

# ***HESPERONEMASTOMA SMILAX*, N. SP., A REMARKABLE NEW HARVESTMAN FROM A CAVE IN WEST VIRGINIA, WITH COMMENTS ON OTHER REPORTED CAVE-DWELLING *HESPERONEMASTOMA* SPECIES (OPILIONES, ISCHYROPSALIDOIDEA, SABACONIDAE)**

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**Abstract:** *Hesperonemastoma smilax*, n. sp., is a minute, highly troglomorphic harvestman described herein from a single male specimen collected in McClung's Cave, Greenbrier County, West Virginia. *Hesperonemastoma* species described previously from caves are briefly discussed. *H. packardi* (Roewer), first collected in a shallow cave in Utah, is a widely distributed surface-dwelling species found mostly in riparian canyon habitats in northern Utah; it shows no troglomorphic adaptations. *Hesperonemastoma inops* (Packard), described from a cave in Kentucky, is not a species of *Hesperonemastoma*, but most likely a juvenile of *Sabacon cavicolens* (Packard), which was described from the same small cave. *Hesperonemastoma pallidimaculosum* (Goodnight and Goodnight) is a moderately adapted troglobiont known from two caves in Alabama.

## INTRODUCTION

Species of the harvestman (Opiliones) genus *Hesperonemastoma* are distributed in three discrete regions: the southern Appalachians of eastern North America, the Rocky Mountains in Utah and Idaho, and the Pacific coastal region from southern California north to the Queen Charlotte Islands, British Columbia, Canada. While three of the six named species inhabit deep forest litter, three species have been reported as collected only in caves. A fourth cave species is described in this article.

All *Hesperonemastoma* species were originally placed in the endemic European/west Asian genus *Nemastoma*. Gruber (1970) demonstrated that these species, in fact, were not members of the family Nemastomatidae and not even of the superfamily Trogluloidea. He placed them in the family Ischyropsalididae, which required that they receive a new generic name, *Hesperonemastoma* Gruber 1970. Gruber's treatment was not meant to be complete. It was incidental to the author's interest in *Nemastoma* itself. For recent work on a range of nemastomatid genera, including troglobionts, see Martens (2006).

Of the four *Hesperonemastoma* species associated with caves, the first, *H. packardi*, was described by Packard in 1877 as *Nemastoma troglodytes*, from Clinton's Cave, Lake Point, Tooele County, Utah. Because that name was preoccupied in *Nemastoma*, Roewer changed it to *packardi* in 1914. *Hesperonemastoma inops* (Packard), also originally described as a *Nemastoma* species, was named in 1884 from immature material collected in Bat Cave, Carter County, Kentucky. The specimens are probably no longer extant, and to my knowledge it has not been collected since.

Goodnight and Goodnight (1945) described *Nemastoma pallidimaculosum* from Rock House Cave, Marshall County, Alabama; below I report a new record from a cave in an adjacent Alabama county. The description of *H. smilax*, n. sp., in this article is the first description of a new *Hesperonemastoma* species in 64 years.

## TAXONOMY

SUPERFAMILY ISCHYROPSALIDOIDEA SIMON 1879

Family Sabaconidae Simon 1879

*Hesperonemastoma* Gruber 1970

*Hesperonemastoma* Gruber 1970, p. 129; Shear, 1986, p. 13; Murphree, 1987, p. 94; Cokendolpher and Lee, 1993, p. 6.

Type species: *Nemastoma pallidimaculosum* Goodnight and Goodnight, 1945, by original designation.

Notes: An excellent diagnosis and description of the genus is provided by Gruber (1970). In my cladistic analysis of 1986, based on a rather small number of morphological characters, I placed *Hesperonemastoma* as sister to *Crosbycus* Roewer 1914 and put both in my new family Ceratolasmatidae, opposing a clade composed of the western North American genera *Ceratolasma* Goodnight and Goodnight 1942 and *Acuclavella* Shear 1986. However, recent molecular evidence has challenged this placement, supporting a widely divergent position for *Crosbycus*, and seeming to show *Hesperonemastoma* as close to *Taracus* of the family Sabaconidae Simon 1879 (Shultz and Regier, 2001). A total evidence approach taken by Giribet et al. (2002) differed somewhat, but still placed *Hesperonemastoma* close to *Taracus*. Finally, and conclu-

