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TROGLOBITIC HARVESTMEN RECENTLY DISCOVERED IN NORTH AMERICAN LAVA TUBES (TRAVUNIIDAE, EREBOMASTRIDAE, TRIAENONYCHIDAE: OPILIONES)

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ABSTRACT

New troglobitic harvestmen are described from lava caves in the states of Washington and Idaho. They include species of Travuniidae: *Speleonychia sengeri*, new genus and species; Erebomastridae: *Speleomaster lexi*, new genus and species; *Speleomaster pecki*, new species. The occurrence of a species of Triaenonychidae is recorded. These species are highly modified for darkness and are unrelated to surface species. The family Travuniidae is represented for the first time in the New World. Morphological, ecological and phylogenetic considerations are discussed.

INTRODUCTION

Specialization of invertebrates in lava tubes and fissures has been found to be comparable to that in limestone caves. Howarth (1972) found examples of cavernicolous adaptation in the recent lava tubes of Hawaii, and others have noted lava cavernicoles in Japan and the United States. The realization that troglobites can occur in lava tubes has been slow in coming, however, and little serious collecting has been done in these caves.

Harvestmen are one of the primary groups of cavernicolous invertebrates. This study has found them to be well represented in lava tubes of western North America. Specimens collected in lava flows in Washington and Idaho include highly specialized laniatorid opilionids that are unrelated to surface populations. The surface laniatorids of the Washington lava fields are of the family Triaenonychidae while only travuniids are found in caves. In central Idaho the surface laniatorids are represented by the triaenonychids while only erebomastrids are found in caves. Eastern Idaho apparently has cavernicolous triaenonychids, but in a different genus from those on the surface.

An obvious evolutionary question arises from these recent discoveries. How did a large taxonomic gap develop between surface and subsurface populations? The answer to this question is related to the length of time these opilionids have been isolated in lava caves. Their lack of eyes, reduced ocular tubercles, elongated appendages and loss of pigment patterns suggest that they have been long isolated. Considered alone, lava caves are a poor choice for prolonged evolution because they can only deteriorate, not grow as limestone caves do. Therefore, lava flows must be rather permeable to invertebrates. If new lava tubes are continuously produced as is the case on Hawaii, cave life must travel through cracks in the lava to these new sites.

The discovery of travuniids in the Washington lava tubes was unexpected, but their presence in this isolated habit supports Vandel (1965) and others who regard these

harvestmen as "living fossils." Previously, travuniids were known only from Eurasia, particularly from caves. In Europe only one of about seventeen species has been collected on the surface. Suzuki (1964) and others have found travuniids outside of caves in Japan and Korea. Of the European troglobites, three species are more specialized (eye tubercle absent) than the Washington travuniid.

Species of Travuniidae have a morphology that also indicates that they are an ancient group. Members of the family are distinguished by a spatulate process (peltonychium) on the hind claws. Some of the primitive structures have been discussed in a previous paper (Briggs, 1971a) that relates travuniids to other families. Unreported structures for travuniids were found on the Washington species. These include a relatively distinct ninth tergite, lateral sclerites and six branched hind claws on juveniles. The juvenile hind claws differ from those described by Roewer (1935) in his comprehensive paper on European travuniids. The juvenile claw illustrated in his paper (Fig. 3) resembles that of a late juvenile erebomastrid, a family which is represented in some European caves (Briggs, 1969). All New World juvenile travuniids that I have examined have a characteristic peltonychium bearing six branches on their hind claws. The aroleum, a possibly primitive structure, is not present or has been modified into an adhesive pad in these claws.

The morphology of the specimens from Idaho of the family Erebomastridae shows specialization for total darkness equal in degree to that of the Washington travuniids. The ocular tubercle is reduced and without corneas. Troglobitic modifications have not been previously reported in this family even though it occurs in limestone caves of eastern United States and Europe. Its presence in Idaho links the eastern United States populations to a single species described from Oregon (Briggs, 1969).

New juvenile erebomastrids have revealed a relationship between this family and the Travuniidae in the developing claws. Early instars have a short peltonychium which later disappears. The hind branches of this peltonychium are the ones that remain in the adult claw.

