Pacific Insects 16 (1): 31-40 20 February 1974

THE CAVERNICOLOUS FAUNA OF HAWAIIAN LAVA TUBES, 5. COLLEMBOLA[1]

By **Peter F. Bellinger**[2] and **Kenneth A. Christiansen**[3]

Abstract: One new genus and three new species of (probably) troglophile Collembola are described. The troglophile species *Sinella caeca* is newly placed in the subgenus *Coecobrya* Yosii. Thirteen other troglophile and trogloxene species are recorded from caves; most of these are new records for the Hawaiian Islands.

The Collembola collected by F. G. Howarth and his associates during their study of the Hawaiian cave fauna are mostly imported litter-inhabiting forms, but include several widely distributed troglophiles and three species known so far only from caves. We are grateful to Mr Howarth and to the Bishop Museum for the opportunity to study this interesting collection.

Friesea sublimis Macnamara

Friesea sublimis Macnamara, 1921: 128.

The specimens have a relatively short mucrodens and other very minor differences from Nearctic specimens; material is insufficient to determine if the differences are significant. This species has not previously been recorded from caves. Specimens of *Friesea*, not certainly of this species, have been collected from litter on Oahu, Hawaii, and Kauai.

KAUAI: Koloa, 5 m, Limestone Quarry Cave, 21.VI.1972, F. G. Howarth, 2 specimens from debris, deep twilight.

Protanura hawaiiensis Bellinger and Christiansen, new species. Fig. 1.

Color: White without trace of pigment.

Clothing: Setae smooth to faintly rugose; many dorsal setae are blunt, other dorsal and all ventral setae are acuminate. Chaetotaxy (Fig. 1A) somewhat variable and frequently asymmetrical. Fine setae sensuales in p$_2$ position on thorax and p on abdomen.

Body: Maximum length in type series 3.25 mm. Sixth abdominal segment conspicuously bilobed; other tubercles inconspicuous, indicated mainly by groups of setae. Surface uniformly covered with granules about 2 μ in diameter.

Antennae: Fourth segment with coarse granulation apically but no retractile papilla; 6 cylindrical blunt sensillae (Fig. 1B) plus 2 which are less clearly differentiated; many acuminate setae, longer than segment width; and a group of 6 short, fine setae ventrally. Third segment imperfectly separated from 4th; apical sense organ of 2 short, bent, apically expanded pegs in a groove, without differentiated guard setae; one long appressed sensilla ventrally. Second segment with 10-11 setae in 2 irregular rows; first segment with 1 row of 6-7 setae.

Head: Eyes and postantennal organ absent; some specimens have irregular patches of smooth cuticle in the ocular area, but these are bilaterally asymmetrical and show no resemblance to typical sense organs. Mandible (Fig. 1C) with 5 coarse teeth of which the basal is much the largest, and about 6 fine apical teeth. Maxilla (Fig. 1D) with 3 lamellae: longest with many fine teeth in 3 irregular rows, 2nd with 3 coarse teeth, 3rd short, tapered, and without teeth.

Legs: Outer apical tibiotarsal setae short; several inner setae reach or exceed the base of the unguis. Pretarsus with an inner tubercle but no unguiculus. Unguis granulate externally and