sively, a multi-locus analysis by Giribet et al. (2009) cemented the relationship of *Hesperonemastoma* to *Taracus*, and Giribet et al. (2009) formalized the transfer of *Hesperonemastoma* to Sabaconidae. Within Sabaconidae, the morphology of *Hesperonemastoma* is extremely divergent. It should be noted, however, that convergence of general body habitus is well known in Opiliones; *Taracus* itself (Sabaconidae), *Ischyropsalis* (Ischyropsalididae), *Nipponopsalis* (Trogulidae), and *Megalopsalis* (Monoscutidae) all resemble one another despite all belonging to separate families and even suborders, perhaps because of a common adaptation for feeding on snails (Nyffeler and Symondson, 2001) or, in the case of the monoscutid, secondary sexual characters of the males. It now seems that the striking similarity of *Hesperonemastoma*, *Crosbycus*, and several genera of Nemastomatidae is also the result of convergence or parallelism. For the time being, a diminished family Ceratolasmatidae and an augmented Sabaconidae are accepted by most harvestmen systematists, but their contents may change drastically in the future (Gruber, 2007; Giribet et al., 2009).

*Hesperonemastoma pallidimaculosum* (Goodnight and Goodnight)

*Nemastoma pallidimaculosa* Goodnight and Goodnight, 1945, p. 241, figs. 1, 2.

*Nemastoma pallidimaculosum*, Roewer, 1951, p. 140 (name corrected to agree in gender with the generic name).

*Hesperonemastoma pallidimaculosum*, Gruber, 1970, p. 134, figs. 1, 2, 5, 12, 13–15, 18; Cokendolpher and Lee, 1993, p. 6.

Types: Male holotype and two female paratypes from Rock House Cave, 1 mile south of Oleander, Marshall County, Alabama, deposited in the American Museum of Natural History, New York (AMNH).

Notes: Gruber (1970) made this species the type of *Hesperonemastoma* and described and illustrated it in detail. It has been collected only once more since 1945. The decision to make this rare, highly divergent species the type of the genus could be questioned.

The male holotype and paratype have rudimentary, unpigmented eyes. The female paratypes are eyeless, and in addition, the eye tubercle is reduced in size. The name derives from rows of “light spots” along the lateral margins of the scute, but in fact these are the impressions on the exoskeleton of the internal apodemes, marked by the absence of the usual granulations of the cuticle, which are darker than their surroundings and quite obvious in this species. These markings occur in all *Hesperonemastoma* species.

New record: ALABAMA: Jackson County, Horseshoe Cave, 6 miles north of Princeton, 30 June 1967, S. Peck and J. Fiske, male (AMNH). This specimen differs from the type males in that the rudimentary eyes have black pigment and the second cheliceromere is somewhat more prolonged dorsally.

*Hesperonemastoma packardi* (Roewer)

*Nemastoma troglodytes* Packard 1877, p. 160, fig. 5; 1888, p. 54, figs. 3, 15.

*Nemastoma packardi* Roewer 1914, p. 163 (new name for *N. troglodytes*); 1923, p. 676; 1951, p. 139.

*Hesperonemastoma packardi*, Gruber, 1970, p. 142, figs. 3, 6, 24; Cokendolpher and Lee, 1993, p. 6.

Notes: Gruber (1970) was evidently not able to locate the types of *packardi*; I found them in 1971 in the Museum of Comparative Zoology, Harvard University (MCZ), where they were not labeled as types, but the collection data are as reported by Packard (1877). Packard evidently believed he only had females, but the series consists of a male and four females. Restudying the holdings of the MCZ in 2007, I found a second vial, this one containing Packard’s original labels and two males and two females. They were not labeled as types but undoubtedly were part of Packard’s original series. One of these specimens, a male, has been designated as the lectotype and the others as paralectotypes.

The distinctive dorsal ornamentation of acute, conical abdominal-area tubercles and the lack of any anvil-shaped tubercles distinguishes this species. Packard (1877) thought the eyes and eye tubercle of his specimens were reduced in size, but they seem quite the same as in epigeal samples of this and other species.

