

INSECTS OF HAWAII

A Manual of the Insects of the Hawaiian Islands, including an Enumeration of the Species and Notes on their Origin, Distribution, Hosts, Parasites, etc.

VOLUME 15
COLLEMBOLA

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PREFACE TO VOLUME 15

The systematic treatment of Hawaiian Collembola by Zimmerman in *Insects of Hawaii*, vol. 2 (1948), is essentially a modified compilation from the papers by Folsom (1932) and Carpenter (1904). Zimmerman listed 32 species in 24 genera, but suggested that these species were only a fraction of the actual fauna; he considered it questionable whether any of those he recorded were endemic. In the last three decades much more extensive collecting, especially by the present authors and the staff of the Bernice P. Bishop Museum, has given a more complete picture of the fauna. We here record 154 species, not all well enough known to be formally described; of these, 92 seem to be endemic to the Hawaiian Islands. A few new species were described in preliminary papers (Bellinger and Christiansen 1974, Christiansen and Luther 1986, Snider 1990). In the present work, 63 additional new species are described and a considerable number of additional species are newly recorded from the Islands. The fauna is evidently still undergoing modification; there is good reason to believe that many immigrant as well as some endemic species have become extinct in the last half century.

The classification followed here is essentially that of Christiansen and Bellinger in *The Collembola of North America* (1980-1981). Although we are aware of imperfections in this classification, we prefer not to make fundamental modifications to the arrangement on the basis of this limited fauna. Furthermore, we believe that recent reclassifications of some groups of Collembola, while admirably increasing our understanding of relationships, suffer from objectionable and semantically useless inflation of category levels.

Distribution of species as given in the text includes information on type collections and a list of sample numbers, arranged by islands, corresponding to the "List of Numbered Localities" at the end of the book. In the distribution maps, conventions are as follows:

- x = 1 collection from that locality
- = 5-7 collections from that locality
- = 8 or more collections from that locality

In the plates showing species characters, conventions are as follows: Double circles or circles with a central dot represent pseudopores. Circles or dots with thin wavy lines represent bothriotricha. Arrows indicate anterior or dorsal directions, or in the case of dorsal views, anterior and outward directions. In plate captions, the term *same* means the specimen is from the same locality as the preceding specimen, or copied from the same author.

Many people have assisted during the eight years we have been working on this

project, and a number of these are recognized in naming the new species described herein. In addition to these we would like to thank Steve Montgomery and Frank Howarth for their general and generous assistance. We would also like to thank the staff of the Bishop Museum for their generous hospitality in making resources available to the senior author during three collecting trips. In particular we would like to thank Gordon Nishida, whose assistance in all aspects of our work was essential to its completion. Greg Luther and Susan Durkee were of great assistance in the early stages of this work. Most of the manuscript preparation was done by Carol Elliott and John Marshall of Grinnell College. Their heroic patience is greatly appreciated. The work was made possible by a number of institutional grants from Grinnell College and Whitehall Foundation grant 86 M.O.S.

All type specimens of new species herein described will be deposited at the Bernice P. Bishop Museum, Honolulu.

CHECKLIST OF THE INSECTS IN THIS VOLUME
Order COLLEMBOLA

Family HYPOGASTRURIDAE Subfamily HYPOGASTRURINAE	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus Hypogastrura Bourlet							
Subgenus Hypogastrura							
pahiku , n. sp.	x				x		
Subgenus Ceratophysella Börner							
boletivora (Packard)	x		x				North America
Subgenus Schoettella Schäffer							
alba (Folsom)					x		
Genus Xenylla Tullberg							
alba Folsom					x		
auka , n. sp.	x						
grisea Axelson	x						Cosmopolitan
hawaiiensis Gama	x				x	x	
welchi Folsom					x		Cosmopolitan
yucatana Mills						x	Pantropical
Genus Willemia Börner							
peke , n. sp.					x		
Subfamily NEANURINAE							
Genus Odontella Schäffer							
kapii , n. sp.						x	
uka , n. sp.	x						
Genus Stachia Folsom							
minuta Folsom					x		
Genus Brachystomella Agren							
contorta Denis	x	x			x	x	Midway; pantropical
hawaiiensis Yosii					x		
heo , n. sp.					x		
kahakai , n. sp.	x						
kiko , n. sp.					x		Nihoa
momona , n. sp.	x						
parvula (Schäffer)	x				x	x	Cosmopolitan
Genus Setanodosa							
kanalua , n. sp.	x				x		
Genus Friesea Dalla Torre							
kai , n. sp.	x				x	x	
ninau , n. sp.	x	x			x	x	Pearl and Hermes Reef
oleia , n. sp.						x	
Genus Oudemansia Schött							
esakii (Kinoshita)					x		Laysan, Pearl and Hermes Reef; East Asia

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus <i>Aethiopella</i> Handschin <i>kuolo</i> , n. sp.						x	
Genus <i>Pseudachorutes</i> Tullberg <i>poahi</i> , n. sp.	x						
Genus <i>Anurida</i> Laboulbène <i>anini</i> , n. sp.	x						
Genus <i>Paranura</i> Axelson <i>nalo</i> , n. sp.					x		
Genus <i>Neanura</i> MacGillivray Subgenus <i>Protanura</i> Börner <i>aleo</i> , n. sp.		x	x				
<i>capitata</i> Folsom					x		
<i>citronella</i> Carpenter					x		
<i>hawaiiensis</i> Bellinger and Christiansen	x						
Subgenus <i>Neanura</i> <i>muscorum</i> Templeton	x	x		x		x	Pearl and Hermes Reef; cosmopolitan
Subgenus <i>Vitronura</i> Yosii <i>giselae</i> Gisin	x	x	x		x	x	Europe, pantropical
Subgenus <i>Paleonura</i> Cassagnau <i>ili</i> , n. sp.	x	x			x		
Subgenus <i>Morulodes</i> Cassagnau <i>setosa</i> Canby						x	Western United States
Family ONYCHIURIDAE							
Genus <i>Onychiurus</i> Gervais Subgenus <i>Onychiurus</i> <i>folsomi</i> Schäffer	x	x				x	Midway; holarctic
Subgenus <i>Protaphorura</i> Absolon <i>cryptopygus</i> Denis	x	x		x	x	x	Central and South America, Antilles
<i>encarpatus</i> Denis	x		x	x	x	x	Pearl and Hermes Reef; United States to Argentina
<i>petaloides</i> Rusek						x	Iraq
Genus <i>Tullbergia</i> Lubbock <i>macrochaeta</i> Rusek	x	x			x		Holarctic
<i>ruseki</i> Christiansen and Bellinger					x		Eastern and central United States
<i>silvicola</i> Folsom	x				x		North America
<i>yosiii</i> Rusek	x		x		x		Midway; holarctic
Genus <i>Prabhergia</i> Salmon <i>nayarii</i> Salmon	x				x	x	India, Indonesia
Family ISOTOMIDAE							
Genus <i>Anurophorus</i> Nicolet <i>lohi</i> , n. sp.	x	x			x	x	
Genus <i>Isotomodes</i> Linnaniemi <i>dagamae</i> Prabho		x			x	x	India
<i>denisi</i> Folsom	x						
<i>fuscus</i> Christiansen and Bellinger	x	x			x		United States
Genus <i>Folsomides</i> Stach <i>parvulus</i> Stach	x	x			x		Pearl and Hermes Reef; cosmopolitan at low latitudes

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus Proisotoma Börner Subgenus Ballistura Börner centralis Denis	x				x	x	Midway; Central and South America, Indonesia, Australia
Subgenus Proisotoma minuta (Tullberg) nigromaculosa Folsom	x	x	x	x	x	x	Cosmopolitan Midway; South Africa?
Genus Archisotoma Linnaniemi sp.					x		
Genus Cryptopygus Willem thermophilus (Axelson)	x	x	x		x	x	Pearl and Hermes Reef, Midway, Kure; cosmopolitan
Genus Folsomina Denis onychiurina Denis	x	x			x	x	Pearl and Hermes Reef; cosmopolitan
Genus Folsomia Willem candida Willem stella Christiansen and Tucker octoculata Handschin	x	x		x	x	x	Cosmopolitan Nearctic and arctic regions Indonesia and East Asia
Genus Isotomiella Bagnall alulu , n. sp. minor (Schäffer)	x	x			x	x	Cosmopolitan
Genus Axelsonia Börner sarahae , n. sp.	x				x		Pearl and Hermes Reef
Genus Isotomurus Börner opala , n. sp. palustris (Müller)	x	x	x		x	x	Cosmopolitan
Genus Isotoma Bourlet Subgenus Pseudisotoma Handschin sensibilis Tullberg Subgenus Halisotoma Bagnall kainui , n. sp.	x	x	x		x	x	Holarctic and Indonesian regions
Subgenus Desoria Nicolet ahiehie , n. sp. bendixenae , n. sp. notabilis Schäffer trispinata MacGillivray perkinsi Carpenter	x		x		x	x	Cosmopolitan Holarctic, India, Indonesia
Family ENTOMOBRYIDAE Subfamily ENTOMOBRYINAE						x	
Genus Orchesellides Bonet sinensis (Denis)	x	x					China
Genus Heteromurus Wankel Subgenus Alloscopus Börner tenuicornis Börner					x		Indonesia and southwestern Pacific
Genus Entomobrya Rondani Subgenus Homidia Börner insularis Carpenter haikea , n. sp. hihiu , n. sp. laha , n. sp.	x				x	x	
	x			x	x	x	
	x	x					
	x	x		x	x	x	

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
sauteri Börner	x	x	x			x	Southeast Asia, United States
socia Denis	x	x	x	x	x	x	Southeast Asia, United States
Subgenus Entomobrya							
albocincta (Templeton)	x	x					Western palearctic
atrocincta Schött	x	x	x		x	x	Pearl and Hermes Reef; cosmopolitan
nyhusae , n. sp.	x	x			x	x	French Frigate Shoals
powehi , n. sp.	x	x	x		x	x	
griseoolivata (Packard)	x	x			x	x	Laysan; North America, Europe
panoanoa , n. sp.	x				x	x	
multifasciata (Tullberg)	x	x	x	x	x	x	Pearl and Hermes Reef; cosmopolitan
unostrigata Stach							Midway; Europe, North America, Australia
Subgenus Entomobryoides Maynard							
mauna , n. sp.	x	x				x	
puakea , n. sp.			x			x	
malena , n. sp.	x				x		
kea , n. sp.	x	x			x		
guthriei Mills	x	x	x		x	x	United States
kalakaua Carpenter	x	x			x	x	
Subgenus Mesentotoma Salmon							
mauka , n. sp.	x	x	x				
nani , n. sp.			x	x			
Genus Sinella Brook							
Subgenus Coecobrya Yosii							
boreae , n. sp.	x	x		x	x		
kukae , n. sp.		x					
lua , n. sp.					x		
caeca (Schött)	x				x		Cosmopolitan
nupa , n. sp.		x					
Subgenus Sinella							
curviseta Brook	x	x		x	x		
yosii Bellinger and Christiansen	x	x		x			
Genus Willowsia Shoebottom							
kahlertae , n. sp.	x			x	x		
mekila , n. sp.					x		
jacobsoni (Börner)	x	x			x		Pantropical
Genus Hawinella Bellinger and Christiansen							
kuaola , n. sp.					x		
lava Bellinger and Christiansen	x				x		
Genus Seira Lubbock							
gobalezai , n. sp.					x		
lelo , n. sp.	x						Nihoa
pihulu , n. sp.	x						Midway
terrestris (Folsom)	x		x		x	x	French Frigate Shoals, Laysan, Midway, Kure; Ocean I., Marcus I., Philippines
Genus Lepidocyrtus Bourlet							
aho , n. sp.					x		
apo , n. sp.	x		x		x	x	
eeu , n. sp.	x	x	x	x	x	x	
hakea , n. sp.		x		x	x		Midway
hukulii , n. sp.	x	x			x	x	

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
kuakea , n. sp.	x	x			x		
heterophthalmus Carpenter	x						
immaculatus Folsom	x	x	x	x	x	x	Midway
inornatus Folsom					x		Marquesas Is.
mele , n. sp.	x	x	x	x	x	x	Midway
pallidus Reuter	x				x		Midway; Europe, Africa, North and South America
olena , n. sp.	x	x			x	x	Midway
poko , n. sp.					x		
violaceus (Fourcroy)			x				Europe, Asia, North America
uku , n. sp.						x	
Genus Pseudosinella Schäffer							
fujiokai Yosii	x	x			x	x	Tonga Is., Indonesia
kalalauensis Christiansen and Luther				x		x	
lahainaensis Christiansen and Luther	x	x					Sonora, Mexico
octopunctata Börner	x	x	x				Holarctic, Southeast Asia, south temperate
Subfamily CYPHODERINAE							
Genus Cyphoderus Nicolet							
similis Folsom	x	x	x	x	x	x	Laysan, Pearl and Hermes Reef; North and South America, West Africa
Subfamily PARONELLINAE							
Genus Salina MacGillivray							
celebensis Schäffer	x	x	x	x	x	x	French Frigate Shoals; Southeast Asia, Indonesia, South America
Subfamily ONCOPODURINAE							
Genus Harlomillsia Bonet							
oculata (Mills)	x	x	x		x		Southern United States to northern South America, Southeast Asia, Indonesia
Subfamily TOMOCERINAE							
Genus Tomocerus Nicolet							
minor (Lubbock)	x	x	x	x	x	x	Western palearctic, North America, New Zealand
Family NEELIDAE							
Genus Neelus Folsom							
Subgenus Neelides Caroli							
minutus Folsom	x		x		x	x	Holarctic
Subgenus Megalothorax Willem							
piloli , n. sp.	x	x			x		
poki , n. sp.	x				x		
Family SMINTHURIDAE							
Genus Sminthurides Börner							
ramosus Folsom					x		Central America?, West Africa?
biniserratus (Salmon)	x	x			x		Southeast Asia, Indonesia, Argentina
lolaelua , n. sp.	x						Midway

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus Arrhopalites Börner							
benitus (Folsom)	x						North America
caecus (Tullberg)	x						Holarctic, Australia
Genus Sminthurinus Börner							
elegans (Fitch)	x	x					Holarctic, Australia
kaha , n. sp.	x				x		
quadrimaculatus (Ryder)		x			x		North America
Genus Bourletiella Banks							
Subgenus Bourletiella							
hortensis (Fitch)	x						Holarctic, Southeast Asia, Australia, Patagonia
insula Folsom	x	x	x		x	x	
Subgenus Deuterosminthurus Börner							
polena , n. sp.		x					
Subgenus Prorastriopes Delamare							
lipsoni Snider					x	x	United States
Subgenus Heterosminthurus Stach							
ihu , n. sp.	x				x		
Genus Sphyrotheca Börner							
nani , n. sp.		x	x		x		
Genus Dicyrtoma Bourlet							
Subgenus Papirioides Folsom							
dubia (Folsom)					x		
kauaiensis Snider						x	
serrata Snider		x			x		
Subgenus Ptenothrix Börner							
hawaiiensis Snider	x	x					
Subgenus Calvatomina Yosii							
bellingeri Snider						x	
brevifibra Snider	x		x		x		
longidigita Snider	x						
maestrus Snider					x	x	
microdentata Snider						x	
sylvestralis Snider					x	x	
tesselata Snider					x		

Order COLLEMBOLA

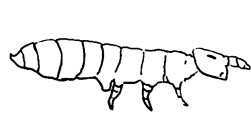
Collembola are terrestrial arthropods with insectlike segmentation of the head and thorax and an abdomen with six segments (properly, five and telson). The mouthparts are withdrawn into the head capsule (entotrophous); wings are primitively absent; the distal leg segment is a tibiotarsus with a dorsal unguis and usually a ventral unguiculus borne on an apical pretarsus. The first abdominal segment bears a ventral pair of basally fused vesicles, the collophore; most species have ventral bifurcate appendages, the tenaculum and furcula, on the third and fourth abdominal segments (the furcula, a jumping appendage that gives the name "springtail" to the group, may appear to arise from the fifth abdominal segment, but the musculature makes its true position clear). With very few exceptions (e.g., *Tomocerus*), juveniles closely resemble adults.

Collembola are abundant and ubiquitous, probably exceeding all other insects in numbers of individuals, but their small size and sensitivity to desiccation restrict most species to humid situations. Most Collembola are detritus feeders; a few are known to feed on leaves or roots of living plants, but only one of these, *Sminthurus viridis* L. (not Hawaiian), is economically significant. Early reports (e.g., Van Zwaluwenburg 1931a) of root damage to sugarcane by Collembola in Hawaii are not supported by more recent studies; at least some species that are abundant in fields have been shown to feed preferentially on weeds or fungi rather than crops (Ulber 1980) and to favor plant growth by consuming pathogenic fungi (Ulber 1983, Curl 1982).

For a general treatment of the morphology and biology of Collembola, see Christiansen and Bellinger (1980–1981).

KEY TO FAMILIES OF COLLEMBOLA

1. Body linear (Fig. 1A,B): at least anterior 4 abdominal segments dorsally separated by membranes lacking setae, or furcula rudimentary or absent (suborder Arthropleona) 2
- Body globular (Fig. 1C); anterior 4 abdominal segments fused dorsally; furcula always well developed (suborder Symphypleona) 10



1A

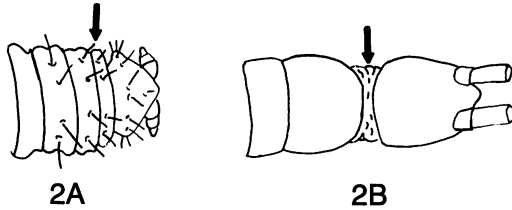


1B

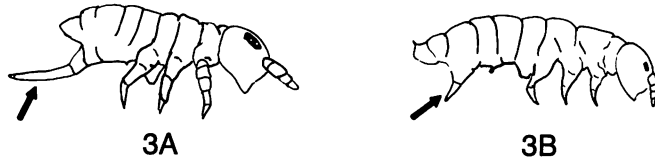


1C

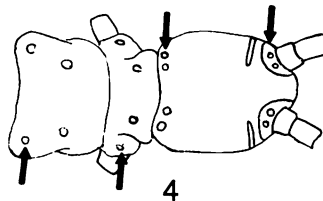
- 2(1). First thoracic segment dorsally distinct and with dorsal setae (Fig. 2A)(section Poduromorpha)..... 3
 First thoracic segment without dorsal setae and frequently not visible dorsally (Fig. 2B)(section Entomobryomorpha)..... 5



- 3(2). Dentes more than 3 times as long as manubrium, with distal rings of granules (Fig. 3A)..... Poduridae (not found in Hawaii)
 Dentes absent or relatively shorter and not ringed (Fig. 3B)..... 4



- 4(3). Pseudocelli present, at least on antennal base (Fig. 4) or dorsum of fifth abdominal segment..... Onychiuridae
 Pseudocelli absent..... Hypogastruridae

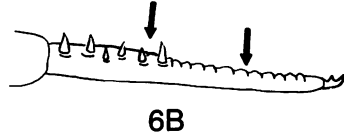
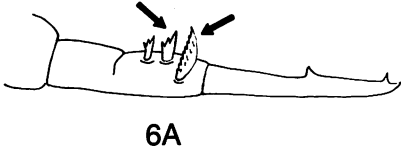


- 5(2). Mucro hairy (Fig. 5A); fourth antennal segment shorter than third; body scaled (first-instar juveniles of at least some species of *Tomocerus* lack all these characters and will run to Isotomidae)..... Entomobryidae (subfamily Tomocerinae)
 Mucro with at most 1-2 setae (Fig. 5B); fourth antennal segment at least as long as third; scales present or absent..... 6

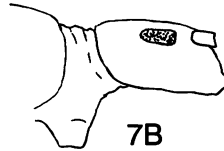
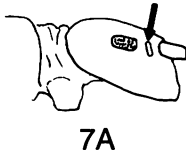


- 6(5). Dentes with dentate spines (Fig. 6A); mucro subequal in length to dens or longer Entomobryidae (subfamily Oncopodurinae)

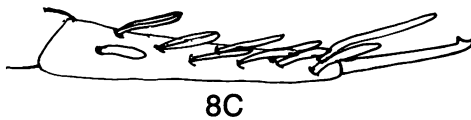
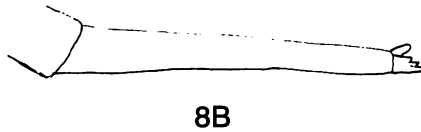
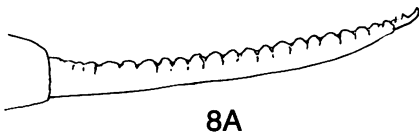
Dental spines simple (rarely) (Fig. 6B) or absent; mucro usually much shorter than dens. 7



7(6). Postantennal organ present (Fig. 7A), or absent and setae at most unilaterally ciliate. Isotomidae
 Postantennal organ absent (Fig. 7B); some setae multilaterally ciliate. 8



8(7). Dens dorsally crenulate and curving upward, basally in line with manubrium (Fig. 8A). Entomobryidae (subfamily Entomobryinae)
 Dens not crenulate, straight and usually forming a basal angle with manubrium (Fig. 8B,C). 9



9(8). Eyes and pigment absent; dens with large dorsal scales and without apical lobe (Fig. 8C). Entomobryidae (subfamily Cyphoderinae)
 Eyes and pigment present; dens without dorsal scales and with apical lobe (Fig. 8B). Entomobryidae (subfamily Paronellinae)
 10(1). Antenna shorter than head; eyes absent. Neelidae
 Antenna longer than head, or at least 1 + 1 eyes (sometimes unpigmented). Sminthuridae

Suborder ARTHROPLEONA

Linear Collembola, with distinct trunk segmentation indicated at least by chaetotaxy and usually by distinct segmental limits. This suborder includes the majority of species of Collembola.

Section PODUROMORPHA

Linear Collembola with the pronotum developed and setaceous; no other characters reliably distinguish all members from Entomobryomorpha, but all species with the furcula short or absent and the postantennal organ lobed or absent belong here. The family Poduridae, with the single holarctic species *Podura aquatica*, is so far unknown in Hawaii.

Family HYPOGASTRURIDAE

This is a diverse group as recognized here, best recognized by the absence of true pseudocelli and the simplicity of the sense organ of the third antennal segment. All Hawaiian poduromorphs with a furcula, or pigment, or eyes, or without a postantennal organ belong here. Two subfamilies are recognized here, for convenience (the actual relationships among the genera are more complex).

KEY TO SUBFAMILIES OF HYPOGASTRURIDAE

Mandible with a basal molar plate (Fig. 9A)..... Hypogastrurinae
Mandible without a molar plate (Fig. 9B) or absent..... Neanurinae



Subfamily HYPOGASTRURINAE

The mandibular molar plate is easily seen in cleared specimens and will distinguish the few Hawaiian species from Neanurinae.

Table 1. Characteristics of Hawaiian Genera of Hypogastrurinae

GENUS	EYES PER SIDE	POSTANTENNAL ORGAN LOBES*	UNGUICULUS	CLAVATE TENENT		TENACULAR TEETH	BODY PIGMENT*
				HAIRS	FURCULA		
<i>Hypogastrura</i>	8	(4)-(6)	+,-	0-1	+	3-4	+(-)
<i>Willemia</i>	0	7-8	+	-	-	-	-
<i>Xenylla</i>	4-5	-	-	1-2	-,+	2-3	+

*Parentheses represent exceptional conditions.

KEY TO GENERA OF HYPOGASTRURINAE

1. Postantennal organ absent. **Xenylla**
 Postantennal organ present. 2
 2(1). Eyes present. **Hypogastrura**
 Eyes absent. **Willemia**

Genus **HYPOGASTRURA** Bourlet, 1839

Type species: *Achorutes viaticus* Tullberg, 1872

This genus includes all Hawaiian species of poduroids with a molar plate on the mandible and 8 + 8 eyes. The genus is comparatively poorly represented in Hawaii. The three species belong to three different subgenera; two are endemic, and the third is probably the same as a nearctic species: *Hypogastrura* (*Schoettella*) *alba*, *H. (Hypogastrura) pahiku*, and *H. (Ceratoophysella) boletivora*.

KEY TO HAWAIIAN SPECIES OF HYPOGASTRURA S.L.

1. Anal spines much longer than hind unguis. **H. (C.) boletivora**
 Anal spines shorter than hind unguis or absent. 2
 2(1). Anal spines and unguiculus absent. **H. (S.) alba**
 Anal spines and unguiculus well developed. **H. (H.) pahiku**

Subgenus **HYPOGASTRURA** s.str.

This, the largest subgenus, is quite diverse in characters, but may be distinguished from *Schoettella* by the presence of the unguiculus and from *Ceratoophysella* by the sensory seta of the second thoracic segment, at p_4 , and the simpler form of the mucro.

Hypogastrura (Hypogastrura) pahiku Christiansen and Bellinger, **new species** (Plate 1)

Color bluish purple to brownish purple; pigment in small densely packed specks 0.0017–0.0024 mm in diameter with a number of large pale spots, or more uniformly distributed large granules 0.0025–0.0034 mm in diameter that are more loosely packed, with scattered fine granules. Fourth antennal segment with prominent apical bulb, unlobed but usually apically indented and slightly to clearly displaced from apex, and 8 clearly differentiated blunt setae. Apical organ of third antennal segment with 2 small, ovoid knobs and 2 larger lateral sense pegs. First antennal segment with 8 setae. Head a rounded hexagon in dorsal view. Labrum without prominent projections. Postantennal organ with 5 (rarely 4 or 6) lobes in an ellipse, 1.5–2 times as long as diameter of nearest eye. Eyes subequal. One weakly clavate tenent hair, longer than unguis, per foot. Unguis with small lateral

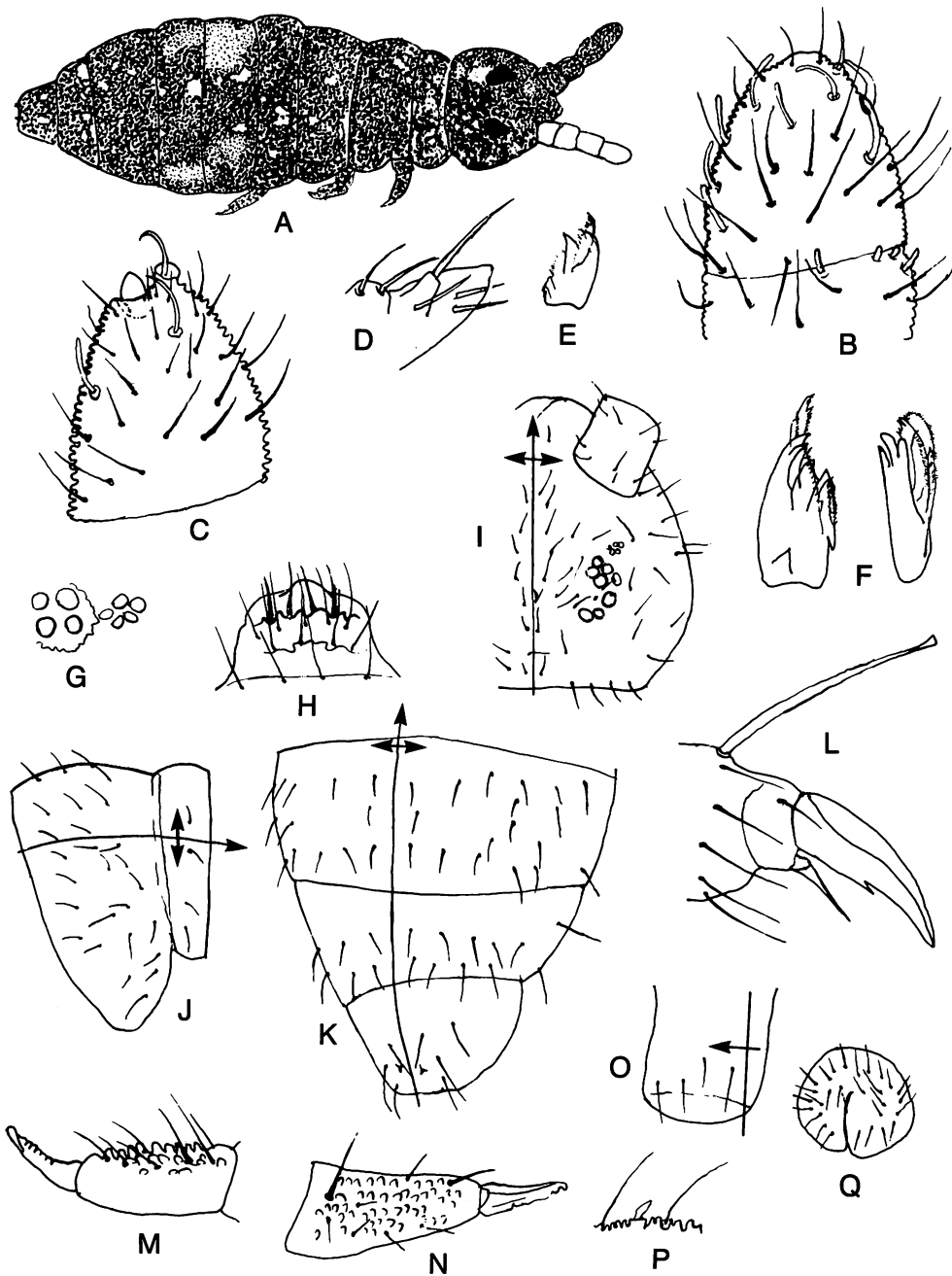
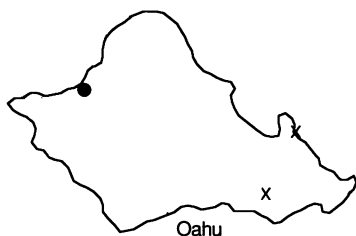


Plate 1—*Hypogastrura (Hypogastrura) pahiku*: A, habitus (5136, Hawaii); B, dorsal surface of fourth antennal segment and apex of third (holotype); C, ventral surface, fourth antennal segment (same); D, maxillary palp (5136, Hawaii); E, maxilla (paratype); F, right and left maxillae (5136, Hawaii); G, postantennal organ and near eyes (paratype); H, labrum and prelabral setae (paratype); I, cephalic chaetotaxy, right side (paratype); J, same, first and second thoracic segments; K, dorsal chaetotaxy, fourth to sixth abdominal segments (same); L, hind foot complex (paratype); M, mucro and dens, seen from side (5136, Hawaii); N, mucro and dens seen from above (paratype); O, ventral tube, seen from side (5136, Hawaii); P, anal spines (paratypes); Q, male genital plate (5136, Hawaii).



Hawaii 2

and inner teeth. Unguiculus gradually tapering, without clear basal lamella. Ventral tube with 4 + 4 setae. Tenaculum with 4 + 4 teeth. Dens with 7 dorsal setae, the longest about twice the length of the shortest, and prominent dorsal tubercles. Mucro with a dorsal notched lamella; ventral margin curved in lateral view. Anal spines 0.1–0.25 as long as inner edge of hind unguis and usually on papillae about as long as spines. Sensory setae of thorax not clearly distinguished. Fourth abdominal segment with seta m_2 absent but m_3 present. Fifth abdominal segment with only 2 rows of setae. Maximum length 1.5 mm.

Remarks: This species is a member of the “*manubrialis*” group. It most closely resembles the nearctic *H. essa* Christiansen and Bellinger, but differs in having a relatively larger postantennal organ, a differently shaped mucro, 7 rather than 6 dental setae, and the dental tubercles. Some specimens completely lack papillae for the anal spines.

Derivatio nominis: Hawaiian, seven.

Ecology: Found in the marine littoral and in grass roots and litter in open areas.

Type locality: Holotype and 3 paratypes, Oahu, Hawaii Kai, XI-14-1965, on surface of puddles, Arakiki (4764).

Additional records: Hawaii: 5110, 5136. Oahu: 4812, 4813, 5123, 5267.

Subgenus **CERATOPHYSELLA** Börner, 1932

Type species: *Podura armata* Nicolet, 1842

This subgenus is characterized by the “spoon-shaped” mucro, elongate lobes of the postantennal organ, lamellate unguiculus, and “sensory” seta of thoracic segment 2 at p_3 . A useful feature for distinguishing species in this group is the number of integumentary granules between the large median setae of the posterior row on abdominal segment 5 (Yosii “a” measure) and the number between these setae and the posterior margin of the tergite (“b” measure). The subgenus is large and diverse in most regions, but only one species has been found in Hawaii so far.

Hypogastrura (Ceratophysella) boletivora (Packard, 1873) (Plate 2)

Rep. Peabody Acad. Sci. 5:30 (*Achorutes*).—Christiansen and Bellinger, 1980.

Color brown to brownish purple; pigment uniform or mottled with small pale spots. Fourth antennal segment with apical bulb indented or bilobed and laterally displaced, blunt setae thick and prominent, and ventral “file” of 15–18 moderately

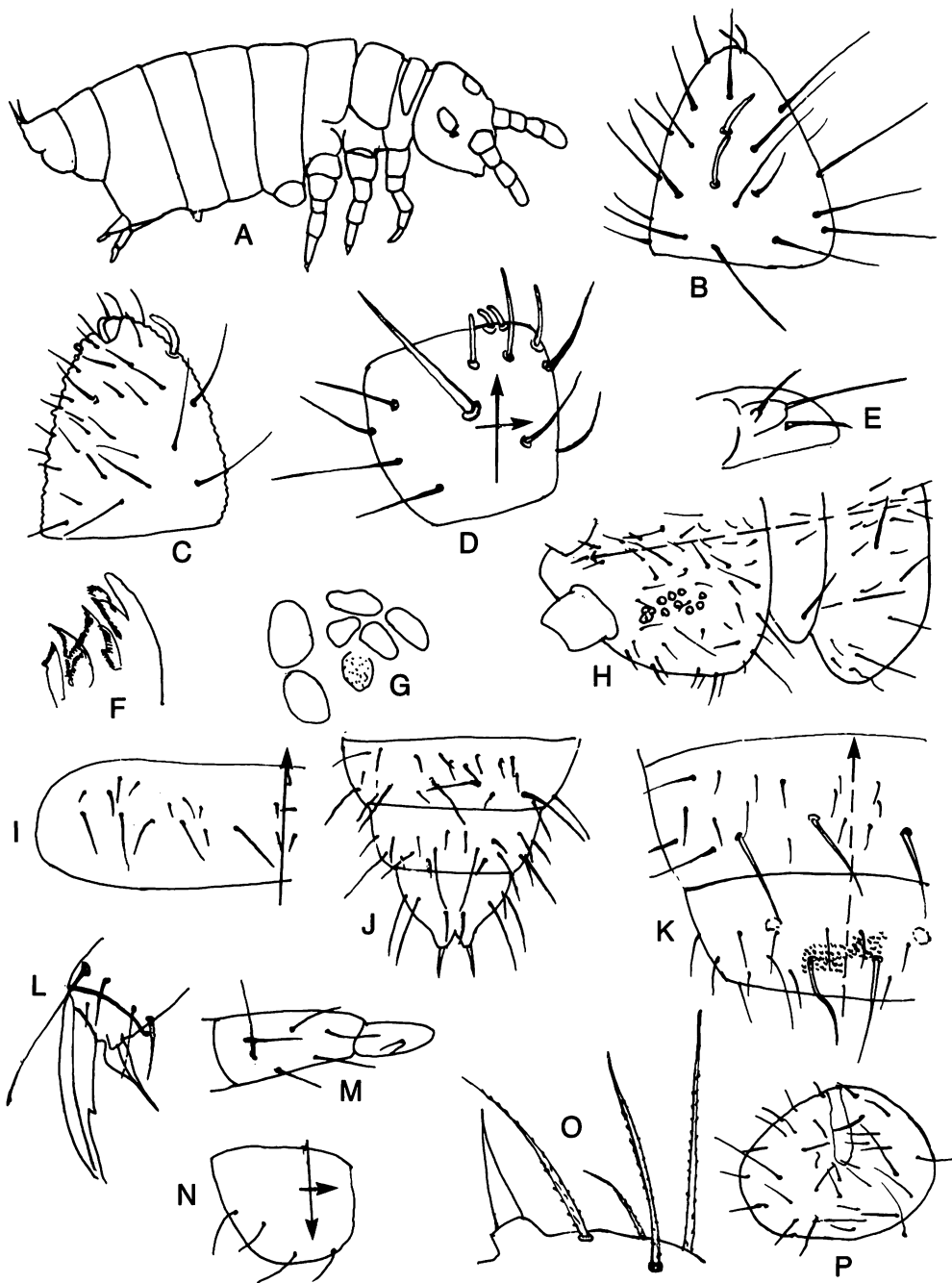
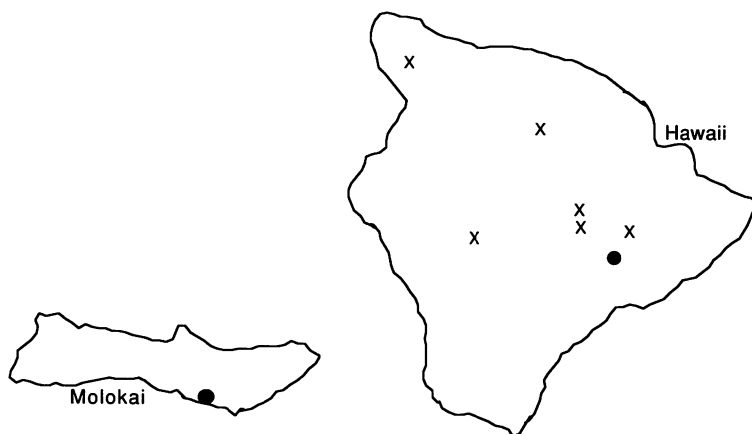


Plate 2—*Hypogastrura (Ceratoophysella) boletivora* (all figures of specimens from Hawaii): A, habitus (6819); B, dorsal surface, fourth antennal segment (4904); C, ventral surface, fourth antennal segment (same); D, dorsal surface, third antennal segment (6912); E, maxillary palp (4904); F, exploded maxilla (5119); G, postantennal organ and nearest eye, left side (4904); H, chaetotaxy, head and first two thoracic segments, left side (5119); I, same, first abdominal segment; J, chaetotaxy, last three abdominal segments (4869); K, chaetotaxy, left side, fourth and fifth abdominal segments (4904); L, hind foot complex (4725); M, mucro and dens (same); N, ventral tube seen from side (6819); O, anal spine and neighboring setae (4725); P, male genital plate (6819).



short, weakly clavate setae. Postantennal organ 2.0–2.5 times as long as diameter of nearest eye, with posterior lobes slightly to distinctly shorter than anterior lobes. Tenent hair slightly shorter than outer edge of unguis and weakly clavate. Unguis with a strong inner tooth at or just beyond middle of inner edge. Unguiculus 0.45–0.55 times length of inner edge of unguis. Dens with 7 dorsal setae not strongly angulate or basally thickened. Mucro lacking basal spinelike fold, 0.4–0.55 times length of dens. Anal spines 1.25–2 times length of inner edge of hind unguis. Fourth abdominal segment with p_1 much shorter than p_2 . Yosii “a” measure 16–18, “b” measure 4. Maximum length 1.8 mm.