1. Contribution No. 30, ISLAND ECOSYSTEMS IRP/IBP HAWAII, National Science Foundation grant no. GB 23075.

2. California State University, Northridge, Calif. 91324.
3. Grinnell College, Grinnell, Iowa 50112.

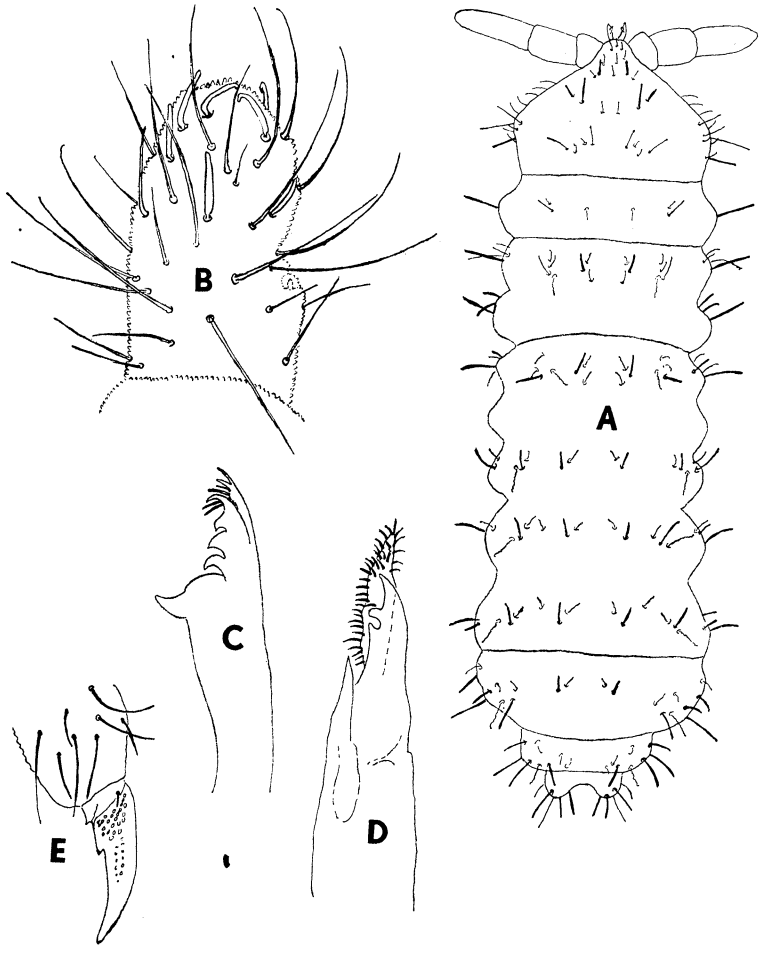

Fig. 1. *Protanura hawaiiensis* (all figures of type specimens): A, body form and dorsal chaetotaxy; B, 3rd and 4th segments of right antenna, dorsal; C, mandible; D, maxilla; E, apex of hind tibiotarsus and unguis.

basally, with a conspicuous inner tooth at about 1/3 its length (Fig. 1E).

Abdomen: Ventral tube with 4+4 or 5+5 setae. Tenaculum perhaps represented by a median tubercle with a group of 5-7 setae. No trace of furcula. Genital area rugose, with many short fine setae; ♂ genital papilla slightly projecting.

Remarks: This species is very similar to *P. citronella* (Carpenter), 1904, described from Oahu and Maui, which, however, has 3+3 eyes and is orange in life. A single poor specimen of *P. citronella* from Maui agrees in those characters which can be made out with *P. hawaiiensis*, except for the presence of eyes; the "postantennal organ" described by Carpenter in *citronella* is apparently an irregular clear area of cuticle. A very poor specimen of the type series of *P. capitata* Folsom, 1932, from Oahu, differs from the present species in having greatly elongate setae, some of which are longer than

the width of the body; other significant characters could not be made out.

Eyeless species of *Protanura* have been referred by Massoud (1967) to the genus *Coecoloba* Yosii, 1956; we prefer not to use this name since *P. hawaiiensis* so closely resembles the eyed species *P. citronella.* Most of the Oriental eyeless species referred to *Coecoloba* have conspicuous segmental tubercles; the most similar to *P. hawaiiensis* is *P. tongana* Yosii, 1964, which has 3+3 median setae on the anterior abdominal segments and a mandible without fine apical teeth.

In some alcoholic and mounted specimens the entire head of the maxilla was seen protruding beyond the mouth opening. It is likely that the groups of fine apical teeth can be opposed to form a basket-like structure which is used in grasping the food. In addition to fungal fragments and plant and other debris, the gut of one specimen contained a recognizable and apparently complete specimen of an isotomid collembolan, almost certainly *Folsomia candida.*

Type data: Holotype ♂ (BISHOP 10112) from Kazumura Cave, 400 m, HAWAII: Mountain View, 15.VII.1972, F. G. Howarth, 1220 m from entrance.