DISCUSSION OF HABITAT

The lava caves inhabited by travuniids are located in one of the Mount Adams lava flows of southern Washington and are described by Halliday (1972) as early postglacial in age. This youth makes the presence of troglobites difficult to explain without the interstitial penetration suggested by Howarth (1972). These caves are located in a dense taiga and are quite moist. The undisturbed habitat of the travuniids is under breakdown in the presence of an unidentified gelatinous slime about 200 meters inside the caves. This habitat has apparently extended into the twilight zone in a cave formerly used to store cheese on wooden racks.

Harvestmen collected in Idaho caves also were found in recent lava flows. One species of Erebomastridae was found in a single ice cave in Craters of the Moon National Monument. The air temperature is about 4°C in this cave, Boy Scout Cave, but specimens were collected adjacent to a permanent ice flow. Peck (1973) reports that millipedes (*Idagona westcotti*) acari (*Rhagidia*), collembola (Entomobyridae), campodeids (*Plusiocampa*), and the troglobitic beetle *Glacicavicola bathyscioides* were taken in Boy Scout Cave with this harvestmen. Even though this cave is only about 20 meters long all these inhabitants except *Idagona* are morphological troglobites. The walls and floor of Boy Scout Cave are significantly free of fungus and organic soil, so permanent moisture may be the chief attraction for cave fauna. Below freezing temperature must occur in

this cave to maintain its permanent ice flows and ice floor.

A similar species of Erebomastridae was found in lava tubes south of Craters of the Moon on the Snake River plain. One cave that deserves special mention consisted of a single room about 100 meters long, separated from the surface by about 5 meters of crawlway. It was located in a prairie grassland well separated from the nearest stream. The room was a relatively warm 13.5°C and had a rock-strewn soil floor with fungus-encrusted walls and ceiling. A variety of troglophiles and troglobites comprised an unusually dense population of fauna in the cave. In addition to the troglobitic harvestmen there were leiodids (*Glacicavicola*), pale centipedes, crickets (*Ceuthophilus*), carabid beetles, and flies in the families Sciaridae (*Lycoriella*), Trixoscelididae and Sphaeroceridae (*Leptocera*, subgenus *Limosina*). The erebomastrid harvestmen in this cave were larger than those in Boy Scout Cave.

All specimens are deposited in the collection of the California Academy of Sciences.

TRAVUNOIDEA Kratochvil

TRAVUNIIDAE Absolon and Kratochvil

Speleonychia, new genus

Description–Abdominal scute with boundaries of fused segments not apparent, odor glands not elevated on tubercles. Eye tubercle low, rounded and deeply recessed from anterior margin. Tergites widely spaced with lateral apices rounded. Ninth tergite separate, articulates with anal plate. Lateral sclerites present, spiracles exposed. Palpi well developed and strongly armed. Chelicerae with comb of uniform teeth on movable finger. Legs unarmed, astragali of normal length. First tarsi with four or five segments, second with more than six, third and fourth tarsi with four segments. Distitarsi of first legs with two segments, of second legs with four or more segments. Tarsi III and IV with four or less branches of small size on peltonychia. Penis with simple distal segment. Female with fewer segments on second distitarsi. Juveniles with six-branched peltonychium on hind claws, aroleum reduced or absent.

Type-species–*Speleonychia sengeri* Briggs, new species.

Remarks–The tarsal segmentation in *Speleonychia* resembles that of the troglobitic European genera *Abasola* and *Dinaria*, but the distitarsi on the second legs have more segments. Also, *Speleonychia* differs from other genera in having reduced lateral spines on the peltonychium and a dimorphic segment count for the second tarsi.

Speleonychia sengeri, new species

(Figures 1-7)

Description–*Male*. Total body length, 1.79 mm. Scute length, 1.25 mm. Length of eye tubercle, 0.15 mm. Scute width, 0.93 mm. Width of eye tubercle, 0.15 mm.

Anterior margin of scute without tubercles, with shallow cheliceral sockets. Scute finely granulate, with slightly elevated shoulders. Fused segments not apparent, not demarked by setae or tubercles. Tergites widely spaced, sparsely setose, lateral apices rounded. Eye tubercle obsolete, low, rounded, widely separated from anterior margin of scute. No evidence of eyes. Sternum wedge-shaped, apex slender, posterior truncate. Labial processes rounded, extend slightly anterior to second endites. Lateral sclerites small, isolated, adjacent to sixth and seventh tergites. Spiracles very small.

Second endites setose, large, project ventrad and anterior to second coxae.

Operculum setose, subtriangular, with anterior apex rounded; does not reach third coxae.