Remarks: We originally regarded this as a distinct, endemic species; however, further study has shown complete overlap with mainland *H. boletivora*. The tenent hair is very weakly clavate, so that the minute expansion can only be seen under the highest magnification. This condition is also found in some nearctic specimens.

Ecology: Found in heavy forest, in litter, and on understory vegetation, at middle elevations (3000–5000 ft.). In some areas where it occurs, it is both ubiquitous and abundant.

Records: Hawaii: 4725, 4869, 4904, 5114, 5119, 5469, 6819, 6839, 6911, 6912. Molokai: 5717, 5720, 5721, 5725, 5727.

Subgenus **SCHOETTELLA** Schäffer, 1896

Type species: *Achorutes ununguiculatus* Tullberg, 1869

Hypogastrura (Schoettella) alba (Folsom, 1932), **new combination** (Plate 3)
Proc. Hawaii. Entomol. Soc. 8:54 (*Schoettella*).

“White. Eyes 8 + 8, remote from antennae, unpigmented. Postantennal organ with five subequal lobes, forming a rosette. Antennae shorter than the head, with several olfactory setae. Unguis untoothed. Unguiculus absent. Tenent hairs absent. Dens with 3 dorsal setae. Mucro about one-third as long as dens, stout, in

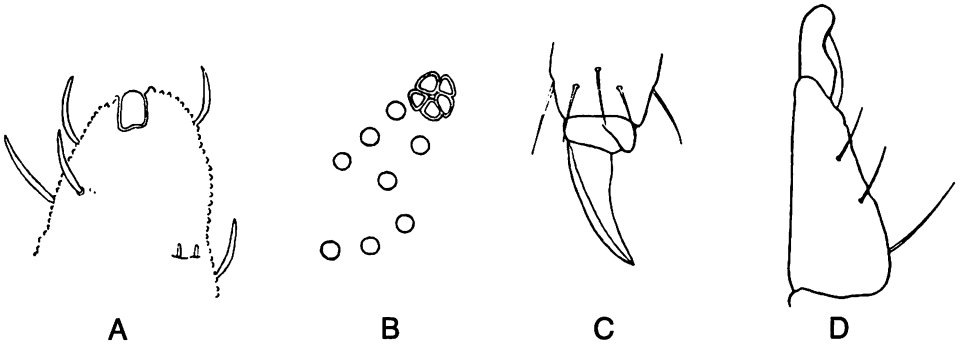


Plate 3—*Hypogastrura (Schoettella) alba* (all figures after Folsom): A, apex of antenna; B, eyes and postantennal organ; C, hind foot complex; D, mucro and dens.

lateral aspect rounded apically, with broad rounding inner lamella. Anal spines absent. Clothing of very few short stiff setae, in two transverse rows on most of the body segments. Integument tuberculate. Length, 0.8 mm.”

Remarks: We have been unable to locate the type specimens of this species and have seen no others; we therefore can do no better than to quote Folsom’s description. The description is difficult to accept. Much of it fits certain species of *Willemia* we have seen, but the eyes and mucro do not. Specimens with the characters given here should be easily recognized. However, it is possible that Folsom confused several species and gave a composite description, as is certainly true of his “*Denisia falcata*.”

Type locality: Oahu, Honolulu, X-8-1927, pineapple roots, Illingworth.
No other records.

Genus **XENYLLA** Tullberg, 1869

Type species: *X. maritima* Tullberg, 1869

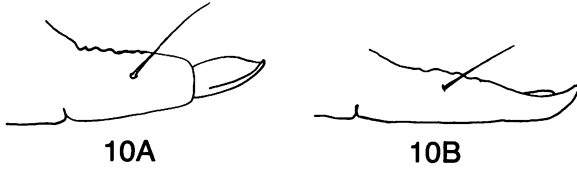
This genus is easily distinguished from other poduroid Collembola in the Islands by the combination of a well-developed mandibular molar plate and absence of the postantennal organ. Hawaiian species have the unguiculus completely absent and 4 + 4 smooth setae on the ventral tube.

We have seen eight species, but two of these (species A and B) are represented so far by single specimens; these are included in the table and key but are not named or described. The Hawaiian species of *Xenylla* are sp. A, *alba*, *auka*, sp. B, *grisea*, *hawaiiensis*, *yucatanana*, and *welchi*.

KEY TO HAWAIIAN SPECIES OF **XENYLLA**

- 1. Eyes 4 + 4..... **yucatanana**
- Eyes 5 + 5..... 2

- 2(1). Mucro fused to dens (Fig. 10B)..... 3
 Mucro distinctly separated from dens (Fig. 10A)..... 4



- 3(2). Mucrodens with a single seta..... 7
 Mucrodens with 2 setae..... **grisea**
 4(2). Color white; anterior 3 eyes far from posterior 2 (Fig. 11A)..... **alba**
 Color gray to blue; anterior 3 eyes near posterior 2 (Fig. 11B)..... 5



- 5(4). Without anal spines (Fig. 12A)..... **sp. A**
 With anal spines (Fig. 12B)..... 6



- 6(5). Mucronal lamella large and running most of length of mucro (Fig. 13A); mucro over half as long as dens..... **welchi**
 Mucronal lamella absent or small and ending well before apex of mucro (Fig. 13B); mucro less than 1/3 as long as dens..... **hawaiiensis**



- 7(3). Tenaculum with 2 + 2 teeth..... **auka**
 Tenaculum with 3 + 3 teeth..... **sp. B**

Table 2. Characteristics of Hawaiian Species of *Xenylla*

SPECIES	COLOR	FOURTH ANTENNAL SEGMENT BLUNT SETAE	EYES	DENTAL SETAE	CHAETOTAXY										REMARKS			
					DORSUM					VENTER								
					HEAD			TH. II-III			ABD. V	HEAD				TH. II-III		ABD. IV
					a ₀	p ₁	p ₂	la ₁	la ₂	m ₃	a ₂	p ₁	m ₃			m ₁		
<i>alba</i>	white	3	5	2	+?	+	+?	+	+	?	?	+	+	-	?	2 tenacular teeth		
<i>auka</i>	dark-medium gray-blue	4	5	1	+	-	+	-	+	+	-	+	+	-	+			
<i>grisea</i>	gray-dark blue	4	5	2	+	-	+	-	+	-	-	+	+	+	-			
<i>hawaiiensis</i>	blue	4	5	2	-	-	+	+	+	+	-	+	+	-	+			
<i>welchi</i>	pale violet-mottled gray	4(3)	5	2	+	+	+	+	+	+	+	+	+	-	+			
<i>yucatanana</i>	blue	4	4	2	+	+	+	-	+	+	+	+	+	+	+	No anal spines		
sp. A	pale gray	4?	5	2	-	-	+	-	+	+	-	-	-	-	-			
sp. B	?	4	5	1	+	-	+	-	+	+	-	+	+	-	-			

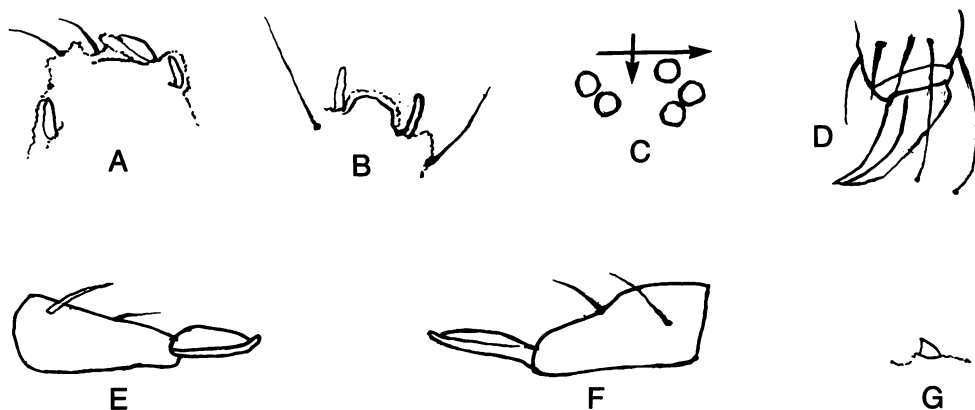


Plate 4—*Xenylla alba* (all figures after Folsom): A, apex of antenna; B, apical organ, third antennal segment; C, eyes; D, hind foot complex; E and F, dentes and mucrones; G, anal spine.

Xenylla alba Folsom, 1932 (Plate 4)

Proc. Hawaii. Entomol. Soc. 8:54.

Color white with 5 + 5 dark eyes on pale eyepatches. Fourth antennal segment with 3 blunt setae, about twice as thick as acuminate setae; apical bulb strongly displaced and deeply withdrawn into antenna. Anterior 3 eyes close together and far from the posterior two. Two weakly clavate tenent hairs per foot, 1.2–1.4 times as long as inner edge of unguis. Mucro distinctly separate from dens with a clear lamella running most of its length and 0.5 to 0.75 as long as dens. Anal spines minute, without papillae. Body setae all smooth. Integumentary granules coarse, conical, 0.002–0.003 mm in diameter. Maximum length 1 mm.

Remarks: We have seen only one poor type specimen. Few structures can be read on this and thus our description and figures are largely after Folsom. The species has not been seen since the type collection; however, the lack of body pigment should make it easy to recognize.

Type locality: Oahu, Honolulu, X-8-1927, pineapple.

Xenylla auka Christiansen and Bellinger, **new species** (Plate 5)

Color medium to dark blue with pigment irregularly mottled. Fourth antennal segment with apical bulb deeply withdrawn into segment and only slightly displaced; four short blunt setae about twice as thick as longest acuminate setae; subapical sense peg spherical. Maxillary palp with one sublobal hair. Eyes subequal, with posterior two closer together than others. Feet each with two long weakly clavate tenent hairs and an untoothed unguis. Mucro fused to dens, which bears 1 seta (rarely none), the whole structure about $\frac{2}{3}$ as long as inner unguis and quite variable in form. Tenaculum with 2 + 2 teeth and no setae. Anal spines short, heavy, and curved, and $\frac{1}{6}$ – $\frac{1}{4}$ as long as inner unguis. All abdominal setae smooth

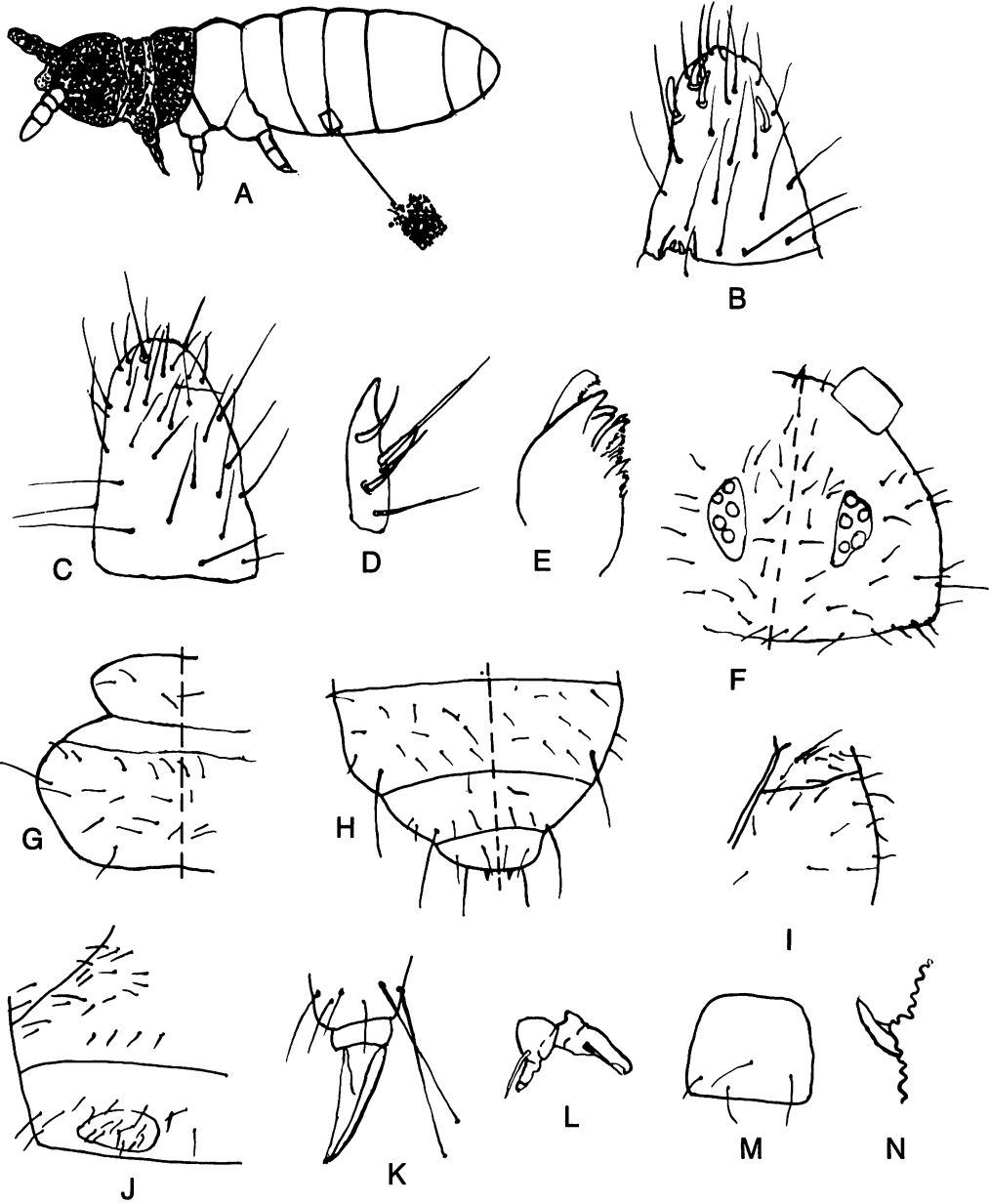


Plate 5—*Xenylla auka* (all figures of type specimens): A, habitus; B, dorsal surface of fourth antennal segment and apical organ of third; C, ventral surface, fourth antennal segment; D, maxillary palps, right and left side; E, maxilla; F, dorsal cephalic chaetotaxy and eye; G, dorsal chaetotaxy, first two thoracic segments, left side; H, dorsal chaetotaxy, last three abdominal segments; I, ventral cephalic chaetotaxy; J, ventral abdominal chaetotaxy, right side, fourth and fifth abdominal segments; K, hind foot complex; L, mucrones and dentes of different specimens; M, ventral tube; N, anal spine.

and acuminate. Integumentary granules 0.0008–0.0016 mm in diameter. Maximum length 1.5 mm.

Remarks: The presence of two tenacular teeth separates this from all other Hawaiian forms. The single specimen of sp. B from Kauai (5308) is similar in most respects, but has three tenacular teeth and a number of differences in chaetotaxy.

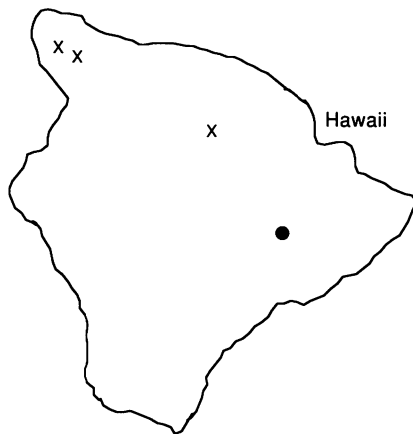
Derivatio nominis: Hawaiian, inland (also weary).

Type locality: Holotype and 7 paratypes, Hawaii, Mauna Kea, Upper Wailuku Road, XI-15-1971, 2800 m, under silverswords, Gressitt (6844).

Xenylla grisea Axelson, 1900 (Plate 6)

Medd. Soc. Fauna Flora Fenn. 26:108.—Gama, 1969.—Christiansen and Bellinger, 1980.

Color grayish blue to dark blue, paler ventrally. Fourth antennal segment with apical bulb displaced laterally and partly to completely withdrawn; blunt setae about twice as thick as other large setae. Subapical sense peg minute and rodlike. Maxillary palp with 1 sublobal hair. Eyes closely grouped, on a clear dark eyepatch. Two weakly clavate tenent hairs per foot, each 1.25–1.5 times length of inner edge of unguis. Unguis with very small inner tooth. Mucro fused to dens, with a small rounded lamella; mucrodens 0.9–2.5 times length of inner edge of hind unguis. Anal spines stout, slightly curved, $\frac{1}{4}$ – $\frac{2}{3}$ as long as inner edge of unguis. Setae acuminate; most posterior curved setae sparsely and weakly serrate. Integumentary granules 0.0006–0.0014 mm in diameter. Maximum length 0.8 mm.



Remarks: The material we have seen from Hawaii may well represent a group of species. The variation in dental structure is very great. The samples are mostly of single specimens, sometimes taken with other species.

Ecology: Found in dense, matted grass, under rotten wood, and under silverswords.

Records: Hawaii: 4857, 4861, 4887, 5137, 5667, 6844.

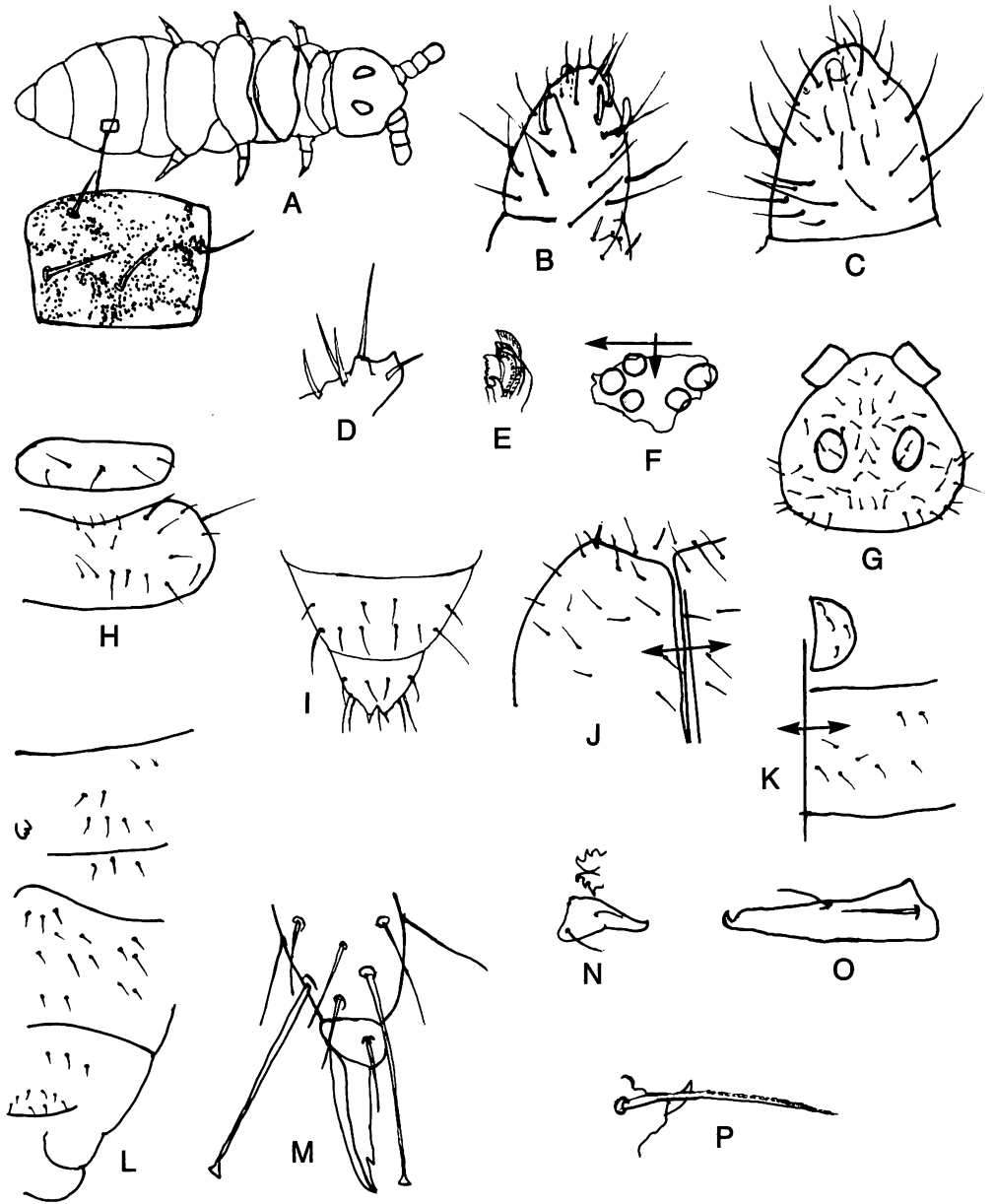
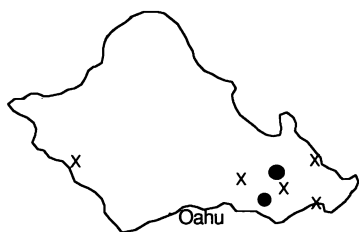


Plate 6—*Xenylla grisea*: A, habitus (4887, Hawaii); B, dorsal surface, fourth antennal segment and apical organ of third (after Gisin); C, ventral surface, fourth antennal segment (5667, Hawaii); D, maxillary palp (4857, Hawaii); E, maxilla (5667, Hawaii); F, left eyepatch (5667, Hawaii); G, cephalic chaetotaxy (after Gama); H, thoracic dorsal chaetotaxy, right side (5667, Hawaii); I, dorsal chaetotaxy, last two abdominal segments (after Gama); J, ventral cephalic chaetotaxy, right side (5667, Hawaii); K, ventral chaetotaxy, left side, first two abdominal segments (after Gama); L, same, third to fifth abdominal segments; M, hind foot complex (4857, Hawaii); N, mucro and dens (4857, Hawaii); O, same (5667, Hawaii); P, anal spine and associated seta (same).

Xenylla hawaiiensis Gama, 1969 (Plate 7)

Mem. Estud. Mus. Zool. Univ. Coimbra 308:48.

Color blue to pale blue-gray or pale purplish blue, paler ventrally. Apical antennal bulb displaced from apex and usually projecting; blunt setae of fourth antennal segment about $1\frac{1}{2}$ times as thick as base of longest pointed setae, subapical sense peg minute cylindrical. Maxillary palp with 1 sublobal hair. Posterior 2 eyes slightly separated from anterior 3; all eyes on clear pigmented but irregular eye-patches. Two weakly clavate tenent hairs per foot, 1.4–1.6 times length of inner edge of unguis. Unguis with a clear inner tooth. Mucro clearly separated from dens, with an apical hook and usually with a small basal lamella; mucro 0.21–0.25 times as long as dens and about $\frac{1}{2}$ as long as inner edge of unguis. Anal spines $\frac{1}{8}$ – $\frac{1}{5}$ as long as inner edge of unguis. Posterior setae sparsely serrate, and longest posterior setae blunt. Integumentary granules 0.0008–0.0021 mm in diameter. Maximum length 0.98 mm.



Kauai 3
Hawaii 1

Remarks: The Oahu and Hawaii specimens we have seen agree perfectly with Gama's description; however, the specimens from Kauai have a very different mucro (see Plate 7K,L) and sometimes have setal bases on the venter of the thorax although setae are never present. They may represent a different species.

Ecology: Found in litter in disturbed areas.

Type locality: Oahu, Mt. Tantalus, XI-8-1966, 1000 ft., acacia and cereus, pan trap, Vockeroth (4828).

Additional records: Hawaii: 5643. Oahu: 4783, 4790, 4793, 4808, 4809, 4818, 4820, 4822, 4825, 4827, 4829, 4839. Kauai: 5278, 5282, 5285.

Xenylla welchi Folsom, 1916 (Plate 8)

Proc. U.S. Natl. Mus. 50:497.—Gama, 1969.—Christiansen and Bellinger, 1980.

Xenylla sensilis Folsom, 1932, Proc. Hawaii. Entomol. Soc. 8:54. **New synonym.**

Color pale grayish blue, blue, or purplish blue, paler ventrally. Apical bulb of fourth antennal segment deeply withdrawn and slightly displaced laterally; blunt setae about twice as thick as base of longest acuminate setae; subapical sense peg minute and rodlike. Maxillary palp with 2 sublobal hairs. Eyes on a well-marked patch; posterior 2 slightly separated from anterior 3. Tenent hairs 1-2-2, clavate, about $1\frac{1}{2}$ times as long as inner edge of unguis. Unguis with clear inner tooth. Mucro clearly separated from dens, with a broad lamella from base to apex; mucro

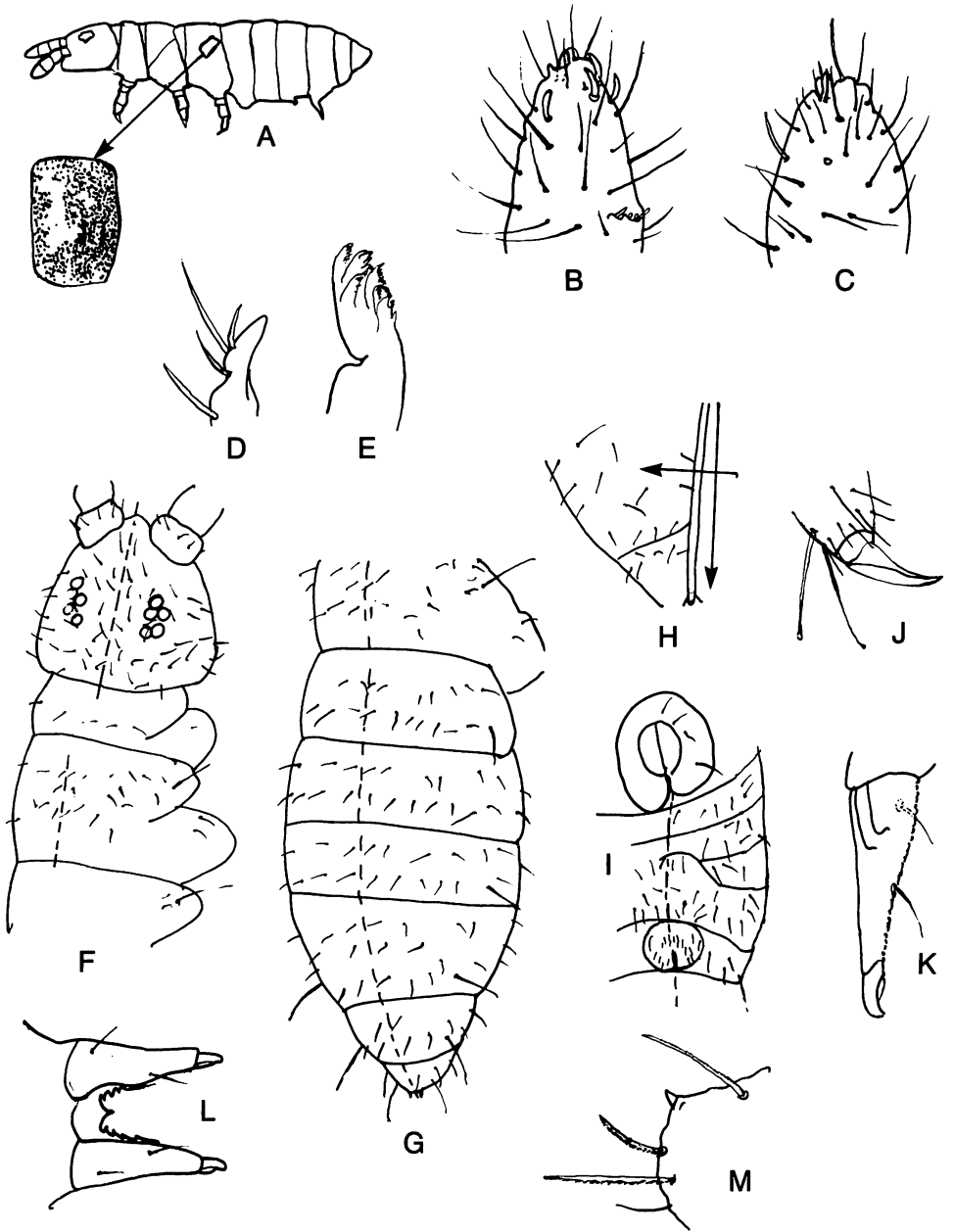


Plate 7—*Xenylla hawaiiensis*: A, habitus (5643, Hawaii); B, dorsal surface, fourth antennal segment and apex of third (4829, Oahu); C, ventral surface, fourth antennal segment (same); D, maxillary palp (same); E, maxilla (same); F, dorsal chaetotaxy and eyes, head, and first two thoracic segments (5278, Kauai); G, dorsal chaetotaxy, abdomen (5278, Kauai); H, ventral cephalic chaetotaxy, left side (4829, Oahu); I, ventral abdominal chaetotaxy, left side, first through fourth abdominal segments (5643, Hawaii); J, hind foot complex (4829, Oahu); K, mucro and dens (after Gama); L, mucrones and dentes (5285, Kauai); M, anal spine and neighboring setae (5643, Hawaii).

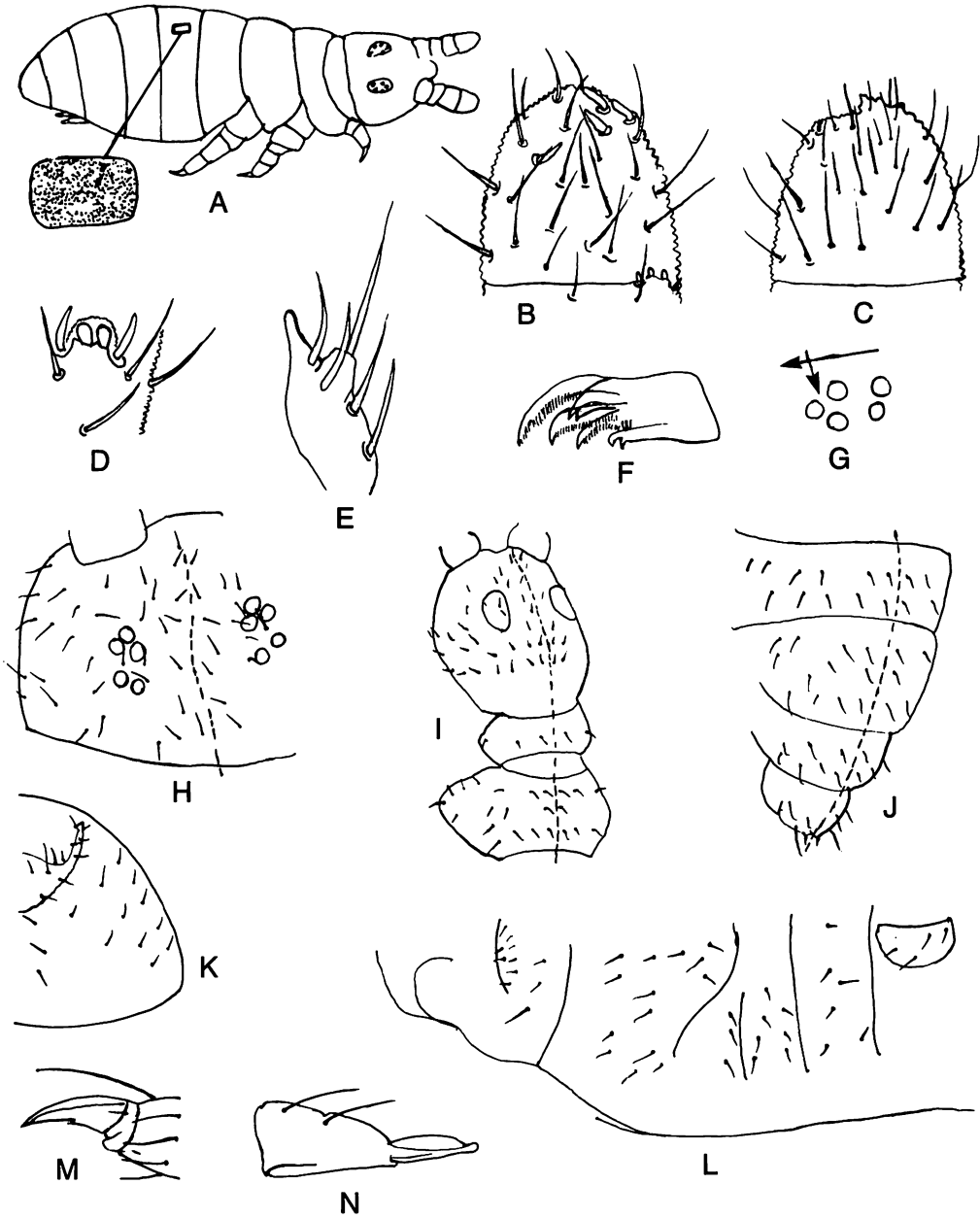
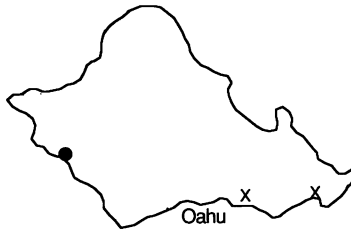


Plate 8—*Xenylla welchi*: A, habitus (4822, Oahu); B, dorsal surface of fourth antennal segment and apical organ of third (4808, Oahu); C, ventral surface of fourth antennal segment (same); D, apical organ, third antennal segment (after Folsom); E, maxillary palp (4808, Oahu); F, maxilla (same); G, eyes (after Folsom); H, cephalic dorsal chaetotaxy (type specimen of *sensilis*); I, dorsal chaetotaxy, first two thoracic segments (after Gama); J, same, last four abdominal segments; K, ventral cephalic chaetotaxy, same; L, same, left side, abdominal segments; M, hind foot complex (after Folsom); N, mucro and dens (same).



0.6–0.7 as long as dens and about as long as inner edge of unguis. Anal spines stout, $\frac{1}{6}$ as long as inner edge of unguis or shorter. Body setae unusually short, smooth and acuminate. Integumentary granules 0.001–0.002 mm in diameter. Maximum length 1.0 mm.

Remarks: We have examined the types of *X. sensilis* and are unable to find any differences between them and *X. welchi*.

Ecology: So far found only in litter in disturbed areas.

Records: Oahu: 4768, 4808, 4822; Honolulu, X-1928.

***Xenylla yucatanana* Mills, 1938 (Plate 9)**

Carnegie Inst. Washington Publ. 491:183.—Gama, 1969.—André, 1988.

Color blue, paler ventrally. Fourth antennal segment with apical bulb laterally displaced and deeply withdrawn; blunt setae about twice as thick as others; subapical sense peg rodlike and minute. Maxillary palp with 3 sublobal hairs. Eyes 4 per side, with anterior 2 clearly separated from posterior 2, all on a single clearly marked dark eye patch. Two weakly clavate tenent hairs per foot, 1.4–1.6 times as long as inner edge of unguis. Unguis with a minute inner tooth. Mucro distinctly separated from dens, with a strong lamella ending well before apex; mucro 0.4–0.5 times length of dens and 0.55–0.65 times length of inner edge of unguis. Anal spines curved, $\frac{1}{9}$ – $\frac{1}{6}$ as long as inner edge of unguis and half as long as supporting papillae. Body setae acuminate; some of the posterior short curved setae sparsely serrate. Integumentary granules coarse and conical, 0.0015–0.0020 mm in diameter. Maximum length 1.0 mm.

