CAVE HARVESTMEN FROM JAMAICA (OPILIONES: PHALANGODIDAE)

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Numerous islands of the West Indies are composed largely of limestone, in which many and often large caves and cave systems have developed. An abundant fauna of obligately cave-inhabiting invertebrates has been found in these caves. The checklist of Nicholas (1962) is an introduction to these interesting and highly specialized animals. Best known is the cave fauna of the largest island, Cuba. Nothing is reported of the cave fauna of the second largest island, Hispaniola. The only obligate cave inhabitant known from Puerto Rico is an amphipod (Holsinger and Peck, 1968). Two cavernicolous crustaceans, a crab and a shrimp, are reported from Jamaica (Hartnoll, 1964). The three new species of opilionids described in this paper include the first known cave-specialized terrestrial invertebrates from Jamaica.

The opilionids reported on in this paper were collected during a preliminary survey of the invertebrate fauna of Jamaican caves, undertaken in April, 1968, by Stewart B. Peck of the Museum of Comparative Zoology, assisted by Mr. Alan Fiske. In six days eight collecting visits were made to seven caves in the western half of the island. A summary report on the Jamaican cave fauna will be prepared by Mr. Peck at a later date.

The opilionids described here are all members of the family Phalangodidae, subfamily Phalangodinae; two genera are represented: *Stygnomma* with one new species, and *Cynortina* with two new species, very closely related.

The types are deposited in the collection of the Museum of Comparative Zoology. Some paratypes are deposited in the collection of the Instituto de Biología Aplicada, University of Barcelona, Barcelona, Spain.

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Suborder Laniatores
Family Phalangodidae
Subfamily Phalangodinae

The author has followed the classification of Goodnight and Goodnight (1951, 1953), a modification of Roewer's system, avoiding the numerous monotypic genera of Roewer by using a combination of generic characters, some of which proved to be variable. Thus the subfamily Stygnommatinae is ignored and all its members are united in one genus *Stygnomma*. The definition of *Stygnomma* is revised below to accommodate the new species.

Stygnomma Roewer 1914

Type species by monotypy *S. fuhrmanni* Roewer from Columbia.

Phalangodids without a common eye tubercle; eyes present or not. Dorsal scute with five areas, boundaries of which are sometimes difficult to discern. First area without a median line. Tarsi of third and fourth legs without scopulae, and with simple untoothed double claws. All tarsi have a varying number of articles. Distitarsus of first tarsus with two or three articles, of second with three or four. Metatarsi of legs divided or not into astragali and calcanea. Femur of first leg normal. Endite of second coxa without a ventral projection. Secondary sexual characters of the male variable, usually expressed as increased spination of the chelicera and palpus, and enlargement of some portion of metatarsus of third leg.

We include the new species in the key made by Goodnight and Goodnight 1951.

Key to species of *Stygnomma*

1a. Spiracle clearly visible, not concealed in any degree by the fourth coxa 2
1b. Spiracle partly concealed by posterior expansion of the fourth coxa 3
2a. Eyes widely separated, and one spine between them ..... *S. fuhrmanni*
2b. Without eyes and without such spine ..... *S. fiskei*
3a. Spine present between the eyes 4
3b. Spine not present between the eyes 5
4a. Eyes close together, lacking development of spines on the free tergites ..... *S. maya*
4b. Eyes widely separated, with some spinose development of tubercles of free tergites in the males ..... *S. spinifera*
5a. Fourth coxa with large spines visible from above .... *S. spinulata*

5b. Fourth coxa without such spines 6
6a. Size about 1 mm in length, color very light ..... *S. teapensis*
6b. Size about 2 mm in length, dorsum darker ..... *S. annulipes*

Though several of the species reported by Goodnight, 1951, were found in caves, it is evident that the new species is the only known member of this genus that is a true cavernicolous form. This species shows a great number of structural adaptations to cave life: complete loss of eyes, minor degree of sclerotization, lighter color, and an increase in length of all appendages in comparison with related epigeic species. The remarkable length of the second pair of legs expresses the development of a tactile function in the legs of blind species. It must be recognized that these differences are due to adaptation for a cave existence, rather than to phylogenetic divergence, and are not valid to segregate this new species from the genus *Stygnomma.*