Other records: HAWAII: Mountain View, Kazumura Cave, 15.VII.1972, same data as holotype, 3 ♂♂ and 2 ♀♀ paratypes; 1.XI.1972, from dark zone on cheese bait, 1 paratype; 13.VII.1972, 1220 m from entrance, 1 ♂ and 1 ♀ paratype; 14.VII.1972, 1220 m from entrance, 2 ♂♂ paratypes. Hawaii Volcanoes National Park, Bird Park Cave # 1, 1250 m, 10.XI.1971, J. Jacobi, dark zone, 1 ♀; 20.VII.1971, 30 m inside, 1 ♀; 28.IV.1972, dark zone, 1 ♀. All collected by F. G. Howarth except as noted.

Onychiurus (Onychiurus) folsomi (Schäffer)

Aphorura folsomi Schäffer, 1900: 249.
Onychiurus (Deutaphorura) folsomi Yosii, 1956b: 50.

This species has been found in large numbers in certain litter samples from Hawaii; it appears to be indistinguishable from Japanese *O. folsomi* as redescribed by Yosii, except possibly for the ♂ ventral organ. *O. folsomi* has been recorded from caves.

HAWAII: Hawaii Volcanoes National Park, Bird Park Cave # 3, 1250 m, 20.VII.—1.X.1971, F. G. Howarth, from pitfall trap 60 m in cave, 2 specimens.

Folsomia candida Willem

Folsomia candida Willem, 1902: 280; Stach, 1947: 178.

The specimens are typical except for a tendency toward medial constriction of the postantennal organ. *E. candida* is a common and widespread troglophile in Europe and North America.

HAWAII: Mountain View, Kazumura Cave, 400 m, 13.VII.1972, F. G. Howarth, J. Jacobi, dark zone, 1220 m from entrance, 3 specimens; 14.VII.1972, F. G. Howarth, 1220 m from entrance, 1 specimen; 1.XI.1972, F. G. Howarth, 1220 m from entrance, 2 specimens. Hawaii Volcanoes National Park, Mauna Loa Strip Trail, 5020 Foot Cave, 1530 m, 1.X.1971, F. G. Howarth, J. Jacobi, cave twilight & transition zone, 1 specimen. KAUAI: Koloa, Koloa Cave # 2, 40 m, 11.VIII.1971, F. G. Howarth, on rotting wood 45 m inside, dark zone, 7 specimens.

Proisotoma perparva Jackson

Proisotoma perparva Jackson, 1927: 493.

A well pigmented hemiedaphic form, originally described from a cave in Trinidad but also found in litter samples from Jamaica and Oahu. A redescription of this poorly known species is planned.

KAUAI: Koloa, Limestone Quarry Cave, 21.VI.1972, F. G. Howarth, from debris, deep twilight, 20+ specimens.

Cryptopygus constrictus (Folsom), new combination

Proisotoma (*Proisotoma*) *constricta* Folsom, 1937: 64.

A Nearctic species, not previously recorded from caves.

KAUAI: Koloa, Limestone Quarry Cave, 21.VI.1972, F. G. Howarth, from debris, deep twilight, 1 specimen.

Cryptopygus sp.

The single defective specimen does not match any known species. A pigmented form showing no cave adaptations.

KAUAI: Koloa, Limestone Quarry Cave, 21.VI.1972, F. G. Howarth, from debris, deep twilight, 1 specimen.

Isotoma notabilis Schäffer

Isotoma notabilis Schäffer, 1896: 187; Stach, 1947: 374.

Typical specimens of a common Holarctic species; it occurs in litter in Hawaii and has been recorded from caves in Europe and North America.

HAWAII: Hawaii Volcanoes National Park, Mauna Loa Strip Trail, 8000 Foot Cave, 2440 m, 27.XI.1971, F. G. Howarth, J. Jacobi, from honeycreeper nest in twilight zone, 15 specimens.

Entomobrya nivalis (Linnaeus)

Podura nivalis Linnaeus, 1758: 609.
Entomobrya nivalis Christiansen, 1758: 457.

A widespread species, common in litter in Hawaii.

HAWAII: Hawaii Volcanoes National Park, Bird Park Cave # 1, 1250 m, 3.VII.1971, F. G. Howarth, 1 specimen.