Remarks: This striking species is easily distinguished from other Hawaiian species by its eye number. In most respects it resembles *X. welchi*. The species seems to be widespread in the tropics; but the redescription by André (1988) makes the identity of *X. yucatanana* auct. and the Hawaiian record uncertain.

Ecology: Found in litter in orchard.

Record: Kauai: 5288.

Genus **WILLEMIA** Börner, 1901

Type species: *W. anophthalma* Börner, 1901

This genus is characterized by well-developed postantennal organs and mandibles with molar plate and apical teeth, combined with the absence of pigment,

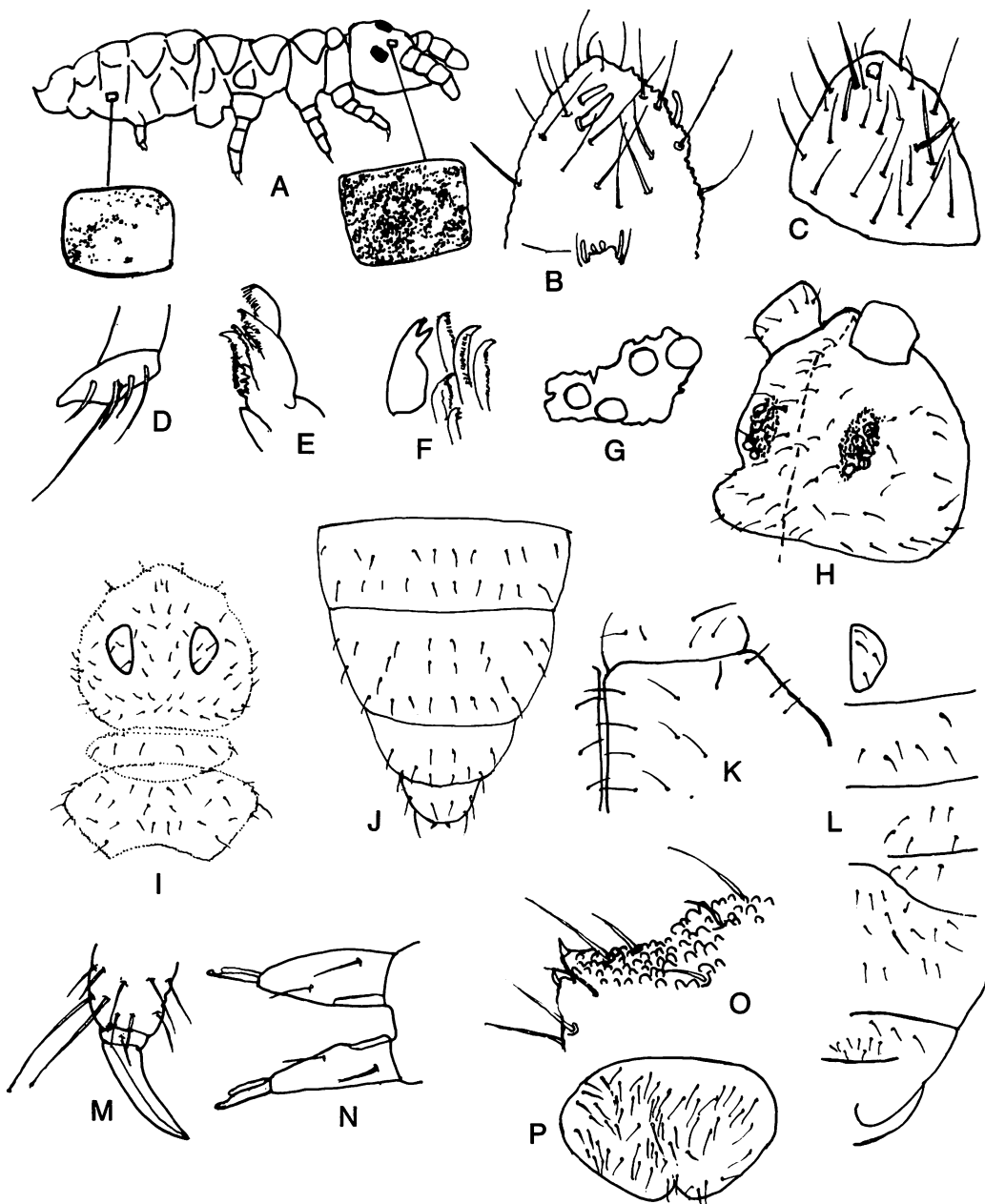


Plate 9—*Xenylla yucatana*: A, habitus (5288, Kauai); B, dorsal surface, fourth antennal segment and apex of third (same); C, ventral surface, fourth antennal segment (same); D, maxillary palp (same); E, maxilla (same); F, maxilla with some blades separated (same); G, left eyepatch (same); H, dorsal cephalic chaetotaxy and eyes (same); I, dorsal chaetotaxy, head and first two thoracic segments (after Gama); J, same, last four abdominal segments; K, ventral cephalic chaetotaxy, left side (5288, Kauai); L, ventral abdominal chaetotaxy, left side (after Gama); M, hind foot complex (5288, Kauai); N, mucrones and dentes (same); O, anal spines and neighboring setae (same); P, male genital plate (same).

eyes, and furcula. There is only one species known in Hawaii, and it is the only eyeless hypogastrurine there.

Willemia peke Christiansen and Bellinger, **new species** (Plate 10)

Fourth antennal segment with 2 large, subapical, conical to subspherical sense pegs and a strikingly smaller ovoid apical peg. Apical sense organ of third antennal segment with 1 erect ovoid peg and 1 curved cylindrical peg pointing away from the first. Postantennal organ of 7-8 lobes, closely packed together in a depression. Tenent hair acuminate. Unguiculus with filamentous apex, $\frac{1}{4}$ - $\frac{1}{3}$ as long as inner edge of unguis. Ventral tube with 4 + 4 setae. Anal spines strong, curved, and about as long as inner edge of unguis. Maximum length 0.8 mm.

Remarks: This species is quite well marked. The conical sense pegs on the fourth antennal segment are clear in all specimens except one. *W. peke* is similar to *W. persimilis bulbosa* Bonet, 1945 in some respects, but differs in details of the fourth antennal segment sense organs, the better developed unguiculus, and the relatively longer anal spines.

Derivatio nominis: Hawaiian, dwarf.

Ecology: So far known only from soil in sugarcane fields, under grass.

Type locality: Holotype and 1 paratype, Oahu, Weed Circle, near Waialua, X-28-1966, soil under grass, PB (4812).

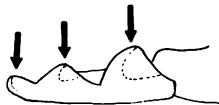
Additional record: Oahu: 4813.

Subfamily NEANURINAE

This group of genera may be recognized by the absence of the mandibular molar plate and sometimes of the mandible itself. It is composite, including probably three or more lines with independently reduced mouthparts that are diverse in other respects.

KEY TO GENERA OF NEANURINAE

1. Mucro trilamellate (Fig. 14). **Odontella**
 Mucro not trilamellate; frequently reduced or absent. 2



14

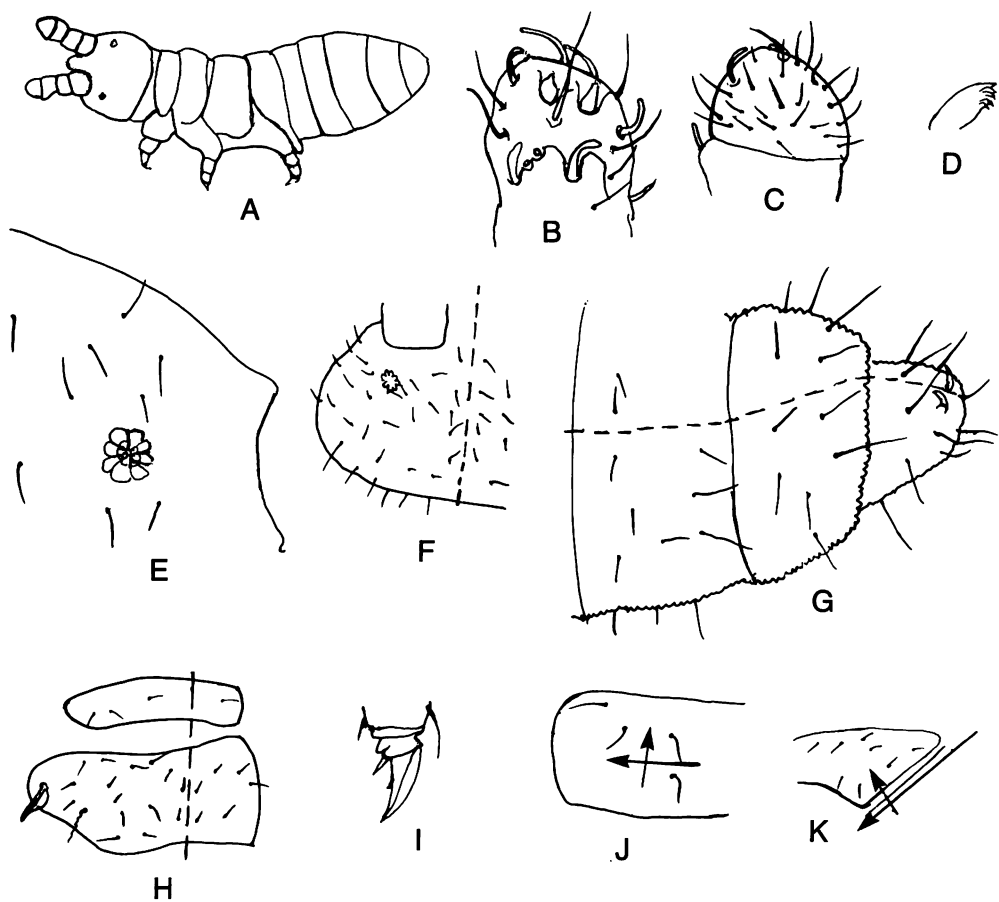


Plate 10—*Willemia peke*: **A**, habitus (4813); **B**, dorsal surface, fourth antennal segment and apex of third (holotype); **C**, ventral surface, fourth antennal segment (4813); **D**, maxilla (same); **E**, postantennal organ (paratype); **F**, cephalic chaetotaxy, left side (4813); **G**, dorsal chaetotaxy, last three abdominal segments (holotype); **H**, same, first and second thoracic segments; **I**, hind foot complex (same); **J**, ventral tube (4813); **K**, left labial triangle (same).

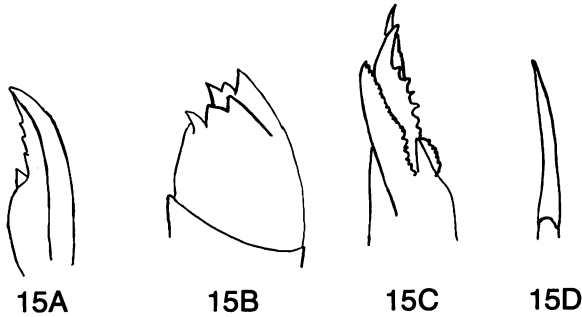
Table 3. Characteristics of Hawaiian Genera of Neanurinae

GENUS (SUBGENUS)	POSTANTENNAL ORGAN			MAXILLA*	UNGUICULUS	FURCULA**	ANAL SPINE
	TUBERCLES	EYES	MANDIBLE				
<i>Anurida</i>							
(<i>Micranurida</i>)	6-7	2	+	simple	-	rud	-
<i>Brachystomella</i>	4-8	8	-	characteristic	-	typ	-
<i>Setanodosa</i>	4-6	8	-	characteristic	-	-	-
<i>Friesea</i>	-	8	+	characteristic	-	typ-rud	3-8
<i>Neanura</i>							
(<i>Morulodes</i>)	-	4	+	simple	-	rud	-
(<i>Neanura</i>)	-	3	+	simple	-	rud	-
(<i>Paleonura</i>)	-	2	+	simple	-	rud	-
(<i>Protanura</i>)	-	0-5	+	toothed	-	rud	-
(<i>Vitronura</i>)	-	1-4	+	simple	-	rud	-
<i>Odontella</i>							
(<i>Odontella</i>)	1, lobed	5	-	simple	-	typ	0-2
<i>Oudemansia</i>	-	8	+	simple	-	typ	6
<i>Stachia</i>	1, lobed	0-1	+	simple	-	rud	-
<i>Paranura</i>	-	2	+	simple	-	rud	-
<i>Aethiopella</i>	many	8	+	simple	-	typ	-
<i>Pseudachorutes</i>							
(<i>Pseudachorutes</i>)	7-8	8	+	simple	-	typ	-

*"simple," with 1-2 needlelike lamellae; "toothed," intermediate. For the characteristic maxillae of *Brachystomella*, *Setanodosa*, and *Friesea*, see Figures 15A and 15B.

**"rud," reduced to unsegmented papillae or absent; "typ," with all segments distinct.

- 2(1). Maxilla sickle-shaped (Fig. 15A); 3 or more anal spines or spinelike setae.... **Friesea**
 Maxilla quadrate (Fig. 15B), narrow and lamellate (Fig. 15C), or needlelike
 (Fig. 15D); anal spines usually absent. 3
- 3(2). Furcula present with all segments distinct. 4
 Furcula reduced or absent; mucro always absent. 7
- 4(3). Head of maxilla quadrate (Fig. 15B). **Brachystomella**
 Maxilla otherwise (Fig. 15C,D). 5



- 5(4). Postantennal organ present; anal spines absent. 6
 Postantennal organ absent; anal spinelike setae may be present. **Oudemansia**
- 6(5). Postantennal organ moruliform (Fig. 16A). **Aethiopella**
 Postantennal organ lobes in a ring (Fig. 16B). **Pseudachorutes**



16A



16B

- 7(3). Last abdominal segment bilobed. **Neanura**
 Last abdominal segment rounded. 8
- 8(7). Postantennal organ present. 9
 Postantennal organ absent. **Paranura**
- 9(8). Dentes present. **Stachia**
 Furcula completely absent. 10
- 10(9). Maxilla quadrate; eyes 8 + 8. **Setanodosa**
 Maxilla needlelike, eyes 2 + 2. **Anurida**

Genus **ODONTELLA** Schäffer, 1897

Type species: *O. loricata* Schäffer, 1897

Typical members of this genus can easily be recognized by the combination of conically projecting mouthparts, simple to star-shaped postantennal organ, trila-mellate mucro, and coarsely tuberculate or reticulate integument. Two species

have been found in the Islands. Both species have a clear eversible sac between the third and fourth antennal segment and fall in the subgenus *Odontella* as defined by Deharveng (1981*b*).

KEY TO HAWAIIAN SPECIES OF ODONTELLA

1. Sixth abdominal segment with anal lobes or spines (Fig. 17A)..... **uka**
 Sixth abdominal segment without anal lobes or spines (Fig. 17B)..... **kapii**



17A



17B

Odontella kapii Christiansen and Bellinger, **new species** (Plate 11)

Color light blue with dark eye patches; venter and appendages paler. Fourth antennal segment with apical lobe (appearing retractile from some angles), 10 or more strongly curled large setae, and about 10 tapered setae with a flattened clavate apical expansion. Apical organ of third antennal segment with 2 short, basally angled pegs in a shallow depression at the segmental margin. Mouthparts unclear, but apparently the maxillae are styliform and untoothed. Postantennal organ with central rod and 4 arms, the posterior arm much shorter than the others. Eyes 5 + 5, subequal. Tenent hairs $\frac{1}{2}$ to $\frac{3}{4}$ length of inner unguis and acuminate. Unguis with strong inner tooth at about $\frac{1}{5}$ of its length from base. Unguiculus absent. Ventral tube apparently with 2 + 2 setae. Tenaculum with 3 + 3 teeth. Dens with 6 large setae, 3 of which are angulate. Mucro subequal to dens in length. Integumental granules stellate or polygonal in basal cross section, except on posterior $\frac{3}{4}$ of the sixth abdominal segment, where they are larger and rounded or elliptical. Numerous more finely granulated areas over body, particularly on intersegmental areas. Body setae acuminate and smooth except on dorsum of the sixth abdominal segment, where they are weakly clavate or truncate. Length 1.6 mm.

Remarks: The combination of distinctive features (strongly curved and clavate setae of the fourth antennal segment, clavate setae on the sixth abdominal segment, and both circular and stellate integumentary granules) found in this species is unique. We have seen only one specimen. Its characters are very clear, and we feel it adequate to name the species.

Derivatio nominis: Hawaiian, curly.

Type locality: Holotype, Kauai, Alakai Swamp, on ridge beside jeep trail, VII-22-1964, 4000 ft., Suman (5305).

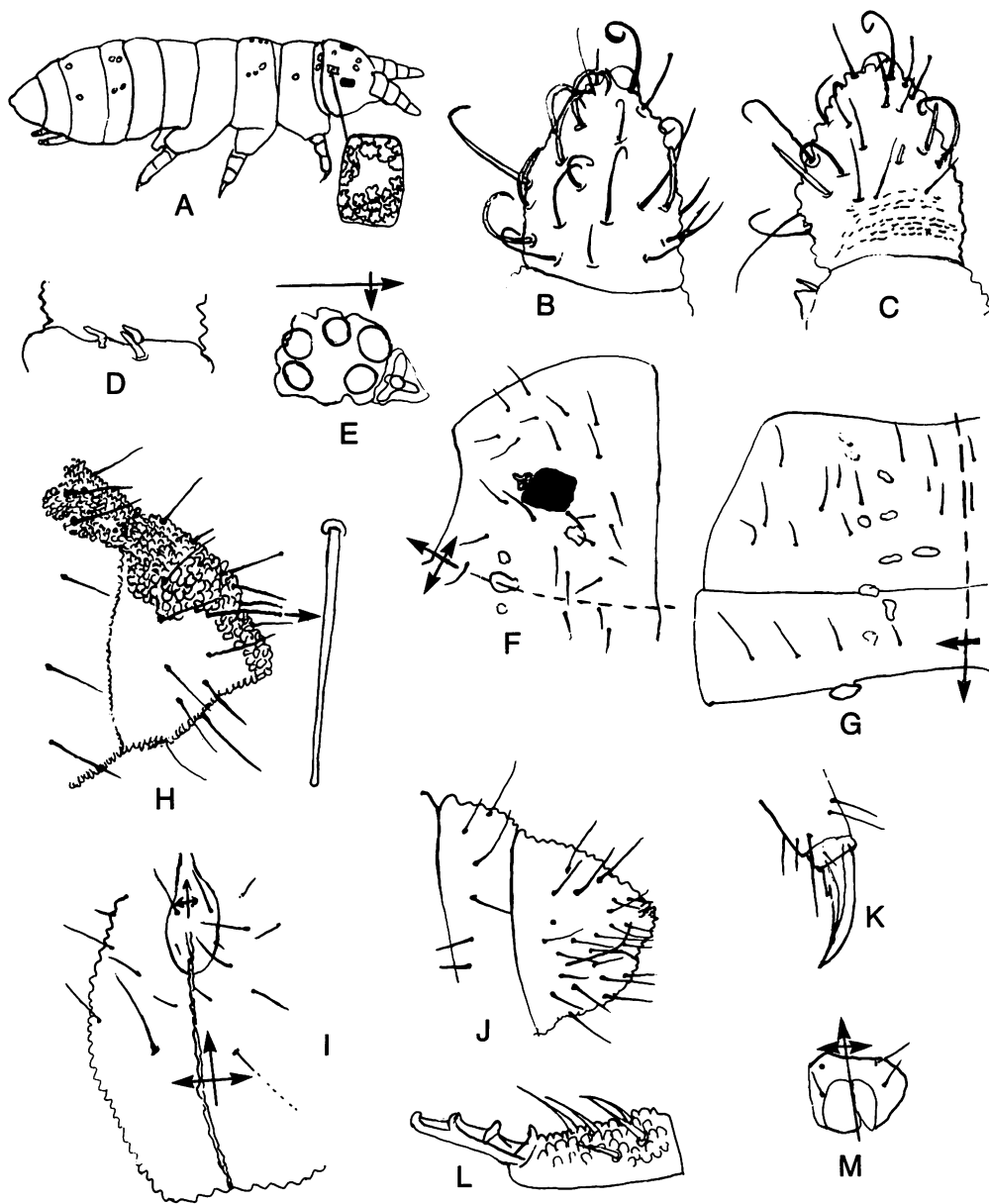
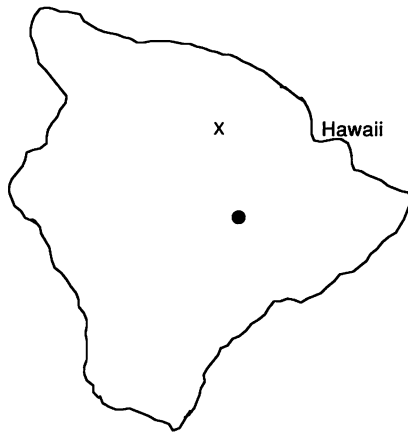


Plate 11—*Odontella kapii* (all figures of holotype): A, habitus; B, dorsum, fourth antennal segment; C, venter, same; D, apical organ of third antennal segment; E, right eyepatch and postantennal organ; F, chaetotaxy and pseudopores, right side of dorsum of head; G, chaetotaxy and finely granulated areas, right side of second and third thoracic segments; H, chaetotaxy and integumentary granules, fifth and sixth abdominal dorsa; I, ventral cephalic chaetotaxy; J, ventral chaetotaxy, last three abdominal segments; K, hind foot complex; L, mucro and dens; M, ventral tube.

Odontella uka Christiansen and Bellinger, **new species** (Plate 12)

Color dark blue, with venter, appendages, and intersegmental membranes paler; dorsum with numerous pale spots and pigment in distinct granules. Fourth antennal segment without apical bulb; with about 10 weakly curved setae and 1 apical strongly curved seta; many of the lateral setae are thickened and blunt, but none are clearly clavate. Apical organ of third antennal segment with 2 ovoid pegs in a shallow groove and a supplementary longer rod. Mouthparts styliform. Post-antennal organ with central axis and 4 radiating arms, with 1 or 2 greatly foreshortened. Eyes 5 + 5, subequal. Tenent hair acuminate. Unguis with small inner tooth at $\frac{1}{5}$ of its length from base. Ventral tube with 2 + 2 setae. Tenaculum with 3 + 3 teeth. Dens with 5 dorsal setae, 3 of which are angled. Mucro subequal in length to dens. Sixth abdominal segment with 2 blunt papillae, without typical spines but finely granulate and clearly distinguished from remaining integument. About 25 more finely granulated areas on the body but not on intersegmental areas. Integumentary granules polygonal in basal cross section. Body setae acuminate; some large setae on last segment finely serrate. Maximum length 1.03 mm.



Remarks: This species resembles *O. pseudolamellifera* Stach, 1949 in many respects, but differs in the structure of the antenna and tenent hair. The serrate abdominal setae and peculiar anal knobs serve to distinguish this species from most known to us. It differs from *O. lamellifera* (Axelson, 1903) in lacking clavate posterior setae; *O. schajovskoy* Izarra, 1982 has postantennal organ lobes of two unequal sizes.

Derivatio nominis: Hawaiian, upland.

Ecology: So far known only from above 4000 ft. from pitfall traps.

Type locality: Holotype and 3 paratypes, Hawaii, east slope of Mauna Loa, X-31-1971, 8000 ft., pitfall trap, Jacobi (5341).

Additional records: Hawaii: 5348, 6839.

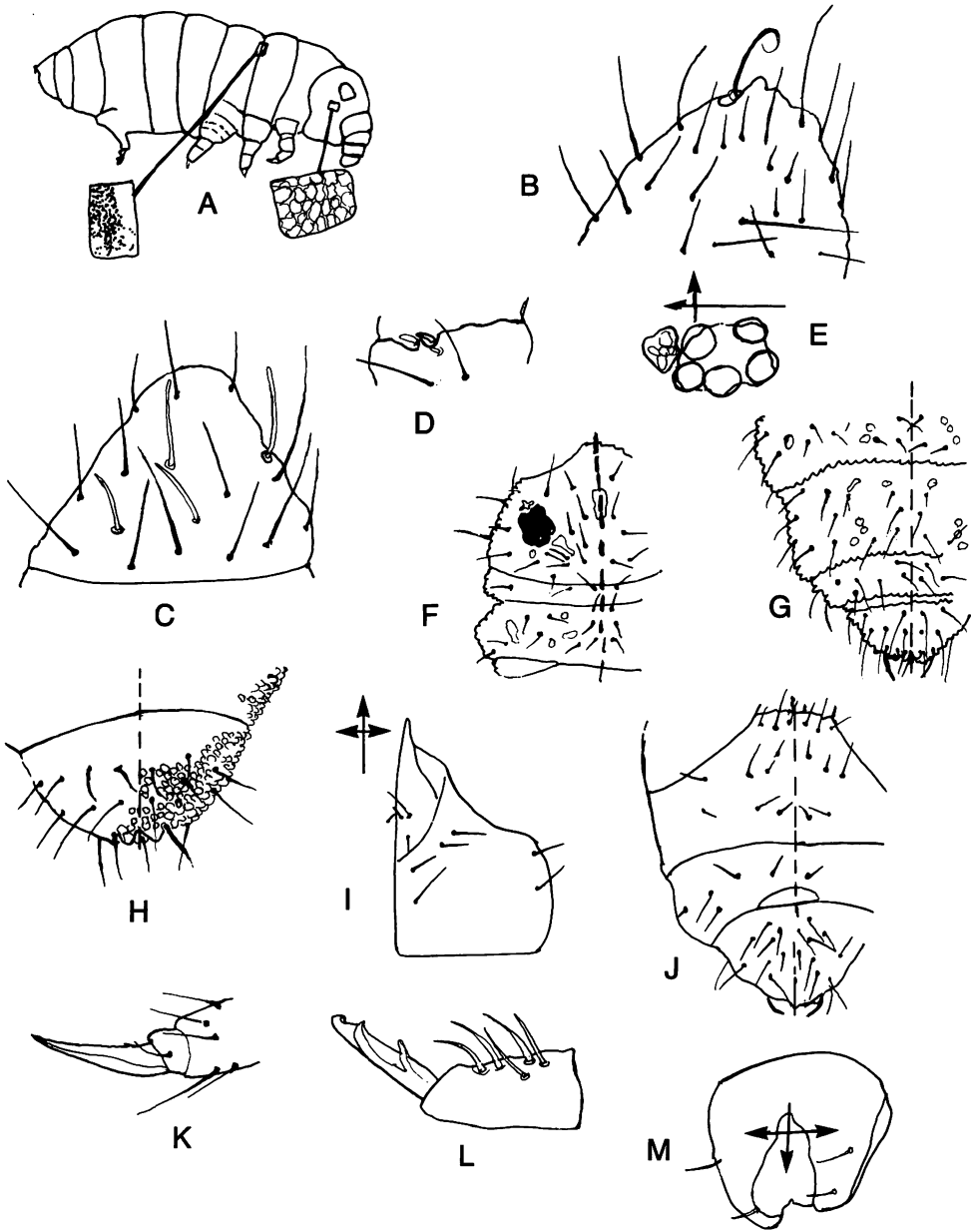


Plate 12—*Odontella uka* (all figures of specimens from Hawaii): A, habitus (holotype); B, dorsal surface of fourth antennal segment (paratype); C, ventral surface, fourth antennal segment (same); D, apical organ, third antennal segment (same); E, eyes and postantennal organ (holotype); F, dorsal chaetotaxy and finely granulated areas, right side, head and first two thoracic segments (6839); G, same, left side, last four abdominal segments; H, detail, sixth abdominal segment showing cuticular granulations; I, ventral chaetotaxy, head (6839); J, detail, right side, last three abdominal segments (paratype); K, hind foot complex (paratype); L, mucro and dens (paratype); M, ventral tube (holotype).

Genus **STACHIA** Folsom, 1932

Type species: *S. minuta* Folsom, 1932

This genus should be easily recognized by the triangular postantennal organ and reduced furcula; the minute size of known specimens may be a juvenile character. There is a single species, *S. minuta*.

Stachia minuta Folsom, 1932 (Plate 13)

Proc. Hawaii. Entomol. Soc. 8:55.

Color white. Fourth antennal segment without apical retractile bulb; with 3 differentiated setae, 2 short and blunt, 1 thickened and conical, and with 3-4 long, strongly curved setae; apex of segment sometimes with a slightly projecting lobe. Mouthparts enclosed in a short buccal cone. [Mandible angulate; maxilla acuminate.] A single unpigmented cornea on each side. Postantennal organ with a central axis and 3 lobes. Tenent hair acuminate. Unguis without teeth. Unguiculus absent. Ventral tube small, with 1 + 1 or 2 + 2 setae. Tenaculum absent. [Furcula a simple bilobed organ without setae or subdivisions.] Body granulation stellate or polygonal in basal cross section, about 15 μ m in diameter on the dorsum of the fifth

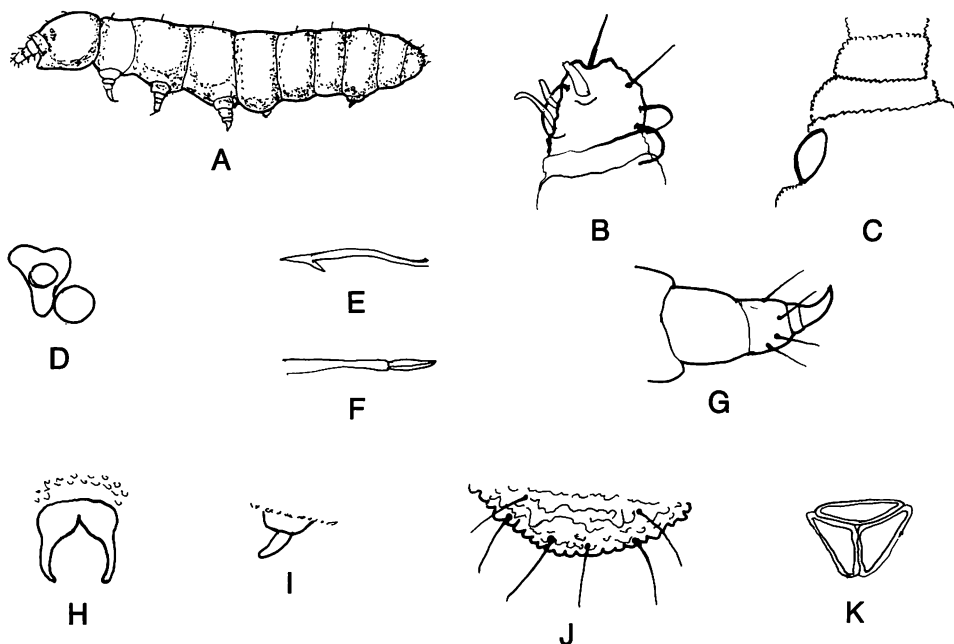


Plate 13—*Stachia minuta*: A, habitus (after Folsom); B, dorsal surface of antenna (type specimen); C, base of antenna and eye (after Folsom); D, eye and postantennal organ (same); E, mandible (same); F, maxilla (same); G, fore foot complex (same); H, furcula from below (same); I, furcula from side (same); J, end of abdomen (after Folsom); K, supranal and subanal valves (type specimen).

abdominal segment. Body setae acuminate and smooth. [Maximum length 0.5 mm.]

Remarks: Parts of the description in brackets are taken from Folsom. The only specimens we saw were part of the type series. The combination of small size (none we saw were over 0.3 mm in length) and poor condition made observation difficult. The type series is composite, containing in addition somewhat larger (to 0.5 mm long) specimens of an unidentified species of *Willemia*; it is possible that Folsom's description is composite. It is remarkable that we have failed to recover this species since its description. In 1986 the senior author made extensive deep-soil collections on Oahu, but failed to collect this form.

Ecology: Found in deep soil layers.

Type locality: Oahu: Honolulu, Wahiawa, X-4-1928, from pineapple soil (deep), Illingworth.

Additional records: Oahu: Wahiawa, VII-12, VIII-12, Honolulu; Tantalus, VIII-4-1930, 1700 ft.

Genus **BRACHYSTOMELLA** Ågren, 1903

Type species: *B. maritima* Ågren, 1903

This genus includes the Hawaiian poduroids with the characteristic brachystomelline maxilla, no mandible, and a complete furcula. All the Hawaiian species have 8 + 8 subequal eyes and labial triangles resembling that of *B. parvula*. The apical antennal bulb, postantennal organ, tibiotarsal setae, and chaetotaxy all furnish useful taxonomic characters. The labrum and supralabral setae are generally very difficult to see, but apparently do not vary significantly. The shape of the mucro is a useful taxonomic feature (see Fig. 18A). The setae of the labial triangle are identified according to the system of Deharveng (see Fig. 18B).

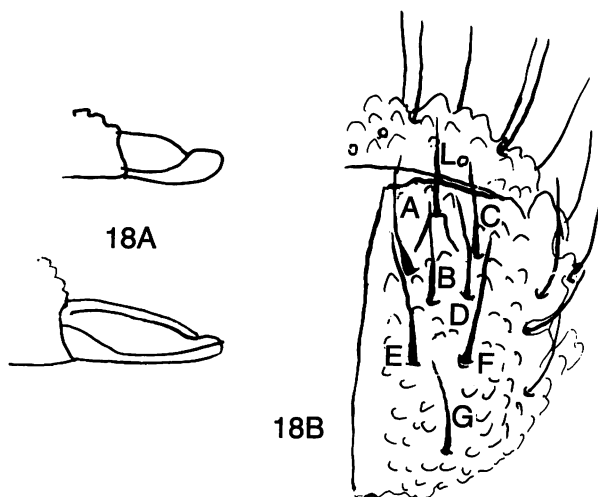


Figure 18—Characters of *Brachystomella*: A, basic mucronal types; B, labial chaetotaxy (after Deharveng).

Table 4. Characteristics of Hawaiian Species of *Brachystomella* and *Setanodosa*

SPECIES	LOBES OF APICAL ANTENNAL ORGAN	LOBES OF POSTANTENNAL ORGAN*	POSTANTENNAL ORGAN/LARGEST EYE	NO. MAXIL-LARY TEETH	CLAVATE SETAE PER LEG*	LONGEST TENENT HAIR/ UNGUIS
<i>Brachystomella contorta</i>	1	5-6(7)	1.1-1.8	8	0-1 weak	1.1-1.25
sp. H	1	6-7	1.7	8	0	0.5-0.6
<i>hawaiiensis</i>	3	6-7	1.5	4?	6-7	1.7
<i>heo</i>	1	6-7	1.6-1.8	8	10-12	0.75-0.85
sp. J	1	6	0.9	8	0	1.1
sp. K	1	7	1.45	7	0	1.1
<i>kahakai</i>	1	4	0.8	7	1	1-1.25
<i>kiko</i>	1	3-4	0.7-1.4	7	2(3)	1.1-1.2
<i>momona</i>	3	6	1.5	8	0	1
<i>parvula</i>	1	(6)7-8	1.6-1.9	7-8	0	0.70-1.1
<i>Setanodosa kanahua</i>	3	4-6	0.8-1.0	7	1(3)	?

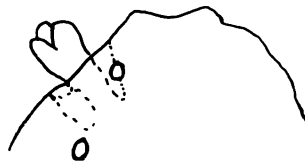
*Parentheses indicate exceptional conditions.

**Mucro: type A as in *contorta*; type B as in *parvula* (see Figure 18A).

In the course of this study we discovered seven undescribed forms; however, three of these (spp. H, J, and K) are represented by such poor samples that we include them in the key and table but do not describe or illustrate them. There are apparently 10 Hawaiian species of *Brachystomella*: *contorta*, sp. H, *hawaiiensis*, *heo*, sp. J, sp. K, *kahakai*, *kiko*, *momona*, and *parvula*.