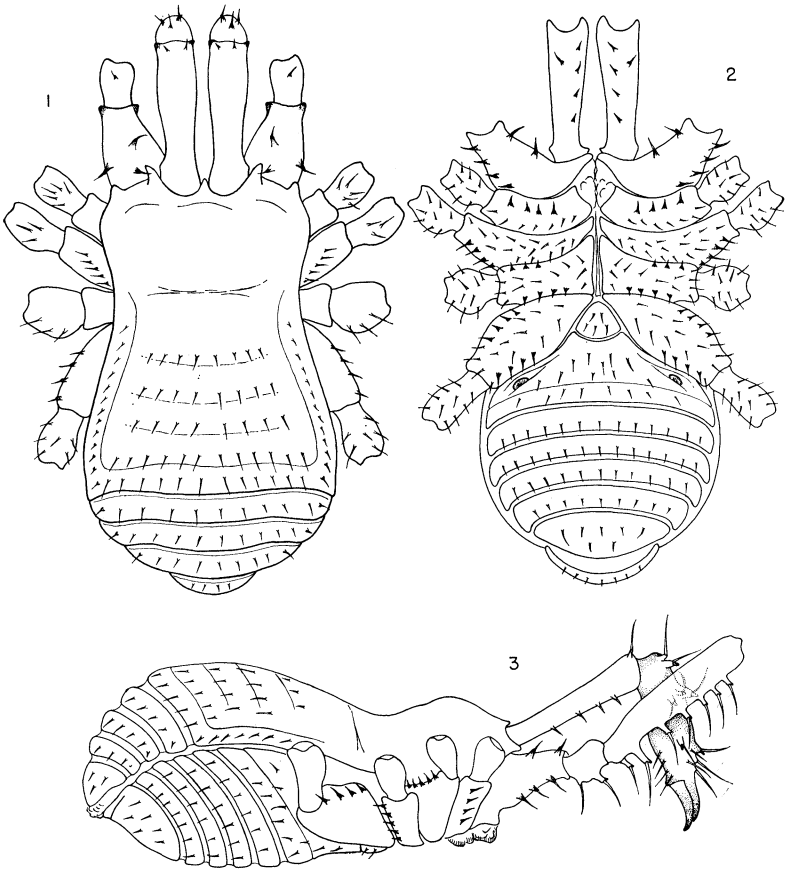
Stygnomma fiskei n. sp.

Figures 1-12

Types. Male holotype, female paratype and 1 juv. from Coffee River Cave, Auchtembeddie, 1½ miles north of Oxford, Manchester Par., Jamaica, collected 4. IV. 1968, in the Museum of Comparative Zoology.

Description. Male holotype. Total length 2.85 mm. Greatest width of body 1.78 mm. Chelicera proximal article, 1.07 mm; distal article, 1.28 mm. Palpal femur, 1.78 mm; petella, 0.86 mm; tibia, 1.40 mm; tarsus, 1.10 mm; total length 5.14 mm. Femur of first leg, 2.14 mm; total leg length 7.92 mm. Second femur, 3.50 mm; total length, 14.00 mm. Third femur, 2.42 mm; total length 9.14 mm. Fourth femur, 3.28 mm; total length, 11.88 mm.

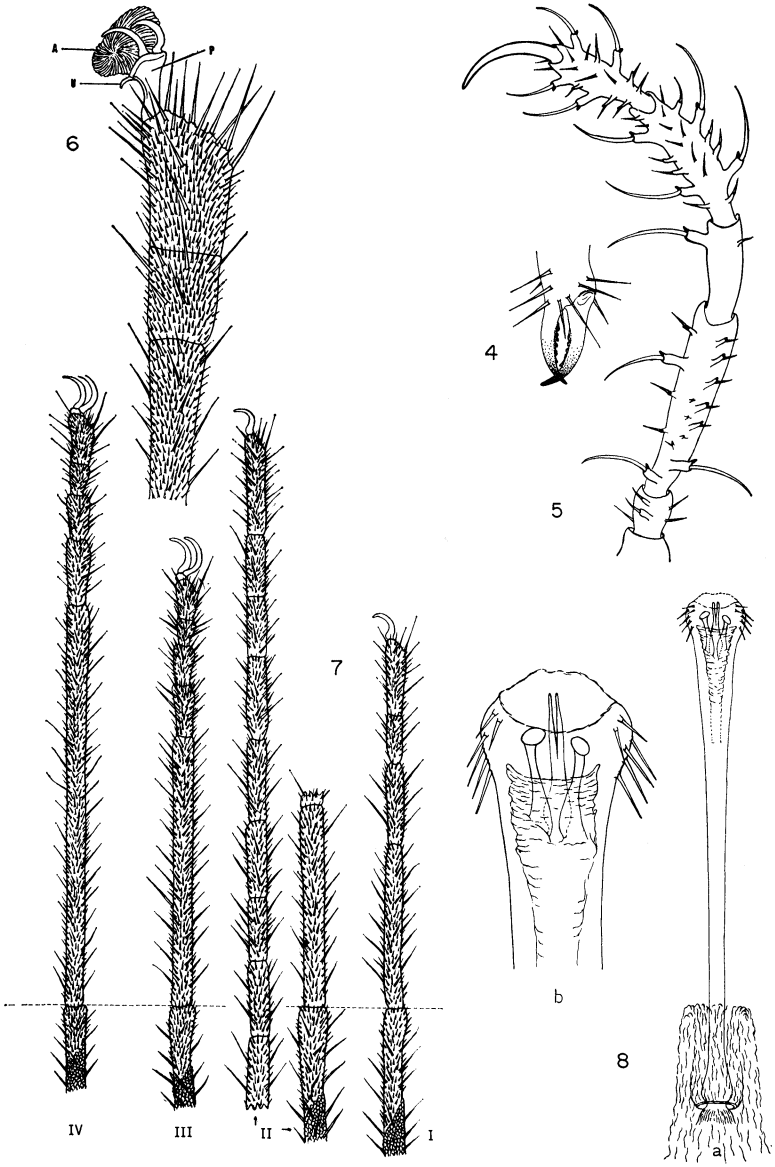
Anterior margin of cephalothorax with one lateral projection on each side, one in the middle and one close to the outer side of each chelicera (Fig. 1). Dorsum smooth, with only a few small granulations along the lateral abdominal scuta, a transverse line of small hairs on the scutum, three free tergites and anal operculum. Cephalothorax without eye tubercle. Eyes and corneal lenses absent. Abdominal scutum with five dorsal areas, except for the first, the boundaries of which are parallel to one another, but very poorly defined. Ventral surface and coxae with scattered thin hairs. Spiracles clearly visible. Hair-tipped tubercles (more or less arranged in rows), are present on the anterior and posterior margins of coxae III and IV, posterior margin of coxa II and near the anterior margin of