Chelicerae setose, with fused pair of seta-bearing tubercles on distodorsal margin of basal segments. Distal segment with seta-bearing tubercles on dorsum. Fixed finger with five teeth, movable finger with comb of seven to eight teeth.

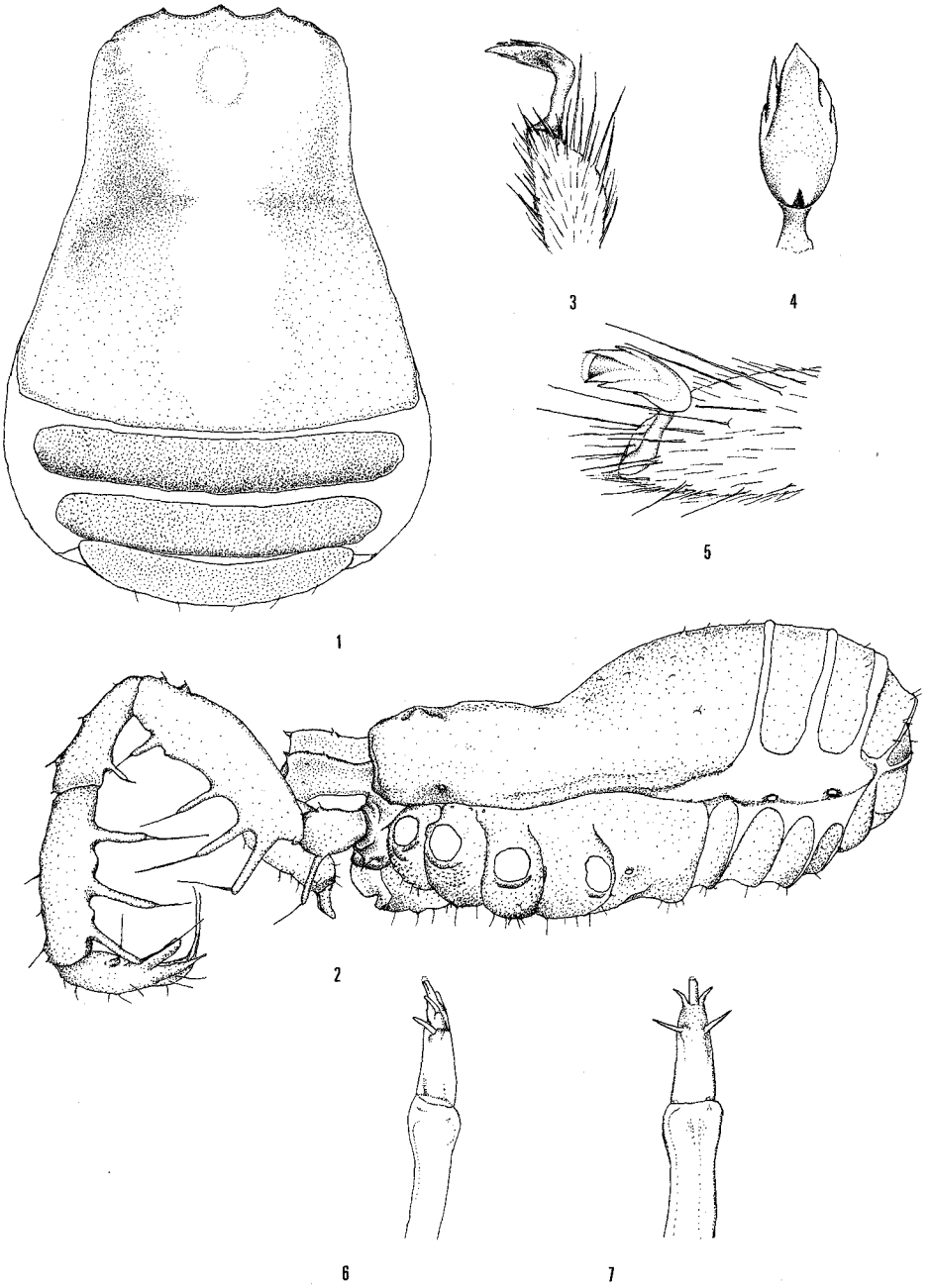


Fig. 1-7.–*Speleonychia sengeri*: 1-2, dorsal and lateral views of male; 3-4, lateral and dorsal views of hind claw of male; 5, hind claw of juvenile; 6-7, lateral and ventral views of penis.

Table 1.–Leg and palpus measurements of *Speleonychia sengeri* in mm.

