype (6.2 mm): D, pereopod 7. Female paratype (5.5 mm): E, Right pleopod 2, anterior.

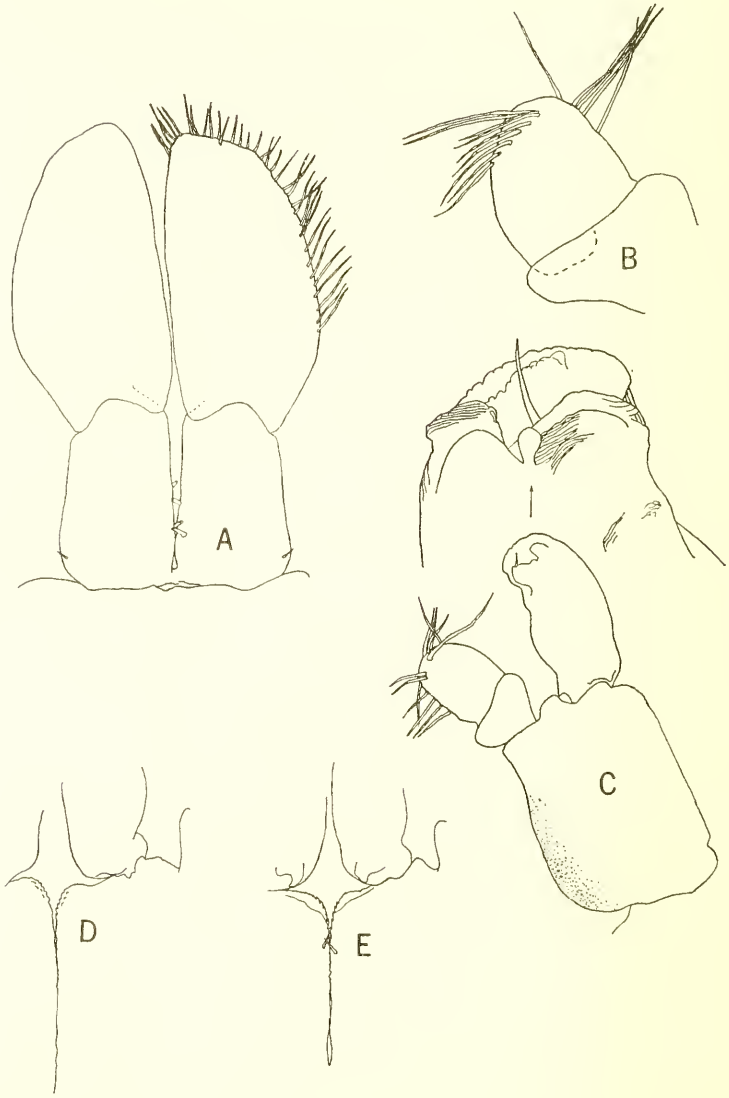

Fig. 4. *Lirceus culveri*, new species. Male paratype (6.2 mm): A, Pleopod 1, anterior (setation shown only on one side); B, Exopodite of pleopod 2, anterior (enlarged). Male paratype (6.0 mm): C, Pleopod 2, anterior (tip enlarged). Male paratype (5.2 mm): D, Inner margin of peduncle of pleopod 2. *Lirceus usdagalun* (4.8 mm male): E, Inner margin of peduncle of pleopod 2 (note comparison with that of *L. culveri*).

plate with row of apical, plumose setae; outer plate with 5–6 retinaculae on inner margin and numerous thick, plumose setae on apex; palpal segments 2–5 with numerous setae.

Gnathopod propod of male: palm rather oblique, with small proximal process bearing 1 heavy spine; median process of palm small to well developed, usually prominent in larger specimens. Gnathopod propod of female proportionately smaller than that of male; median process absent. Dactyls of pereopods 2–7 bearing 2 spines each. Male pleopod 1: peduncle 65–70 percent length of exopod, with 2–3 retinaculae; exopod nearly 50 percent longer than wide, inner margin nearly straight, unarmed; outer margin of exopod convex, armed with relatively long setae. Male pleopod 2: peduncle about ⅓ longer than wide, distomedial margin weakly serrulate, without spines. Exopod of male pleopod 2 somewhat variable, slightly more than ½ length of peduncle; distal segment subquadrate, bearing 5 long, very weakly barbed (not indicated in Fig. 4B, C), apical to subapical setae and 7–9 long, naked setae on lateral margin. Endopod 2 of male pleopod 2 suboblong, about twice as long as broad; apex with 3 distinct processes and 1 spur; caudal process broadly rounded, margin partly rugose; cephalic process smaller and less broadly rounded than caudal process, anterior surface rugose; mesial process with short stalk and flattened tip bent anteriad; spur slender, finger-like, slightly curved, sometimes reaching just beyond caudal process. Female pleopod 2 short; lateral margin oblique distally, nearly straight proximally; apex with 2 long, terminal setae and 1 shorter subterminal seta. Pleopods 3–5 of both sexes generally similar to those of *L. usdagalun*. Uropod about 5.5 percent length of body, about 20 percent length of pleotelson; peduncle about as broad as long, a little more than twice as long as exopod; endopod about ⅔ longer than exopod; rami bearing long, terminal setae.

Remarks: The small spine on the distomedial margin of the peduncle of male pleopod 2 of *L. usdagalun* was not indicated in Fig. 3C in the description of that species by Holsinger and Bowman (1973). A corrected illustration of this structure is provided by us in Fig. 4E.

Type-locality: McDavids Cave, located approximately 6 km northeast of Clinchport in the Rye Cove karst area of Scott Co., Virginia, is a large, stream-passage cave developed along the strike in the Rye Cove limestone of Middle Ordovician age (Holsinger, 1975).