Figs. 1-3. *Stygnomma fiskei* n. sp., male holotype. 1. Dorsal view. 2. Ventral view 3. Lateral view.

coxa I. The endite of the second coxa without a ventral projection (Fig. 2).

Chelicera long and slender. Dorsum of proximal article smooth, but with a pair of apical tubercles; ventral surface with a row of four small tubercles. Distal article armed on dorsal surface with seven strong hair-tipped tubercles different in size and placed irregularly (Fig. 3). Base with long slender hairs. Claws curved inward. Immovable finger with 6 teeth, movable finger with 5 teeth (Fig. 4).


A
P
V
6
4
5
7
b
8
a
IV
III
II
I

Palpus about twice as long as the body, armed ventrolaterally as in Fig. 5, dorsally unarmed. Tarsal claw long and curved.

Legs extremely long and slender, covered with hairs and fine granules. Metatarsi divided into astragali and calcanea. Fine granulations on legs terminate abruptly at calcaneus of metatarsus. Femur of first leg has a row of few small tubercles on the ventral surface. The fourth leg has an extremely long first tarsal article, other legs have first tarsal article longer than the remaining ones (Fig. 7). Tarsal formula: 4, 10, 5, 5. Distitarsus of first tarsus with two articles, second with four. Third and fourth tarsi of immature specimens with pretarsus (P), arolium (A) and unguiculus (U) (Fig. 6).

Body concolorous, pale yellow-orange, with venter somewhat lighter than dorsum. Appendages the same color as body, but tarsus and metatarsus lighter yellowish.

Penis long and slender. Total length, 1.40 mm. Ventral plate of penis armed as in Fig. 8a and b. Tip folded into membranous cover, and connected at two lateral projections.

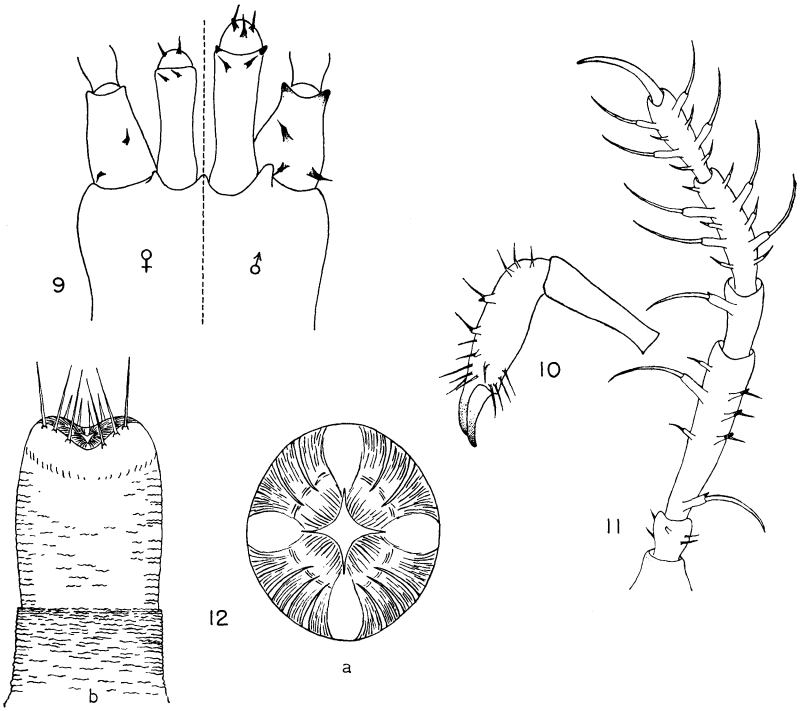
Female paratype. Total body length, 2.67 mm. Greatest width of body 1.57 mm. Chelicera proximal article, 0.78 mm; distal article, 1.28 mm. Palpal femur, 1.52 mm; patella, 0.71 mm; tibia, 1.25 mm; tarsus, 0.92 mm; total length 4.40 mm. Femur of first leg, 1.86 mm; total leg length 7.21 mm. Second femur, 3.28 mm; total length, 13.54 mm. Third femur, 2.25 mm; total length, 9.25 mm. Fourth femur, 3.21 mm; total length 11.25 mm.