In the absence of the types, Gruber relied on a male and five females from Rose Lake, Idaho (AMNH). According to the United States Geological Survey database on place names, all place names including “Rose Lake” in Idaho are in Kootenai County. This county is in the northern panhandle of Idaho, about 600 miles north of the localities for *packardi* in northern Utah. Based on experience with the distribution of other soil and litter arthropods, I would expect *H. modestum* from this region, not *packardi*, though the collecting of soil and litter animals done by William Leonard and Casey Richart has not revealed any additional *Hesperonemastoma* specimens from northern Idaho. Gruber (1970) illustrates (his fig. 24) the palpal femur of the ID male with a very distinct ventral swelling and glandular area. I did not detect this modification in *packardi* males from Utah, although the femora of the males are slightly thicker than those of the females. I could not verify Gruber’s own observation because the single palpus loose in the vial with the ID specimens is from a female. However, this character seems to be variable in *H. modestum*, and the same situation might obtain with *packardi*, assuming that all specimens studied by Gruber as *H. modestum* are actually that species; I have found four undescribed species from within the range of *H. modestum*. The palpal length was exactly the same (2.75 mm) in a *packardi* male and the ID male (as measured by Gruber). My observations of the penis of a *packardi* male from Utah differs from Gruber’s of the ID male; he figures the glans with about twenty strongly curved, large basal setae and at least four small distal setae, while my observations of a

male from the *H. packardi* type series show twelve straight, large basal setae and only two small distal setae. Given the generally low interspecific variability in penes in *Hesperonemastoma*, this could be significant. Finally, the ID specimens are entirely smooth and lack the abdominal-area tubercles typical of Utah *packardi*. To further complicate matters, there is a single female conforming to the ID specimens in the AMNH; this female is labeled “Lost Creek Reservoir” without further data. The USGS database contains no such name for any reservoir in Idaho, but “Lost Creek” is a name applied to streams in eight Idaho counties alone, as well as many other places in the northern Rocky Mountains. It is not possible to assign this specimen to a specific locality. It may well be that the ID specimens described by Gruber (1970) are not *packardi* but an undescribed species.

Clinton’s Cave, type locality for *packardi*, is west of Lake Point Station, close to the border between Tooele and Salt Lake Counties, Utah, overlooking the Great Salt Lake. Other details of its location are not given here because of conservation concerns. The cave itself is described in detail by Packard (1877). It appears to have been excavated by wave action of the Great Salt Lake during a previous higher stand of shoreline. The cave is relatively shallow; light penetrates, however faintly, throughout. At the time of Packard’s visit the cave was also quite dry, and specimens were collected from beneath flat stones on the floor of the cave, where a small amount of moisture had accumulated.

Clinton’s Cave is also the type locality of a tiny polydesmidan milliped, *Polydesmus cavicolus* Packard 1877. This species has recently been recollected and actually belongs to an undescribed genus of the family Macrosternodesmidae (Shear and Shelley, in prep.) Neither of the species appears cave-adapted, and their presence in the cave is probably accidental. The collections of the AMNH show that in fact *H. packardi* is relatively abundant and perhaps widely distributed on the surface in northern Utah. Detailed records will be given in the forthcoming revision; most are from the mountains and canyons in the Salt Lake City vicinity, but other regions of Utah remain poorly explored for soil and litter arthropods, and *H. packardi* may turn up in even more localities with further collecting.

In conclusion, *H. packardi* is a widely distributed surface-dwelling, leaf-litter species and is not troglomorphic or distinctly troglomorphic.

*Hesperonemastoma inops* (Packard)

*Nemastoma inops* Packard 1884, p. 203; 1888, p. 55, fig. 4. Roewer, 1914, p. 168; 1923, p. 677; 1951, p. 139. [Roewer 1923 is not in the reference list]

*Hesperonemastoma inops*, Gruber, 1970, p. 138; Coken-dolpher and Lee, 1993, p. 6.

Types: Two juvenile cotypes from Bat Cave, Carter County, Kentucky. Present whereabouts unknown, prob-

ably no longer in existence. Some Packard types, as with *H. packardi*, are in the collections of the MCZ, but neither the types of this species nor of *Phlegmacera* (= *Sabacon*) *cavicolens*, described from the same sample, were to be found in either the type collection or the general collection when searched for in 1970 and 1971 (Shear, 1975).