	I	II	III	IV	Palpus
Trochanter	0.29	0.29	0.29	0.29	0.29
Femur	1.58	2.54	1.79	2.21	0.63
Patella	0.33	0.48	0.39	0.33	0.33
Tibia	1.05	2.09	1.31	1.73	0.54
Metatarsus	1.43	2.22	2.06	2.63	
Tarsus	0.96	2.22	0.93	1.10	0.72
Total	5.64	9.84	6.77	8.29	2.51

Palpi with elongate spines. Palpal coxae with ventral spine; trochanters with long ventral spine and short dorsal spine; femora with four to five ventral spines, two mesal spines and four short dorsal spines; patellas with one ventral spine and two mesal spines; tibia with three long ectal spines and four mesal spines. Tarsi slender, with four ectal spines and three mesal spines.

Tarsal formula of male holotype; 4-16,17-4-4. Tarsal formula of male paratypes: 4 to 5-15 to 20-4-4. Distitarsi of first legs with two segments, of second legs with seven segments. Astragali with faint false articulations, particularly on third legs. Tarsal claw of hind legs with four or less distolateral splinters on peltonychium.

Penis with simple ventral plate bearing a central pair and a small apical pair of lateral setae, apex narrow.

Color a uniform light yellow.

Female. Similar to male except larger in size, tarsal formula 4-11 to 14-4-4. Second distitarsi with four to five segments.

Ovipositor with four distal lobes; lateral pair largest, with apical setae,

Juvenile. Hind claws with six scale-like branches on peltonychium; apices without aroleum, but with clear adhesive secretion. Tarsi with typical juvenile segmentation. Body color a uniform white except for dusky peltonychia.

Type data–Holotype male, allotype female and 20 paratypes, Nielsen's Big Cave, 18 km W Trout Lake, Skamania County, Washington, 18 August 1972, under breakdown in slime zone about 200 meters inside cave, R. Lem, G. Wong, C. Senger, and T. Briggs. Seven adults and one juvenile, Cheese Cave, 2 km W Trout Lake, Klickitat County, Washington, 19 August 1972 and 25 August 1972, 620 meters, on wood in dark zone in both upper and lower sections and on breakdown in twilight, F. G. Howarth, N. C. Howarth, L. Ferguson and L. Nieuwenhuis. Two juveniles, Jug Cave, 7 km W Trout Lake, Kilickitat County, Washington, under breakdown slime zone, T. Briggs. Two adults, Trout Lake Caves, near Trout Lake, Klickitat County, Washington, 9 November 1969, C. Senger.

Etymology–This species is named for Dr. C. Senger, Western Washington State College, who brought specimens and localities to my attention.

EREBOMASTRIDAE Briggs
Speleomaster, New Genus

Scute smooth, with segment areas undifferentiated. Eye tubercle tuberculate, low mound well separated from anterior margin of scute. Tergites well separated. Ninth tergite not indicated on anal plate. Lateral sclerites absent, soft lateral integument

exposed. Sternum with setae on center of broad posterior plate. Spiracles exposed. Labial processes do not extend anterior to second endites. Operculum small.

Palpal tarsi with five longest spines, two anterior pairs and one posterior mesodorsal. First tarsus with five or more segments, second tarsus with more than eight segments, third tarsus with five or more segments, fourth tarsus with six or more segments. Distitarsus of first legs with two segments, of second with four or more segments. Tibia of second leg with distal process on male. Tarsal claw of hind legs with two uniform branches meeting at 180° on stem nearly equal in length to branches.

Penis with simple dorsoventrally flattened distal segment, basal stem of sclerotized tube flared at apex. Apex of basal stem with cup-shaped receptical.

Juveniles with aroleum on posterior claws.

Type species–*Speleomaster lexi* Briggs, new species.

Remarks–*Speleomaster* is related to *Cryptomaster* Briggs, an epigean genus found along the coast of Southern Oregon. The similarity extends to the sexually dimorphic process on the second tibia and the structure of the hind claws. Significant differences occur in the structure of the penis and in the segmentation of the tarsi. *Speleomaster* species are apparently without a ventral plate on the penis. If subfamily designations are warranted for Erebomastridae, eastern and western United States fauna can be grouped into two subfamilies.

Speleomaster lexi, new species
(Figures 8-11)

Description–*Male*. Total body length, 2.86 mm. Scute length, 2.14 mm. Length of eye tubercle, 0.26 mm. Scute width, 2.41 mm. Width of eye tubercle, 0.35 mm.