Similar in appearance to male but lacking the small tubercles on the first femur. Armature of chelicera and palpus are much reduced and less prominent, as shown in Figs. 9, 10, 11. Also body and appendages are reduced in size.

Ovipositor short and enlarged. Total length, 0.70 mm. Width at widest portion, 0.60 mm. Ventral plate armed as in Fig. 12a. Apex in a frontal view shows a geometric drawing as in Fig. 12b.

Variations. Males studied showed some variability. One of the two males from Oxford Cave has the following measurements: total length, 2.75 mm; width of body, 1.72 mm; chelicera, proximal segment, 0.80 mm; distal segment, 1.10 mm. Palpal femur, 1.60 mm;

Figs. 4-8. *Stygnomma fiskei* n. sp. 4. Lateral view of cheliceral claws, male holotype. 5. Ventral view of palpus, male holotype. 6. Fourth tarsus of immature specimen. 7. Lateral view of tarsi and distal portion of metatarsi of male holotype. 8. Ventral face of penis of male holotype; a. Whole penis. b. Tip, much enlarged. (Abbreviations: A, arolium; P, pretarsus; U, unguiculus.)



Figs. 9-12. *Stygnomma fiskei* n. sp. 9. Part of anterior of dorsum showing differences between female paratype and male holotype. 10. Lateral view of chelicera, female paratype. 11. Ventral view of palpus, female paratype. 12. Ovipositor; a. Ventral view. b. Frontal view.

patella, 0.78 mm; tibia, 1.27 mm; tarsus, 0.95 mm; total length, 4.60 mm. First femur, 1.71 mm; total length, 6.78 mm. Second femur, 2.75 mm; total length, 11.60 mm. Third femur, 2.00 mm; total length, 7.70 mm. Fourth femur, 2.50 mm; total length, 10.10 mm.

There is some variation also in the armature of the chelicera and palpus. This male, in the ventrolateral surface of the femur of the palpus, has a row of only three tubercles, instead of five as does the holotype. The other male has five on the right femur and four on the left. The measurements of this specimen are about the same as of the holotype.

Diagnosis. Aside from the morphological differences due to adaptation to cave life, we can recognize the new species by the following

combination of characters: spiracle clearly visible, not concealed by the fourth coxa, dorsum smooth, without any kind of granulations or spines. Eyes and corneal lenses absent. Fourth coxa normal, without large spines. Size about 3 mm.

Habitat. These animals were found on flood debris on silt banks in a side passage about 150 m from the entrance. Coffee River Cave, also called Princess Alice Cave, with a very irregular floor, carries a torrential river subject to heavy flooding. Oxford Cave is a smooth-floored, large, walk-in cave with no standing water, inhabited by abundant fauna including a large bat colony.

Records. Besides the holotype and female paratype there are two male paratypes and three immatures from Oxford Cave at the same locality.

Cynortina Banks 1909

Type species by monotypy *C. tarsalis* Banks 1909 from Costa Rica.

If one applies the limited characters for generic classification pointed out by Goodnight and Goodnight (1953), the genus *Cynortina* becomes an integration of sixteen different Roewer genera. Thus the Mexican and Central American phalangodids are divided at present into eight recognized genera.

Specimens examined possessed intermediate characters between two genera, *Cynortina* and *Sitalcina,* the only difference between them being the position of eye tubercle. It is removed from the anterior margin of cephalothorax in *Cynortina,* and not removed in *Sitalcina* (Briggs, 1968).

But, this difference is not so abrupt as once thought, because in the studied specimens, the eye tuburcle is only slightly removed from the anterior margin. On the other hand, there are no great differences between these two genera, and some characters of the examined specimens agree better with *Sitalcina,* such as tarsal formula, others with *Cynortina,* as the position of the eye tubercle. Tradition might call for the establishment of a new genus, but restricted separation of genera, as adopted by Goodnight and Goodnight (1953), does not support such division. It is thought best to place them in the genus *Cynortina* as its species range across Central America and the West Indies, while all but one species of *Sitalcina* have been found in California. Perhaps *Sitalcina* should eventually be synonymized with *Cynortina.*

The definition of *Cynortina* is revised as follows. Phalangodids with eye tubercle rounded above, unarmed or with small tubercles or spinules, usually removed from the anterior margin of cephalo-

thorax. Eyes present or not. Dorsal scute with five areas, boundaries of which are sometimes difficult to discern. First area without a median line. First tarsus with three articles, second, third and fourth tarsi with a varying number of articles. Distitarsus of first tarsus with two articles, of second with three. Metatarsi of legs divided or not, into astragali and calcanea. Femur of first leg normal. Endite of second coxa without a ventral projection. Secondary sexual characters of the male are variable.

Cynortina goodnighti n. sp.