Notes: The original material is probably lost and the species has never been collected again, despite the fact that the Carter County caves are among the most intensively studied in the United States, the record of exploration going back to the early nineteenth century. The description by Packard (1884, 1888) raises doubts as to the position of this species. His description and illustration of the palpus (Packard, 1884, 1888) is completely unlike that of any other species of *Hesperonemastoma* in that the segments are much shorter and thicker and in quite different proportions. Packard (1884) also described *Phlegmacera cavicolens* (now *Sabacon cavicolens*; see Shear, 1975) from the same cave, from specimens collected at the same time. The description of *Nemastoma inops* and the illustration of the palpus fit an immature individual of *Sabacon*; indeed, *inops* is only about a fourth the size of a mature *S. cavicolens* (1 mm long vs. 4 to 5.5 mm for mature female *S. cavicolens*). At this size, immature *S. cavicolens* are white, have poorly pigmented eyes, and the palpi closely resemble Packard’s illustration of the *inops* palpus—the enlarged tibia of adults is only a little bigger than the patella in these very young juveniles. In samples of the Pacific coast species of *Hesperonemastoma*, the individuals most commonly incorrectly included as *Hesperonemastoma* are small juveniles of *Sabacon*. Furthermore, Bat Cave is a shallow cave “not suitable for the survival of normal troglonites” (S.B. Peck 2007, pers. comm.). Therefore I confidently hypothesize that *Nemastoma inops* is a synonym of *Sabacon cavicolens*, but in the absence of the original specimens, it’s impossible to prove it.

*Hesperonemastoma smilax*, n. sp.

Figures 1–10.

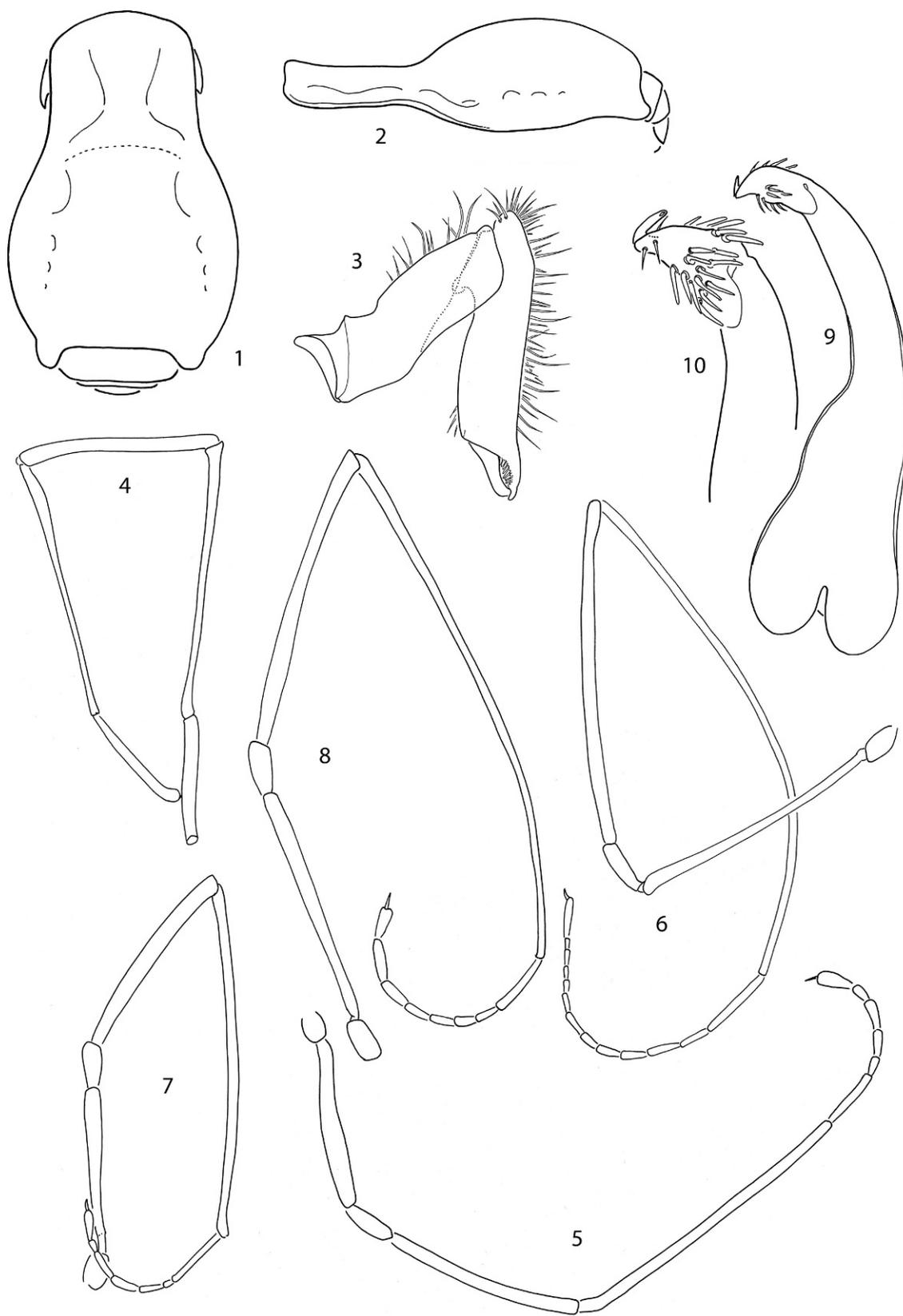
Suggested vernacular name: McClung’s Cave Harvestman.