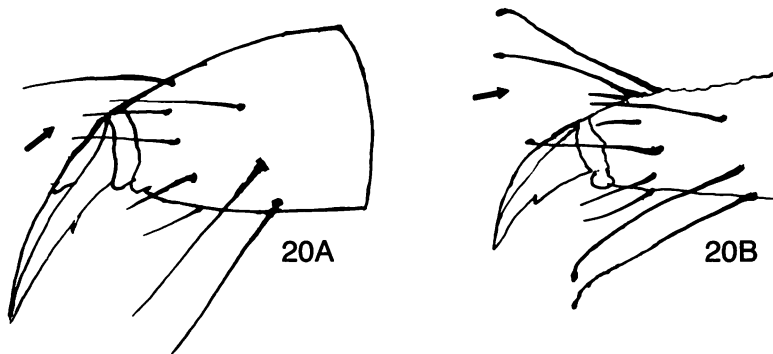
KEY TO HAWAIIAN SPECIES OF BRACHYSTOMELLA

1. Apical bulb of fourth antennal segment clearly 3-lobed (Fig. 19). 2
- Apical bulb of fourth antennal segment apically or simple indented. 3



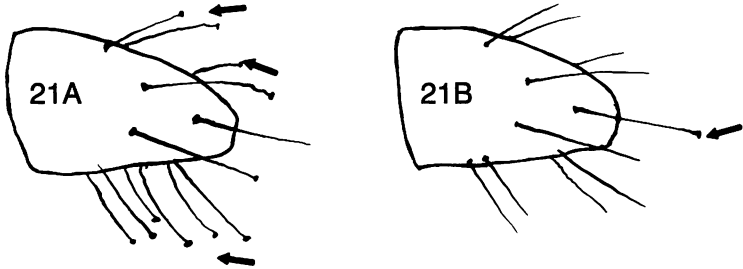
INNER UNGUAL TOOTH	NO. DENTAL SETAE	MUCRO**	CLAVATE ABDOMINAL SETAE	UNPAIRED ABD. VI SETA	LOCATION
+	5	A	-	+	Hawaii, Kauai, Maui, Midway Atoll, Oahu
+	5	A	-	+	Oahu
+	4	B	-	?	Oahu
+	5	B	±	+	Oahu
+	5	B	-	+	Oahu
++	6	B	-	+	Maui
+	3-4	intermediate	+	+	Hawaii
+	3	B	weak	+?	Nihoa, Oahu
minute	5	B	-	+	Hawaii
+	5	B	-	+	Hawaii, Kauai, Oahu
-	-	-	+	+	Hawaii, Oahu

- 2(1). All tibiotarsal setae acuminate (Fig. 20A)..... **momona**
 Six to seven tibiotarsal setae clavate (Fig. 20B)..... **hawaiiensis**



- 3(1). Dorsal dental setae 5 or 6..... 4
 Dorsal dental setae 3 or 4..... 9
 4(3). Dorsal dental setae 6..... **sp. K**
 Dorsal dental setae 5..... 5

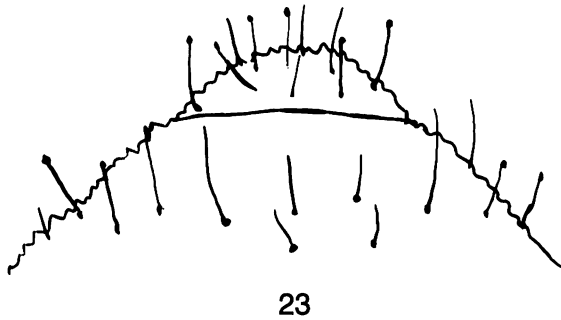
- 5(4). Ten or more tibiotarsal setae truncate to clavate (Fig. 21A)..... **heo**
 At most 1 tibiotarsal seta truncate or clavate (Fig. 21B)..... 6



- 6(5). Longest distal tibiotarsal setae about half as long as inner edge of unguis..... **sp. H**
 Longest distal tibiotarsal setae $\frac{2}{3}$ to 1.3 times as long as inner edge of unguis..... 7
 7(6). Apex of mucro broad (Fig. 22A)..... **contorta**
 Apex of mucro pointed (Fig. 22B)..... 8



- 8(7). Postantennal organ smaller than diameter of largest eye..... **sp. J**
 Postantennal organ larger than diameter of largest eye..... **parvula**
 9(3). Last 2 abdominal segments with many clavate setae (Fig. 23)..... **kahakai**
 Last 2 abdominal segments with 4 clavate setae or none..... **kiko**



Brachystomella contorta Denis, 1931 (Plate 14)
 Boll. Lab. Zool. Gen. Agric. Portici 25:80.—Yosii, 1959.

Color medium to light blue with pigment in patches that are generally lightly pigmented and densely packed but occasionally heavily pigmented and densely packed. Intersegmental membranes and ventral surface paler. Body oval elongate.

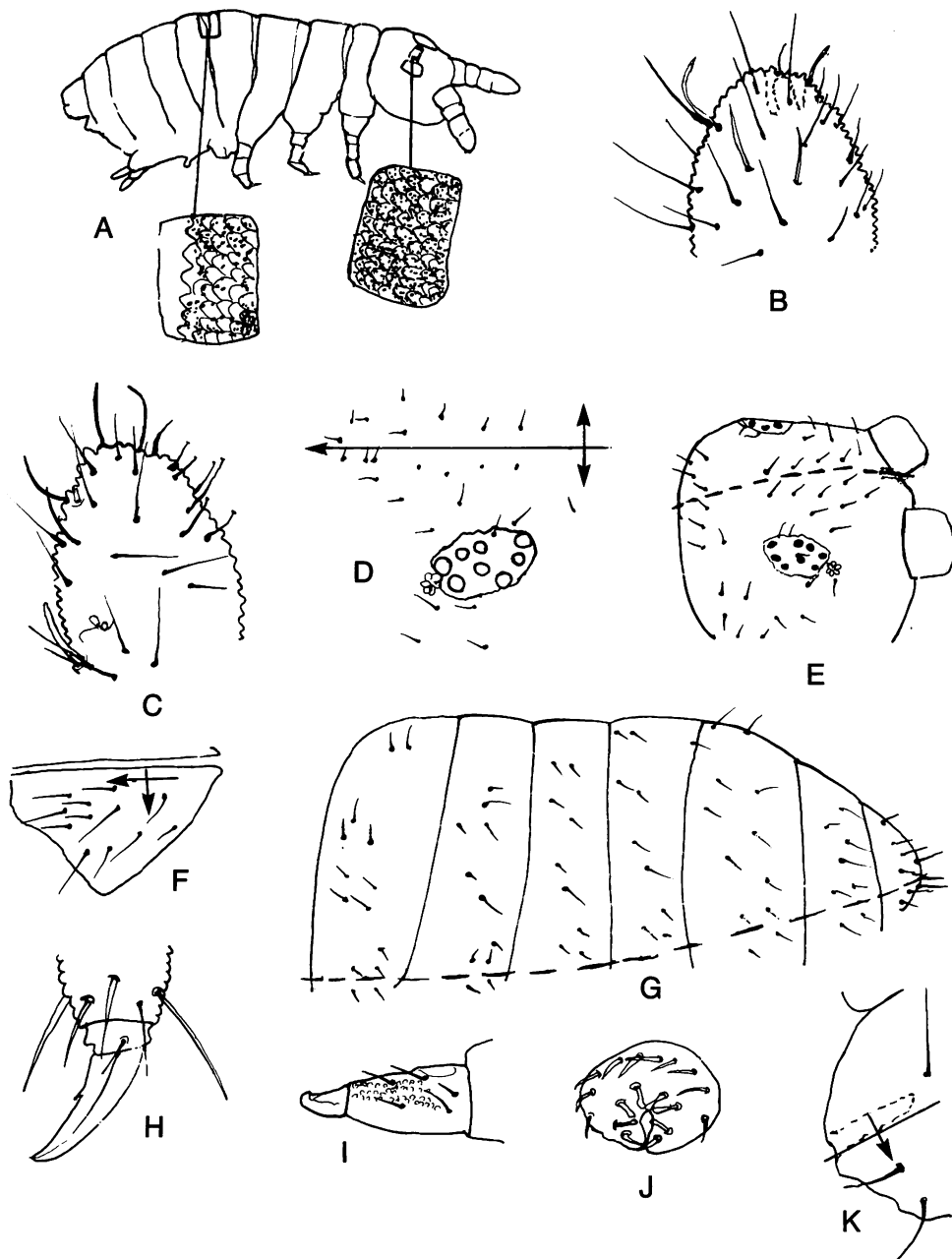
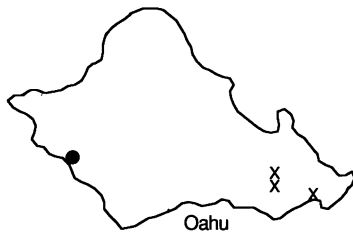


Plate 14—*Brachystomella contorta*: A, habitus (4824, Oahu); B, dorsum of fourth and apex of third antennal segments (5176, Maui); C, ventral surface, fourth antennal segment (same); D, eyepatch and postantennal organ, left side (5288, Kauai); E, cephalic dorsal chaetotaxy (5176, Maui); F, labial triangle, right side (5288, Kauai); G, dorsal chaetotaxy, right side, third thoracic segment–sixth abdominal segment (5176, Maui); H, fore foot complex (same); I, mucro and dens (same); J, male genital plate (5306, Midway Atoll); K, ventral tube (4824, Oahu).

Fourth antennal segment only weakly separated from third; apical organ simple, slightly laterally displaced from tip of segment, completely withdrawn into antenna but clearly visible; ventral file of about 10 mostly weakly truncate setae about half as long as longest setae of segment. Apical organ of third antennal segment as in *B. parvula*. Postantennal organ (in Hawaiian material) with 5-6(7) lobes, 1.2-1.8 times as long as largest eye. Tibiotarsus with inner distal setae somewhat heavier than others but not clearly spinelike; 1 tenent hair, very weakly clavate to acuminate and 0.80-0.91 times as long as inner unguis. Unguis with clear inner tooth. Ventral tube with 3 + 3 setae. Dens with 5 dorsal setae and heavily tuberculate dorsal surface. Mucro with strong, blunt, curved tip and twisted lamella. Body setae acuminate except for longest setae in posterior rows on third through fifth abdominal segments, which are usually truncate; sixth abdominal segment with unpaired median seta (rarely 2); longest abdominal setae about 1.25 times as long as inner hind unguis. Body tubercles conical; largest 2.8-3.3 μm in basal diameter. Male genital plate with a surrounding ring of acuminate setae and 6(8) heavy blunt inner setae. Maximum length 1 mm.



Hawaii 2
Kauai 2
Midway 2
Maui 1

Remarks: Assignment of these specimens to Denis's species must be tentative until the male genital plate of Costa Rican forms has been described. This is the most widespread species in Hawaii.

Ecology: Found mostly in litter in disturbed areas; also found in bird nests and under wood.

Records: Hawaii: 5120, 5142. Maui: 5176. Oahu: 4768, 4808, 4824, 4828, 6791. Kauai: 4749, 5288. Midway: 5306, 6818.

***Brachystomella hawaiiensis* Yosii, 1965 (Plate 15)**

Contrib. Biol. Lab. Kyoto Univ. 19:4.

Color uniform dark blue with mottled pigment and paler venter; extremities darkly pigmented. Apical organ of fourth antennal segment trilobed, in a deep pit. Apical organ of third segment of a pair of small rods in a shallow groove. Labial triangle as in *B. parvula*. Postantennal organ with 6-7 lobes, 1.5 times the diameter of an eye. Tibiotarsus with 3 long outer distal setae, 2 shorter lateral distal setae, and 2 long inner proximal setae clavate. Unguis with strong inner and lateral teeth. Ventral tube with 3 + 3 setae. Dens with 4 setae and fine dorsal granulations. Mucro straight, with small dorsal granulations. Body setae short, smooth, and simple. Length 2.5 mm.

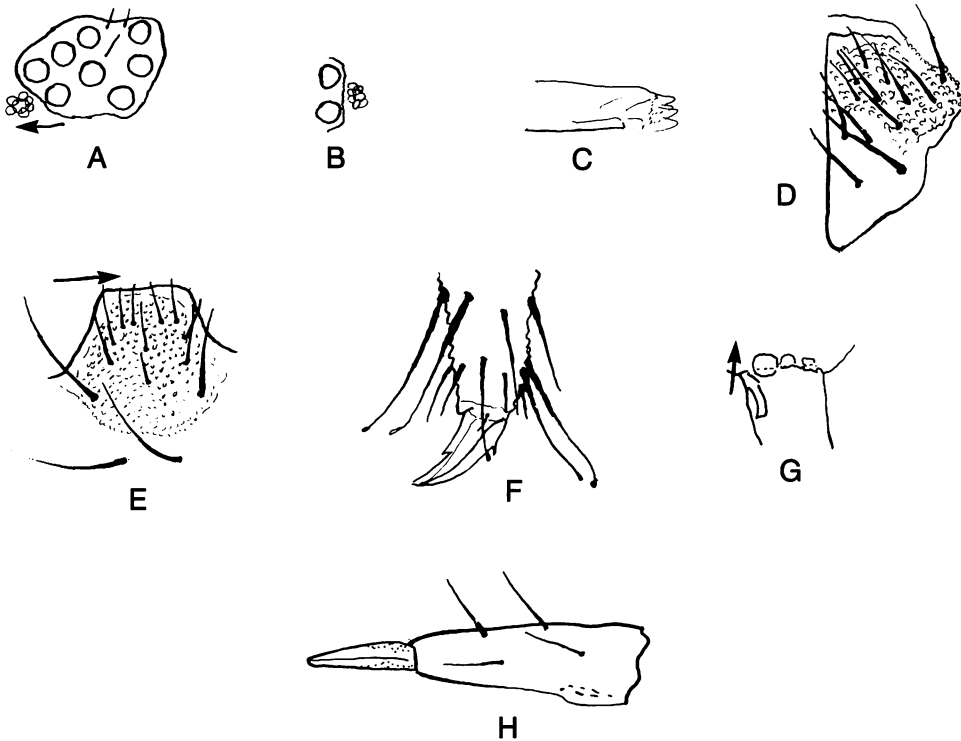


Plate 15—*Brachystomella hawaiiensis* (all figures after Yosii): A, eyepatch and postantennal organ; B, side view of postantennal organ; C, maxilla; D, left labial triangle; E, labrum; F, mid tibia and foot complex; G, dental base; H, mucro and dens.

Remarks: We have not seen any specimens of this species. Yosii identifies Christiansen as the collector, but this is in error. The location of the types is unknown. Yosii mentions the maxilla (misidentified as mandible) as having “many teeth,” but figures only 4. It is possible that *B. momona* is a synonym of *B. hawaiiensis*, but the differences in dental and tibiotarsal setae, dental granulation, etc., make this unlikely.

Type locality: Oahu, Mt. Kaala, I-19-1945, collector unknown.

***Brachystomella heo* Christiansen and Bellinger, new species (Plate 16)**

Color pale blue, with pigment in the form of patches of granules, more dense on dorsum of head, more widely scattered on venter, and absent from legs and furcula. Apical organ of fourth antennal segment simple, on ventral surface, and $\frac{1}{2}$ to $\frac{3}{4}$ withdrawn into segment; ventral file obscure, of about 6(7) weakly truncate setae half as long as adjacent acuminate setae. Labial setae atypical, with D seta either missing or in group with lateral setae. Postantennal organ with 6-7 lobes, 1.6-1.8 times the diameter of the largest eyes. Coxa and femur each with 2-4 long, apically

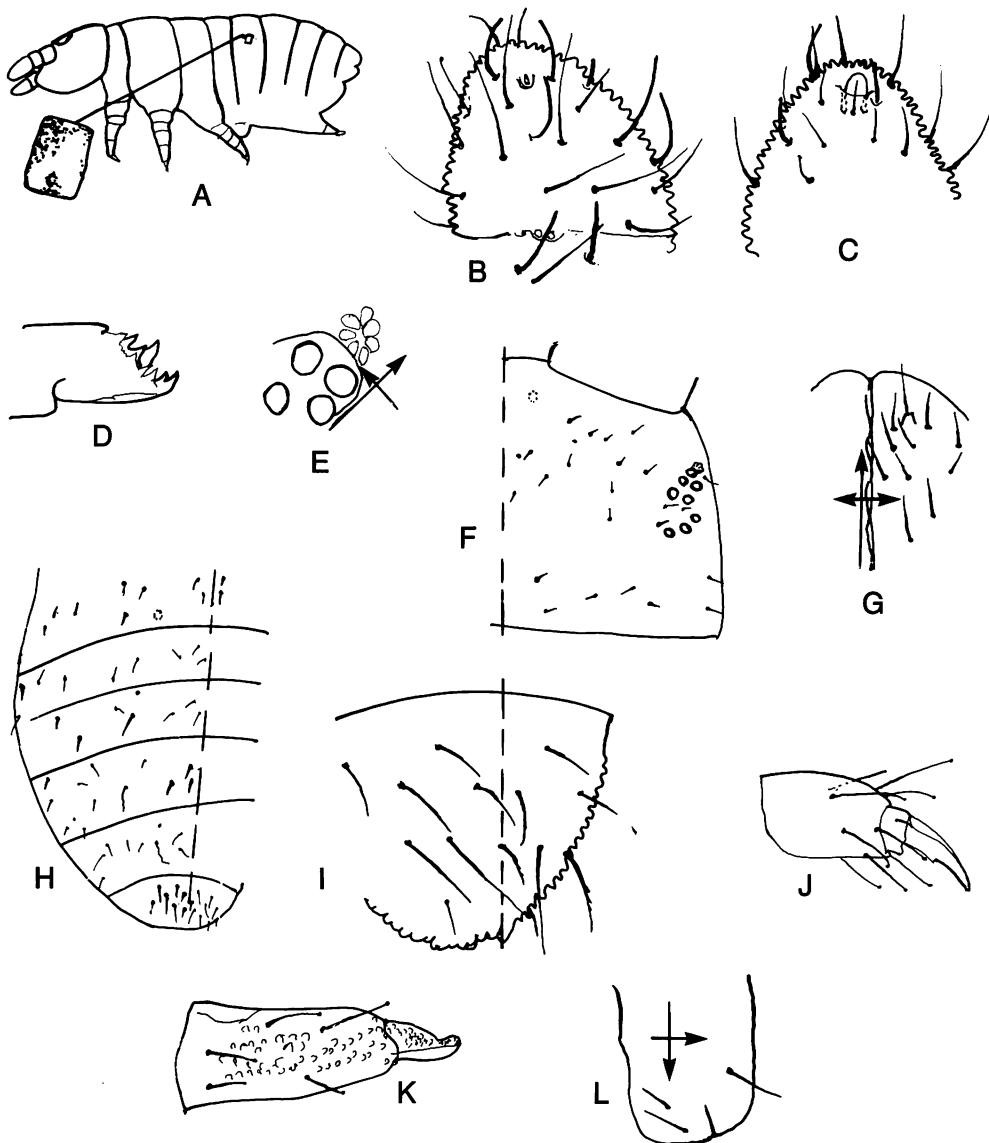


Plate 16—*Brachystomella heo* (all figures of type specimens): A, habitus; B, fourth antennal segment and apex of third, outer surface (holotype); C, apex of fourth segment, inner surface (same); D, maxilla; E, postantennal organ and neighboring eyes; F, dorsal cephalic chaetotaxy, right side; G, labial triangle, left side; H, dorsal abdominal chaetotaxy, left side; I, detail, sixth abdominal dorsal chaetotaxy (holotype); J, fore foot complex; K, mucro and dens; L, ventral tube.

curved, truncate to slightly clavate setae. Tibiotarsus with 10–12 such setae, the largest being clearly clavate. Unguis with small inner tooth. Ventral tube with 3 + 3 setae. Dens with 2–5 rows of coarse dorsal tubercles and 5 setae, which are clavate on large specimens. Mucro with a curved rod forming a trough apically, and a median granulate swelling ending well before the apex of the trough. Body setae smooth and acuminate, except for the largest sixth abdominal segment setae, which are sometimes truncate, and short posterior setae, which are sometimes weakly serrate. Body tubercles conical, 1.6–2.9 μm in basal diameter. Males not seen. Maximum length 1 mm.

Remarks: This is one of a group of species closely related to *B. contorta*; it is distinguished from the others by the many curved truncate or clavate setae on the legs. Unfortunately, it is known only from the type series, with a single adult female and eight immature specimens.

Derivatio nominis: Hawaiian, knob.

Type locality: Holotype and 12 paratypes, Oahu, Mt. Tantalus, XI-1966, 1000 ft., pan trap, J. Vockeroth (4827).

***Brachystomella kahakai* Christiansen and Bellinger, new species (Plate 17)**

Color light to dark blue with rather uniformly scattered granules over dorsal and lateral surfaces of head and body. Apical organ of fourth antennal segment near apex, almost or completely withdrawn into segment, and apically indented; ventral file absent. Apical organ of third antennal segment of 2 spherical knobs. Postantennal organ 4-lobed, slightly smaller than nearest eye. Inner distal setae of tibiotarsus not spinelike; one clearly clavate tenent hair per foot. Unguis with inner tooth. Ventral tube with 3 + 3 setae. Dens with 4–6 rows of dorsal tubercles and 3–4 dorsal setae. Mucro with 2 broad lamellae and a blunt, slightly upturned apex. Longest body setae slightly clavate. Body tubercles conical, 3.3–4.5 μm in basal diameter. Maximum length 1.1 mm.

Remarks: The two collections of this species are very similar, except that those from the type locality have 3 + 3 dental setae, while the others have 4 + 4 (3 basal and 1 distal). The first type is very like *B. hiemalis* Yosii, 1956, which has 2 or 3 clavate tenent hairs and other minor differences. The species is very well marked. No males were seen.

Derivatio nominis: Hawaiian, seashore.

Ecology: Known only from litter at the supralittoral fringe.

Type locality: Holotype and 1 paratype, Hawaii, 2 mi. S of Kailua-Kona, I-2-1983, near high tide mark of rocky beach, sifted from debris, KC (5660).

Additional record: Hawaii: 5142.

***Brachystomella kiko* Christiansen and Bellinger, new species (Plate 18)**

Color blue with mottled granular pigment over antennae, dorsum, and sides of body, darker toward front end of animal; venter, legs, and furcula with scattered pigment granules or unpigmented. Apical organ of fourth antennal segment nearly

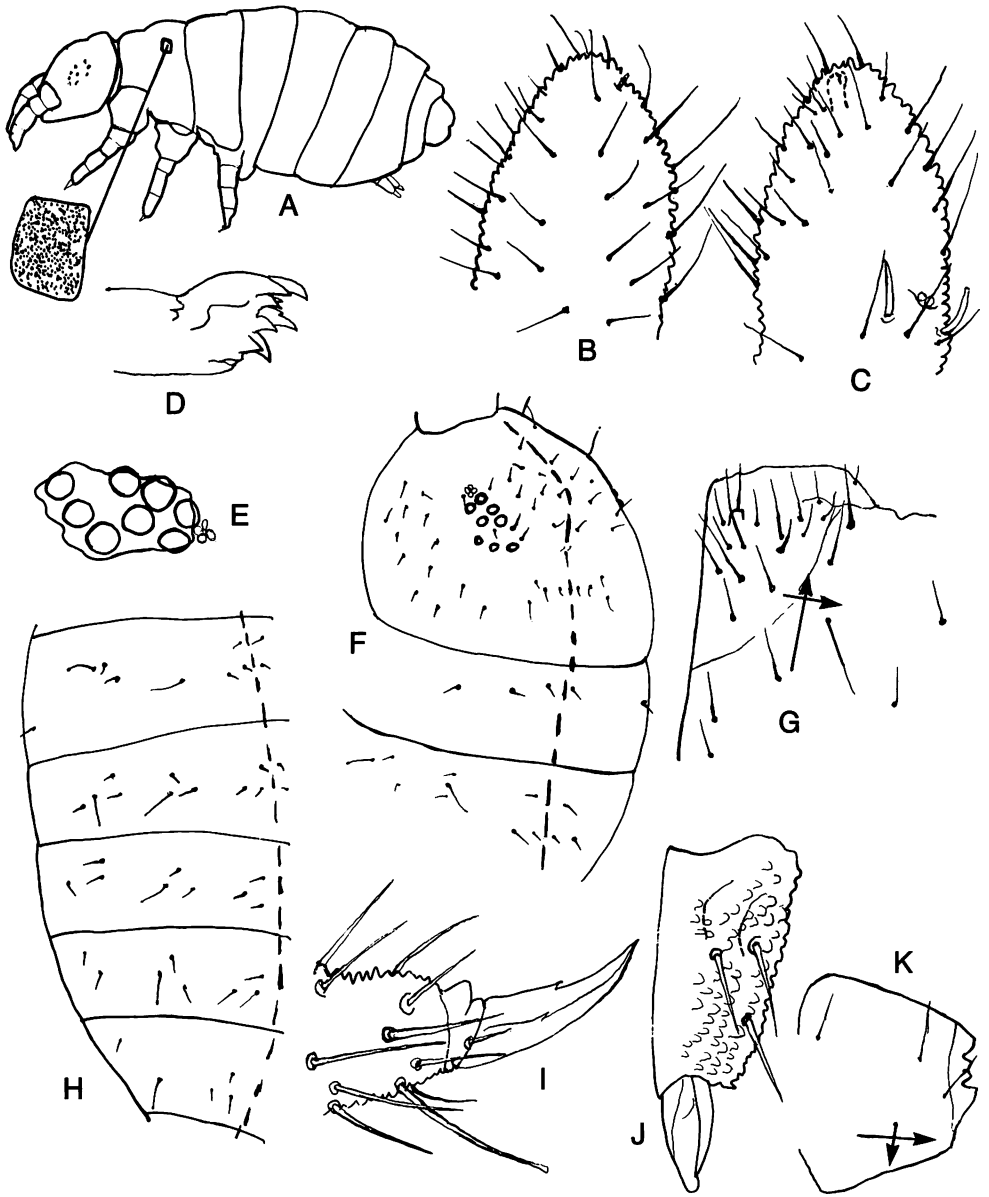


Plate 17—*Brachystomella kahakai*: A, habitus (holotype); B, dorsum, fourth and apex of third antennal segment (paratype); C, venter, fourth and apex of third antennal segment (same); D, maxilla (same); E, eyepatch and post-antennal organ (5142, Hawaii); F, dorsal chaetotaxy, head and first two thoracic segments (paratype); G, left labial triangle (same); H, dorsal chaetotaxy, third thoracic segment-fifth abdominal segment (same); I, fore foot complex (holotype); J, mucro and dens (same); K, ventral tube (same).

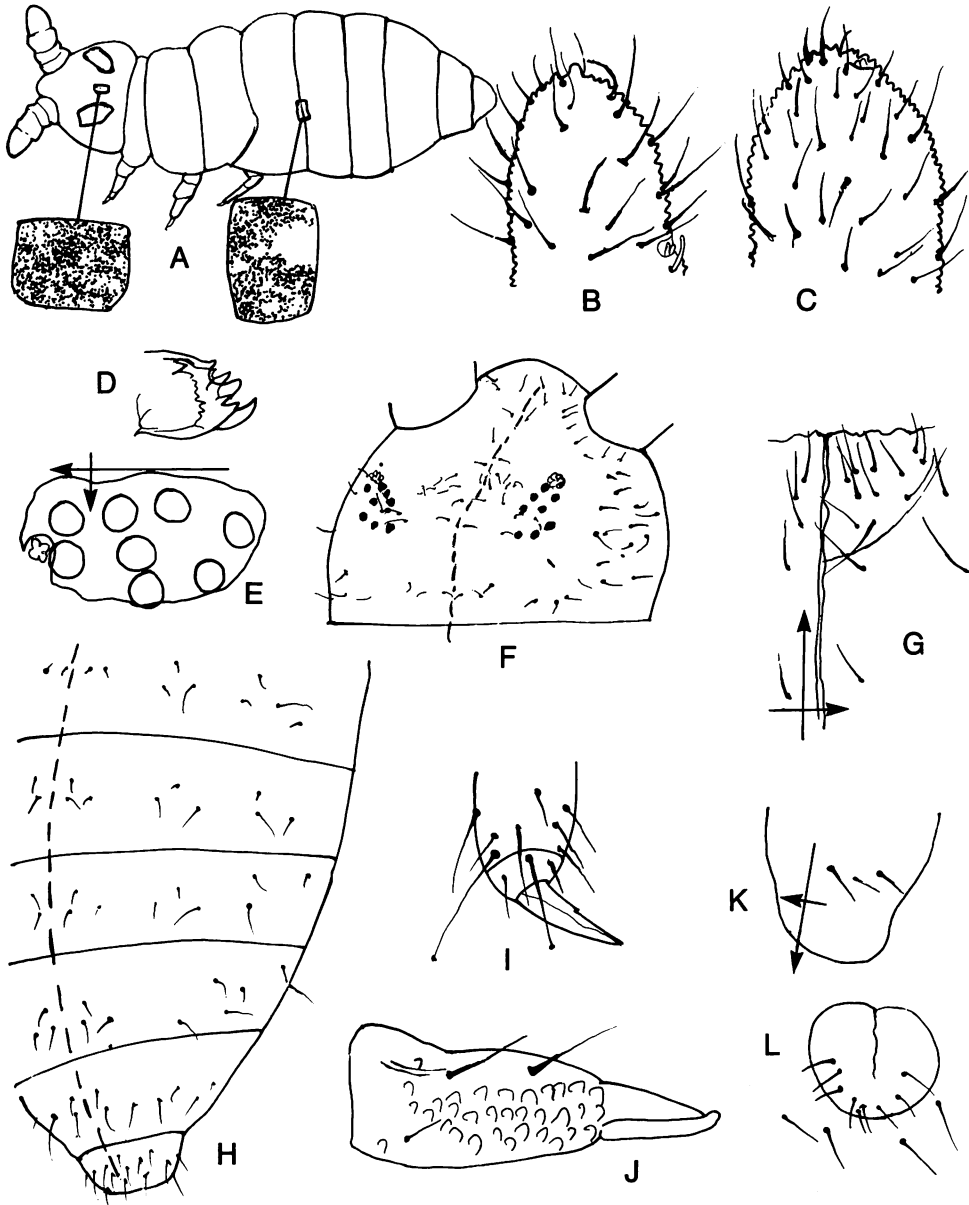
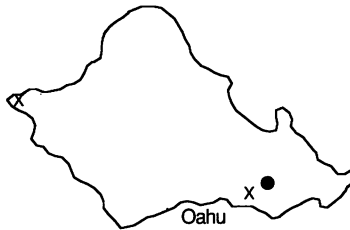


Plate 18—*Brachystomella kiko*: A, habitus (4811, Oahu); B, dorsum, fourth antennal segment and apex of third (same); C, ventral surface, fourth and apex of third antennal segment (paratype); D, maxilla (4811, Oahu); E, eyepatch and postantennal organ (same); F, cephalic dorsal chaetotaxy (paratype); G, left labial triangle (same); H, dorsal abdominal chaetotaxy (same); I, mid foot complex (4811, Oahu); J, mucro and dens (same); K, ventral tube (paratype); L, male genital plate (6789, Oahu).

or completely withdrawn into segment, simple, (usually) with a small apical indentation; no clear ventral file, but about 8 anterior setae are straight, slightly truncate, and distinctly shorter than the remaining setae. Postantennal organ with 4 lobes, 0.7–1.4 times as long as nearest eye. Eyes subequal. Tibiotarsus with 2 moderately thickened spinelike setae on inner surface; 1 strongly clavate tenent hair and 1 other (rarely 2) smaller and truncate to moderately clavate. Unguis with small inner tooth. Ventral tube with 3 + 3 setae, all on the same level. Dens with 2–3 rows of dorsal tubercles and 3 dorsal setae. Mucro with slightly curved rod forming a narrow trough at apex and a median, gradually tapering, finely granulate dorsal swelling. Body setae usually acuminate, but the largest setae of the fifth and sixth abdominal segments may be weakly clavate and the thick intermediate posterior setae are sometimes sparsely serrate. Body tubercles conical, the largest 2.2–3.3 μm in basal diameter. Male genital plate without strongly differentiated setae. Maximum length 1.2 mm.



Remarks: The mucro and three dental setae distinguish this from other Hawaiian species. Serrate body setae are common on Oahu specimens. One sample taken “on ocean water” off Oahu has some specimens with differences in chaetotaxy and lacking the apical bulb indentation; these may represent a separate taxon, but unfortunately all are immature.

Derivatio nominis: Hawaiian, speckled.

Ecology: In litter, shallow soil, and animal carcasses in lowland areas.

Type locality: Holotype and 6 paratypes, Nihoa, Miller Valley, IV-20–25-1983, 20 m, pitfall trap under shrubs, Gagne (6193).

Additional records: Oahu: 4763, 4811, 6786, 6789, 6792.

***Brachystomella momona* Christiansen and Bellinger, new species (Plate 19)**

Color medium blue with pigment extremely mottled, having numerous irregular pale or unpigmented patches; legs, furcula, venter, and apex of antennae with only a faint wash of pigment; eyepatches clearly darker than rest of head. Apical organ of fourth antennal segment trilobed and projecting for about half its length from the inner antennal surface; ventral file of about 7 straight, weakly truncate setae $\frac{1}{2}$ to $\frac{2}{3}$ as long as nearest acuminate setae. Labium with seta L not on clear papilla. Postantennal organ with 6 lobes, 1.5 times the diameter of the largest eyes. Eyes subequal. All tibiotarsal setae acuminate; basal inner setae as long as tibiotarsus

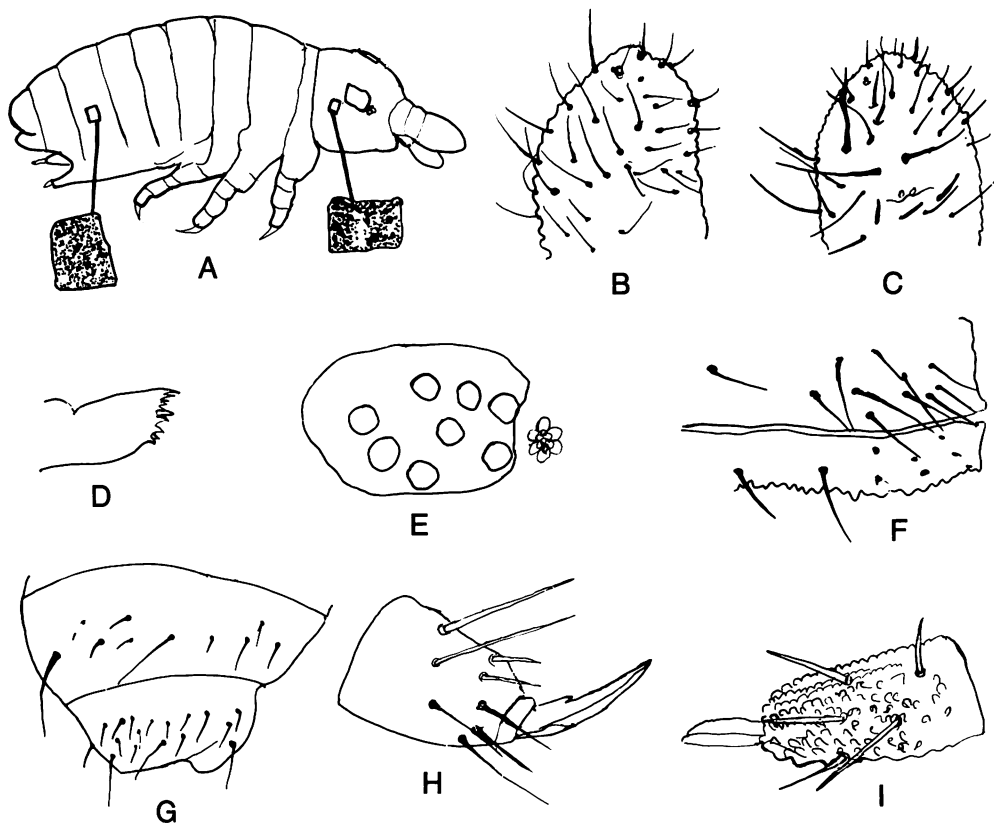


Plate 19—*Brachystomella momona* (all figures of holotype): A, habitus; B, outer surface of fourth and apex of third antennal segment; C, inner surface, same; D, maxilla; E, right eyepatch and postantennal organ; F, labial triangles; G, chaetotaxy, last two abdominal segments; H, hind foot complex; I, mucro and dens.

and straight. Unguis with minute inner tooth. Ventral tube not seen. Dens with 5 dorsal setae and 8–10 rows of coarse tuberculations. Mucro with two lamellae, the inner being much the broader and finely granulate. All body setae acuminate and smooth. Body tubercles conical and 1.5–2.2 μm in basal diameter. Male not seen. Length 0.8 mm.

Remarks: We have only a single specimen of this species, but it is an adult and has so many unusual features that we feel secure in naming it. In most respects it resembles *B. taxcoana* Palacios-Vargas and Najt, 1981, which, however, has the dens less coarsely tuberculate, the mucro more symmetrical and granulate, and shorter sensory setae. *Brachystomella momona* is distinguished from all other Hawaiian species by the trilobed antennal bulb; the long, straight tibiotarsal setae, the many rows of dental tubercles, and the very long p_2 setae on the fifth abdominal segment are characters we have not seen in any other species.

It is remarkable that we have only a single specimen of this species. Its locality is

one from which we have examined over 100 collections, and one into which recent introduction is unlikely.