Figures 13-19

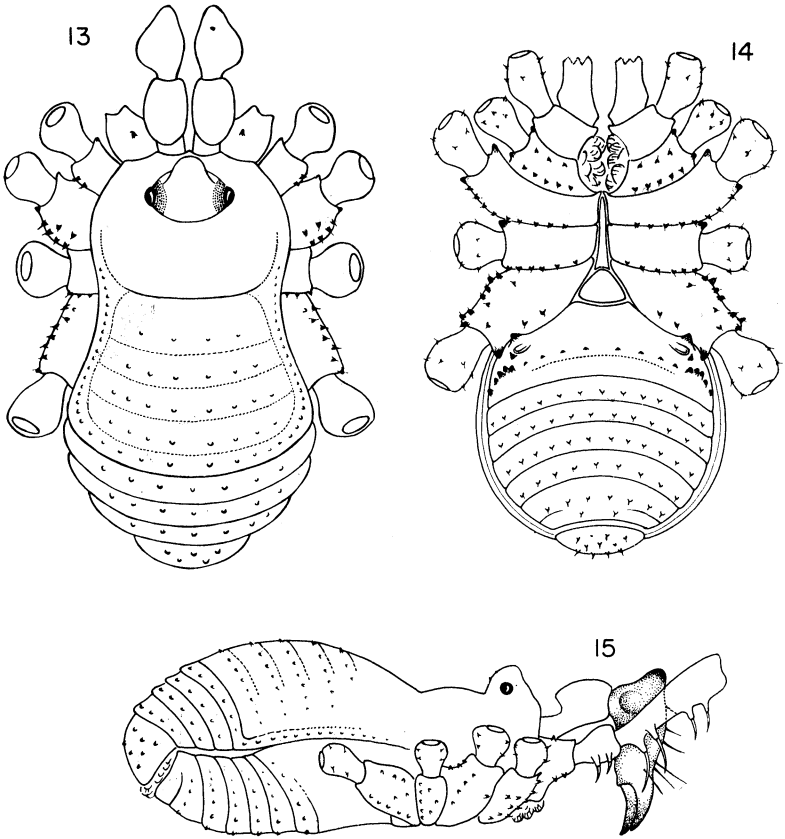
Type. Male holotype and female paratype from St. Claire Cave, 1½ miles southwest of Ewarton, St. Catherine Par., Jamaica, collected 7. IV. 1968, in the Museum of Comparative Zoology.

Description. Male. Total body length, 2 mm. Greatest body width 1.32 mm. Proximal cheliceral article, 0.51 mm; distal article, 0.70 mm. Palpal femur, 0.62 mm; patella, 0.35 mm; tibia, 0.39 mm; tarsus, 0.39 mm; total length, 1.75 mm. Femur of first leg, 0.78 mm; total leg length, 2.90 mm. Second femur, 1.10 mm; total length, 4.40 mm. Third femur, 0.85 mm; total length 3.64 mm. Fourth femur, 1.14 mm; total length, 4.48 mm.

Body pearshaped. Anterior margin of the cephalothorax without frontal or lateral projections, only slightly curved at the level of the insertion of the chelicera and palpus. Dorsum smooth, but with a row of small tubercles along the lateral margin of abdominal scutum, and transverse rows on each area and also on each of the three free tergites. Anal operculum thickly covered with tubercles. The boundaries of the five dorsal scutal areas poorly defined (Fig. 13).

Eye tubercle removed from the anterior margin of the cephalothorax, wider than long, and with a dorsal rounded cone inclined slightly forward. Eyes and corneal lenses present, situated at the base of the eye tubercle (Fig. 15).

Ventral surface with a transverse row of tubercles on each sternite (Fig. 14). Laterally, between second and third sternite, 5 to 6 big tubercles on each side, and one bigger tubercle above spiracle directed upwards. Fourth coxa with a distal-ventral tubercle, bigger than the others, near the spiracle. For this reason the spiracles, though visible, appear more or less surrounded by prominences. Rows of tubercles are present near anterior and posterior margins of coxa I and posterior margins of coxa II and III, and entire