Type: Male holotype from McClung’s Cave, Greenbrier County, West Virginia, collected March 23, 1961, by Lyle G. Conrad, deposited in the Virginia Museum of Natural History (VMNH), Martinsville, Virginia.

Diagnosis: Distinct from other known species of *Hesperonemastoma* in being not only eyeless, but in lacking the eye tubercle; the scute is completely smooth, without the paired tubercles, anvil-shaped tubercles, elevations, or black granules found in other species.

Etymology: The species epithet is a noun in apposition, the generic name of the greenbrier, catclaw vine, or wait-a-minute plant, a pernicious vine with hooked thorns from which the West Virginia county takes its name.

Description: length, 1.0 mm, greatest width 0.55 mm. Cephalic part of scutum nearly flat, eye tubercle absent



Figures 1 to 10. Male *Hesperonemastoma smilax*, n. sp. (1) body, dorsal view. (2) scutum, lateral view. (3) right chelicera, lateral view. (4) palpus, posterior view. (5) leg 1, posterior view. (6) leg 2, posterior view. (7) leg 3, posterior view. (8) leg 4, posterior view. (9) penis, dorsal view. (10) glans penis, dorsal view.

**Table 1. Appendage article lengths in mm of *H. smilax* male holotype.**

Appendage	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus
Palp	0.6	1.38	1.16	1.34	...	0.7
Leg 1	0.20	0.89	0.30	1.06	1.65	1.06
Leg 2	0.24	1.30	0.27	1.83	2.71	1.95
Leg 3	0.21	1.18	0.39	1.41	2.19	1.34
Leg 4	0.26	1.50	0.35	2.00	3.00	2.00

(Figs. 1, 2); abdominal part of scutum gently domed, smooth, lacking any paired ornament; all surfaces minutely granulate, granules concolorous with intervening cuticle; single large, subtriangular lateral sclerite. Color uniform yellow-tan after long preservation, color in life unknown. Chelicerae (Fig. 3) disproportionately large compared to congeners. Basal chelicere 0.5 mm long, 0.16 mm wide, not basally constricted, lacking crest; distal chelicere elongate, 0.66 mm long, 0.16 mm wide, slightly elevated above proximal articulation, setal coat most dense on elevated part. Pedipalp 5.18 mm long, thin, with extremely elongate trochanter; palpal hairs scattered, becoming much more dense on tibia and tarsus; claw absent (Fig. 4). Legs (Figs. 5–8) very long, thin; femora and patellae smooth to sparsely setose, lacking sculpture; femora with single basal false articulation; tibiae densely hairy, without false articulations; metatarsi densely hairy, with false articulations distal on metatarsi 2, 4; tarsi with articles as follows: tarsus 1, 6; tarsus 2, 13, tarsus 3, 7; tarsus 4, 8. Legs in order of length in mm: 4 (9.11), 2 (8.30), 1 (6.96), 3 (6.72). Measurements of articles of palpus and legs as in Table 1. Penis (Figs. 9, 10) typical for genus, shaft relatively short, glans set with stout, decurved setae, stylus sharply recurved.