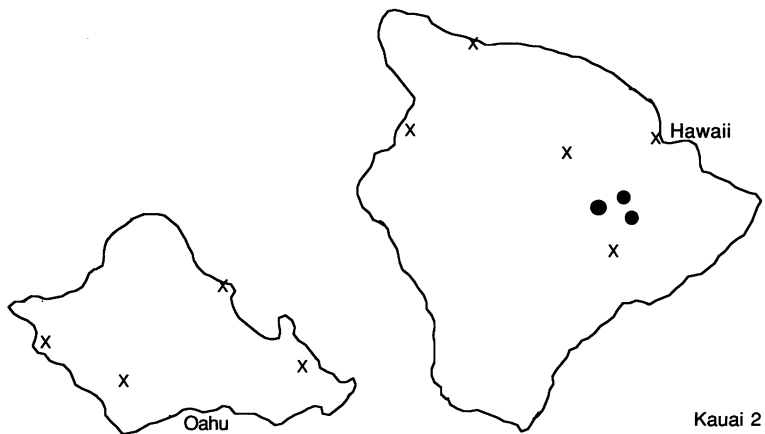
Derivatio nominis: Hawaiian, fat.

Type locality: Holotype, Hawaii, Volcanoes National Park, Steaming Bluff Trail; date and collector unknown (5068).

Brachystomella parvula (Schäffer, 1896) (Plate 20)

Mitt. Naturhist. Mus. Hamburg 13:176 (*Schoettella*).—Stach, 1949.—Christiansen and Bellinger, 1980.

Color medium to light blue, with venter and appendages paler than dorsum; pigment in rather uniformly scattered granules, or aggregated in circular to oval patches. Body ovoid elongate. Third and fourth antennal segments weakly divided ventrally but fused dorsally. Apical organ of fourth segment simple, usually protruding slightly from apex of segment; ventral file of about 12 setae that are acuminate to truncate and about $\frac{2}{3}$ as long as adjacent setae. Apical organ of third antennal segment of 2 short, apically expanded rods. Postantennal organ of 7–8 (rarely 6) lobes, 1.6–1.9 times as long as largest eye. Tibiotarsus without spinelike or clavate setae. Unguis with well-developed inner tooth. Ventral tube with 3 + 3 setae. Dens with 2 to 3 complete rows of coarse dorsal tubercles and third and sometimes fourth on its basal $\frac{1}{3}$, and 5 dorsal setae. Mucro with straight, pointed rod and broad, simple lamellae. All body setae smooth and acuminate, few in number and mostly remarkably small; one small median ventral seta on sixth abdominal segment. Male genital plate not seen. Maximum length 0.8 mm.



Remarks: Hawaiian specimens we have seen are all female. This tiny species is unusual in the depauperate chaetotaxy. The small size makes it difficult to study, but most populations throughout the Islands appear uniform. One high-altitude collection (5341, from 8000 ft. on Mauna Loa) has the postantennal organ 2.8 times the diameter of the nearest eye and might represent a distinct taxon.

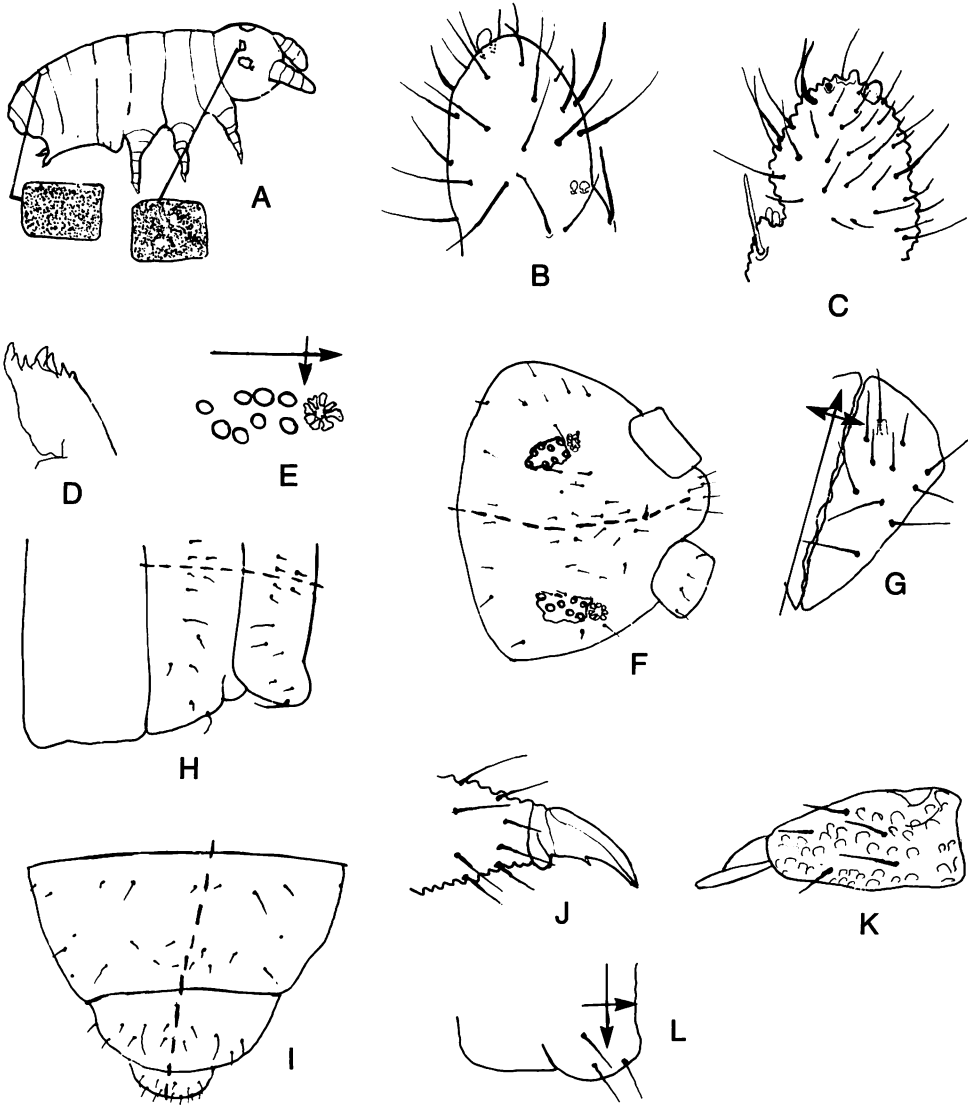


Plate 20—*Brachystomella parvula*: A, habitus (6712, Kauai); B, dorsum of fourth and apex of third antennal segment (4863, Hawaii); C, venter of same (5664, Hawaii); D, maxilla (4863, Hawaii); E, left eyepatch and postantennal organ (same); F, dorsal cephalic chaetotaxy (4860, Hawaii); G, left labial triangle (4807, Oahu); H, dorsal chaetotaxy, right side, second thoracic segment—first abdominal segment (5664, Hawaii); I, same, left side, fourth to sixth abdominal segments; J, fore foot complex (5341, Hawaii); K, mucro and dens (same); L, ventral tube (6712, Kauai).

Ecology: Mostly found in open ohia woods and scrub, in litter and soil, below 1200 m; also in other open areas and grasslands; one record from moss.

Records: Hawaii: 4854, 4859, 4860, 4861, 4863, 4865, 4867, 4869, 4871, 4904, 4905, 4930, 4932, 5111, 5115, 5341, 5664, 5668, 6824, 6912. Oahu: 4796, 4805, 4807, 4814. Kauai: 5288, 6712.

Genus **SETANODOSA** Salmon, 1942

Type species: *S. tetrabrachta* Salmon, 1942

This genus includes species with the characteristic brachystomelline maxilla, no mandible, and no furcula. There is a single Hawaiian species.

Setanodosa kanalua Christiansen and Bellinger, **new species** (Plate 21)

Color blue, varying from dark to mottled over body and appendages, pigment being in punctiform masses with scattered granules between; eyepatches not clearly darker. Fourth antennal segment fused to third, without blunt setae, with a strongly trilobed apical bulb and a ventral file of some 12 setae that are about half as long as neighboring setae and truncate. Apical organ of third antennal segment of 1 ovoid and 1 indented blunt peg behind integumentary papillae. Labium with numerous relatively similar setae. Postantennal organ of 4–6 lobes, subequal to or slightly smaller than eyes. Eyes 8 + 8. Two dorsal tenent hairs clavate; a third inner seta sometimes weakly clavate. Unguis untoothed. Ventral tube not clearly observed. Long lateral setae of the last 3 abdominal segments clavate, and longest posterior abdominal setae occasionally blunt; other body and head setae acuminate and smooth. Male genital plate not seen. Maximum length 1.8 mm.

Remarks: We have seen two specimens of this species, one from Hawaii and one from Oahu. They agree in most features, but differences in the number of postantennal organ lobes (6 and 4, respectively) and other details suggest that two species may be involved. Most other species of *Setanodosa* differ from *kanalua* in having only five eyes or more than three tenent hairs; "*Anurida*" *rosasi* Bonet, 1934 is said to have five maxillary teeth and is otherwise insufficiently described.

Derivatio nominis: Hawaiian, doubtful.

Type locality: Holotype, Hawaii, Hilo, Saddle Road, VIII-30-1957, 2000 ft., beaten from ohia trees, Mockford (6533).

Additional record: Oahu: 4818.

Genus **FRIESEA** Dalla Torre, 1895

Type species: *Triaena mirabilis* Tullberg, 1871

Members of this genus are characterized by the absence of the postantennal organ and by the characteristic triangular, lamellate maxilla; most species have an odd number of anal spines. Three species of *Friesea* are known from Hawaii at present: *kai*, *ninau*, and *oleia*; one of these may be a species complex.

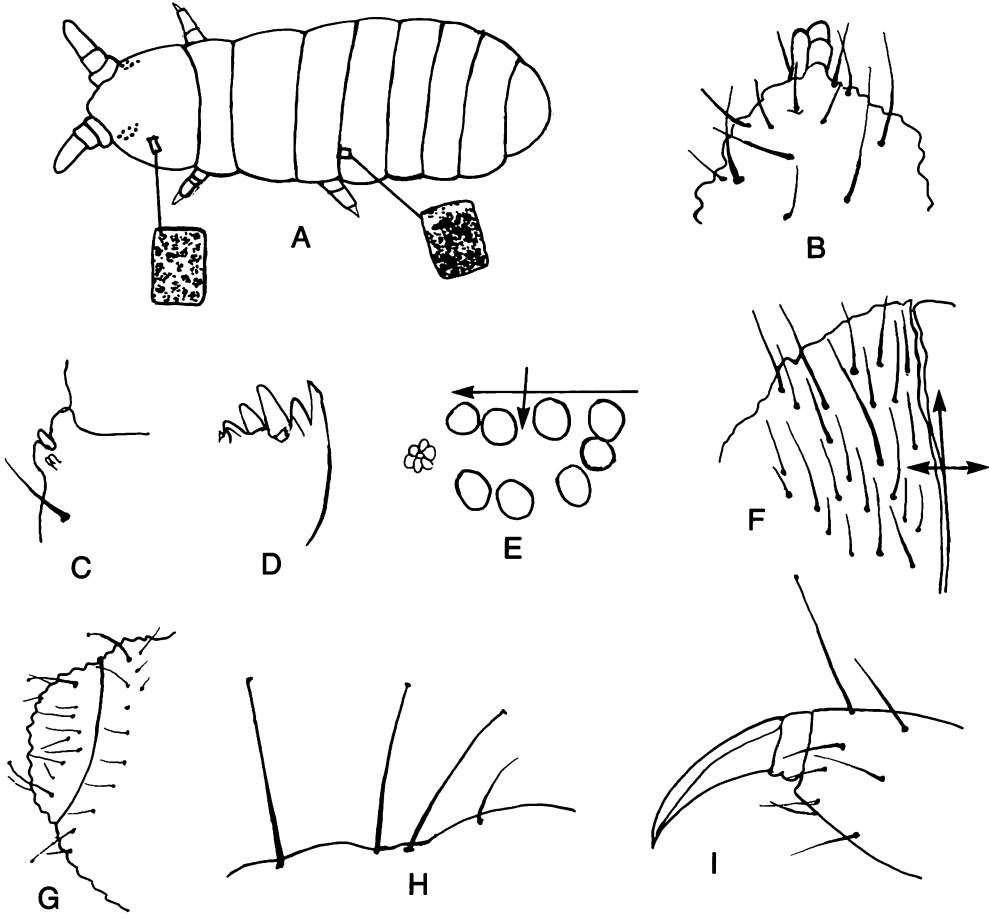


Plate 21—*Setanodosia kanalua*: A, habitus (holotype); B, apex of fourth antennal segment (same); C, apical organ of third antennal segment (same); D, maxilla (same); E, eyes and postantennal organ, left side (same); F, right labial triangle (same); G, dorsum, last two abdominal segments (4818, Oahu); H, enlargement of large posterior abdominal setae (same); I, hind foot complex (same).

Table 5. Summary of Chaetotactic Features of Hawaiian *Friesea* *

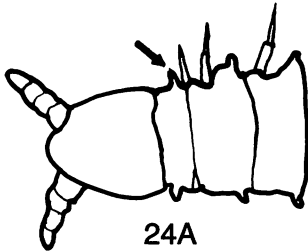
DORSAL	HEAD	TH. II	TH. III	ABD. I	II		III			IV						V	VI								
	c ₄	m ₄	m ₄	m ₅	m ₅	m ₆	a ₂	m ₅	m ₆	a ₂	a ₃	a ₄	a ₅	a ₆	m ₂	m ₃	m ₅	m ₆	a ₂	a ₃	a ₄	m ₀	m ₁	m ₂	p ₀
<i>kai</i>	+	+	+	±	-	-	+	+	+	±	+	+	+	+	-	-	+	+	-	-	+	s	-	+	-
<i>ninau</i>	+	±	±	-	-	-	-	-	-	±	+	+	-	+	-	-	+	-	-	-	-	s	-	+	-
<i>oleia</i>	+	-	-	-	-	-	+	-	-	+	+	+	+	+	-	+	+	+	+	+	+	-	-	-	+

VENTRAL	ABD. II						III								IV						V									
	a ₂	a ₃	m ₁	m ₂	m ₃	p ₅	a ₂	a ₅	a ₇	m ₁	m ₇	m ₈	p ₂	p ₃	p ₆	p ₇	a ₁	a ₂	a ₄	m ₀	m ₁	p ₂	p ₃	a ₁	a ₂	a ₃	a ₄	a ₅	a ₆	p ₃
<i>kai</i>	+	-	-	+	-	+	+	-	+	+	+	-	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+
<i>ninau</i>	+	+	+	+	±	±	+	±	±	+	+	±	±	+	-	+	+	±	+	+	-	+	+	+	-	+	+	+	+	+
<i>oleia</i>	-	+	-	+	+	+	+	+	-	+	-	-	+	+	+	+	-	-	-	-	+	+	-	+	+	+	+	+	+	+

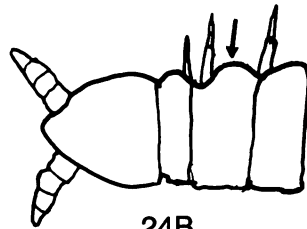
*For designation of chaetotaxy features see Grow and Christiansen (1974).

KEY TO HAWAIIAN SPECIES OF FRIESEA

1. Three curved anal spines. **ninau**
 Six to 8 straight anal spines. 2
 2(1). Thorax with lateral projections (Fig. 24A). **kai**
 Thorax without lateral projections (Fig. 24B). **oleia**



24A



24B

Friesea kai Christiansen and Bellinger, **new species** (Plate 22)

Color dark blue. Fourth antennal segment with apical bulb trilobed (possibly sometimes bilobed), in a deep pit, and 6 large curved blunt setae on the dorsal and lateral surfaces; ventral surface with many acuminate and slightly peglike setae. Sense organ of third antennal segment with 2 short, heavy curved pegs on dorsal surface and 2 long, curved, pointed thick setae on ventral surface. Eyes 8 + 8, normal in size and position. Mouthparts normal for group, mandible with 4 small distal teeth and 4 large basal ones, the apical tooth smaller than others and usually beside the anteapical tooth and difficult to see; the basalmost tooth is very thin and flexible. Dorsal maxillary lamella with 14–19 very fine teeth; ventral lamella with 2 teeth and a basal pluglike structure. Thoracic segments each with paired tubular lateral projections bearing an indented area of unsculptured cuticle apically. Tenent hair long and acuminate. Unguis without teeth and unusually long and acuminate. Ventral tube with 3 + 3 setae. Tenaculum with 2 + 2 teeth. Mucro well separated from dens, with a basal bulbous swelling. Anal spines 7, in rows of 4, 2, and 1. Maximum length 2 mm.

Remarks: This species is distinguished from all other members of the genus by the thoracic projections. In other respects it is most similar to *F. oshoro* Uchida and Tamura, 1966, which has a relatively longer mucro, and to *F. petiti* (Delamare and Massoud, 1964), from which it differs in anal spines and other respects. It shares the peculiar pluglike structure on the maxilla with *F. carlota* Christiansen and Bellinger, 1988 and *F. rothi* Christiansen and Bellinger, 1988.

Derivatio nominis: Hawaiian, shore.

Ecology: Found only in the upper and middle littoral zone.

Type locality: Holotype and 12 paratypes, Hawaii, Hilo, Banyan Drive near Uncle Billy's Hotel, I-19-1982, rocky shore, porous lava, high-tide zone, KC (5130).

Additional records: Oahu: 4831. Kauai: 6528, 6529, 6534.

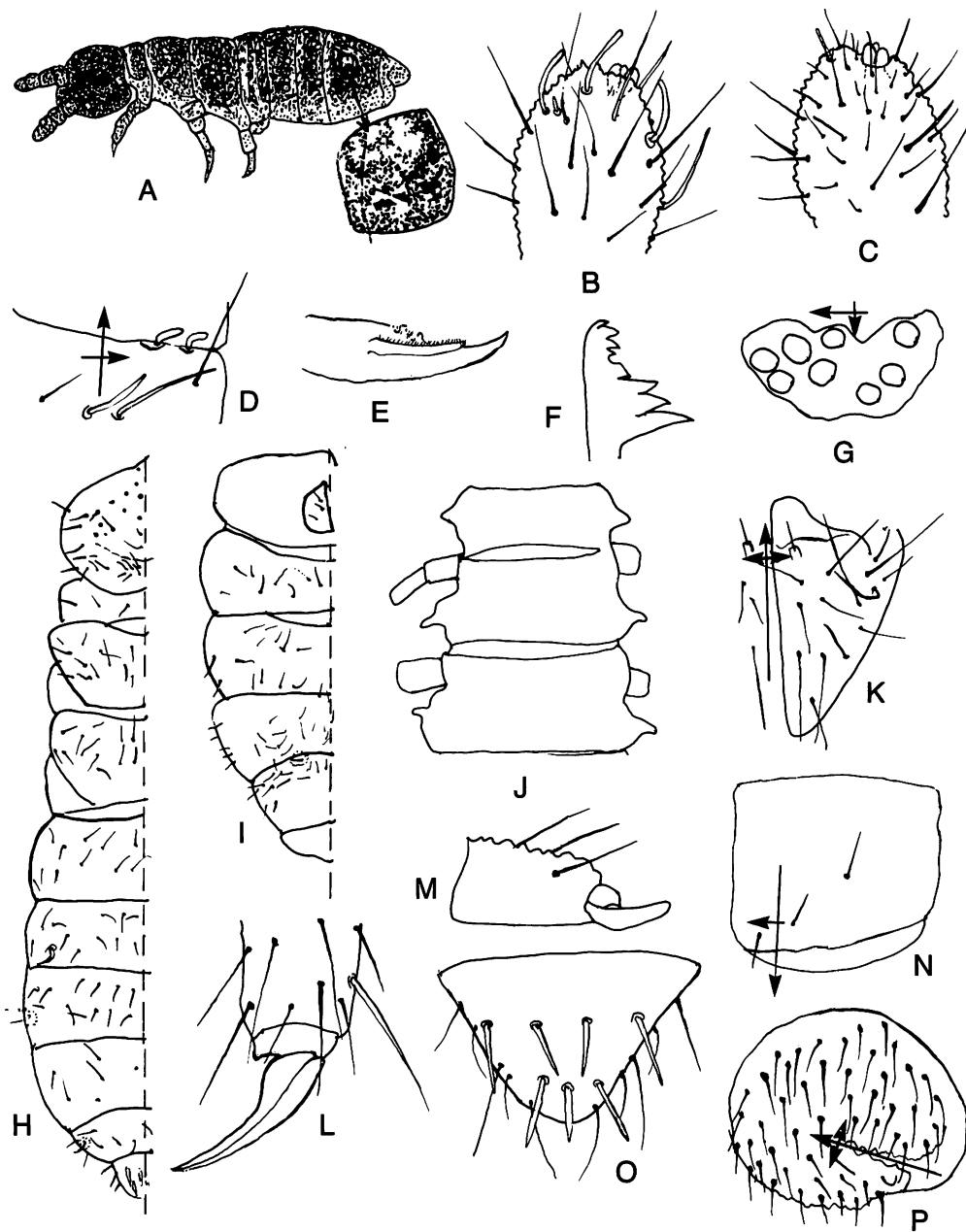
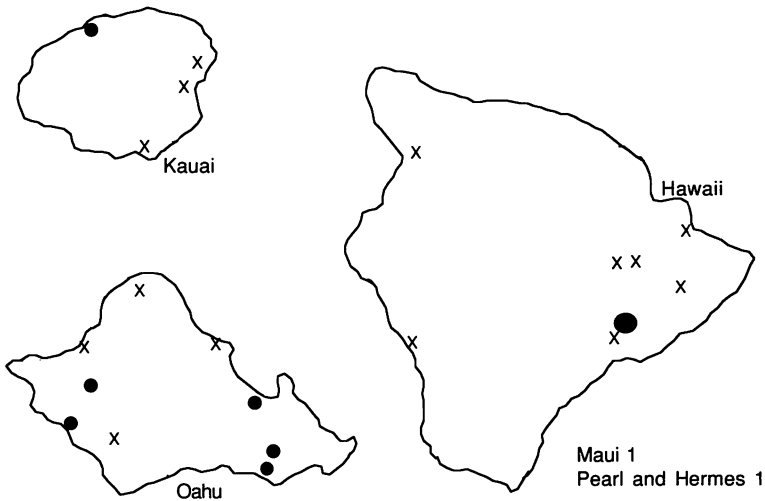


Plate 22—*Friesea kai*: A, habitus (paratype); B, dorsal surface, fourth antennal segment (holotype); C, ventral surface, fourth antennal segment (same); D, apical organ, third antennal segment (same); E, maxilla (same); F, mandible (same); G, left eyepatch (6534, Kauai); H, semidiagrammatic dorsal chaetotaxy (composite, type specimens), encircled setae float; I, ventral abdominal chaetotaxy (holotype); J, outline of thorax seen from above, showing lateral tubercles (same); K, left labial triangle (paratype); L, hind foot complex (4831, Oahu); M, mucro and dens (paratype); N, ventral tube (6534, Kauai); O, sixth abdominal segment (holotype); P, male genital plate (paratype).

Friesea ninau Christiansen and Bellinger, **new species** (Plate 23)*Friesea sublimis* Macnamara of Bellinger and Christiansen, 1974

Color dark blue to pale grayish blue with venter paler. Fourth antennal segment with a clear unlobed apical bulb, slightly displaced from tip and deeply withdrawn, and with 6 curved blunt setae, the apical 2 being considerably thicker than the others; without clearly differentiated peglike setae. Labral setae 2, 3, 5, 2, with the median unpaired setae longer than the others. Mandible with 5 apical teeth and 3 larger basal teeth. Maxilla with 3 lamellae; largest with 1 tooth, middle lamella with about 10 fine teeth, and smallest lamella apparently with 3 teeth. Labial chaetotaxy as in other members of genus (see Pl. 23G). Eyes 8 + 8, subequal, in normal arrangement. Tenent hairs weakly clavate, 5 (rarely 4) per foot. Ungual teeth absent. Ventral tube with 4 + 4 setae. Tenaculum with 2 + 2 teeth. Furcula about 0.9 length of hind unguis; dens with 3 setae; mucro clearly separated from dens, with lamella weak or absent. Anal spines 3, subequal in size. Chaetotaxy as shown in Table 5; large setae on fifth and sixth abdominal segments clavate to rounded apically. On fourth abdominal segment, the p setae are usually but not always clavate or truncate; remaining large setae vary, but usually there is at least 1 pair of clavate setae per segment. Female genital plate with about 12–16 simple setae. Male genital plate with 18–30 simple setae. Maximum length 1.5 mm.



Remarks: The Hawaiian forms may represent a species complex, or fall within the range of variation of some previously named species, but we prefer to treat them as one species until the systematics of the group of *Friesea* with three anal spines has been clarified. *Friesea ninau* differs from *F. sublimis* Macnamara, 1921 (as redescribed from Macnamara's types by Rusek [1971b]) in the structure of the maxilla and absence of unguual teeth. It also resembles *F. claviseta* Axelson, 1900, but differs from *claviseta* as defined by Massoud (1967) in having the mucro sepa-

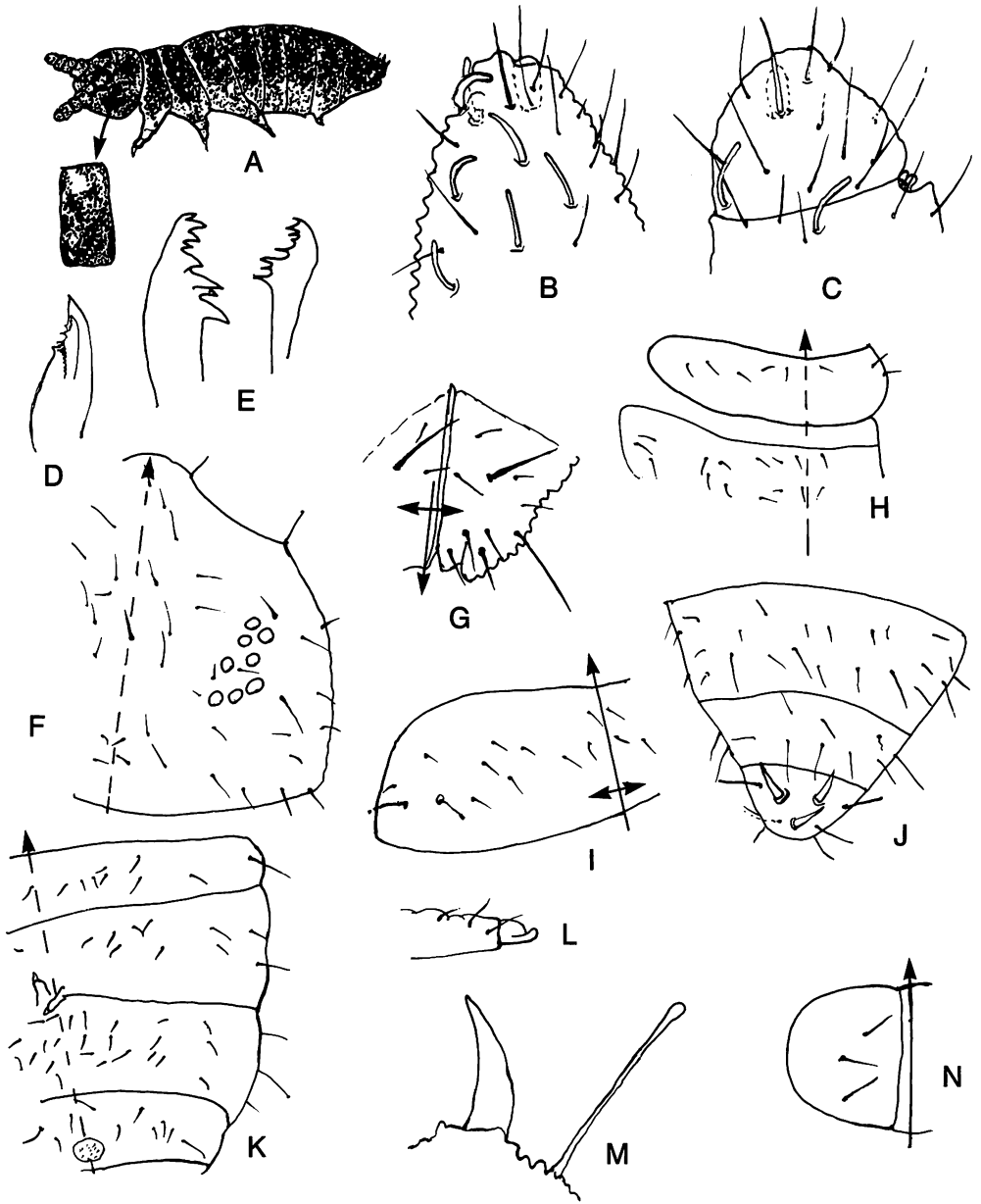


Plate 23—*Friesea ninau*: A, habitus (6758, Oahu); B, dorsal surface, fourth antennal segment (4806, Oahu); C, ventral surface, fourth antennal segment and apical organ, third antennal segment (same); D, maxilla (5207, Kauai); E, right and left mandibles (same); F, eyes and cephalic chaetotaxy, right side (5059, Hawaii); G, right labial triangle (4808, Oahu); H, chaetotaxy, left side, first and second thoracic segments (holotype); I, chaetotaxy, left side, first abdominal segment (same); J, dorsal chaetotaxy, last three abdominal segments (5059, Hawaii); K, ventral abdominal chaetotaxy, left side, second through fifth abdominal segments (5207, Kauai); L, mucro and dens (4806, Oahu); M, anal spine and neighboring seta (same); N, ventral tube (5207, Kauai).

rate from the dens, and from the description of Stach (1949) and of Christiansen and Bellinger (1980) in the enlarged two apical antennal blunt setae; no good recent redescription of Scandinavian *F. claviseta* is available.

The Hawaiian populations are quite variable in form of the mucro, blunt setae of the fourth antennal segment, and distribution and form of body setae. Some of this variation seems to be geographic. Specimens from Hawaii have the posterior dorsal setae of the fourth abdominal segment short, acuminate, and often serrate. In specimens from Kauai, these setae are long and clavate, while they are intermediate in specimens from Oahu. Specimens from Kauai are also larger than those from Oahu or Hawaii and may also differ from them in lacking seta a_5 on the fourth abdominal segment. In addition, specimens from the Hanakapiai Stream Trail on Kauai show more variation than that seen in all other populations combined.

Derivatio nominis: Hawaiian, question.

Ecology: Most commonly found in moss at all elevations. Also found in litter, soil, nests, and animal bedding.

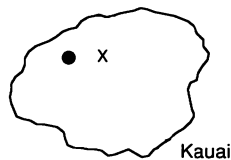
Type locality: Holotype and 4 paratypes, Kauai, Hanakapiai Stream Trail, 0.5 mi. from beach, VII-8-1981, moss on rocks in stream, Goff (5281).

Additional records: Hawaii: 2994, 4724, 4860, 4869, 4904, 4934, 4939, 4976, 4981, 4997, 4998, 4999, 5000, 5003, 5043, 5050, 5051, 5059, 5119, 5307, 6851. Maui: 5263. Oahu: 4752, 4774, 4775, 4786, 4789, 4798, 4806, 4808, 4813, 4816, 4820, 4840, 4916, 5291, 6526, 6758, 6763. Kauai: 4748, 5207, 5209, 5281, 5282, 6527, 6727. Pearl and Hermes Reef: 4910, 6831.

***Friesea oleia* Christiansen and Bellinger, new species (Plate 24)**

Color dark blue. Fourth antennal segment with an unclear unlobed apical bulb in a shallow pit; 3 curved, slightly blunted setae, the apicalmost being somewhat thicker than the others; ventral surface with 8–10 straight to slightly curved blunt cylindrical short setae. Apical organ of third antennal segment of 2 central small oval pegs and 2 lateral supplementary elliptical rods, about twice as long as inner pegs. Mandible with 2 small subequal apical teeth, 1 median tooth, and 3 large basal teeth. Dorsal lamella of maxilla with 9–11 teeth, middle with 2, and ventral with 4 teeth. Eyes 8 + 8, normal in structure and position. Four anterior and four posterior large heavily clavate tenent hairs on each tibiotarsus. Unguis without teeth. Ventral tube with 3 + 3 setae. Furcula and tenaculum absent. Anal spines heavy, 8 in females and 6 in males. Male genital plate with four large, broad, flat setae and numerous small acuminate setae. Maximum length 2 mm.

Remarks: This remarkable species is unlike any we have previously seen. There



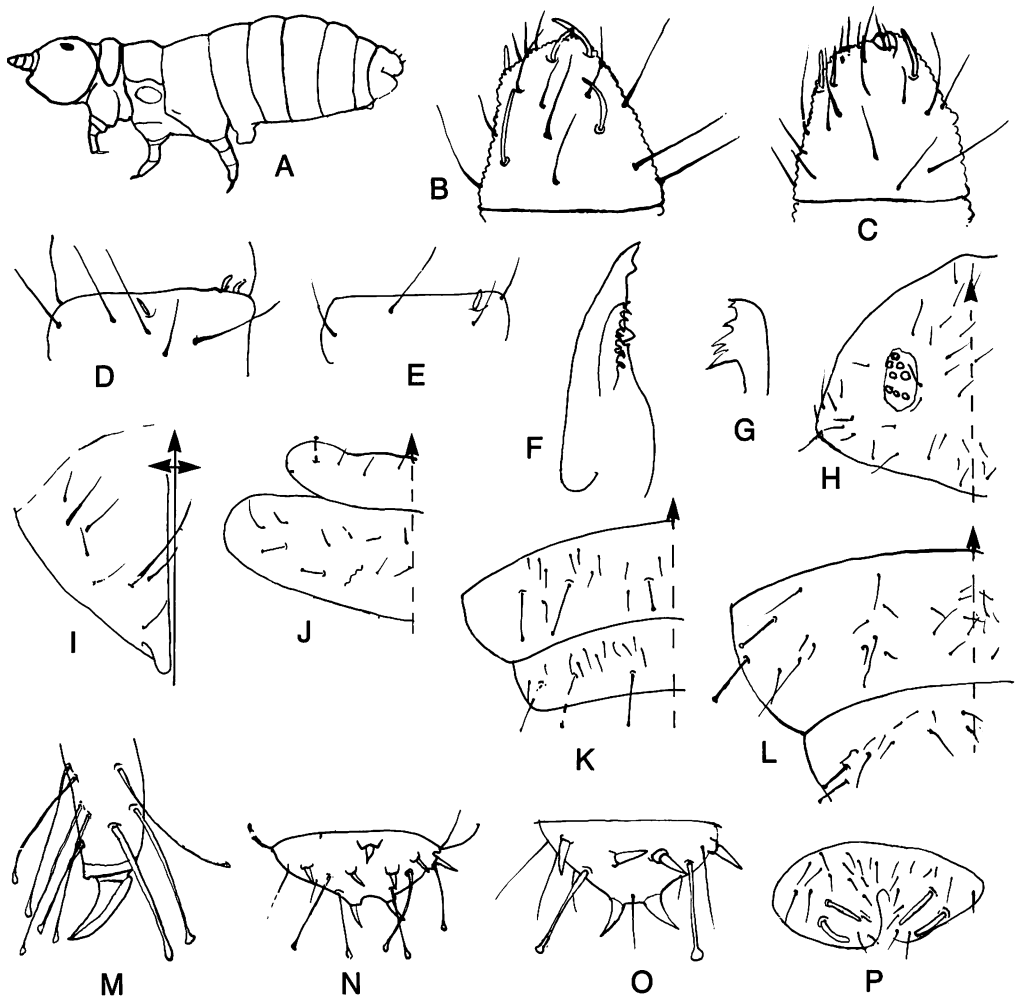


Plate 24—*Friesea oleia* (all figures of specimens from Kauai): **A**, habitus (6528); **B**, dorsal surface, fourth antennal segment (holotype); **C**, ventral surface, fourth antennal segment (same); **D**, apical organ, third antennal segment, dorsal surface (same); **E**, same, ventral surface (same); **F**, maxilla (same); **G**, mandible (same); **H**, left side of dorsum of head (6534); **I**, right labial triangle (same); **J**, dorsal chaetotaxy, left side, first two thoracic segments (holotype); **K**, same, fourth and fifth abdominal segments; **L**, ventral chaetotaxy, right side, fourth and fifth abdominal segments (same); **M**, mid foot complex (6534); **N**, dorsum, sixth abdominal segment (holotype); **O**, same (6534); **P**, male genital plate (same).

are only three specimens, one female and two males, all from the vicinity of the Alakai Swamp. The peculiar condition of the anal spines as well as the numerous heavy tenent hairs, combined with the reduced chaetotaxy, serve to separate it from all known species.

Derivatio nominis: Hawaiian, uncommon.

Ecology: Known from trees in wet upland forest.

Type locality: Holotype, Kauai, near Kokee Inn, VIII-19-1957, beating ohia leaves, Mockford (6529).

Additional records: Kauai: 6528, 6534.

Genus **OUDEMANSIA** Schött, 1893

Type species: *O. coerulea* Schött, 1893

This genus is represented in Hawaii by a single species. The combination of conical projecting mouthparts, absence of postantennal organ, and presence of a large multisetaceous dens makes the genus easy to identify.