Sinella (Coecobrya) caeca (Schött)

Entomobrya caeca Schött, 1896: 178.

The specimens from Hawaii are in good agreement with those from the U.S. Mainland which have been identified as this species; *S. caeca* in this sense is quite different from the animals described under this name by European authors or by Yosii (1964), but since *S. caeca* was described originally from the United States it is almost certain that this is Schött's species. *S. caeca* in our sense has the clearly differentiated smooth setae on the manubrium characteristic of Yosii's subgenus *Coecobrya*, as well as a distinct row of "smooth" setae on the inner surface of the tibiotarsus. The Hawaiian specimens may be distinctive in the distribution of the macrochaetae on the 4th abdominal segment, but this feature appears to be variable. *S. caeca* is a common and widespread troglophile in North America.

HAWAII: Mountain View, Kazumura Cave, 400 m, 1.XI.1972, F. G. Howarth, from cheese bait in dark zone, 1 specimen. Kaumana, Kaumana Cave, 290 m, 2.X.1971, F. G. Howarth, dark zone, 9 specimens. OAHU: Honolulu, Judd St. Cave, 30 m, 21.V.1972,

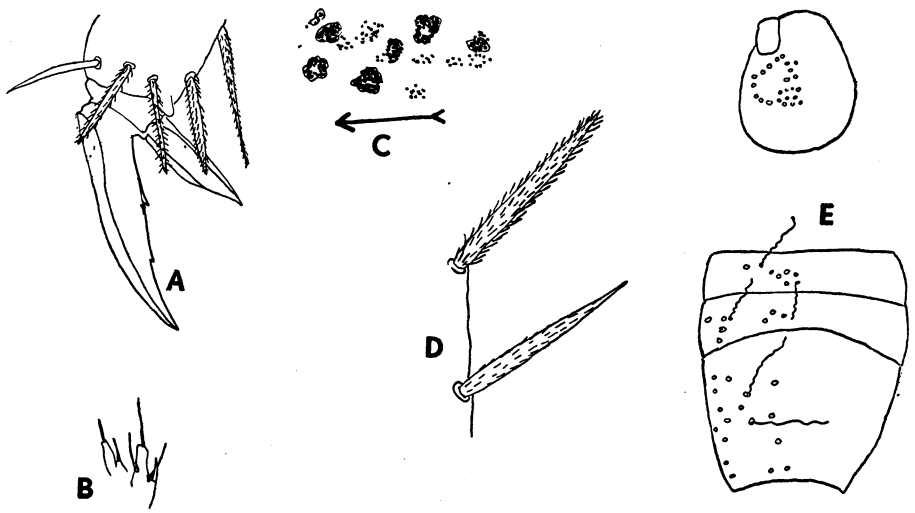

Fig. 2. *Sinella yosiia* (all figures of type specimens): A, fore foot complex; B, left hand margin of left apical labial organ; C, eyes of left side of head; D, setae along inner distal margin of tibiotarsus; E, distribution of macrochaetae and bothriotrichia on dorsum of head and abdominal segments 2-4.

F. G. Howarth, dark zone, 1 specimen.

Sinella (Sinella) yosiia Bellinger and Christiansen, new species. Fig. 2, table 1.

Color: Varying from entirely white except for weakly pigmented eyespots to orange-red in alcohol or blue in mounted specimens; color due to scattered pigment granules concentrated on side and dorsum of body. Pigmented specimens usually have a triangular patch between the eyes and dark transverse lines at the posterior margins of the 3rd and 4th abdominal segments, while the legs and antennae are uniform pale blue.

Clothing: Normal body setae are small and acuminate, and uniformly ciliate as are all the setae on the dorsum of the manubrium. Chaetotaxy as in fig. 2E.

Antennae: Fourth segment lacks an apical bulb. Apical organs of 2nd and 3rd segments consist of 2 or 3 blunt oval pegs close together, and a somewhat longer oval seta on the opposite side.

Head: Eyes (fig. 2C) always appear to lack corneae, but there are usually 6 pigment spots per side (fewer in the single specimen from Maui), with additional scattered pigment between them. Labral papillae not clearly visible. Labial appendage (fig. 2B) has a remarkably short external differentiated seta which never reaches the apex of the same papilla.