Notes: McClung's Cave is located near Lewisburg, West Virginia. Extensive land holdings surrounding the Lightner Entrance to the cave have recently been purchased by the West Virginia Cave Conservancy. The cave has over 17 miles of mapped passageways, and may possibly be part of a system of four interconnected named caves with more than 77 miles of passageways. The cave has a rich fauna (J. Holsinger, pers. com.; Fong et al., 2007), including troglobionts (two millipeds, a dipluran, a collembolan, a pseudoscorpion, a spider, and a beetle), stygobionts (a flatworm, a snail, an amphipod, and a crayfish) troglaphiles (a terrestrial snail, a third millipede, a dipteran, and a second spider and amphipod), and troglonexes (yet another millipede, a second collembolan, and a cricket). Because of the small size and pale coloration of *H. smilax*, it is unlikely that the species will be collected again without intensive effort. A group of speleobiologists from American University under the direction of David Culver has been closely examining Greenbrier County caves in recent years; even so, they have not found this species again.

The slightly elevated second chelicere of this species is similar to that of *H. pallidimaculosum*, but the

first chelicere lacks the constriction and crest found in that species and generally in other *Hesperonemastoma* (see Figs. 12, 13 in Gruber, 1970). In *H. kepharti* (Crosby and Bishop), a leaf-litter species distributed from northern Alabama to southern Virginia (and the closest to *smilax* geographically), the elevation of the second chelicere is much exaggerated and extends dorsal from the articulation of the first and second cheliceres to about half the length of the latter. This modification of the chelicerae, however slight or pronounced, seems to separate the species of *Hesperonemastoma* into a western and an eastern clade, since the western species have the proximal part of the second chelicere evenly rounded and not at all exceeding the articulation dorsally. The long palpal trochanter and long, thin legs also suggest *pallidimaculosum*, but the elongation is even more pronounced in *smilax*.

*Hesperonemastoma smilax* shows extreme troglomorphy, in that not only is every trace of eyes gone, the eye tubercle itself is entirely flattened. This character alone would mark it as the most highly modified harvestman troglomorph in North America, since in all others at least a low eye tubercle is present, even if the eyes are entirely reduced. Cuticular ornament has also been reduced; no trace of the abdominal-area tubercles or anvil-shaped tubercles remains, and the small black denticles, so prominently covering the scute and abdominal tergites in the other eastern species, are difficult to see. The cuticle is thin and leathery, as opposed to the hard, black, heavily sclerotized cuticle of surface-dwelling species, and the legs and palpi are extraordinarily long and threadlike. It is clear that this species has undergone a long period of adaptation to its subterranean environment. *H. smilax* occurs approximately 75 miles due north of the northernmost records of the nearest congener, *H. kepharti*, suggesting that *H. smilax* is a relict of a once more northerly distribution of the genus.

As for comparisons with other species from caves, while *Hesperonemastoma packardi* of Utah was collected in a cave, that species has no troglomorphic adaptations, and its occurrence in the cave, as explained above, is clearly accidental. *H. inops* is likely not a member of the genus. *H. pallidimaculosum* is from northern Alabama and differs in its lesser degree of troglomorphy—males have small eyes, and females, while eyeless, retain the eye tubercle. Roewer (1951) described an animal he called *Crosbycus goodnightorum* from Fountain Cave, Madison County, Virginia, and

it is conceivable this could represent yet another troglomorphic *Hesperonemastoma*. However, Rambla (1968) established from the description (the specimens seem to have been lost) that *C. goodnighti* is a juvenile *Nemastoma* (see also Shear, 2008). Subsequent collecting in Fountain Cave has not turned this species up. There are no native *Nemastoma* species in North America and no records of European members of the genus having established themselves in the United States. It is possible the collection from which Roewer worked was mislabeled. For a fuller discussion of *Crosbycus*, see Shear (1986).

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