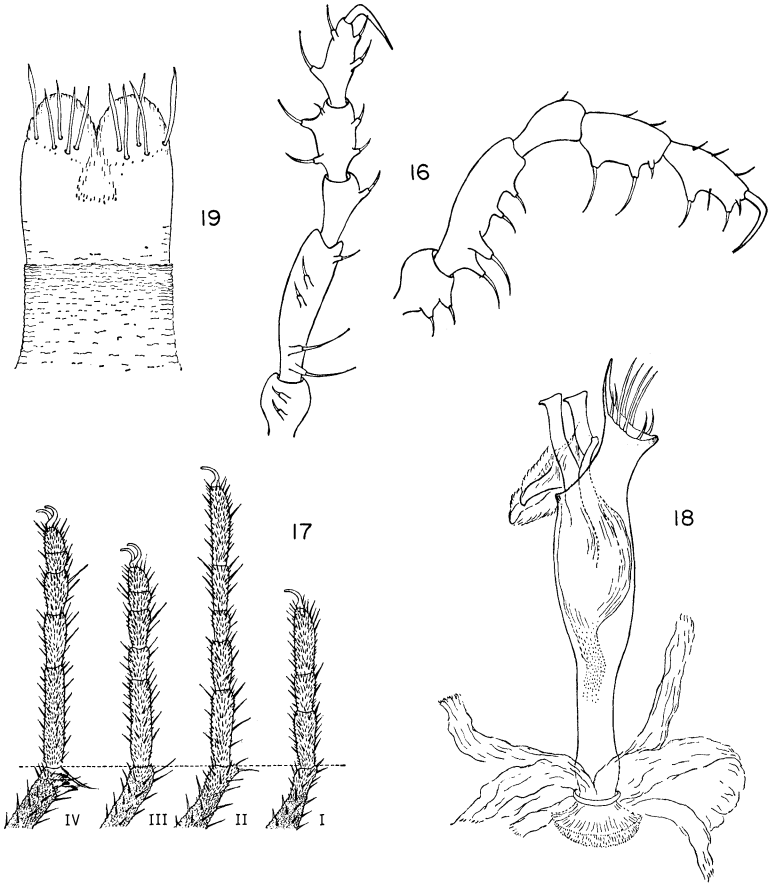


Figs. 13-15. *Cynortina goodnighti* n. sp., male holotype. 13. Dorsal view. 14. Ventral view. 15 Lateral view

surface of coxa IV is covered with bigger tubercles more or less arranged in rows.

Chelicera small, smooth except for a few hairs on the frontal margin of the distal article. Proximal article slender at the base but enlarged dorsally and distally. Distal article somewhat enlarged laterally at the base and with a large rounded elevation on the apex (Fig. 15). Palpus about the same length as the body, unarmed dorsally, armed ventrally and laterally as in Fig. 16.

Legs moderately long, clothed with thin hairs and faintly granulate. Metatarsi divided into astragali and calcanea. Fine granula-



Figs. 16-19. *Cynortina goodnighti* n. sp. 16. Ventral and lateral view of palpus, male holotype. 17. Lateral view of tarsi and distal portion of metatarsi, male holotype. 18. Lateral view of penis. 19. Ventral view of ovipositor.

tions on legs terminate abruptly at calcanea of metatarsi. Fourth metatarsus has three strong, hair-tipped tubercles, two of them directed upward, another directed downward and with a very long hair (Fig. 17). Femur of fourth leg somewhat curved. Femur of tibia of fourth leg with two apical short hair-tipped tubercles on the retrolateral margin. First metatarsus somewhat enlarged at the base.

Entire dorsum reddish brown, areas of dorsum poorly outlined, three free tergites outlined in darker reddish brown. Venter and coxae concolorous with dorsum. Chelicera and palpus lighter reddish brown. Tarsi of legs yellowish, contrasting with other leg articles, which are concolorous with the body.

Penis in lateral view shown in Fig. 18. Relatively large, and somewhat more enlarged in the middle portion. Total length, 0.64 mm. Apical portion truncate with a sharp-pointed process, and with eight setae arranged in two lateral groups of four. Basal portion encircled with a membranous process which appears subdivided in Fig. 18.

Tip simple, long and slender, and accompanied by two elongated processes, both of which appear to be folded within the penis when they are retracted.

Female. Total body length, 2.14 mm. Greatest width of body 1.42 mm. Chelicera, proximal article, 0.40 mm, distal article, 0.64 mm. Palpal femur, 0.59 mm; patella, 0.35 mm; tibia, 0.38 mm; tarsus, 0.38 mm; total length, 1.70 mm. Femur of first leg, 0.68 mm; total leg length, 2.80 mm. Second femur, 1.02 mm; total length, 4.32 mm. Third femur, 0.75 mm; total length, 3.32 mm. Fourth femur, 1.06 mm; total length, 4.42 mm.

Similar in appearance to male but lacking the large rounded elevation on the apex of the distal article of chelicera. Body somewhat large and appendages slightly shorter. Tarsal formula as in male.

Ovipositor short and thick. Total length, 0.52 mm. Distal portion provided with relatively short setae distributed as shown in Fig. 19.

Diagnosis. Unlike the related *C. pecki* this species is colored and has eyes.

Habitat. The type locality is a large, long, multi-level cave with a temporary stream and an abundant and varied fauna including a huge bat colony.

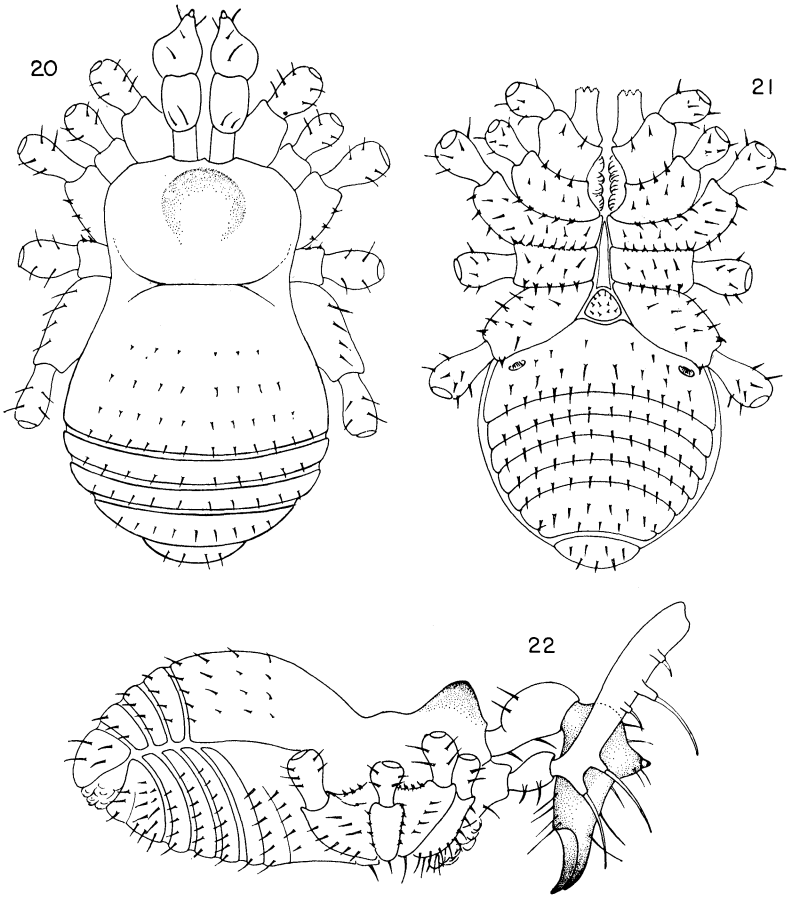
Records. This species is known only from the holotype and paratype.