Distribution and ecology: *L. culveri* is known only from the type-locality, where it has been collected twice from on and around gravels (some fused) in areas of the cave stream marked by riffles. Two other troglobitic crustaceans, the isopod *Asellus recurvatus* and the amphipod *Stygobromus mackini*, also inhabit the stream, but they generally occur on rocks and appear much less common than *L. culveri*. On the August 1974 visit, two small female crayfish, *Cambarus bartonii*, also were collected from the stream; this species is a troglophile or trogloxene.

The August 1974 collection contained five males and five females, two

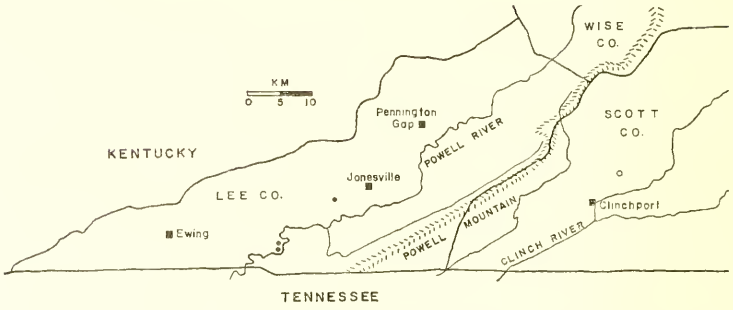

Fig. 5. Distribution of troglobitic species of *Lirceus* in southwestern Virginia: *L. culveri*, open circle (Scott County); *L. usdagalun*, closed circles (Lee County).

of which were ovigerous. The ovigerous females measured 5.6 and 7.8 mm and were carrying 18 and 28 eggs, respectively. The November 1975 collection contained nine males and 17 females, three of which were ovigerous or larviparous. Two of these females measured 4.8 and 4.9 mm and were carrying 11 and 13 newly-hatched young, respectively. The other female, 5.2 mm in length, had eight eggs in the brood pouch. Some of the newly-hatched young and eggs from the females in the latter collection were probably lost from the pouches before counts were made.

Etymology: It is a pleasure to name this new species in honor of our friend and colleague, Dr. David C. Culver, whose studies on the ecology of aquatic cave stream communities in the Appalachians have contributed substantially to our knowledge of biospeleology.

Discussion

Morphologically and ecologically, *L. culveri* appears to be closely related to *L. usdagalun* and the two species probably share a relatively recent common ancestor. Although the morphological differences between these species are not great, they do, however, appear to be consistent and of enough significance to warrant separation of the two forms at the species-level. As presently known, *L. usdagalun* and *L. culveri* occur in separate karst areas in adjacent tributaries of the upper Tennessee River drainage basin—the former from the Powell River Valley and the latter from the Clinch River Valley. The ranges (see Fig. 5), which are allopatric, are situated approximately 45 km apart and are physically separated by the Powell Mountain and other potential barriers to the dispersal of aquatic cavernicoles.

In view of the absence of either of these species from surface seeps or springs and the fact that both appear to be confined ecologically to the substrates of cave streams, there is little, if any, possibility for gene

exchange between populations presumably isolated in separate karst areas. The ancestor to these species was probably an epigean form whose range covered parts of both the Powell and Clinch valleys, but which has since been eliminated from surface habitats.

L. usdagalun was originally described from three caves in Lee County by Holsinger and Bowman (1973) but has since been found in a fourth cave—Gallohan No. 2. However, the latter cave is hydrologically integrated with nearby Gallohan Cave No. 1 (type-locality of *L. usdagalun*) and these two caves share the same stream (Holsinger, 1975). The Gallohan caves are indicated by the same closed circle on the map in Fig. 5. As previously noted, *L. culveri* is known only from its type-locality, but the discovery of additional populations of this species from other nearby cave streams which contribute to the extensive subterranean drainage system in Rye Cove will not be surprising.

Several epigean species of *Lirceus* occur in the surface waters of the karst areas in Rye Cove and south-central Lee County. To gain further insight into the distribution of *Lirceus* in these areas and to check for similarities between the epigean and hypogean species, we searched several springs and small surface streams for populations of *Lirceus*. At least two, and possibly three, species were found, none of which can be assigned with certainty to any described species in the genus. All of these species differ significantly from *L. culveri* and *L. usdagalun*, especially in the structure of the gnathopods, shape of the head and usually the body, and in the proportionate length and setation of the uropods. In addition, the surface species are pigmented and eyed. One of these species, a small form (up to 6.0 mm in length) with yellow banding of the pereonites, was found in springs of both karst areas. A larger, unbanded species (length up to 10.0 mm) was found in the surface stream of a blind valley leading to the entrance of Alley Cave in Rye Cove. Finally, a relatively small (up to 7.0 mm in length), lightly pigmented, eyed form was collected from the stream in Alley Cave. The stream in this cave is recharged from the surface stream in the blind valley and is, in turn, a subterranean tributary to the larger stream in McDavids Cave which contains *L. culveri*. The form in Alley Cave may be conspecific with the species in the surface feeder stream, but its size is smaller and the body is narrower and more lightly pigmented. This same lightly pigmented, narrow-bodied form was also found along with the small, yellow-banded species in a series of small springs which empty into Mill Creek on the eastern side of Rye Cove. It is perhaps of biological interest that these springs are the resurgence of the subterranean waters in McDavids Cave.

Further study is obviously necessary to ascertain the taxonomic relationship between the epigean species in Lee and Scott counties, and also to determine more precisely the relationship between the epigean and hypogean species. Considering the present taxonomic confusion in the genus *Lirceus* (see Styron, 1969; Williams, 1972; Holsinger and

Bowman, 1973), this may prove to be a difficult task until the systematics of the genus are adequately revised.

Acknowledgments

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