Legs: Tibiotarsus has a single row of inner "smooth" setae (fig. 2D). Tenent hair acuminate. Unguis (fig. 2A) lacks external or lateral teeth and has 3 relatively small internal teeth. Unguiculus acuminate, with an extremely minute outer tooth.

Furcula. Mucro bidentate with the apical tooth about 1 1/4 × as long as the anteapical tooth; basal spine just attains the apex of the anteapical tooth.

Remarks. This species is similar in some respects to *S. decemoculata* Uchida, but differs in eye number and claw structure. *S. pulcherrima* Agrell, described as having 6 eyes, actually has 8 according to Gama (1961); it also differs in the claw and tenent hair structure and the shape of the body setae. The unusually short external labial seta

is clear in all specimens seen, and clearly distinguishes this species from all similar Nearctic forms. In the largest specimens the inner ciliate tibiotarsal setae are heavy and spine-like. The single specimen from Maui resembles the others except in eye number; material is insufficient to justify separating it.

Type data: Holotype (BISHOP 10113) from HAWAII, Mountain View, Kazumura Cave, 400 m, 22.VI.1972, F. G. Howarth, 200 m from entrance.

Other records: HAWAII, Kazumra Cave, 22.VI.1972, same data as holotype, 5 paratypes; 25.VII.1971, F. G. Howarth, dark zone, 60 m from entrance, 10 paratypes; 15.VII. 1972, F. G. Howarth, dark zone, on bait, 1 paratype; 15.VII.1972, F. G. Howarth, 1220 m from entrance, 1 paratype; 1.XI.1972, F. G. Howarth, dark zone, on cheese bait, 2 paratypes, 8.XII.1972, W. C. Gagné, F. G. Howarth, dark zone, 5 paratypes. Kaumana, Kaumana Cave, 290 m, 2.X.1971, F. G. Howarth, dark zone, 2 specimens; 26.IV.1972, F. G. Howarth, dark zone, 1 specimen; 30.X.1972, F. G. Howarth, dark zone, 1 specimen. Hawaii Volcanoes National Park, Mauna Loa Strip Trail, 5020 Foot Lava Tube, 1.X.1971, F. G. Howarth, J. Jacobi, cave twilight and transition zones, 2 specimens. MAUI: Hana, Holoinawawai Stream Cave, 290 m, 14.XII.1971, F. G. Howarth, 1 specimen.

Genus **Hawinella** Bellinger and Christiansen, new genus

Entomobryini. Eyeless. With wing teeth on unguis and unguiculus. Body scales finely striate, broadly fusiform and pointed, unpigmented and soft. Body and head with abundant large lasiotrichia (holochaetotic in Yosii's terms). Scales lacking on antennae, legs, or dens, but present on head, body, and manubrium. Mucro falcate, with basal spine surpassing the apex. Mouthparts normal for the tribe.

Type species: *Hawinella lava*, n. sp.

Remarks: The genus is very similar to *Lepidosinella* Handschin, 1920, in many respects, but differs in the presence of scales on the manubrium, the scale structure, the structure of the mouthparts, and a number of minor features. It is distinguished from *Drepanosira* Bonet and other Entomobryini with pointed scales by the foot structure and the absence of eyes and pigment.

Hawinella lava Bellinger and Christiansen, new species. Fig. 3, table 1.

Color: White without trace of pigment.

Clothing: Dorsal surface of head with many large acuminate macrochaetae distributed as in the genus *Sinella*, and completely covered with scales. Sides and dorsum of body with large, apically expanded macrochaetae, acuminate and ciliate setae of various sizes, and scales. Venter of abdomen has several large acuminate and ciliate setae near the base of the manubrium. Legs without scales. Manubrium has ciliate acuminate macrochaetae on the dorsal and lateral surfaces, but is covered with narrow pointed scales ventrally. All scales except those on the venter of the manubrium are broadly elliptical, with a minutely pointed tip and separate striations. Chaetotaxy as in fig. 3I; setae and scales as in fig. 3C-E, G, H.

Body: Form very similar to that of *Sinella caeca*.