Oudemansia esakii (Kinoshita, 1932) (Plate 25)

Icon. Ins. Japon.: 2124 (*Pseudachorutes*).—Yosii, 1958.

Color dark purple-blue with many scattered pale spots and usually pale intersegmental lines. Fourth antennal segment with deeply trilobed apical bulb and 6-7 thick "sensory" setae, only 2 of which are apically blunt; segment separated from third only ventrally. Apical organ of third antennal segment of 2 curved pegs and an accessory blunt seta, none of which are recessed. Mouthparts projecting into a truncate cone. Mandible with 1 large basal tooth, 2 large apical teeth, and 8-13 smaller intermediate teeth. Maxilla styloform. Postantennal organ absent. Eyes 8 + 8, subequal. No clavate tenent hairs. Unguis with clear inner tooth. Unguiculus absent. Ventral tube with 3 + 3 distoanterior setae and 1 + 1 basal setae. Dens subequal in length to manubrium, with 6 dorsal and no ventral setae. Mucro about $\frac{3}{8}$ as long as dens. Integumental granules about 0.004 mm in diameter. All body setae acuminate and smooth. Sixth abdominal segment without clear anal spines but with many basally expanded setae, 6 of which are spinelike. Female genital plate with 16 short, smooth setae. Maximum length 3 mm.

Remarks: The Hawaiian specimens differ in a number of details of chaetotaxy and mandibular structure from descriptions of Japanese specimens, and they may be a separate species, but the general similarity is sufficient that we think it best to consider them conspecific until comparison can be made with Japanese material.

Ecology: Found on intertidal zones and beaches.

Records: Oahu: 5245. Laysan: 6196. Pearl and Hermes Reef: 6197, 6831.

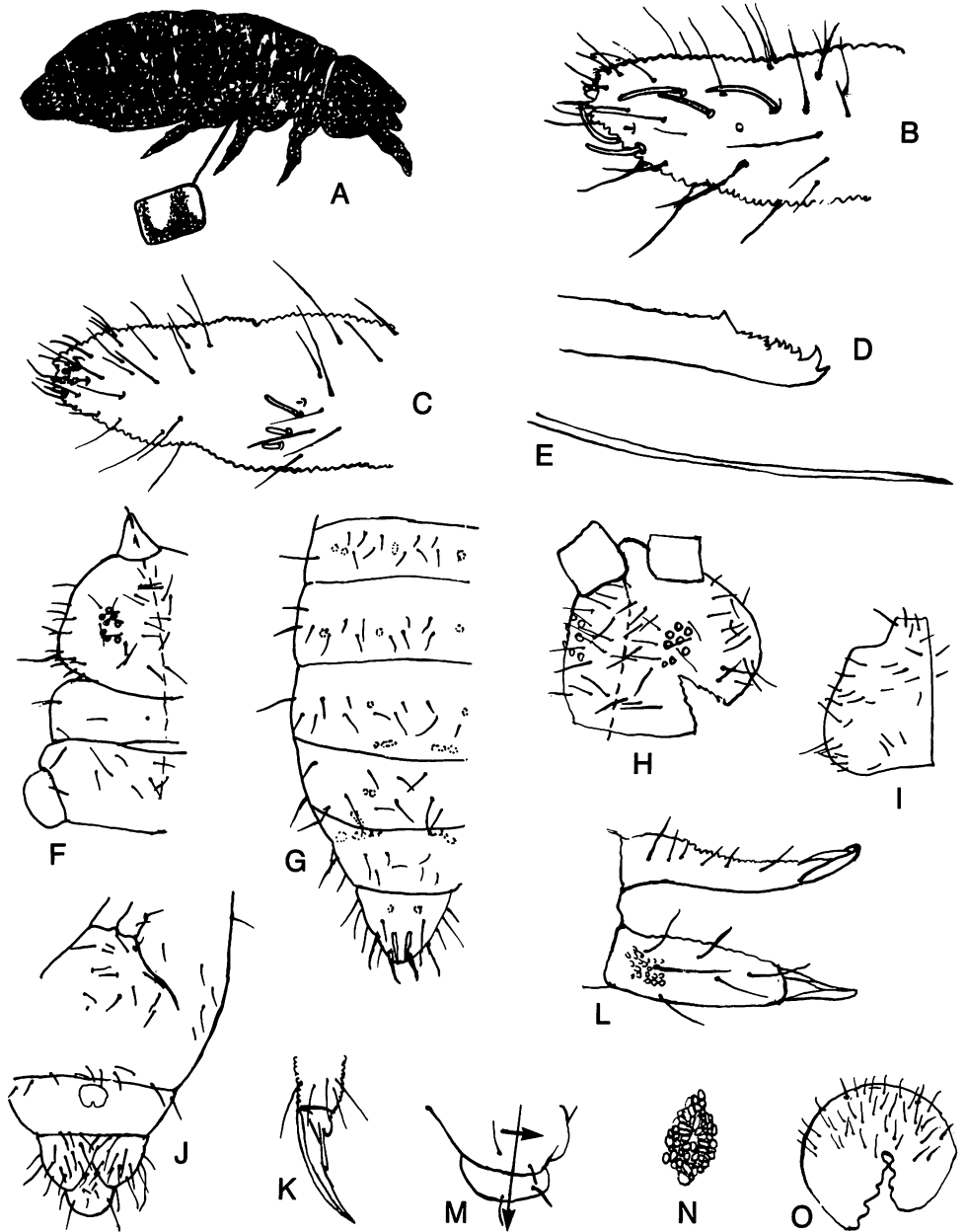


Plate 25—*Oudemansia esakii*: A, habitus (6197, Pearl and Hermes Reef); B, dorsum, fourth and third antennal segments (same); C, same, venter (same); D, mandible (5245, Oahu); E, maxilla (same); F, dorsal chaetotaxy and foveae, left side (6197, Pearl and Hermes Reef); G, same, abdomen; H, dorsal cephalic chaetotaxy (5245, Oahu); I, ventral cephalic chaetotaxy, left side (6197, Pearl and Hermes Reef); J, posterior ventral abdominal chaetotaxy, left side (same); K, hind foot complex (5245, Oahu); L, dentes and mucrones (same); M, ventral tube (6197, Pearl and Hermes Reef); N, detail of abdominal cuticle, dorsum, fourth abdominal segment (5245, Oahu); O, male genital plate (6197, Pearl and Hermes Reef).

Genus **AETHIOPELLA** Handschin, 1942

Type species: *Pseudachorutes flavoantennatus* Philiptschenko, 1926

As defined by Massoud (1967), this genus differs from *Pseudachorutes* only in the moruliform postantennal organ. There is a single Hawaiian species, *A. kuolo*, which is very close to the species of *Pseudachorutes* described here. They are only arbitrarily separated in genus on the basis of the different postantennal organ. In all other respects they are very similar.

Aethiopella kuolo Christiansen and Bellinger, new species (Plate 26)

Color mottled pale blue, paler beneath. Fourth antennal segment fused to third dorsally but separated ventrally, with trilobed bulb in an apical pit and 3 weakly differentiated sensory setae; no ventral "file." Apical organ of third antennal segment of 2 short angled rods in a shallow groove at the intersegmental fold. Mandible with 3 teeth. Maxilla styliiform. Postantennal organ with over 30 lobes in a cluster, about $1\frac{1}{4}$ times diameter of nearest eye. Eyes 8 + 8, subequal. Tenent hairs acuminate; inner subapical seta much longer than others. Unguis with small but clear inner tooth. Ventral tube with 3 + 3 setae. Tenaculum without setae, with 2 + 2 teeth. Furcula short; dens with 3 setae, a little less than twice as long as mucro. Mucro with clear lateral lamella and basal swelling. Dorsal chaetotaxy unusual, with each body segment having 1 pair of large lateral setae and a number of minute (7–10 μm long) setae, which are irregular in position and difficult to see. All setae acuminate and smooth. Female genital plate with 6 setae. Male genital plate with 26 setae in 2 circles, those of the inner circle being thicker than others. Maximum length 1.25 mm.

Remarks: We have only three specimens of this species, but since they include an adult male and female and the form is so distinctive we believe it merits description. It resembles *Pseudachorutes insularis* Yosii, 1965 in some respects, but has a very different mucro. The most similar species of *Aethiopella* is *A. tournieri* Delamare, 1951, which has four mandibular teeth, a mucro that is only $\frac{1}{3}$ as long as the dens, and a striking blue-and-white pattern.

Derivatio nominis: Hawaiian, baggy.

Type locality: Holotype and 2 paratypes, Kauai, Hanalei Valley State Conservation Area, VII-25-1986, 100 m, dry forest, under bark, KC (6728).

Ecology: In mixed forests under bark and in moss in lowland area.

Additional records: Kauai: 5209, 6717.

Genus **PSEUDACHORUTES** Tullberg, 1871

Type species: *P. subcrassus* Tullberg, 1871

This genus is readily distinguished from most other Hawaiian forms by the combination of conically projecting mouthparts, 8 + 8 eyes, absence of the unguiculus, and well-developed furcula with a single mucronal lamella. The most similar spe-

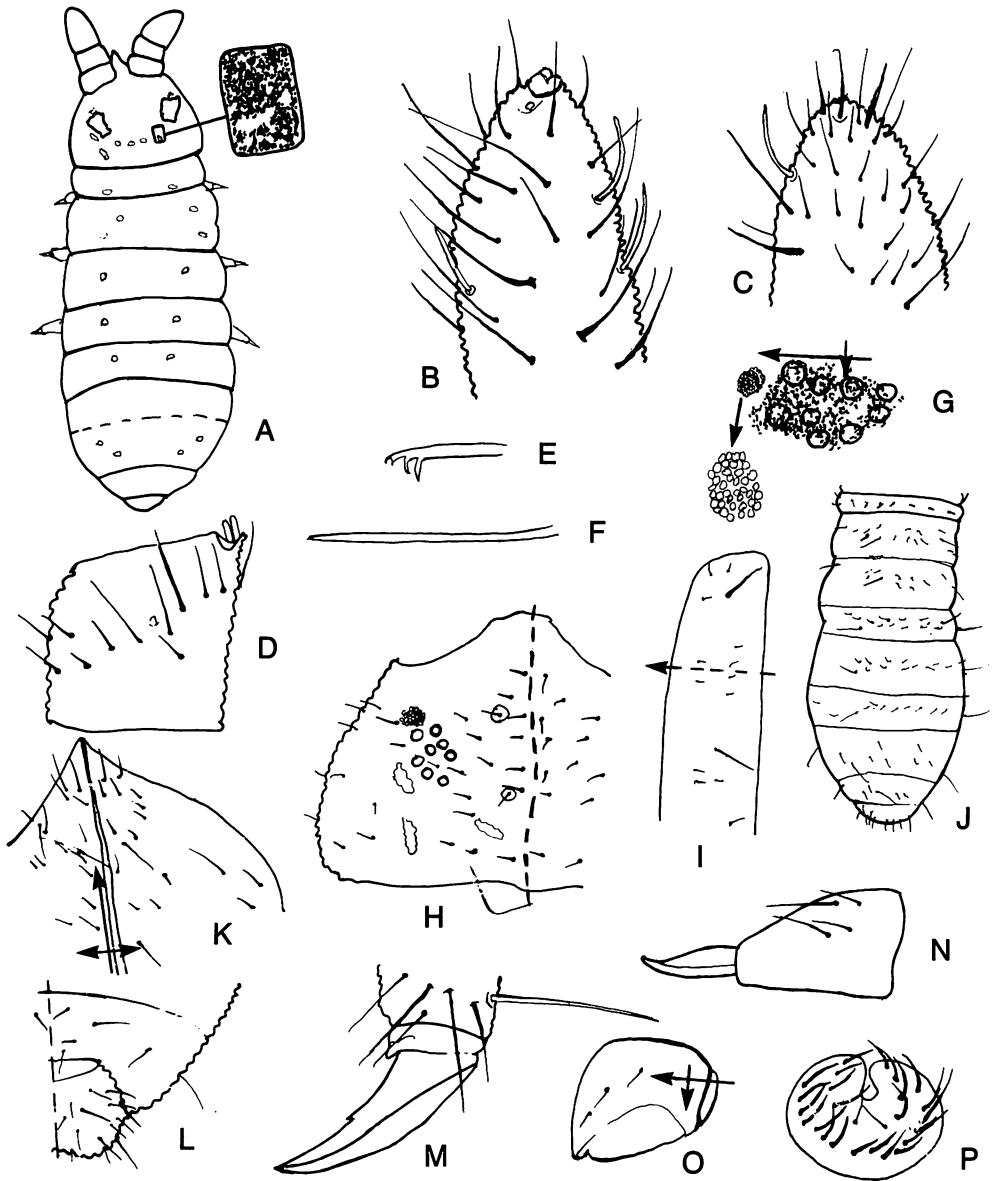


Plate 26—*Aethiopella kuolo*: A, habitus, with clear nongranulate areas shown (6717, Kauai). All remaining figures of 5209, Kauai: B, dorsum, third and fourth antennal segments; C, venter, fourth antennal segment; D, venter of third antennal segment; E, mandible; F, maxilla; G, left eyepatch and postantennal organ; H, dorsal chaetotaxy, left half of head, encircled setae sometimes absent; I, enlargement of second thoracic segment chaetotaxy; J, dorsal trunk chaetotaxy; K, ventral cephalic chaetotaxy; L, ventral abdominal chaetotaxy, left side, last two abdominal segments; M, hind foot complex; N, mucro and dens; O, ventral tube; P, male genital plate.

cies belongs to the genus *Aethiopella*, which is arbitrarily separated as a result of its having the tubercles of the postantennal organ in a cluster instead of a single ring. There is a single Hawaiian species, *P. poahi*.

***Pseudachorutes poahi* Christiansen and Bellinger, new species (Plate 27)**

Color dark blue with paler intersegmental membranes, ventral surface, and appendages. Fourth antennal segment with apical bulb in a shallow pit, unlobed but sometimes apically indented, and 4 to 6 curved, blunt "sensory" setae; fourth antennal segment fused to third dorsally and only weakly separated ventrally. Third antennal segment apical organ of 2 subspherical pegs. Mandible reduced and unclear, apparently with only 1-2 apical teeth. Maxilla styliform. Postantennal organ with 7-8 lobes in a rough circle, subequal to nearest eye in diameter. Eyes 8 + 8, subequal. Tenent hairs small and acuminate. Unguis with a strong inner tooth. Ventral tube with 3 + 3 setae. Tenaculum with setae, with 3 + 3 teeth. Furcula well developed; dens with 5-6 dorsal setae, 3 times as long as mucro; mucro with large lateral lamella and a basal swelling that is sometimes tuberculate. All body setae acuminate and smooth. Head and first 6 trunk segments with well-developed paired pseudopores. Female genital plate with 10 setae. Male not seen. Maximum length 1.4 mm.

Remarks: This species resembles both *P. curtus* Christiansen and Bellinger, 1980 and *P. japonicus* Kinoshita, 1916. It differs from the former in lacking a ventral antennal "file" and in mouthparts and chaetotaxy. It differs from both species in the postantennal organ and mucronal structure. The chaetotaxy and mandible are obscure and not seen clearly in any specimen.

Derivatio nominis: Hawaiian, obscure.

Type locality: Holotype and 5 paratypes, Hawaii, east slope of Mauna Loa, X-31-1971, 8000 ft., pitfall trap, Jacobi (5341).

Genus **ANURIDA** Laboulbène, 1865

Type species: *Achorutes maritimus* Guérin, 1838

This genus is characterized by the absence of a furcula, unlobed sixth abdominal segment, and the presence of toothed mandibles without a molar plate and a well-developed postantennal organ. The only known Hawaiian species is a minute member of the subgenus *Micranurida* Börner, 1901 (type species: *M. pygmaea* Börner, 1901).

***Anurida (Micranurida) anini* Christiansen and Bellinger, new species (Plate 28)**

Color white, with eyes dark. Fourth antennal segment with a strong unlobed apical bulb in a moderately deep pit and 5 broadly oval "sensory" setae. Apex of third antennal segment ventrally with 2 minute pegs and 2 lateral thickened rods. Mandible not clearly seen but apparently with 3 teeth. Maxilla simple. Eyes 2 + 2, subequal, on separate pigment spots. Postantennal organ with 6-7 lobes, slightly

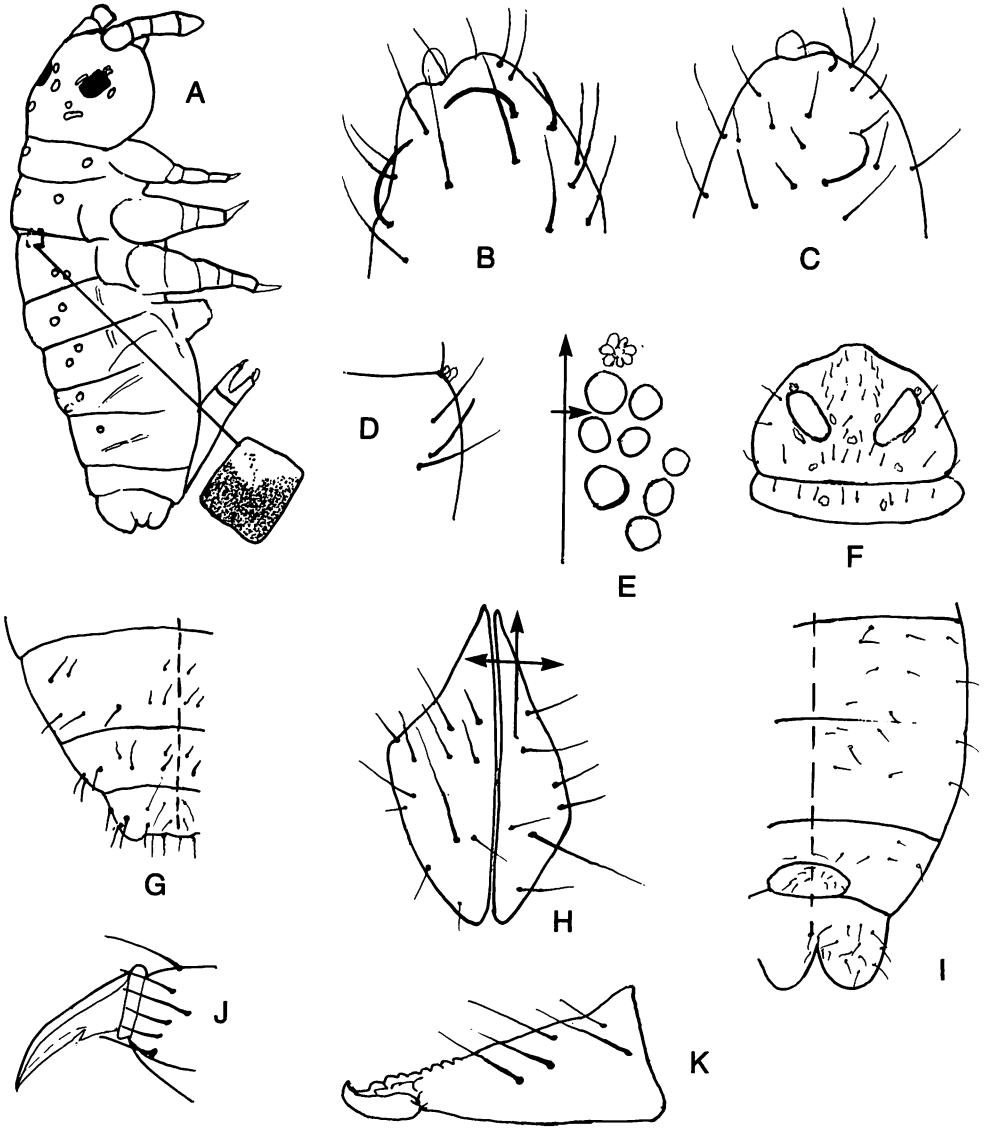


Plate 27—*Pseudachorutes poahi*: A, habitus (holotype); B, dorsum of antennal apex (same); C, ventral surface of antennal apex (same); D, apical organ, third antennal segment (same); E, left eyepatch and postantennal organ (paratype); F, chaetotaxy, head and first thoracic segment, and foveae (composite, types); G, posterior dorsal chaetotaxy (paratype); H, labial chaetotaxy (paratype); I, ventral chaetotaxy, last four abdominal segments (composite of two paratypes); J, hind foot complex (holotype); K, manubrium and dentes (same).

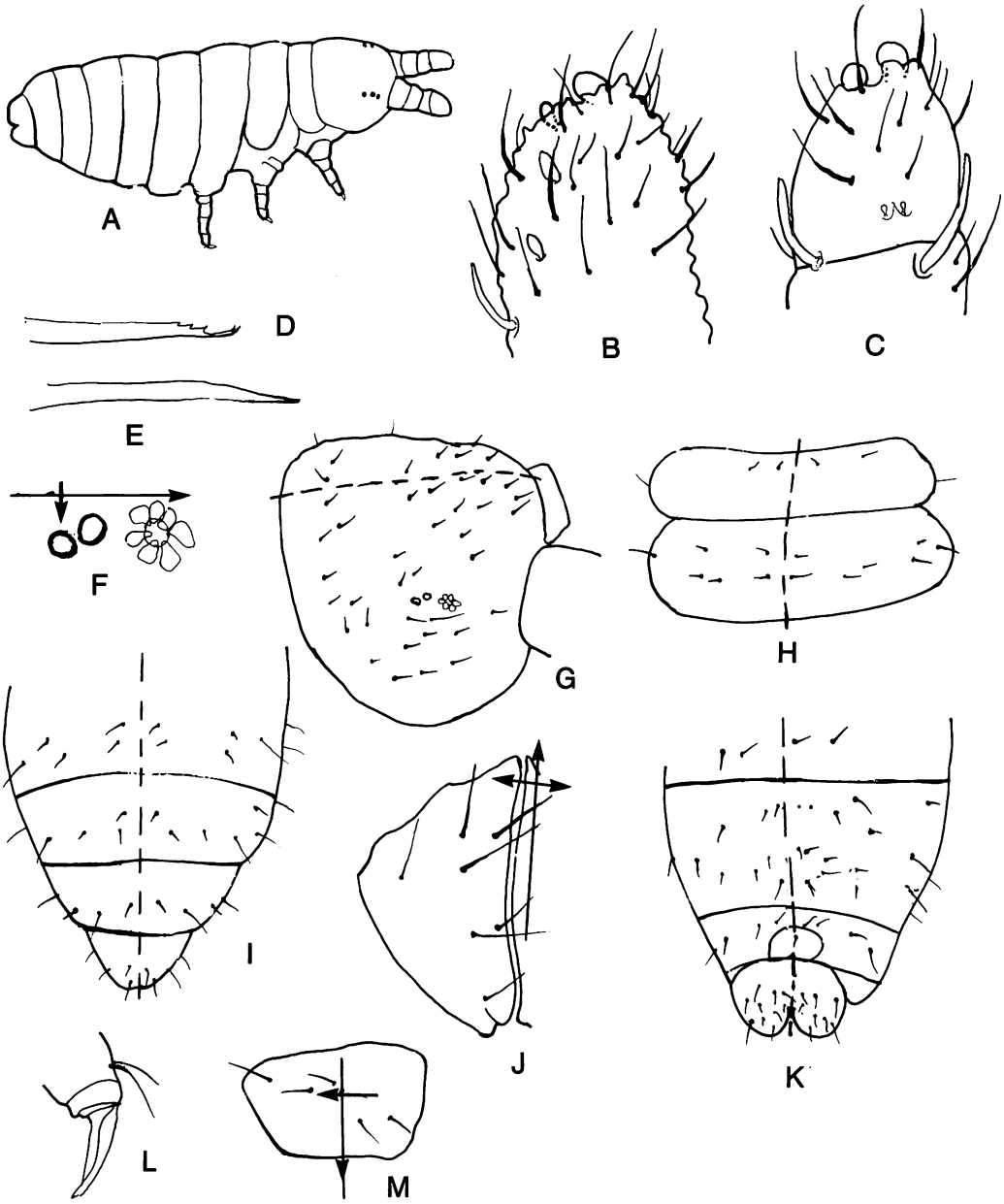


Plate 28—*Anurida (Micranurida) anini*: **A**, habitus (holotype); **B**, dorsal surface, third and fourth antennal segments (same); **C**, lateral surface, third and fourth antennal segments (same); **D**, mandible, seen on edge (paratype); **E**, maxilla (same); **F**, eyes and postantennal organ (same); **G**, cephalic dorsal chaetotaxy (same); **H**, dorsal chaetotaxy, first two thoracic segments (holotype); **I**, dorsal abdominal chaetotaxy, last four segments (paratype); **J**, ventral cephalic chaetotaxy, right side (holotype); **K**, ventral abdominal chaetotaxy, left side, last three abdominal segments (paratype); **L**, hind foot complex (paratype); **M**, ventral tube (holotype).

more than twice diameter of nearest eye. Tenent hair acuminate. Unguis without inner or lateral teeth. Unguiculus absent. Ventral tube with 4 + 4 setae. Integument finely and uniformly granulate; granules about 1 μm in diameter. Body setae all short, slightly curved, and acuminate. Female genital area not clearly set off from surrounding integument, without setae. Maximum length 0.6 mm.

Remarks: Specimens we have seen are very similar to *A. (M.) pygmaea* and to *A. (M.) meridionalis* Cassagnau, 1952. *A. anini* differs from both in the possession of five broadly oval antennal setae. Chaetotaxy of the Hawaiian specimens is unlike that of nearctic *A. (M.) pygmaea*; the chaetotaxy of *A. (M.) meridionalis* has not been illustrated. The status of this form requires further study. Known only from the type locality.

Derivatio nominis: Hawaiian, tiny.

Type locality: Hawaii, Puu Anahulu, III-28-1964, 2300 ft., mixed forest, litter, Haas (5115).

Genus **PARANURA** Axelson, 1902

Type species: *Paranura sexpunctata* Axelson, 1902

Members of this genus have an undivided sixth abdominal segment, clearly visible from above; no postantennal organ; fewer than 6 + 6 eyes; no furcula; no unguiculus; well-developed blunt antennal setae; and reduced maxillae and tridentate mandibles as in *Neanura*.

The concept of *Paranura* as recognized in *The Collembola of North America* has been revised by Deharveng (1981a) to exclude the species with one greatly enlarged antennal blunt seta (transferred to *Sensillanura*). The Hawaiian species described here does not fit well in *Paranura* in either sense, but we do not wish to erect a new genus on the basis of the material at hand.

Paranura nalo Christiansen and Bellinger, **new species** (Plate 29)

Color white. Body greatly flattened, recalling *Phylliomeria* Delamare, 1948, dorsally concave in alcohol. Fourth antennal segment fused with third, with no apical bulb but with 6 indistinct long, blunt setae. Eyes 2 + 2, unusually small and projecting, without pigment. Mandible tridentate; maxilla with 2 finely toothed rami. Labium with 1 large and 7 small setae per side. Tenent hair acuminate. Unguis untoothed, coarsely granulate on inner surface. Ventral tube with 4 + 4 smooth setae. Vestige of furcula in the form of a knob bearing 8 short acuminate setae. All trunk segments distinct except for the fourth and fifth abdominal segments, which are partially fused. Male genital plate with a double ring of 16 minute setae. Body setae short and acuminate, from less than $\frac{1}{4}$ (most) to $\frac{3}{4}$ length of inner edge of unguis. Integument with coarse irregular tubercles, 15–95 μm in diameter, with groups of 4–18 tubercles set off by reticulation. Maximum length about 3.5 mm.

Remarks: This species is unusual in many respects and differs from all the Neanurini with which we are familiar in the small size of the dorsal body setae.

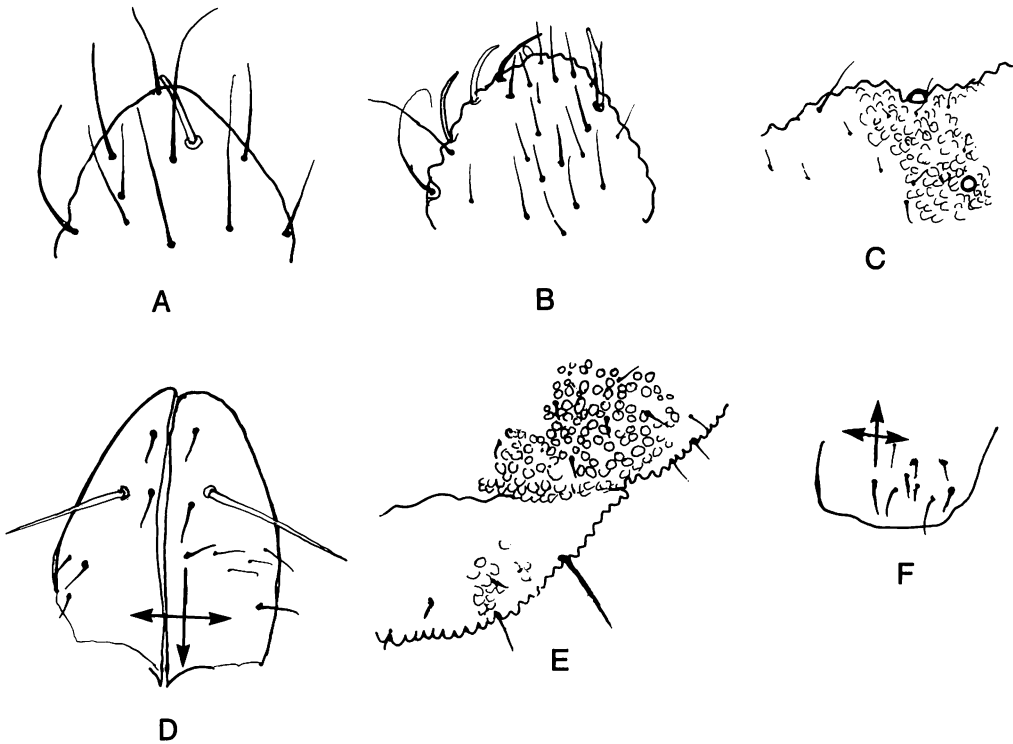


Plate 29—*Paranura nalo* (all figures of 6189, Oahu): A, dorsum, antennal apex; B, venter, same; C, eyes, right side of head; D, labial triangle; E, posterior dorsum of abdomen, right side; F, furcula vestige.

The resemblance to *Phylliomeria* may be more than superficial; however, this form does not fit well in any of the genera associated with *Phylliomeria* by Cassagnau (1983). We have seen only two specimens of this species.

Derivatio nominis: Hawaiian, forgotten.

Type locality: Holotype, Oahu, Poamoho Trail, Koolau Range, VI-15-1972, 650 m, wet leaf litter, Gagne (6189).

Genus **NEANURA** MacGillivray, 1893

Type species: *Achorutes muscorum* Templeton, 1835

We place in this genus all Hawaiian Collembola lacking a furcula and with well-developed body tubercles and a bilobed sixth abdominal segment. The species lack postantennal organs and unguiculi; some body setae are conspicuously larger than others, and these are often serrate and/or blunt. Dorsal cephalic and trunk setae form characteristic groups, identified according to a system formulated by Gama

(1964) (Fig. 25A); the ventral chaetotaxy has also proved useful in some cases (Fig. 25D). Also see Cassagnau and Deharveng (1981).

Recent work on the classification of the Neanurinae by Yosii, Cassagnau, and Deharveng has improved our knowledge of relationships in this group. However, it has also blurred the distinction between genera near *Neanura*; for example, the evolution of simple mouthparts seems to have taken place several times independently. The position of the principal species group in Hawaii in the modern classification is still not clear. We therefore prefer to place all Hawaiian species meeting the definition given here in the single genus *Neanura*, while indicating their presumed position in the system of Cassagnau (1983) by the use of subgeneric names.

There are eight Hawaiian species of *Neanura*: *N. (Protanura) aleo*, *N. (Paleonura) ili*, *N. (Protanura) capitata*, *N. (Protanura) citronella*, *N. (Vitronura) giselae*, *N. (Protanura) hawaiiensis*, *N. (Neanura) muscorum*, and *N. (Morulodes) setosa*.

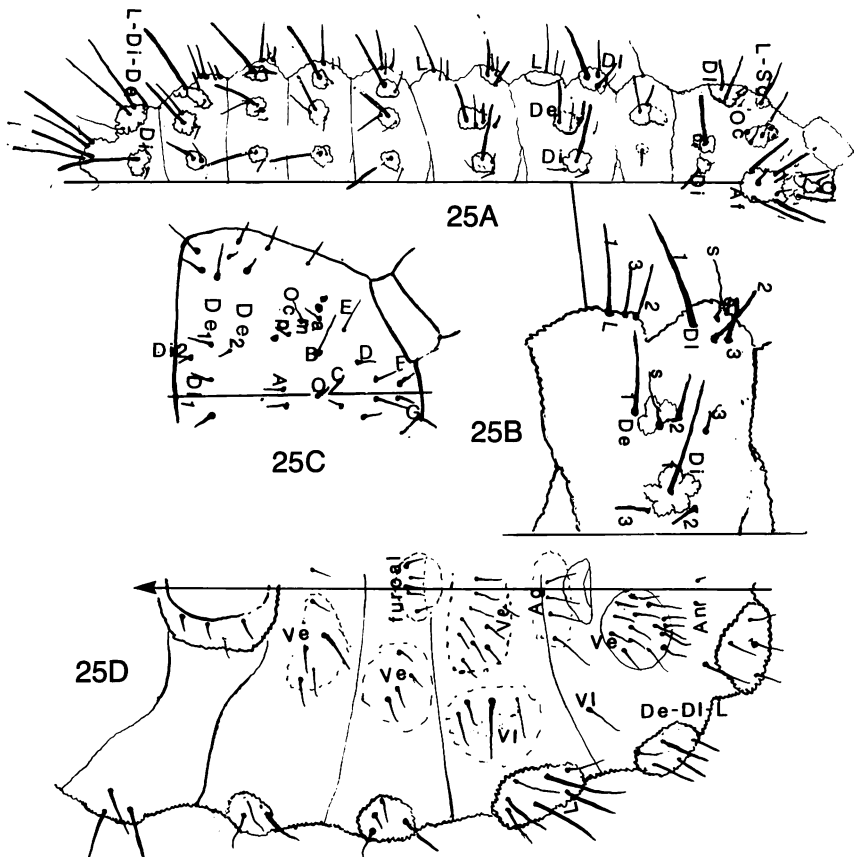
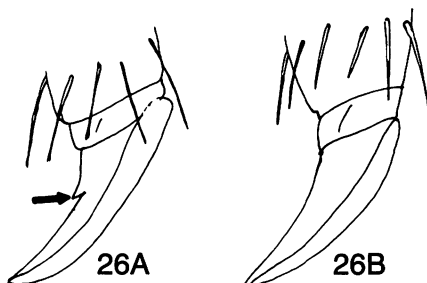


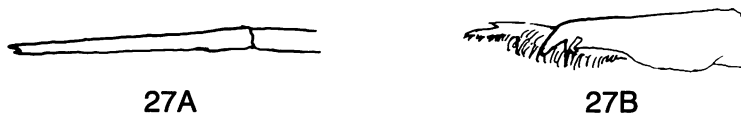
Figure 25—Characters of *Neanura* (all figures after Deharveng): **A**, dorsal chaetotaxy and tubercle designation; **B**, seta designations within tubercles; **C**, cephalic chaetotaxy and seta lettering; **D**, ventral chaetotaxy. Tubercle designations: Af, anterofrontal; Ag, anogenital; An, anal; C, clypeal; De, dorsoexternal; Di, dorsointernal; Dl, dorsolateral; L, lateral; Oc, ocular; So, subocular; Ve, ventral; VI, ventrolateral.

KEY TO HAWAIIAN SPECIES OF NEANURA

1. Unguis with inner tooth (Fig. 26A)..... 2
 Unguis without tooth (Fig. 26B)..... 6



- 2(1). With patches of blue pigmentation; maxilla needlelike (Fig. 27A) (subgenus *Morulodes*)..... **N. (*Morulodes*) setosa**
 Color white to orange; maxilla complex (Fig. 27B) (subgenus *Protanura*)..... 3



- 3(2). Longest body setae clavate (Fig. 28B)..... **N. (*Protanura*) capitata**
 Longest body setae not clavate (Fig. 28A)..... 4

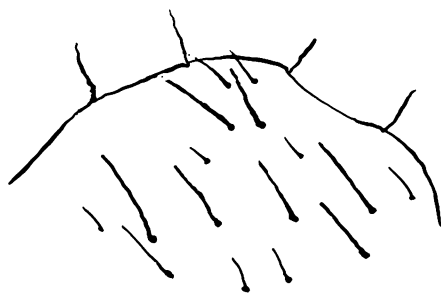


- 4(3). Eyes absent..... **N. (*Protanura*) hawaiiensis**
 Eyes present..... 5
 5(4). Longest body setae less than 2.5 times as long as inner edge of unguis.....
 **N. (*Protanura*) aleo**
 Longest body setae more than 2.5 times as long as inner edge of unguis.....
 **N. (*Protanura*) citronella**
 6(1). Eyes 3 + 3, at least 2 of which are pigmented; color blue (subgenus *Neanura*).....
 **N. (*Neanura*) muscorum**
 Eyes 2 + 2; color white in alcohol, orange in life..... 7

- 7(6). Cephalic setae C and E present (Fig. 29A); dorsal tubercles well developed (subgenus *Vitronura*)..... **N. (*Vitronura*) giselae**
 Cephalic setae C, E, and O absent (Fig. 29B); dorsal tubercles weakly developed or absent (subgenus *Paleonura*)..... **N. (*Paleonura*) ili**



29A



29B

Subgenus **PROTANURA** Börner, 1906

Type species: *Neanura quadrioculata* Börner, 1901

We place here the Hawaiian species of *Neanura* having many mandibular teeth and a complex, fringed maxilla. The species have identical mouthparts and are further similar in antennal setae and trunk chaetotaxy; the ventral tube in all has 4 + 4 setae.