Anterior margin of scute with shallow cheliceral sockets above, with projections along ectal margin of base of each chelicera and each palpus. Scute finely granulate, without indication of fused segments. Tergites with row of widely spaced setose tubercles. Eye tubercle small, tuberculate, conical, recessed, without indication of eyes. Sternum narrow, broadens between fourth coxae into pentagonal shape. Pair of setae present near center of pentagon. Groove between second and third sternites.

Second endites project anteroventrally, medially recurved at apices. Labial processes visible between second endites.

Operculum small, heart-shaped with invagination posterior, setose.

Chelicerae spinose, basal segments linear, anterior of distal segments with acute tubercles including a fused pair, fixed finger with larger teeth than movable finger.

Palpi with numerous elongate spines. Coxa with subaligned row of spines. Trochanter with two ventral spines. Femur with seven ventral spines, two mesal spines and four-five dorsal spines. Patella with one ventral spine and three mesal spines. Tibia with five mesal and five ectal spines. Tarsus with four ectal and seven mesal spines of which five are longest.

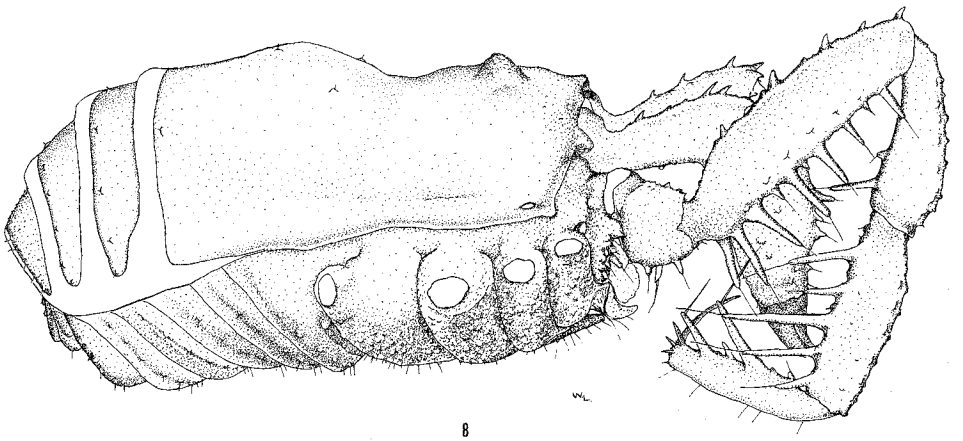
Tarsal formula of male holotype: 8, 9-20, 19-6-8. Tarsal formula of paratypes: 7 to 9-18 to 22-6 to 8-6 to 8. Distitarsi of first legs with two segments, of second legs with four segments. Astragali with numerous rigid false articulations. Venter of apical portion of second tibia with a broad seta-bearing tubercle. Tarsal claw of hind legs with base of stem swollen.

Penis with small, flattened dorsal plate bearing short lateral setae at narrow apex; dorsal plate folds ventrally into receptical at apex of basal segment. Basal segment an elongate, narrow, sclerotized tube that widens at apex.

Color a uniform light yellow-orange.

Female. Similar to male except larger in size, second tibia without apical tubercle.

Juvenile. Hind claws of early instars with apical aroleum and additional scale-like branches on short peltonychium. Hind claws of late instars with two apical branches on stem, spherical aroleum held between branches. Color a uniform white.



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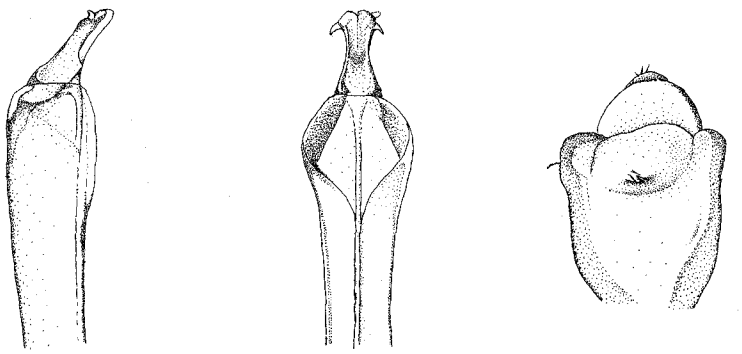

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Figs. 8-11.–*Speleomaster lexi*: 8, lateral view of male; 9-10, lateral and ventral views of penis; 11, lateral view of ovipositor.