Antennae: Fourth segment oval and unringed, without apical bulb, with 2 small curved subapical setae. Third segment with small obscure apical sense organ. Antennae lack other clear sense organs or scales.

Head: Eyes absent. Labium with clearly differentiated external seta, as in *Entomobrya*. Ventral margin of labium with all setae similar in size and shape and uniformly ciliate.

Legs: Tibiotarsus with all setae uniformly ciliate except for distalmost inner seta and tenent hair, which are smooth. Unguis (fig. 3A, B) with 2 basal teeth, 1 small and 1 large and wing-like,

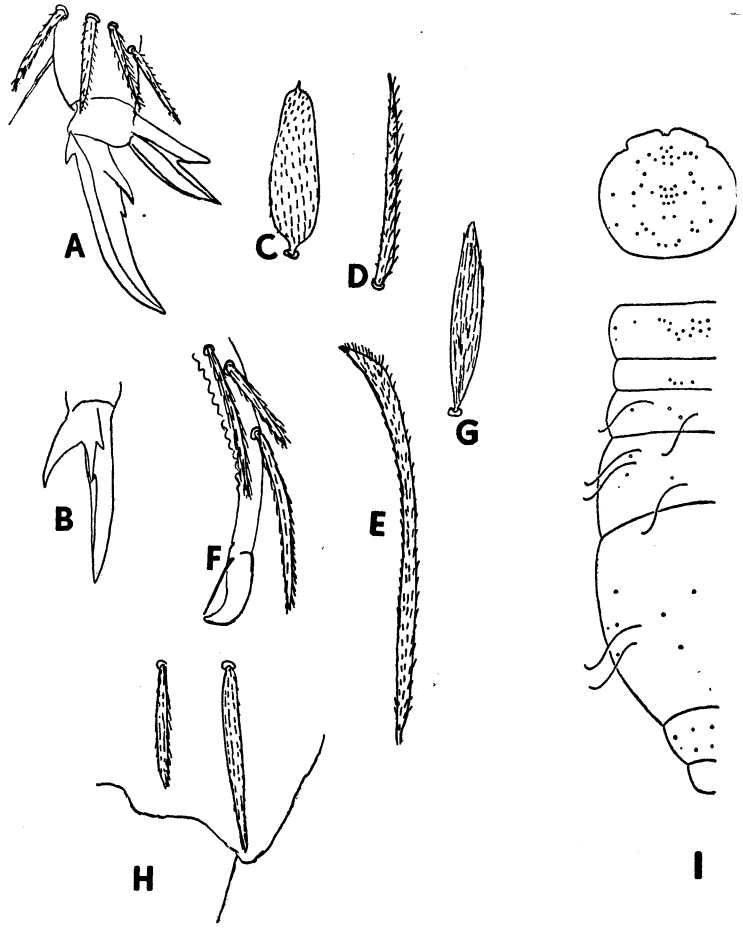

Fig. 3. *Hawinella lava* (all except I figures of type specimens): A, hind foot complex; B, mid unguis seen from inner surface; C, typical scale of head and body; D, macrochaeta from dorsum of head; E, macrochaeta from anterior margin of mesothorax; F, end of dens and mucro; G, scale from venter of manubrium; H, macrochaetae on venter of abdomen at base of manubrium on left side; I, chaetotaxy, omitting plurichaetotic 2nd thoracic segment, based largely on the Kazumura Cave specimen but checked with types (position of bothriotrichia somewhat in doubt due to poor condition of the specimens).

1 median inner tooth, and 1 small outer tooth. Unguiculus (fig. 3A) with large wing-like outer tooth.

Furcula: Dentes have slender acuminate setae but no scales. Mucro (fig. 3F) unidentate, with a well developed basal spine.

Remarks: The specimens are in rather poor condition, but so far as can be determined those from Oahu and Hawaii are very similar in all respects.

Type data: Holotype (BISHOP 10114) from OAHU, Makua Cave, 5 m, 31.X.1971, F. G. Howarth.

Other records: OAHU: Makua Cave, 31.X.1971, same data as holotype, 1 paratype.