Species of this group have in the past been placed in *Protanura* and in *Coecoloba* Yosii, 1956 (type species: *Protanura lobella* Yosii, 1954). They do in fact show similarity in mouthparts and other characters to *Coecoloba*, but members of the latter group are all blind, whereas three of the four Hawaiian species have eyes. It may eventually be necessary to place these species in a distinct genus.

The species differ in eye number, size and shape of trunk setae, boss structure, and tibiotarsal setae. Some of these differences are noted in Table 6. Eyes, when present, are represented only by corneas, without pigment spots. Species are all white or yellowish. Patches of extremely fine reticulate integument are found on the dorsal surface of the head and trunk; these may furnish additional taxonomic characters, but some at least have been found to be asymmetrical.

At present we recognize four Hawaiian species of subgenus *Protanura*: *aleo*, *capitata*, *citronella*, and *hawaiiensis*. It is very likely that others remain to be discovered.

Neanura (Protanura) aleo Christiansen and Bellinger, **new species** (Plate 30)

Color orange to white. Fourth antennal segment with apical bulb of 4-6 lobes, only weakly differentiated from normal sculpturing, and with 5-6 clear, slightly blunt to blunt setae; subapical sense peg spherical and about the same size as cuticular granulations. Apical organ of third antennal segment with 2 short pegs in a shallow groove; without distinct accessory rods. Eyes 2 + 2 (rarely 3 + 3), close

Table 6. Characteristics of Hawaiian Species of *Neanura*

SUBGENUS	SPECIES	LARGE ANTENNAL BLUNT SETAE	EYES PER SIDE*	MANDIBULAR TEETH*	COMPLEX MAXILLAE	BLUE BODY PIGMENT	ORANGE PIGMENT	UNGUAL TOOTH	LONGEST ABDOMINAL SETAE
<i>Protanura</i>	<i>aleo</i>	6≈**	2(3)	5	+	-	+	+	acuminate
	<i>capitata</i>	6≈	3	5	+	-	-	+	clavate
	<i>citronella</i>	6≈	3-4(5)	5	+	-	+	+	acuminate to slightly blunt
	<i>hawaiiensis</i>	6≈	0	5	+	-	+/-	+	truncate
<i>Paleonura</i>	<i>ili</i>	7-8; 1-2 longer	2	2	-	-	-	-	acuminate to slightly blunt
<i>Neanura</i>	<i>muscorum</i>	6≈	3	3	-	+	-	-	blunt
<i>Vitronura</i>	<i>giselae</i>	6-7≈	2(1)	3	-	-	+/-	-	blunt
<i>Morulodes</i>	<i>setosa</i>	6; of varied lengths	4	3 (1 minute)	-	+	-	+	acuminate and serrate

Special Features of *Protanura*

SPECIES	INNER SUBAPICAL SETAE OF TIBIOTARSUS	LONGEST BODY SETAE/ INNER UNGUIS
<i>aleo</i>	curved, acuminate	1.9-2.2
<i>capitata</i>	straight, acuminate	3.4
<i>citronella</i>	curved, clavate	2.8-3.2
<i>hawaiiensis</i>	straight, acuminate	1.7-2.2

*Parentheses indicate exceptional conditions.

**≈ = approximately the same size.

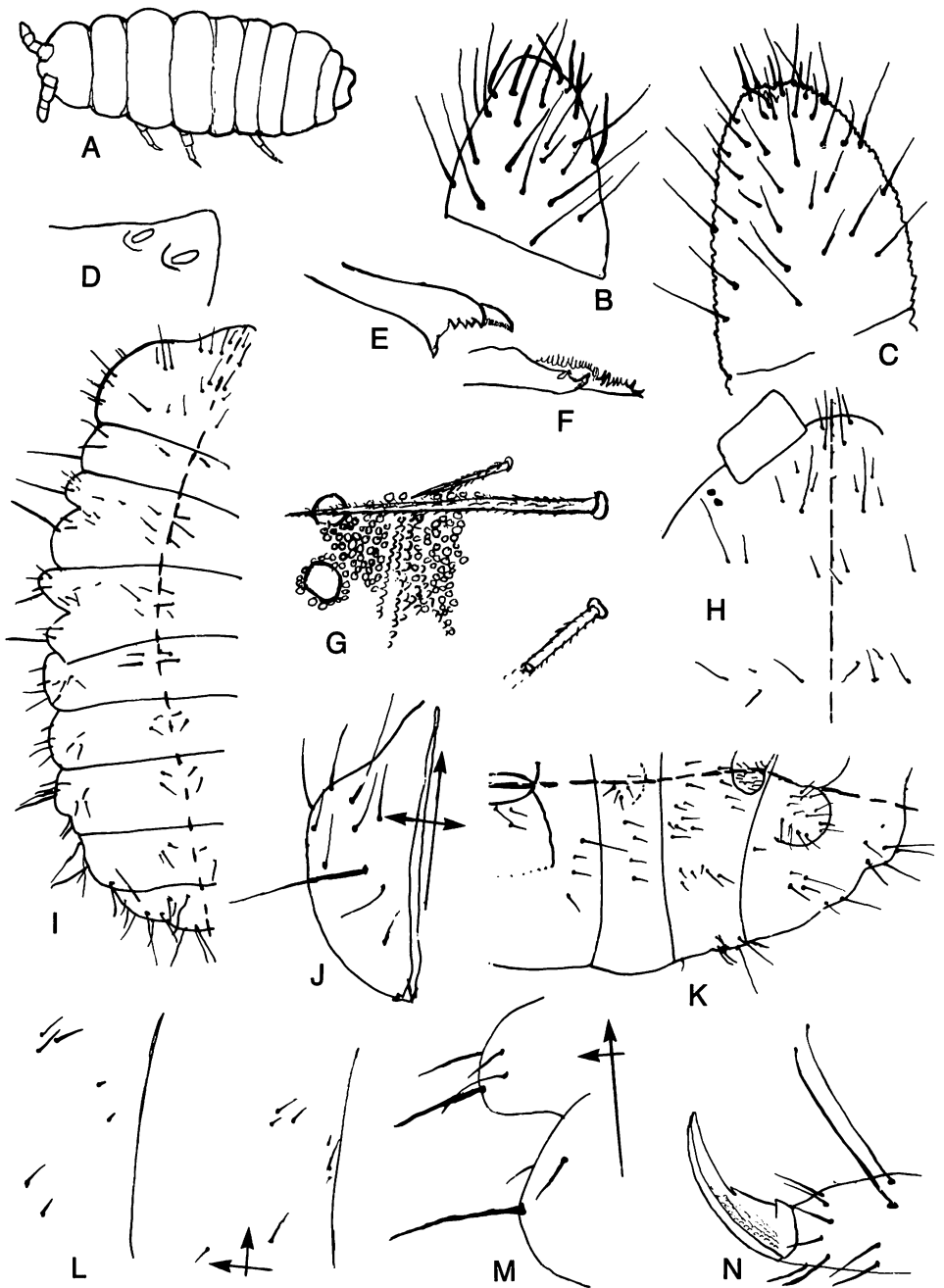
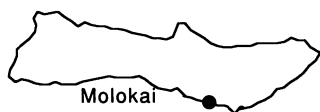


Plate 30—*Neanura (Protanura) aleo* (all figures of specimens from Molokai): **A**, habitus, setae and tubercles omitted (5484); **B**, dorsum, fourth antennal segment (paratype); **C**, ventral surface, fourth antennal segment (5484); **D**, apical organ, third antennal segment (5716); **E**, mandible (paratype); **F**, maxilla (same); **G**, eyes and ocular setae (5484); **H**, dorsal cephalic setae (holotype); **I**, dorsal chaetotaxy, left side (paratype); **J**, labial chaetotaxy, left side (paratype); **K**, ventral abdominal chaetotaxy, right side (holotype); **L**, detail, dorsal chaetotaxy of second and third thoracic segments (holotype); **M**, D₁ and L setae, second thoracic segment and first abdominal segment, seen from below (paratype); **N**, hind foot complex (5484).

together. No clearly differentiated postantennal organ, but 2 patches of integument with extremely minute reticulations are located in this area. Mandible with apical tooth somewhat larger than 3 subequal intermediate teeth, all of which are much smaller than the thin, flexible basal tooth; the latter is often folded over, giving a flat appearance to the base; apex of mandible with a finely serrate projection. Dorsal maxillary lamella heavy and tridentate; ventral lamella with 3-4 rows of slender, slightly curved, flexible teeth, subequal in size except for slight shortening in apical $\frac{1}{2}$. Tibiotarsus without clear tenent hairs, but with elongate subapical inner setae, 1.4-1.6 times as long as inner edge of unguis, and apically curved, acuminate, or slightly truncate. Unguis tuberculate along most of median surface. Cephalic setae A-G always present; seta O unpaired, varying in position but usually just in front of A setae. Dorsal trunk chaetotaxy given in Table 7. Dorsolateral boss of second thoracic segment with fifth seta very small, blunt, and curved. Second thoracic through third abdominal segments each with a minute anterior setula between the D_1 and D_2 bosses. D_1 bosses of fourth abdominal segment fused. Ventral abdominal chaetotaxy given in Table 7. Integumentary granules uniform, 2.5-3.5 μm in diameter. Maximum length 3.6 mm.



Maui 1

Remarks: This species resembles *N. citronella* in eye structure, but the typical eye number is different, the longest trunk setae are shorter, and the fused D_1 bosses of the fourth abdominal segment distinguish it further. Two of the collected specimens have 3 + 3 eyes, whereas the cave forms have 2 + 2 (2 + 3 in one case); in other respects they are very similar.

Derivatio nominis: Hawaiian, tower.

Ecology: Found primarily in caves, 1200 m and above.

Type locality: Holotype and 2 paratypes, Molokai, Lua Lolo Cave, Kawela, I-6-1981, 1200 m, deep zone, Howarth (5485).

Additional records: Maui: 6862. Molokai: 5484, 5716.

***Neanura (Protanura) capitata* Folsom, 1932 (Plate 31)**

Proc. Hawaii. Entomol. Soc. 8:56 (*Protanura*).

Color white. Fourth antennal segment without distinct apical bulb; with 6 clear blunt setae. Apical organ of third antennal segment with 2 oval pegs in a shallow groove; without distinct accessory rods. Eyes 3 + 3. No postantennal organ visible. Mouthparts as in *N. aleo*. Differentiated tenent hairs absent. Subapical inner tibiotarsal setae about 1.6 times length of inner edge of unguis. Unguis with well-developed inner tooth and tuberculate along most of medial surface. Cephalic setae E and O missing. Dorsal trunk chaetotaxy given in Table 7. Lateral boss of second thoracic segment with fifth seta a minute cylindrical peg. Ventral abdominal chaetotaxy given in Table 7. No minute intermediate setulae on dorsum of trunk.

Table 7. Chaetotaxy of *Neanura*

SPECIES	SEGMENT	DORSAL TRUNK SETAE				VENTRAL ABDOMINAL SETAE
		D _i	D _c	D _l	L	
<i>aleo</i>	Th. I	1	2	1	-	
	II	3	4	4	3-4	
	III	3	4	4	3-4	
	Abd. I	2	3	2	4	
	II	2	3	2	4	Ve 4+4
	III	2	3	2	4	Furca 7(9), Ve 4+4
	IV	2	3	2(3)	4	Ve 8+8, 7+8, VI 5+5
	V	8	-	-	-	Ag 3+3, VI 1+1
VI	7(6)	-	-	-	14+14-18+18	
<i>capitata</i>	Th. I	1	2	1	-	
	II	2	3	4	3	
	III	3	3	4	3	
	Abd. I	2	3	2	3	
	II	2	3	2	5	4+4
	III	2	3	2	5	Furca 6, Ve 5+?
	IV	2	2	3	4	Ve 7+7, VI 5+5
	V	8	-	-	-	Ag 4+3, VI 1+1
VI	7	-	-	-	14+15	
<i>citronella</i>	Th. I	1	2(3)	1	-	
	II	3	4	4	3-4	
	III	3	4	4	3-4	
	Abd. I	2	2	2	4	
	II	2	2	2	4	Ve 4+4
	III	2	2	2	4	Furca 8, Ve 4+4(4+5)
	IV	2	3(2)	2(3)	4(5)	Ve 8+8(7+7), VI 5+5
	V	8(7)	-	-	-	Ag 3+3, VI 1+1
VI	7(8)	-	-	-	14+14	
<i>hawaiiensis</i>	Th. I	1	2	1	-	
	II	3	4	4	3	
	III	3	4	4	4	
	Abd. I	2	3	2	3-4	
	II	2	3	2	4	Ve 4+4
	III	2	3	2	4	Furca 9, Ve 5+5-6+6
	IV	2	3	2(3)	4	Ve 8+8, VI 5+5
	V	8	-	-	-	Ag 3+3(3+4), VI 1+1
VI	7	-	-	-	Ve 13+13-14+14(14+15)	

Table 7. (continued)

SPECIES	SEGMENT	DORSAL TRUNK SETAE				VENTRAL ABDOMINAL SETAE
		D _i	D _c	D _l	L	
<i>muscorum</i>	Th. I	1	2	1	-	
	II	3	4	4	3	
	III	3	4	4	3	
	Abd. I	2	4(3)	2	3	
	II	2	4(3)	2	3	Ve 5+5
	III	2	4(3)	2	3(4)	Furca 5-6(7), Ve 5+5(4+5)
	IV	2	3	3	7	Ve 8+8-9+10(7+7), VI 4+4(4+5)(5+5)
	V	3(2)	8	-	-	Ag 3+3, VI 1+1
VI	7	-	-	-	14+14	
<i>giselae</i>	Th. I	1	2	1	-	
	II	3	4(5)	4	3	
	III	3	4(5)	4	3	
	Abd. I	2	4(3)	2	3	
	II	2	4(3)	2	3	Ve 5+5(4+4)(4+5)(5+6)
	III	2	4(3)	2	3	Furca 5(6), Ve 4+4(3+3)(5+5)
	IV	2	4(3)	2(3)	6	Ve 8+8-9+9(6+7), VI 5+5(4+4)
	V	3	5	-	-	Ag 3+3(2+3), VI 1+1
VI	7	-	-	-	15+15-17+17	
<i>ili</i>	Th. I	1	2(3)	1	-	
	II	3	3	4	3	
	III	3	3	4	3	
	Abd. I	2	3	2	3	
	II	2	3	2	3	Ve 4+4(4+5)
	III	2	3	2	3	Furca 4-5(3), Ve 3+3(4+4)
	IV	2	2	3(2)	6	Ve 7+7(7+8), VI 4+4(3+3)
	V	2	5	-	-	Ag 4+3(3+3), VI 2+2(2+3)(3+3)
VI	6	-	-	-	16+16(15+16)	
<i>setosa</i>	Th. I	1	2	1	-	
	II	3	5	4	3	
	III	3	5	4	3	
	Abd. I	2	4	2	3	
	II	2	4	2	4	Ve 4+4
	III	2	4	2	4	Furca 4, Ve 3+2
	IV	2	—6—	—	7	Ve 8+7, VI 4+4
	V	7	-	-	-	Ag 5+5, VI 4+5
VI	-	-	-	-	16+16	

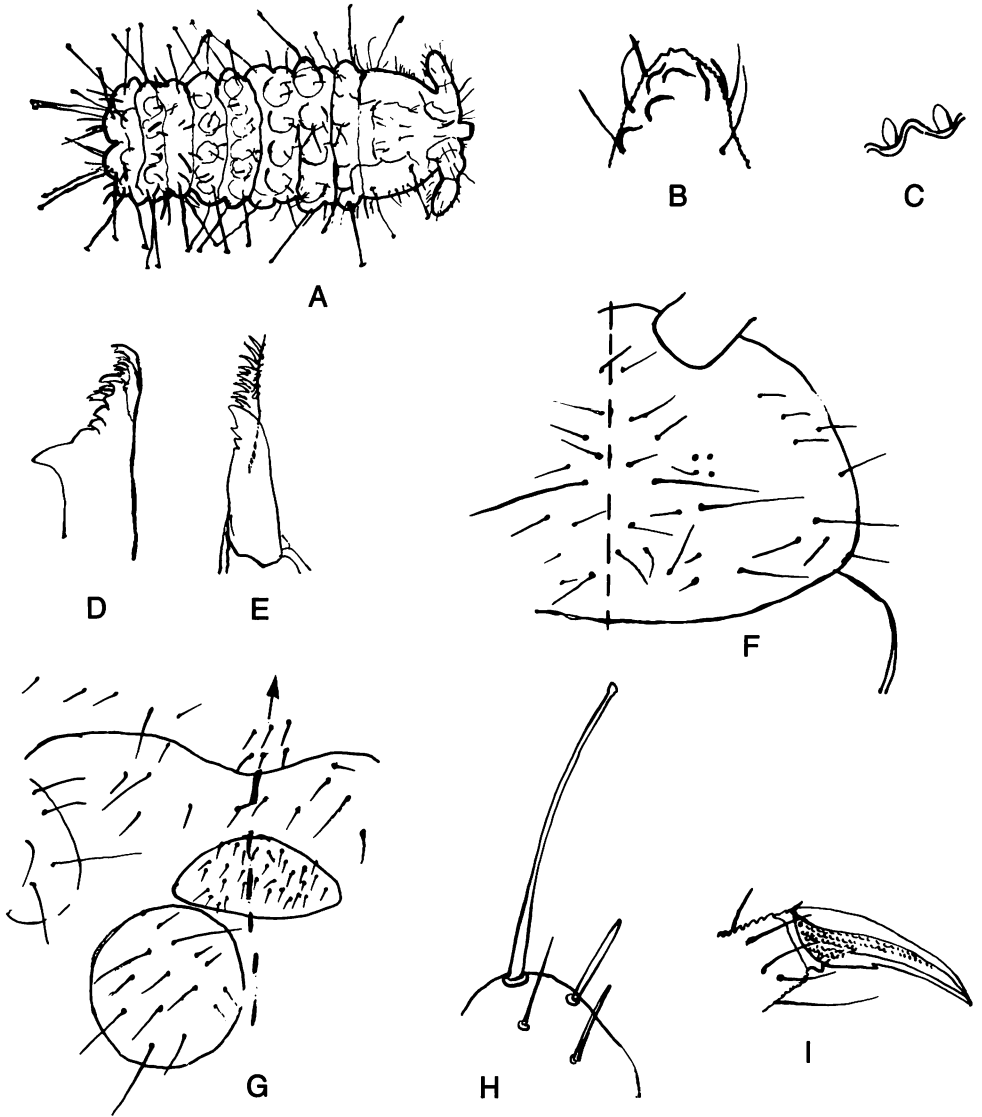


Plate 31—*Neanura (Protanura) capitata*: **A**, habitus (after Folsom); **B**, apex of antenna (same); **C**, apical organ, third antennal segment (same); **D**, mandible (same); **E**, maxilla (same); **F**, eyes and dorsal cephalic chaetotaxy, right side (type specimen); **G**, ventral abdominal chaetotaxy, fourth through sixth abdominal segments (type specimen); **H**, detail of lateral setae, first abdominal segment (same); **I**, hind foot complex (after Folsom).

All D_i bosses weakly developed but separate. Longest body setae strongly clavate or capitate. Integumentary granules 3–4.5 μm in diameter. Maximum length 3 mm.

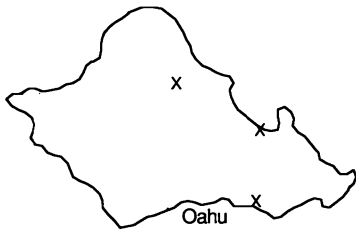
Remarks: The single type specimen we have seen showed 3 + 3 distinct eyes. The heavy clavate or capitate setae readily distinguish this species from other Hawaiian members of the subgenus.

Type locality: Honolulu, XI-13-1930.

Neanura (Protanura) citronella Carpenter, 1904 (Plate 32)

Fauna Hawaiiensis 3:303.

Color light orange in life, yellowish in preserved material. Fourth antennal segment with trilobed apical bulb, not in a pit but still clearly differentiated from other antennal structures, and with 6 clear blunt setae; subapical sense peg rodlike, smaller than neighboring integumentary granules. Apical organ of third antennal segment with 2 short curved pegs in a shallow groove and 1 slender, blunt guard seta considerably lateral and basal of the groove. At the usual location of the post-antennal organ there is a depression slightly larger than the nearest eye. Eyes 3 + 3 to 5 + 5. Mouthparts as in *N. aleo*. Tibiotarsus without differentiated tenent hairs; subapical inner setae about 1.8 times length of inner edge of unguis and apically expanded. Unguis with clear inner tooth and tuberculate medial surface. Cephalic dorsal setae A–G present, O sometimes absent. Dorsal trunk chaetotaxy given in Table 7. Second thoracic segment with a fifth seta, a short curved peg, on the dorsolateral boss. Second thoracic through third abdominal segments each sometimes with minute anterior setulae between the D_i and D_e bosses. Chaetotaxy of venter of abdominal segments given in Table 7. Long body setae acuminate or slightly blunt. Integumentary granules uniform, 2.5–3.1 μm in diameter. Maximum length 3 mm.



Maui 1

Remarks: We have examined two type specimens: a badly mangled one from Bishop Museum and a somewhat better one from the National Museum of Ireland. In addition we have seen two recent collections. They are similar in most observed respects. The legs have the subapical tibiotarsal setae clearly expanded apically. Our description is based on the recent specimens.

A battered specimen from Maui labeled *citronella*, and probably used by Carpenter, lacks the postantennal organ, and the few short setae seen are quite different from those on the recent Oahu material. It may well represent a different species. In addition, Carpenter's figures show a capitate body seta like those on *N. capitata*. Carpenter saw collections both from Waianae and from Honolulu (the only known

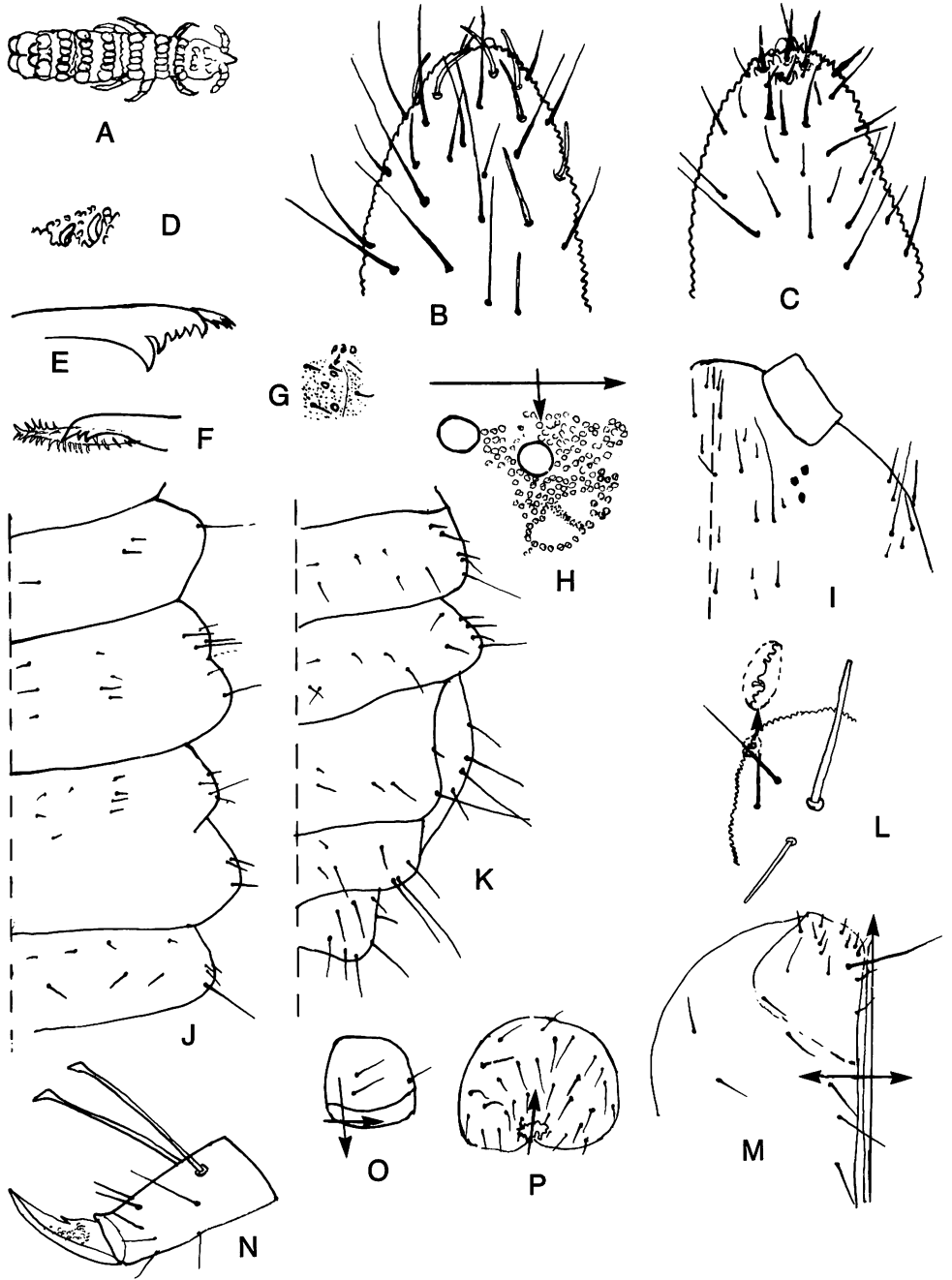


Plate 32—*Neanura (Protanura) citronella*: A, habitus (after Carpenter); B, dorsum of fourth antennal segment (5301, Oahu); C, ventral surface, fourth antennal segment (same); D, apical organ, third antennal segment (same); E, mandible (same); F, maxilla (same); G, eyes (after Carpenter); H, eyes and postantennal organ (5301, Oahu); I, dorsal chaetotaxy of head (same); J, composite dorsal chaetotaxy, right side, first thoracic segment—first abdominal segment; K, same, second through sixth abdominal segments; L, detail of dorsolateral setae, second thoracic segment (same); M, ventral cephalic chaetotaxy, right side (same); N, mid foot complex (same); O, ventral tube (same); P, male genital plate (same).

locality for *N. capitata*), so it may well be that his description and figures are composite and based on as many as three species.

For the moment we believe it is best to consider the recent Koolau Mountains specimens as representative of the species. It is possible that further collections will change our ideas of the identity of *N. citronella*.

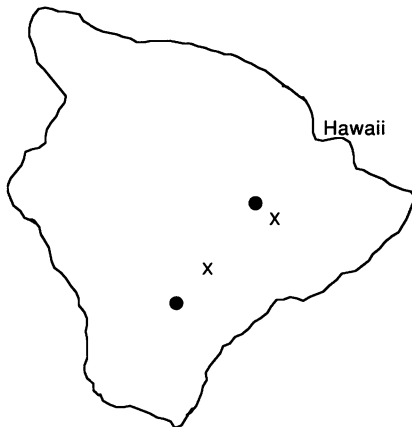
Type locality: Oahu, Honolulu, V-1896, Perkins.

Additional records: Oahu: 5301, 6760.

***Neanura (Protanura) hawaiiensis* Bellinger and Christiansen, 1974, new combination** (Plate 33)

Pac. Insects 16:31 (*Protanura*).

Color in life orange to white. Apex of fourth antennal segment varying from having no clearly differentiated apical bulb (Pl. 32B) to having one or two distinct projecting bulbs (Pl. 32C); segment with 6 clearly distinguished blunt setae; subapical sense peg spherical and about as large as integument granulations. Apical organ of third antennal segment with 2 short swollen pegs in a shallow groove and 2 lateral basal guard setae, one a basally bent blunt rod, the other a small conical peg, close to each other. Eyes and postantennal organ absent; extremely finely reticulate integument in place of eyes. Mouthparts indistinguishable from those of *N. aleo*. Tibiotarsus without distinguishable tenent hairs; subapical inner setae acuminate and 1.1–1.2 times length of inner edge of unguis. Unguis with a strongly developed inner tooth and tuberculate on inner portions. Cephalic dorsal setae A–G always present, but D or E setae sometimes unilateral and A setae rarely (2 specimens) 4 in number; O seta always present, rarely double. Ocular seta 1 always present; setae 2 or 3 (occasionally both) present. Dorsal trunk chaetotaxy given in Table 7. Second thoracic segment with fifth seta of dorsolateral boss as a short, curved peg. Trunk segments from second thoracic through third abdominal with a minute setula between D_1 and D_2 bosses. D_1 bosses of fourth abdominal segment separate. Ventral abdominal chaetotaxy given in Table 7. Integumentary granules uniform, 2.5–3.5 μm in diameter. Maximum length 3.3 mm.



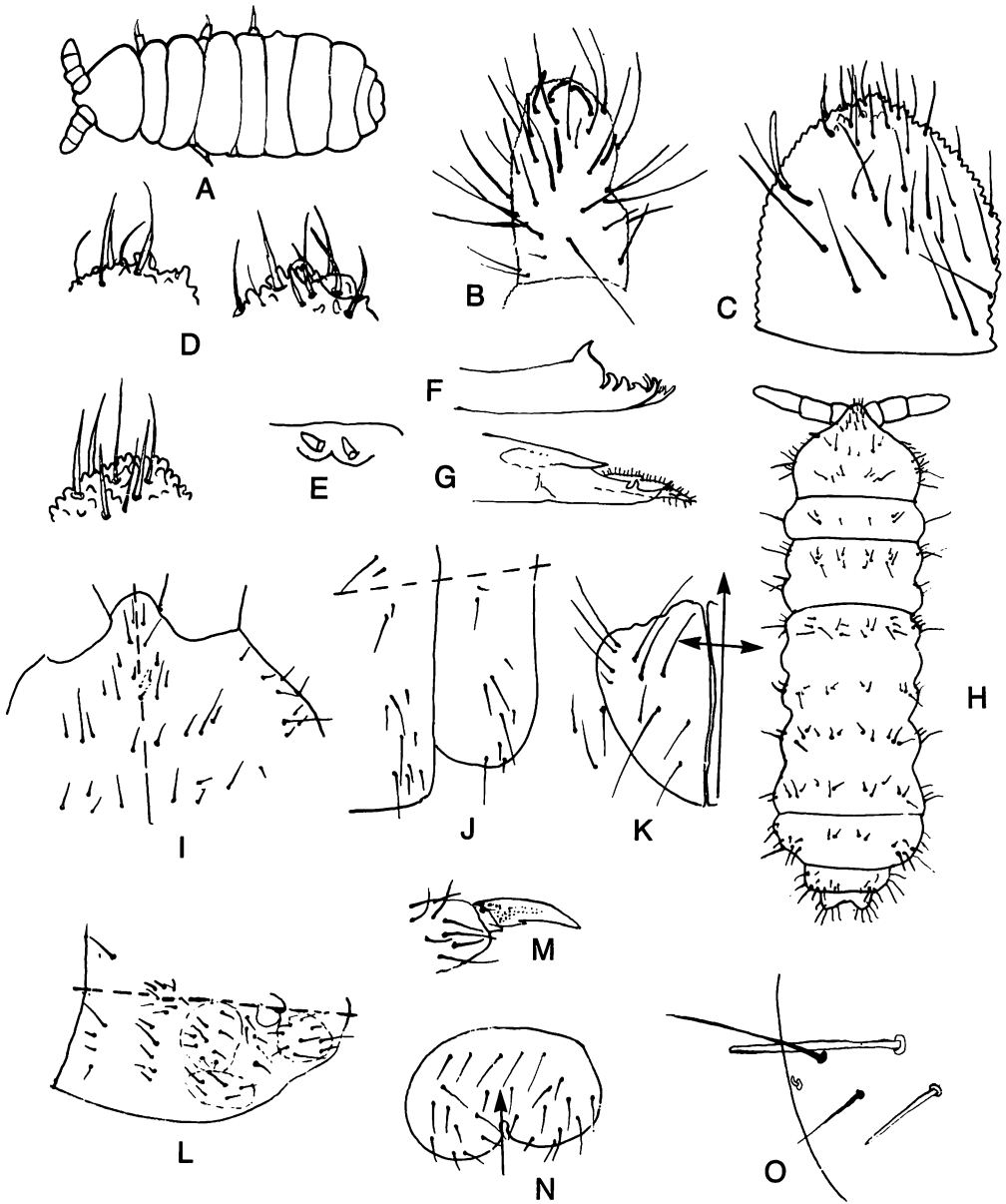


Plate 33—*Neanura (Protanura) hawaiiensis* (all figures of specimens from Hawaii): A, habitus, setae and tubercles omitted (5422); B, dorsum, third and fourth antennal segments (after Bellinger and Christiansen); C, ventral surface, fourth antennal segment (7053); D, variations in antennal apex (holotype, paratype); E, apical organ of third antennal segment (5433); F, mandible (after Bellinger and Christiansen); G, maxilla (same); H, dorsal chaetotaxy (after Bellinger and Christiansen); I, dorsal cephalic chaetotaxy (paratypes); J, detail of chaetotaxy, first and second abdominal segments (5433); K, labial chaetotaxy, right side (paratype); L, ventral abdominal chaetotaxy (5433); M, hind foot complex (after Bellinger and Christiansen); N, male genital plate (5433); O, detail of lateral setae, second thoracic segment (holotype).

Remarks: This is the most numerous species of *Protanura* in our collections. It is also the only eyeless species. The variability in some features may be indicative of what will be found in other species with more collections.

Ecology: Known only from caves.

Type locality: Hawaii, Mountain View, Kazumura Cave, 400 m, cave depths, Howarth.

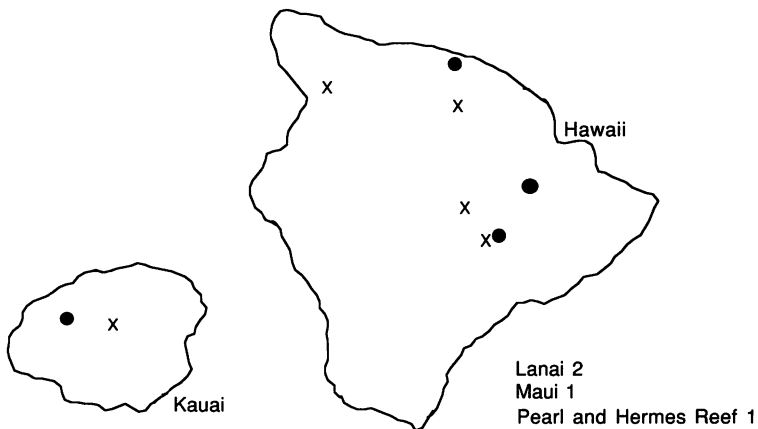
Additional records: Hawaii: 5418, 5420, 5422, 5433, 5465, 5468, 7053.

Subgenus **NEANURA** s.str.

Neanura (Neanura) muscorum (Templeton, 1835) (Plate 34)

Trans. Entomol. Soc. London 1:97 (*Achorutes*).—Stach, 1951.—Christiansen and Bellinger, 1980.

Color medium to dark blue, paler ventrally. Fourth antennal segment with projecting, trilobed apical bulb and 6 subequal curved, blunt setae; subapical sense peg small and spherical. Apical organ of third antennal segment with 2 short, curved pegs in a shallow groove and 2 basally angled, slender blunt setae, one lateral to organ and the second lateral and basal at a greater distance. Eyes 3 + 3, not in a straight line. Mandible tridentate; maxilla needlelike. Antennal and frontal tubercles fused; all other tubercles well developed and separate, consisting of weakly demarcated clusters of granules forming bosses that in larger specimens are separated by linear agranulate partitions. Tenent hairs acuminate. Unguis untoothed. Ventral tube with 4 + 4 setae. Cephalic dorsal setae C, D, E, and O well developed. Dorsal trunk chaetotaxy given in Table 7. Ventral abdominal chaetotaxy given in Table 7. Second abdominal segment with inner ventral setae; fourth with 4 + 4 lateral ventral setae, not in a straight line. Most body setae acuminate; largest setae weakly blunt and weakly serrate. Maximum length 3.0 mm.