Cynortina pecki n. sp.

Figures 20-26

Type. Male holotype and one female paratype from Worthy Park Cave, St. Catherine Par., Jamaica, collected 6. IV. 1968, in the Museum of Comparative Zoology.

Description. Male. Total body length, 1.61 mm. Greatest body width 1.10 mm. Chelicera, proximal article, 0.53 mm; distal article,



Figs. 20-22. *Cynortina pecki* n. sp., male holotype. 20. Dorsal view. 21. Ventral view. 22. Lateral view.

0.71 mm. Palpal femur, 0.71 mm; patella, 0.40 mm; tibia, 0.54 mm; tarsus, 0.46 mm; total length, 2.11 mm. Femur of first leg, 1.35 mm; total length, 5.00 mm. Second femur, 3.32 mm; total length, 9.14 mm. Third femur, 1.78 mm; total length, 6.17 mm. Fourth femur, 2.17 mm; total length, 8.53 mm.

Body pearshaped. Anterior margin of the cephalothorax without frontal or lateral projections, only slightly curved at the level of the insertion of the chelicera and palpus. Dorsum smooth, only with a transverse row of thin hairs in each area, each of the three free

tergites and the anal operculum. Eye tubercle slightly removed from the anterior margin of the cephalothorax (Fig. 20). Eyes and corneal lenses absent. Abdominal scutum with five dorsal areas, the first without a median line, the boundaries of which are parallel to one another, but very poorly defined. Ventral surface and coxae with scattered thin hairs. Spiracles clearly visible. Hair-tipped tubercles (arranged in rows) are present on the anterior and posterior margins of coxa III. In the remaining coxae, there are some similar tubercles, but not arranged in rows. The endite of the second coxa lacks a ventral projection (Figs. 21, 22).

Chelicera has a few scattered, long hairs. Proximal article slender at the base and enlarged dorsally in the distal two-thirds. Distal article somewhat enlarged laterally at the base and with a large frontal elevation tipped with a rounded tooth (Fig. 23). Palpus almost twice as long as the body. Armed in ventrolateral view as in Fig. 23. Dorsally unarmed except for rows of long hairs. Tarsal claw long and curved.