Table 1. Measurements (in mm) of *Sinella (S.) yosiia* n. sp. and *Hawinella lava* n. gen., n. sp.*

	Sinella (S.) yosiia Localities						*Hawinella lava* Localities	
	Holotype	Kaumana Cave	5020 ft Cave	Kazumura Cave	Kazumura Cave	Kazumura Cave	Makua Cave	Makua Cave
Cephalic diagonal	.46	.49	.68	.46	.52	-57	.27	.27
Antennal segment 4	.42	.56	.77	.66	.66	.57	.20	.21
Antennal segment 3	.24	.36	.53	.32	.38	.35	.09	.11
Antennal segment 2	.20	.34	.53	.39	.41	.39	.11	.11
Antennal segment 1	.10	.14	.31	.21	.22	.19	.05	.07
Thoracic segment 2	.18	.28	.40	.35	.36	.32	.16	.11
Abdominal segment 3	.10	.12	.21	.13	.14	.19	.10	.07
Abdominal segment 4	.46	.53	.89	.72	.77	.89	.31	.30
Manubrium	.30	.42	.60	.56	.56	.50	.18	.16
Dens	.40	.49	.80	.64	.71	.63	.23	.22
Mucro	.014	.018	.028	.024	.021	.022	.018	.016
Hind tibiotarsus	.36	.49	.77	.67	.66	.60	.18	.15
Inner margin unguis	.046	.050	.070	.073	.067	.073	.028	.023
Unguiculus, hind foot	.028	.030	.045	.042	.045	.049	.018	.018
Tenent Hair	.028	.030	.045	.038	.036	.039		

* All measurements (except where otherwise stated) taken along longest linear length. Body segments measured along mid-dorsal line.

HAWAII: Mountain View, Kazumura Cave, 400 m, 15.VII.1972, F. G. Howarth, 1220 m from entrance, 1 specimen.

Lepidocyrtus cf. **cyaneus** Tullberg

Lepidocyrtus cyaneus Tullberg, 1871: 150.

A member of a widespread Holarctic species or species complex.

MAUI: Cape Kinau, Nukuele Pt., 22.I.1971, F. G. Howarth, J. Maciolek, E. L. Bousfield, on brackish pool in twilight zone, 2 specimens.

Lepidocyrtus cf. **ruber** Schött

Lepidocyrtus ruber Schött, 1902: 31.

These species of *Lepidocyrtus* have well developed eyes and no indication of adaptation for cave life, and appear to be the same as forms which are common in Hawaiian litter samples. Final determination of their identity will require further study of this difficult genus.

KAUAI: Koloa, Limestone Quarry Cave, Passage D and E, 5.VII.1973, F. G. Howarth, R. C. Rice, 7 specimens.

Pseudosinella sp.

A species which cannot be identified at present, but which is probably undescribed. A similar form has been seen in a litter sample from Hawaii.

OAHU: Honolulu, Judd St. Cave, 30 m, 21.V.1972, F. G. Howarth, dark zone, 2 specimens.

Salina maculata Folsom

Salina maculata Folsom, 1932: 71.

A Hawaiian endemic, recorded from several islands. *S. maculata* is commonly found on or above the soil surface, and has pigment and exceptionally well developed eyes; it is presumably accidental in caves.

HAWAII: Mountain View, Kazumura Cave, 400 m. 28.VII.1971, F. G. Howarth, 60 m from entrance, 1 specimen.

Cyphoderus assimilis Börner

Cyphoderus assimilis Börner, 1906: 181.

Generally a myrmecophilous species, and previously recorded from Oahu, with ants.

OAHU: Honolulu, Judd St. Cave, 30 m, 21.V.1972, F. G. Howarth, dark zone, 1 specimen.

DISCUSSION

The majority of the species here recorded from Hawaiian caves are clearly not peculiar to that habitat, but are soil or litter or even (*S. maculata*) epigeic forms. Several of them, however, are well known as troglophiles (e.g. *F. candida*, *S. caeca*.) While the newly described species have only been found in caves, knowledge of the Hawaiian litter fauna is too incomplete to support the suggestion that they are troglobites, and the occurrence of 2 of the species on more than one island is evidence against their restriction to caves.