Table 2.–Leg and palpus measurements of *speleomaster lexi* in mm.

	I	II	III	IV	Palpus
Trochanter	0.38	0.41	0.47	0.44	0.47
Femur	2.94	4.70	2.31	3.76	1.32
Patella	0.74	0.97	0.80	0.74	0.94
Tibia	2.46	4.65	2.85	2.94	1.18
Metatarsus	3.47	5.00	4.40	6.92	
Tarsus	1.70	4.55	1.42	1.44	1.57
Total	11.69	20.28	12.25	16.22	5.48

Type data–Holotype male, allotype female and six paratypes, lava cave near Mammoth Cave, 37 km N Shoshone, Lincoln County, Idaho, 20 August 1972, under breakdown in soil floor of room near surface, 13.5°C, R. Lem and T. Briggs. One juvenile, Gwendolyn Cave, 37 km N of Shoshone, Lincoln County Idaho, 11 March 1972, low room 50-100 meters inside entrance, 5-8°C estimated temperature, J. Thornton, S. Lex and G. Huppert.

Etymology–This species is named for the first collector, Scott Lex.

Speleomaster pecki, new species
(Figures 12-15)

Description–*Female*. Total body length, 2.27 mm. Scute length, 1.94 mm. Length of eye tubercle, 0.21 mm. Scute width, 2.00 mm. Width of eye tubercle, 0.33 mm.

Anterior margin of scute with shallow cheliceral sockets above, with projections along ectal margin of each chelicera and each palpus. Scute finely granulate, without indication of fused segments. Odor gland on slightly elevated tubercle. Eye tubercle conical, tuberculate, recessed, without indication of eyes. Sternum narrow, broadens between fourth coxae into pentagonal shape. Groove between second and third sternites.

Second endites project anteroventrally, medially recurved at apices.

Operculum small, uniformly rounded, setose.

Chelicerae spinose, basal segments linear, anterior of distal segments with acute tubercles including a fused pair, fixed finger with larger teeth than movable finger.

Palpi with numerous elongate spines. Coxa with subaligned row of spines. Trochanter with two ventral spines. Femur with seven ventral spines, two mesal spines and four-five dorsal spines. Patella with one ventral spine and three mesal spines. Tibia with five mesal and five ectal spines. Tarsus with four ectal and seven mesal spines of which five are longest.

Table 3.–Leg and palpus measurements of *Speleomaster pecki* in mm.

	I	II	III	IV	Palpus
Trochanter	0.30	0.43	0.36	0.46	0.39
Femur	2.00	3.72	2.12	3.24	1.27
Patella	0.46	0.76	0.55	0.70	0.82
Tibia	1.88	3.64	2.18	3.54	1.03
Metatarsus	2.03	3.28	3.18	4.55	
Tarsus	1.45	3.58	1.09	1.39	1.40
Total	8.12	15.41	8.98	13.88	4.91