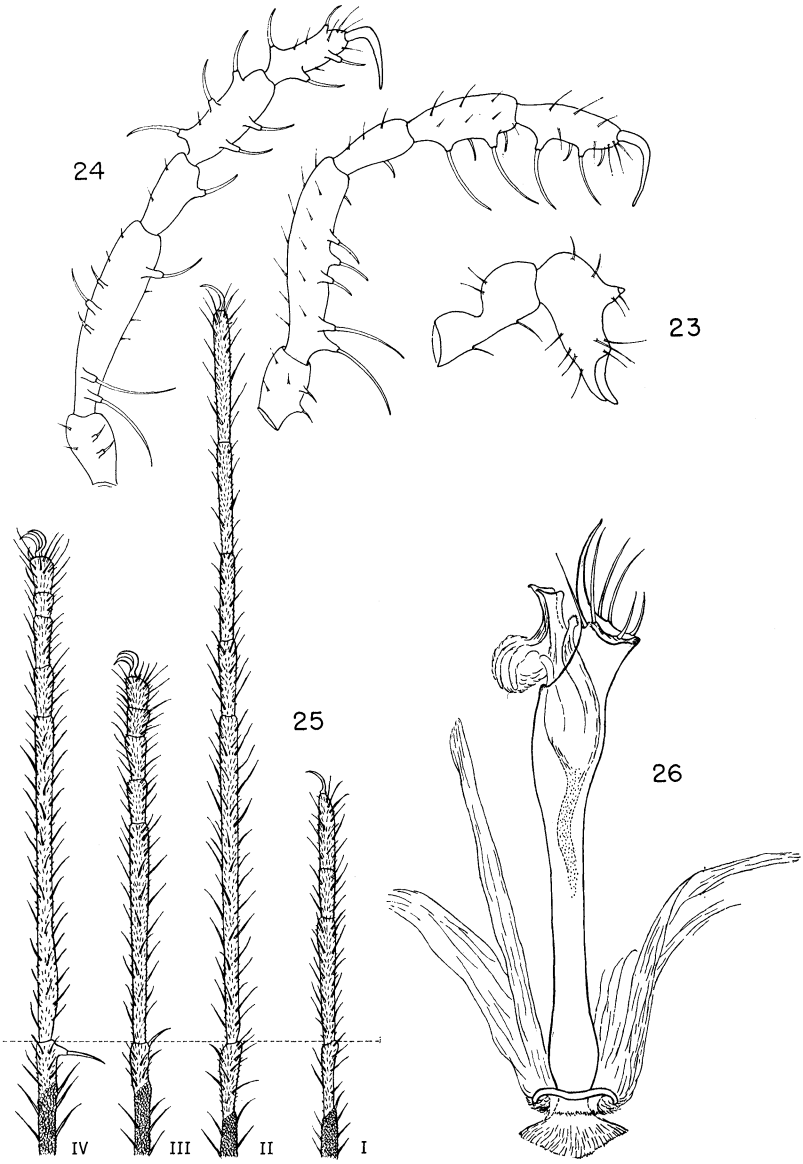
Legs extremely long and slender, clothed with hairs and finely granulate. Metatarsi divided into astragali and calcanea. Fine granulations on legs terminate abruptly at calcaneus of metatarsus. First and fourth legs have an extremely long first tarsal article, other legs have first tarsal article longer than the remaining ones (Fig. 25). Fourth metatarsus with a very long hair-tipped tubercle situated at the apex (Fig. 25). First metatarsus somewhat enlarged at the base. Tarsal formula: 3, 5, 5, 5. Distitarsus of first tarsus with two articles, second with four.

Body concolorous, pale yellow-orange, with venter somewhat lighter than dorsum. Appendages the same color as the body, but tarsus and metatarsus lighter yellowish.

Penis long and slender, in lateral view as shown in Fig. 26. Total length, 0.85 mm. Morphologically similar to that of *C. goodnighti.*

Female. Measurements of entire body and appendages are the same as of male, except the abdomen is somewhat wider. Tarsal formula as in male. Similar in appearance to males, but chelicera without the large frontal elevation tipped with a rounded tooth. Fourth metatarsus without hair-tipped tubercle on the apex, and first metatarsus not enlarged at the base. Ovipositor short and thick. Total length, 0.50 mm. Very similar to the former species.

Variations. There is no variation in the number of tarsal articles. In some of the females studied, the double claws of the third and



Figs. 23-26. *Cynortina pecki* n. sp., male holotype. 23. Lateral view of chelicera. 24. Ventral and lateral view of palpus. 25. Lateral view of distal portion of tarsi and metatarsi. 26. Lateral view of penis.

fourth tarsi are somewhat enlarged and have the inside edge sinuous.

Diagnosis. Unlike the related *C. goodnighti,* this species lacks eyes and is yellowish orange in color.

Habitat. These animals were found half-way through the cave in a chamber containing a scattering of guano. This cave has an assortment of environments along an intermittent river, reached after a 27 foot vertical descent. Abundant cave fauna is present.

Records. Eight female paratypes were collected with the holotype.

CONCLUSIONS

Of these three new species, *S. fiskei* and *C. pecki* are certainly true cavernicoles. The third, *C. goodnighti,* does not show any adaptation to cave life, and it probably is an epigeic form that has penetrated into the caves, but may be found both inside and outside of caves.

The similar appearance of *S. fiskei* and *C. pecki* is a manifestation of convergence toward a special kind of life more than of a true phylogenetic relationship. Actually *C. pecki* appears to be very closely related to *C. goodnighti.* These two species agree strongly with one another, and in spite of their different appearance, they still clearly show their relationship.

Doubtlessly *C. pecki* is the nearest form to *C. goodnighti,* but adapted to cave life. This shows itself by different adaptations, such as the increased length of appendages. The palpus has about the same length as the body in *C. goodnighti* and is almost twice as long as the body in *C. pecki.* The length of the second pair of legs in this animal is extraordinarily increased as often occurs in blind species. In *C. goodnighti* eyes are present and the retina has the characteristic black color. Eyes and corneal lenses are absent in *C. pecki,* and there are no traces of black color in retina. Sclerotization, too, apears decreased in *C. pecki.* Hair-tipped tubercles are fewer in number and less developed. The prominences surrounding the spiracles in *C. goodnighti* have disappeared in *C. pecki.*

Color of *C. goodnighti* is reddish brown, as is usual in epigeic forms. The coloration of *C. pecki* is pale yellowish, as is the tendency among the cave adapted phalangodids.

The morphology of the male genitalia is particularly pertinent to evaluation of the relationship between these forms. The penes of *C. pecki* and *C. goodnighti* are of the same type, but in *C. pecki* longer and tighter, and with a delicate appearance. In contrast, the penis of *S. fiskei* is of a very different type (Figs. 8, 18, 26).

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