Except for the new species and *Salina maculata*, all those recorded are known from other parts of the world and are probably introduced elements in Hawaii. It is noteworthy, however, that except for *O. folsomi*, *F. candida*, *E. nivalis*, and *L. cyaneus*, which are listed by Folsom (1932; the first 3 under other names), all are new records for the Hawaiian Islands. Most of the other species, however, have previously been collected in Hawaiian litter samples (Bellinger, unpublished records).

REFERENCES

Agrell, I. 1939. Die Arthropodenfauna von Madeira. XVIII. Collembola. *Ark. Zool.* **31B**(10): 1—7.

Börner, C. 1906. Das System des Collembolen. *Mitt. Naturhist. Mus. Hamburg* **23**: 147—188.

Carpenter, G. H. 1904. Collembola. *Fauna Hawaiiensis* **3**: 299—303.

Christiansen, K. A. 1958. The Nearctic members of the genus *Entomobrya* (Collembola). *Bull. Mus. Comp. Zool.* **118**: 437—545.

Denis, J. R. 1941. Catalogue des Entomobryens Siraeformes et Lepidocyrtiformes. *Bull. Sci. Bourgogne* **9**: 41—118.

Folsom, J. W. 1932. Hawaiian Collembola. *Proc. Hawaiian Ent. Soc.* **8**: 51—92.

1937. Nearctic Collembola of the family Isotomidae. *U. S. Nat. Mus. Bull.* **168**: 1—144.

da Gama, M. M. 1961. Nova contribuiç ão para o estudo dos colembolos da Ilha da Madeira.

Mem. Estud. Mus. Zool. Univ. Coimbra **274:** 1—20.

Handschin, E. H. 1920. Collembolen aus Java. *Rev. Suisse Zool.* **28:** 135—148.

Jackson, C. H. N. 1927. On some new Collembola from Trinidad. *Ann. & Mag. Nat. Hist.* (9) **19:** 485—497.

Linnaeus, C. 1758. *Systema Naturae* (ed. 10). Aptera: 608—609.

Macnamara, C. 1921. A new species of *Friesea*. *Canad. Ent.* **53:** 125—129.

Massoud, Z. 1967. Monographie des Neanuridae. *Biol. Amer. Austr.* **3:** 7—400.

Salmon, J. T. 1964—1965. An index to the Collembola. *Bull. Roy. Soc. New Zealand* **7:** 1—651.

Schäffer, C. 1896. Die Collembola der Umgebung von Hamburg. *Mitt. Naturhist. Mus. Hamburg* **13:** 147—216.

1900. Ueber württembergische Collembola. *Jahresh. Ver. Vaterl. Naturkunde* Württemberg **56:** 245—280.

Schött, H. 1896. North American Apterygogenea. *Proc. Calif. Acad. Sci.* (2)**6:** 169—196.

1902. Études sur les collemboles du nord. *Bih. K. Svenska Vet.-Akad. Handl.* **28**(4(2)): 1—48.

Stach, J. 1947. *The Apterygotan fauna of Poland. Family: Isotomidae.* 1—488.

Tullberg, T. 1871. Förteckning öfver Svenska Podurider. *Öfv. K. Vet.-Akad. Förhandl* **28:** 143—155.

Uchida, H. 1940. Some Japanese cavernicolous springtails. *Bull. Tokyo Sci. Mus.* **3:** 1—5.

Willem, V. 1902. Note preliminaire sur les collemboles des grottes de Han et de Rochefort. *Ann. Soc. Ent. Belg.* **46:** 275—283.

Yosii, R. 1956a. Höhlencollembolen Japans II. *Jap. J. Zool.* **11:** 609—627.

1956b. Monographie zur Höhlencollembolen Japans. *Contr. Biol. Lab. Kyoto Univ.* **3:** 1—109, 355 fig.

1961. Phylogenetische Bedeutung der Chaetotaxie bei den Collembolen. *Contr. Biol. Lab. Kyoto Univ.* **12:** 1—37.

1964. Some Collembola from Okinawa caves, with notes on *Sinella-Coecebrya* complex of Japan. *Bull. Akiyoshi-dai Sci. Mus.* **3:** 25—34.