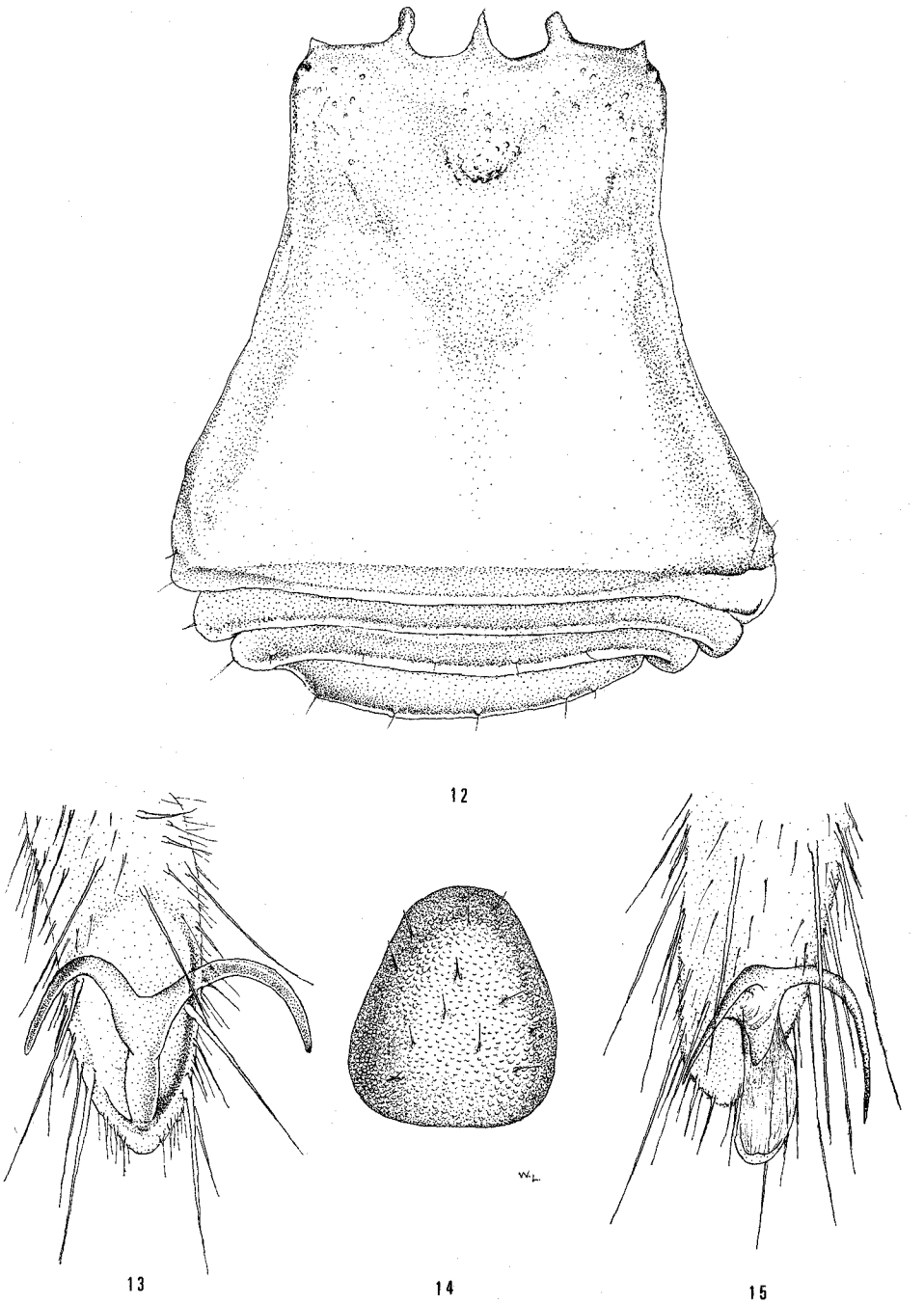
Tarsal formula of female holotype: 6,7-16-5-6,7. Distitarsi of first legs with two segments, of second legs with four segments. Astragali with numerous rigid false articulations. Tarsal claw of hind legs with a uniform stem.

Ovipositor without setae on distal lobes.

Color a uniform light yellow.

Male. Not known.

Juvenile. Hind claws of middle instars with two elongate branches from base of peltonychium, spherical aroleum held between branches, color a uniform white.



Figs. 12-15.–*Speleomaster pecki*: 12, dorsal view of female; 13, hind claw of female; 14, operculum of female; 15, hind claw of middle instar juvenile.

Type data–Holotype female, Boy Scout Cave (lava), Craters of the Moon National Monument, Butte County, Idaho, 1 October 1969, S. and J. Peck. Two juveniles, Boy

Scout Cave, same locality, 21 August 1972, under breakdown near ice, 4°C, R. Lem and T. Briggs.

Etymology–This species is named for the first collector, Dr. Stewart Peck, Carleton University.

Remarks–*Speleomaster pecki* differs notably from *Speleomaster lexi* in segmentation on the tarsi, the shape of the operculum and the overall size.

Triaenonychidae Pocock

A cavernicolous, juvenile triaenonychid was collected by R. Wescott in Crystal Falls Cave (lava), Clark County, Idaho. Its simple six-branched hind claws distinguish it from other related families and its tarsal formula of 2-2-3-3 is a characteristic of late instar Laniatorids (earlier instars are 1-1-1-1). Lack of pigmentation, spination of the first legs and shallow segmental folds distinguishes this juvenile from *Sclerobunus* Banks, the widespread surface triaenonychid genus, and places it near *Cyptobunus* Banks. Species of *Cyptobunus* have been found in a number of limestone caves in states adjacent to this locality, but have not been found on the surface (Briggs, 1971b). All known species in this genus and the juvenile from Crystal Falls Cave have functional eyes.

ACKNOWLEDGEMENTS

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