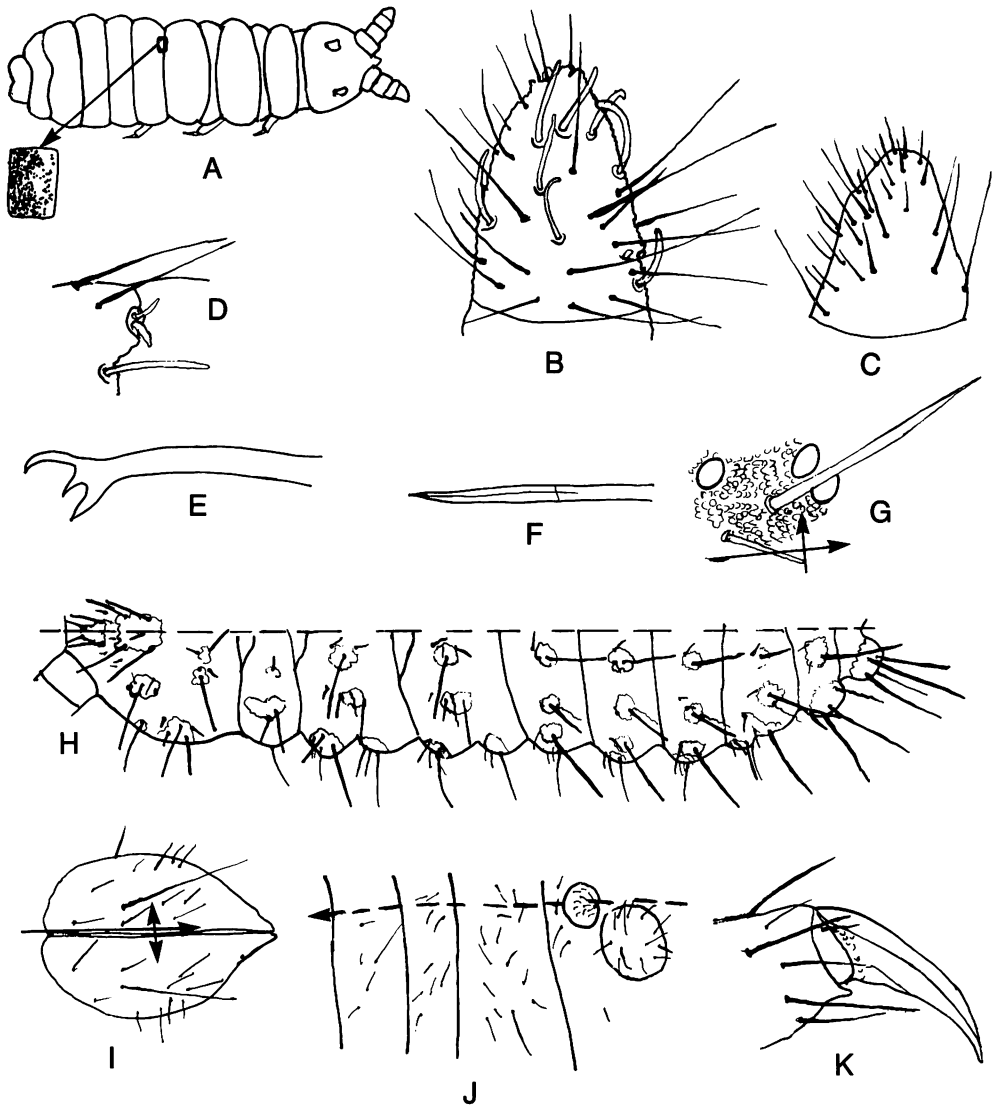


Plate 34—*Neanura (N.) muscorum*: A, habitus (setae omitted) (6839, Hawaii); B, dorsum, third and fourth antennal segments (6680, Maui); C, ventral surface, fourth antennal segment (same); D, apical organ, third antennal segment (another specimen, same); E, mandible (after Christiansen and Bellinger); F, maxilla (after Gisin); G, left eyepatch (6680, Maui); H, dorsal chaetotaxy, left side (after Deharveng); I, ventral labial chaetotaxy (5681, Hawaii); J, ventral abdominal chaetotaxy (6680, Maui); K, hind foot complex (6680, Maui).

Remarks: The Hawaiian specimens agree well with previous descriptions. However, they show much less variation in chaetotaxy than does nearctic material. The small sample from Pearl and Hermes Reef has serrate body setae and 4 + 4 D₁ setae on the fifth abdominal segment. This may be a different species, but is more likely a local segregate associated with the facultative parthenogenesis that is characteristic of *N. muscorum*.

Ecology: Found in litter and epiphytic plants in wet forests between 2000 and 4000 ft. elevation (the Pearl and Hermes Reef collection is an exception).

Records: Hawaii: 4856, 4860, 4873, 4934, 4935, 4936, 4937, 5126, 5266, 5276, 5330, 5372, 5649, 5681, 5682, 5684, 5691, 6839. Maui: 6680. Lanai: 6698, 6700. Kauai: 5071, 5208, 5215. Pearl and Hermes Reef: 4912.

Subgenus **VITRONURA** Yosii, 1969a

Type species: *Neanura mandarina* Yosii, 1954

This subgenus, as recently revised by Cassagnau and Deharveng (1981), includes species of *Neanura* with simple mouthparts and with three interocular tubercles, the antennal tubercles distinct and separate. There is a single Hawaiian species.

Neanura (Vitronura) giselae Gisin, 1950 (Plate 35)

Mitt. Schweiz. Entomol. Ges. 23:414 [*Neanura (Lathriopyga)*].—Cassagnau and Deharveng, 1981

Color in life white to orange; in alcohol, white. Fourth antennal segment with trilobed apical bulb, sometimes withdrawn so that only tips of lobes can be seen, and 6–7 clear blunt setae, all subequal in size; subapical sense peg small and capitate. Third and fourth segments fused dorsally but clearly separate ventrally. Apical organ of third segment with 2 short, curved pegs in a deep groove and 2 basally bent blunt rods, one lateral and one basal of the pegs. Eyes 2 + 2 (rarely 1 + 1); anterior eye in front of ocular boss. Clypeal and frontal (unpaired) and antennal, ocular, dorsointernal, dorsoexternal, and dorsolateral-lateral bosses all distinct on head; lateral bosses often not completely distinct in dorsal view. Integument of cephalic and trunk bosses with complex sculpturing formed of clusters of tubercles. Tenent hairs acuminate. Unguis untoothed. Cephalic setae A–G always present. Dorsal trunk chaetotaxy given in Table 7. Ventral abdominal chaetotaxy given in Table 7. Venter of second abdominal segment without inner setae. Ventral lateral setae of fourth abdominal segment 5 (rarely 4), not in a line. Many larger dorsal setae blunt; all setae smooth or very finely serrate. Maximum length 2.3 mm.

Remarks: Specimens from Hilo and from parts of Oahu match the description of *N. giselae* given by Cassagnau and Deharveng (1981) in their revision of *Vitronura* almost perfectly; the only obvious difference is that the anterior eye in our material is well separated from the ocular tubercle. Specimens from other localities are generally similar in chaetotaxy and other features, but there are minor differences,

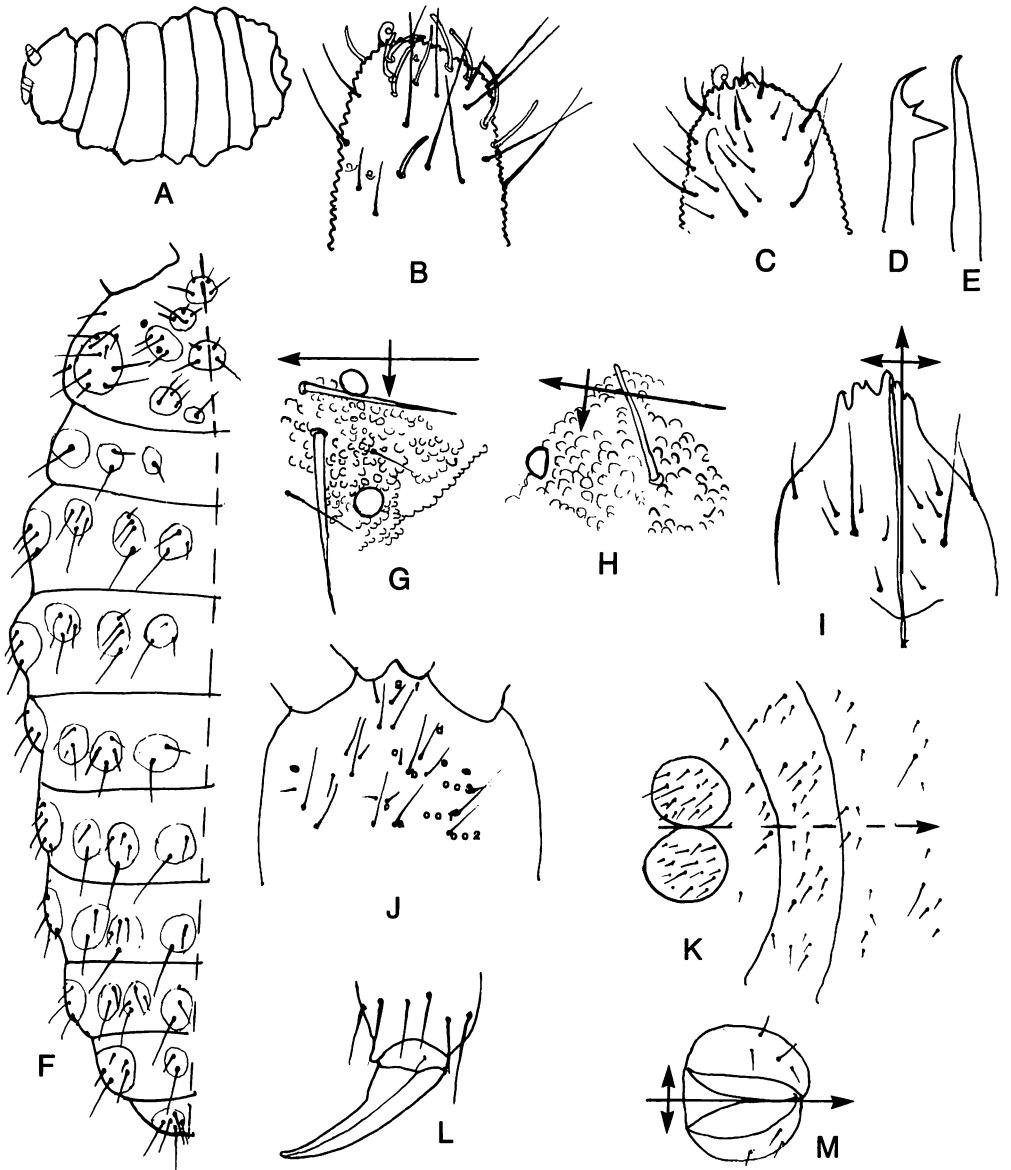
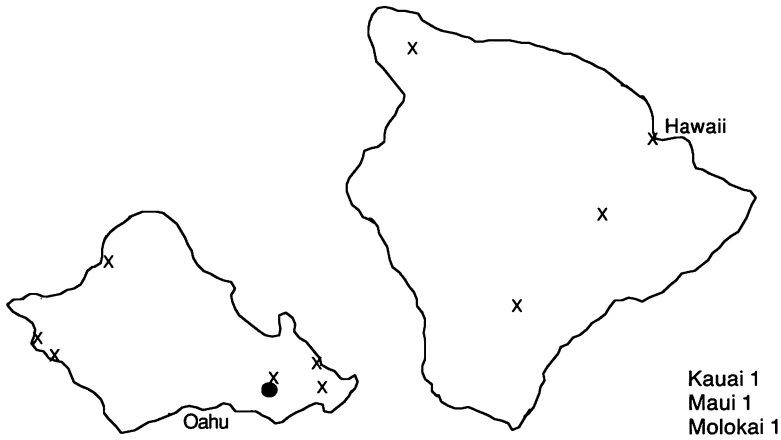


Plate 35—*Neanura (Vitronura) giselae*: A, habitus, setae and tubercles omitted (6728, Kauai); B, dorsum of fourth antennal segment and apex of third (5345, Hawaii); C, ventral surface, fourth segment (same); D, mandible (4791, Oahu); E, maxilla (same); F, dorsal chaetotaxy, left side (composite, Hawaiian specimens); G, eyes and neighboring setae (4774, Oahu); H, same (4786, Oahu); I, labial chaetotaxy (4783, Oahu); J, detail of cephalic chaetotaxy (4785, Oahu); K, ventral abdominal chaetotaxy (4871, Hawaii); L, hind foot complex (6728, Kauai); M, ventral tube (same).



mainly between localities, as shown in Table 8. It is not clear whether this is a single, locally variable species or a cluster of closely related species. *Neanura giselae* was described from Switzerland and has been recorded from Africa and Mexico as well as the Oriental Region; its affinities are with numerous Oriental species, but its origin is unknown. Variation in blunt sensory setae of the fourth antennal segment is largely the result of differences in the structure of the basal seta, which may be acuminate and indistinguishable from ordinary setae.

Ecology: Found mostly in litter in disturbed sites and grassland, mostly at lower elevations.

Records: Hawaii: 4871, 5119, 5345, 6845. Maui: 6705. Molokai: 5727. Oahu: 4752, 4768, 4774, 4775, 4783, 4785, 4786, 4791, 4792, 4814, 4832, 5223, 6526. Kauai: 6728.

Table 8. Variation in Chaetotaxy in Hawaiian *Neanura giselae*

EYE NO.	CEPHALIC DORSAL SETAE O	THORACIC D _c SETAE		ANTENNAL BLUNT SETAE	LOCATION
		II	III		
2	1	4	5	6	Oahu
2	1	4	4	6	Oahu
2	0	5	5	6	Oahu
2	2	4	4	6	Oahu
1	1	4	5	7	Oahu
1	2	5	5	6	Oahu
1	1	4	4	6	Oahu
2	1	4	5	7	Hawaii, Oahu
2	0	4	5	6	Kauai
2	2	6	6	7	Maui

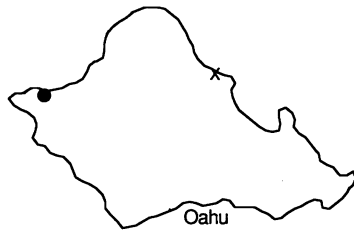
Subgenus **PALEONURA** Cassagnau, 1982

Type species: *Paleonura spectabilis* Cassagnau, 1982

This subgenus includes species of *Neanura* with reduced mouthparts as in *Neanura* s.str., but with dorsal tubercles poorly developed; the fourth antennal segment lacks the greatly enlarged blunt seta found in subgenus *Sensillanura* and its American relatives. Other species of *Paleonura* are found in Southeast Asia and the Marquesas Islands. There is a single Hawaiian species, *N. ili*.

Neanura (Paleonura) ili Christiansen and Bellinger, new species (Plate 36)

Color (in preserved specimens) white to pale yellow. Apex of fourth antennal segment with trilobed bulb, not withdrawn and similar to other surface sculpturing; 7-8 subequal blunt sensory setae; subapical sense peg minute and spherical. Apical organ of third antennal segment of 2 short curved pegs in a shallow groove, and 2 slender, basally bent accessory rods, one lateral and one much farther lateral and basal. Eyes 2 + 2. Tenent hairs acuminate. Unguis untoothed. Integument uniformly granulate; granules 0.025-0.038 μm in diameter. Cephalic ocular, dorsoexternal, dorsolateral, and lateral bosses and lateral and posterior bosses of trunk clear; others absent or weakly developed. Cephalic setae C, E, and O always absent; A setae vary in size and position. Dorsal trunk setae given in Table 7. Ventral abdominal chaetotaxy given in Table 7. Second abdominal segment with a pair of inner ventral setae. Fourth abdominal segment with 4 + 4 (rarely 3 + 3) ventrolateral setae in straight lines. Body setae all acuminate or weakly blunt, and smooth. Maximum length 2.3 mm.



Hawaii 1
Maui 1

Remarks: Specimens in life vary from orange to white. The cephalic A setae vary greatly in size, and in one Oahu specimen the A seta of one side is a microseta. Little variation in other characters was seen.

Cassagnau (1982), in describing *Paleonura*, listed 11 species that belong in this group. *N. ili* differs from all of these in details of chaetotaxy, as it does from the other Hawaiian species (in *Protanura* and *Vitronura*) that lack blue pigment. It is most similar to *Neanura insularum* Carpenter, 1934 from the Marquesas Islands, which has small cephalic D setae.

Derivatio nominis: Hawaiian, bark.

Ecology: Found from coastal areas through scrub land to rain forest at middle elevations (about 1800 ft.), in litter and under debris and low vegetation.

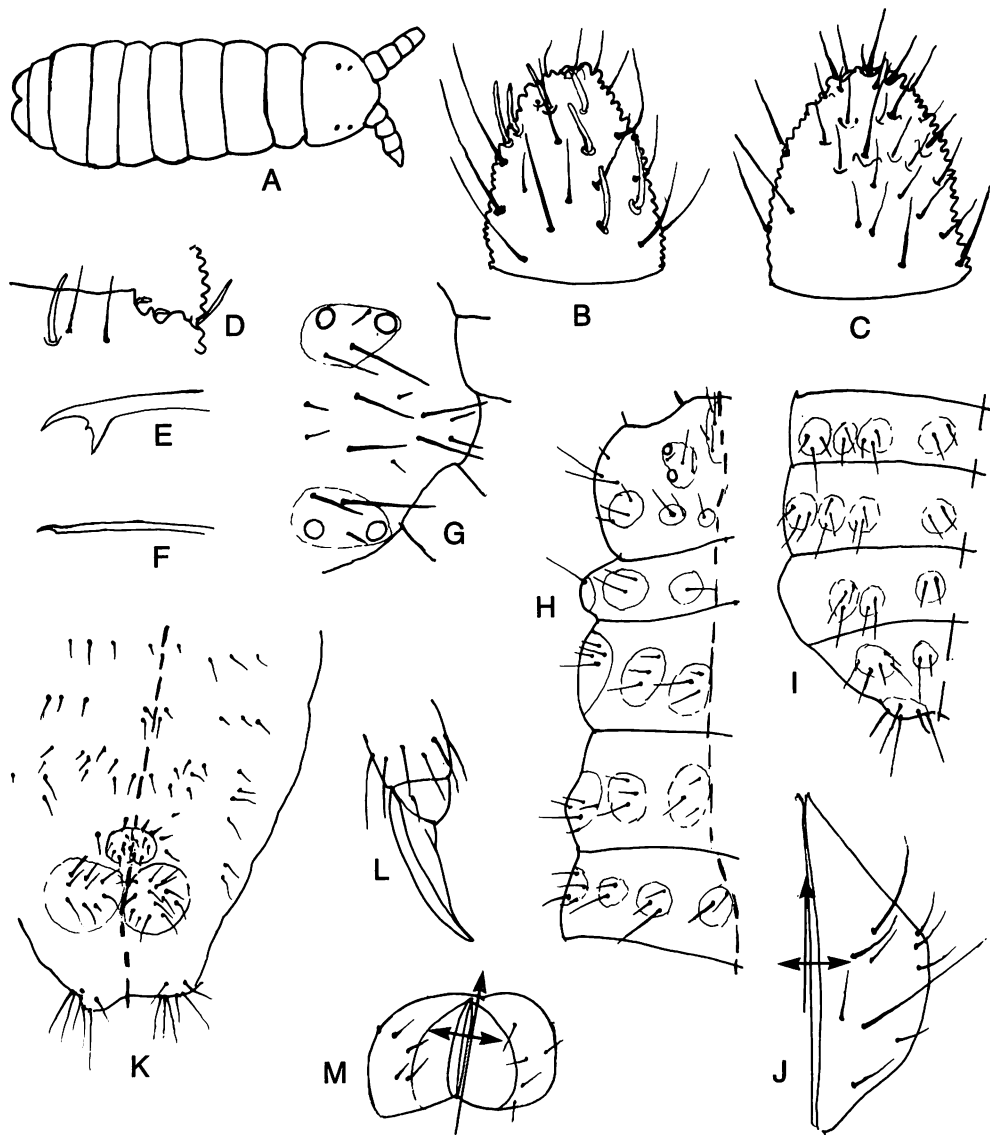


Plate 36—*Neanura (Paleonura) ili*: **A**, habitus, setae and tubercles omitted (5163, Maui); **B**, dorsum, fourth antennal segment (holotype); **C**, ventral surface, fourth antennal segment (same); **D**, apical organ, third antennal segment (5227, Oahu); **E**, mandible (5226, Oahu); **F**, maxilla (same); **G**, dorsal cephalic chaetotaxy (holotype); **H**, dorsal chaetotaxy, through first abdominal segment, left side (5226, Oahu); **I**, same, second through fifth abdominal segments; **J**, labial chaetotaxy, left side (same); **K**, ventral abdominal chaetotaxy (5227, Oahu); **L**, hind foot complex (paratype); **M**, ventral tube (same).

Type locality: Holotype and 1 paratype, Oahu, Kahana Bay, III-1-1982, about 1800 ft., under bark and decayed wood, KC (5242).

Additional records: Hawaii: 5138. Maui: 5163. Oahu: 5226, 5227.

Subgenus **MORULODES** Cassagnau, 1955

Type species: *Morulodes millsii* Cassagnau, 1955

This subgenus includes the only neanurines with strong body tubercles, no post-antennal organ, and more than 3 + 3 eyes. Mouthparts are variable, reduced in some species and hypertrophied in others. (In *The Collembola of North America*, we placed *Morulodes* as a synonym of the very different genus *Crossodonthina*, because of an unfortunate error in interpreting the mouthpart structure of the latter.) There is a single Hawaiian species, *N. (Morulodes) setosa*.

Neanura (Morulodes) setosa Canby, 1926 (Plate 37)

J. Entomol. Zool. 18:41.—Christiansen and Bellinger, 1980.

Color blue with bosses darker than other areas. Fourth antennal segment with trilobed apical bulb, weakly developed and only slightly differentiated from other sculpturing, and 6 clear blunt setae, the longest being about 1.5 times as long as the shortest; subapical sense peg minute and slightly swollen. Apical organ of third segment with 2 short curved pegs in a shallow groove and 2 basally bent blunt setae, one lateral and one more distant and lateral and basal of the organ. Eyes 4 + 4, 3 anterior and 1 posterior on each side. Clypeal, antennofrontal, and ocular bosses clearly developed; dorsointernal and dorsoexternal bosses fused, as are the dorsolateral and lateral bosses. All trunk bosses distinct except that dorsoexternal and dorsolateral bosses are fused on the fourth abdominal segment, and all bosses are fused on each side of the fifth abdominal segment. Integument of bosses with complex sculpturing, including ridges clearly limiting the bosses. Tenent hairs acuminate. Unguis with prominent inner tooth. Clypeal boss with 6, antennofrontal with 7, and ocular bosses with 2 + 2 setae. Dorsal trunk chaetotaxy given in Table 7. Ventral abdominal chaetotaxy given in Table 7. Second abdominal segment lacking median ventral setae. Lateral ventral setae of the fourth abdominal segment not in a straight line. Large setae curved and heavily serrate. Maximum length (in nearctic specimens) 3.0 mm.

Remarks: The single Hawaiian specimen agrees well with those from the mainland United States except for minor differences in the antenna.

Record: Oahu: 4786.

Family ONYCHIURIDAE

This family is characterized by the presence of pseudocelli (which are sometimes hard to see) on the head and trunk and by the distinctive and usually complex sense organ of the third antennal segment. Eyes are always absent; the Hawaiian species

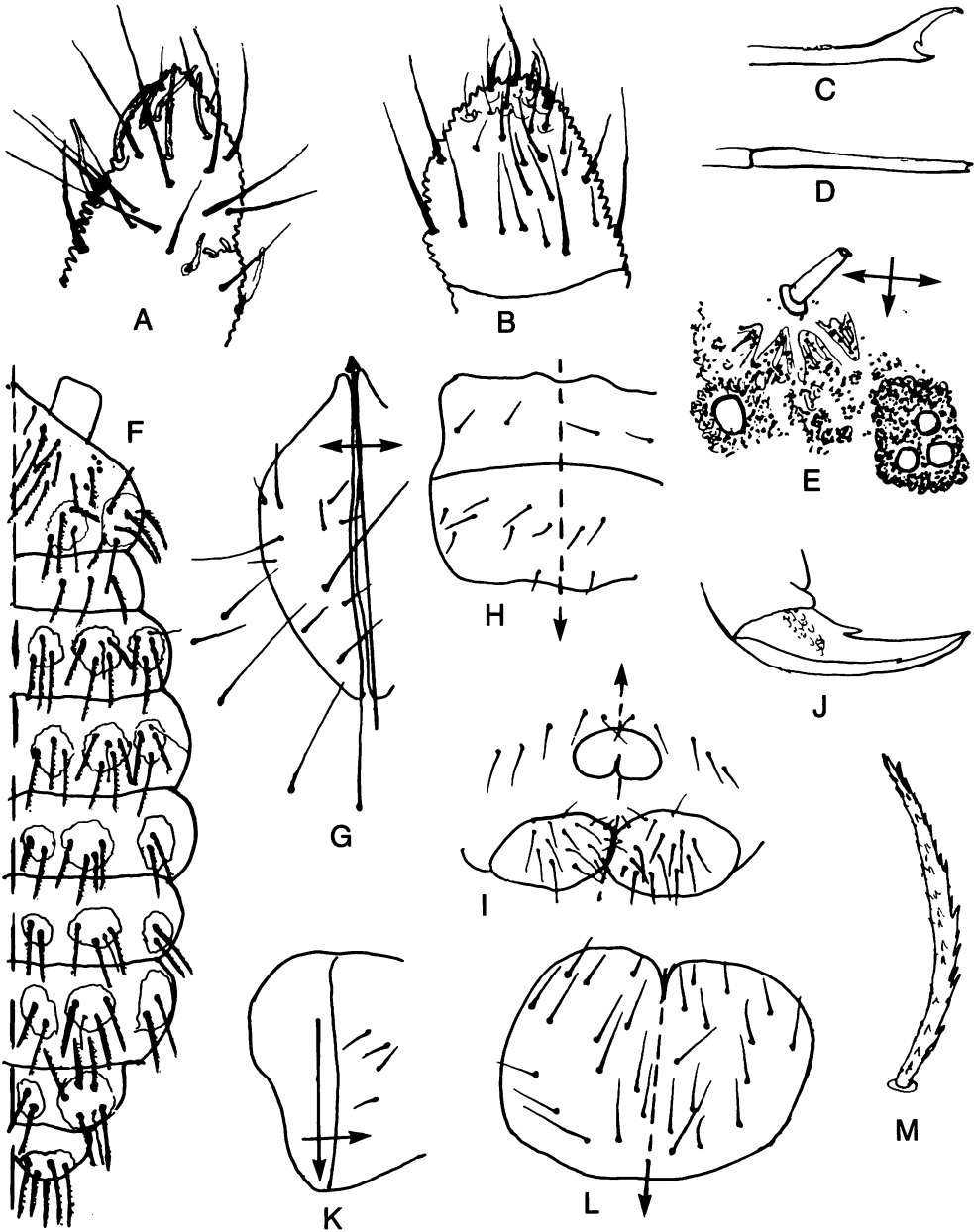
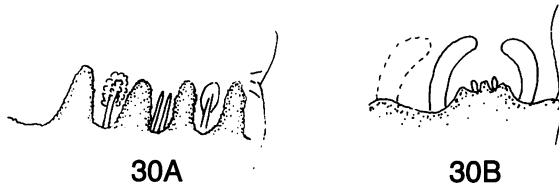


Plate 37—*Neanura (Morulodes) setosa*: A, dorsum of fourth and apex of third antennal segments (4786, Oahu); B, ventral surface, fourth antennal segment (same); C, mandible (same); D, maxilla (same); E, eyes (same); F, dorsal chaetotaxy, right side (after Christiansen and Bellinger); G, median ventral cephalic setae, right side (4786, Oahu); H, ventral abdominal chaetotaxy, third and fourth segments (same); I, ventral abdominal chaetotaxy, fifth and sixth segments (same); J, hind foot complex (same); K, ventral tube (same); L, male genital plate (same); M, enlarged posterior seta (same).

lack pigment and have no trace of a furcula. Body form and mouthpart structure are in general as in Hypogastrurinae; the most similar of the latter (*Willemia*) differ in having the postantennal organ tubercles in a circle instead of in two parallel lines.

KEY TO HAWAIIAN GENERA OF ONYCHIURIDAE

- 1. Apical sense organ of third antennal segment with sense clubs concealed behind 4-5 granulate integumental papillae (Fig. 30A)..... **Onychiurus**
- Apical sense organ of third antennal segment without concealing papillae; sense clubs exposed and bent toward each other (Fig. 30B)..... 2



- 2(1). Postantennal organ with more than 20 lobes (Fig. 31A)..... **Tullbergia**
- Postantennal organ of 6-8 lobes (Fig. 31B)..... **Prabhergia**



Genus **ONYCHIURUS** Gervais, 1841

Type species: *Podura ambulans* Linnaeus, 1758

This genus includes all Hawaiian Collembola lacking eyes and furcula and with pseudocelli and multipapillate sense organs on the third antennal segment. For a more complete account of this large, primarily holarctic genus, see *The Collembola of North America*. There are four Hawaiian species of *Onychiurus*, one local, the others widespread: *cryptopygus*, *encarpatus*, *folsomi*, and *petaloides*.

KEY TO HAWAIIAN SPECIES OF ONYCHIURUS

- 1. Lobes of postantennal organ simple (Fig. 32A)..... 2
- Lobes of postantennal organ complex (Fig. 32B)..... **folsomi**



Table 9. Characteristics of Hawaiian Species of *Onychiurus* s.l.

SPECIES	PSEUDOCELLI*																	
	HEAD		DORSAL					VENTRAL					POSTANTENNAL ORGAN					
	ANT.	POST.	THORAX			ABDOMEN					HEAD	THORAX	ABDOMEN				LOBES	TYPES
			I	II	III	I	II	III	IV	V			II	III	IV	V		
<i>cryptopygus</i>	3	2+1	1-2	3	3	3	3	2-3	3-4	3	1	-	1	-	-	-	10-12	simple
<i>encarpatus</i>	3	2+2	2	3	3(2)	3	3	4-5	3	2-3	1-2	-	1	0-1	0-1	1	20-26	simple
<i>folsomi</i>	3	2+1	1	2	2	3	3	3	3	2-3	3	+	1	0-1	1	1	10-16	compound
<i>petaloides</i>	3	2+1	1-2	3	3	3	3	3	4	3(0)	1	-	1	-	-	-	18-22	simple

*Parentheses indicate exceptional conditions.

- 2(1). With anal spines (Fig. 33A)..... 3
 Without anal spines (Fig. 33B)..... **cryptopygus**



- 3(2). Unguiculus less than 1/2 as long as inner unguis..... **petaloides**
 Unguiculus more than 1/2 as long as inner unguis..... **encarpatus**

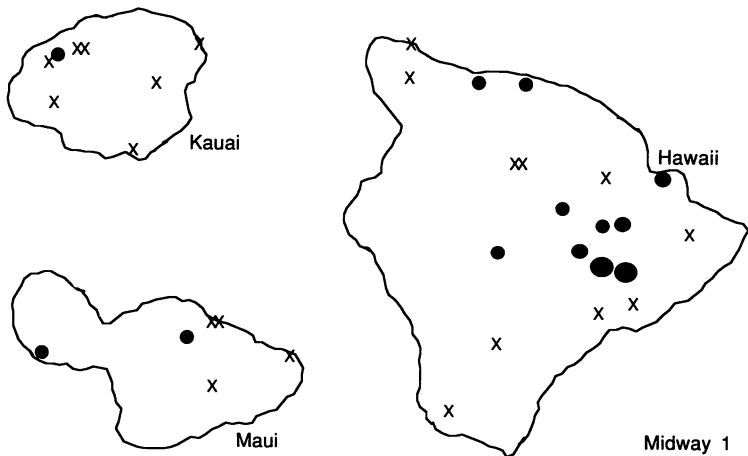
Subgenus **ONYCHIURUS** s.str.

In the typical subgenus the tubercles of the postantennal organ are compound. There is a single species in Hawaii.

Onychiurus (Onychiurus) folsomi (Schäffer, 1900) (Plate 38)

Jahresh. Ver. Vaterl. Naturk. Wuerttemb. 56:249 (*Aphorura*).—Christiansen and Bellinger, 1980.

Color white. Body elongate elliptical to oval. Fourth antennal segment without apical bulb or clearly differentiated blunt setae; subapical sense peg short and slightly expanded, in a shallow pit. Apical organ of third antennal segment with 5 guard setae, 4 papillae, 2 similar flattened paddlelike sense clubs, and 2 sense rods. Tenent hair acuminate, 0.8-1.0 times length of inner edge of unguis. Unguis untoothed or with 2 small inner teeth. Unguiculus slender, gradually tapered and slightly shorter to slightly longer than inner edge of unguis. Ventral tube with 6 +



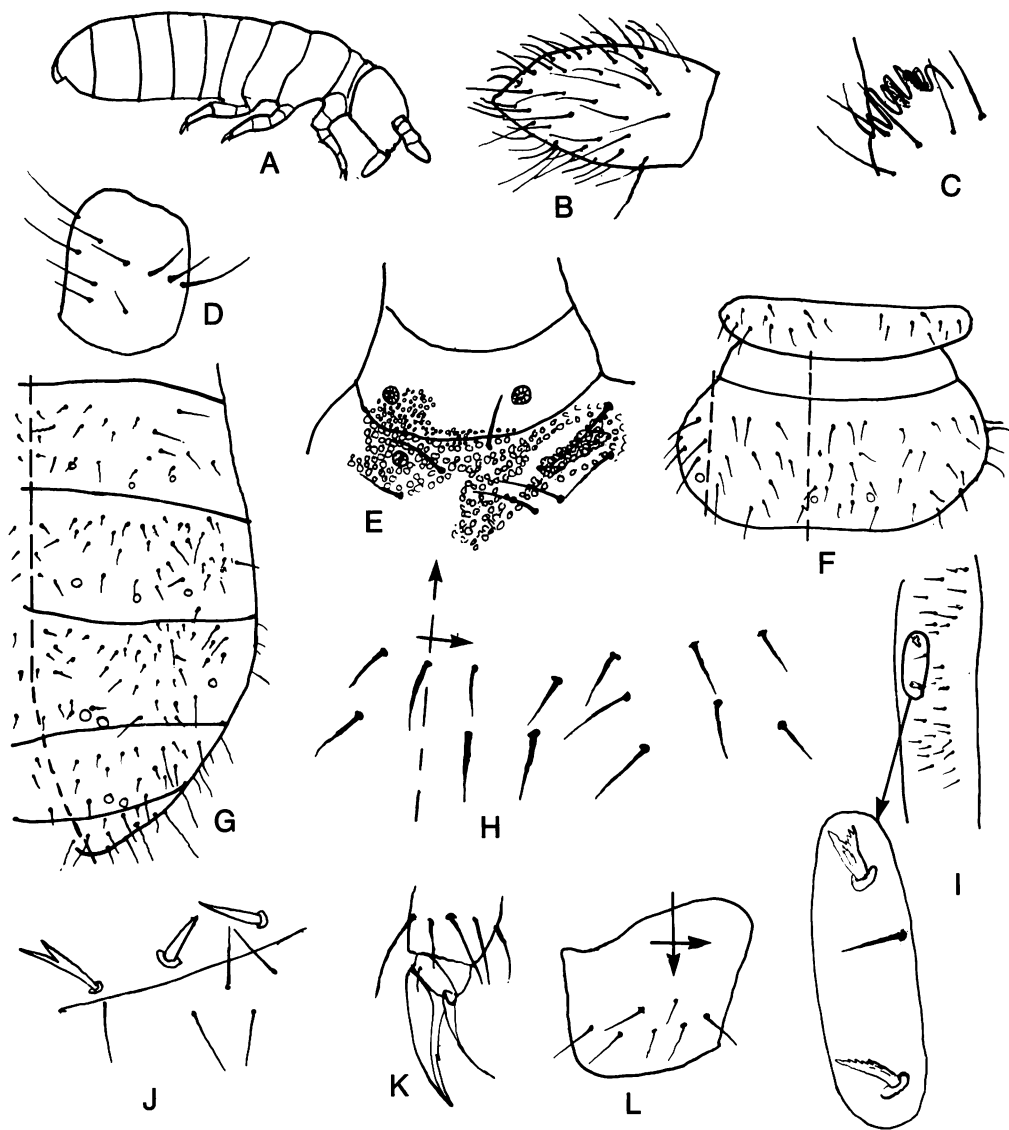


Plate 38—*Onychiurus (Onychiurus) folsomi*: **A**, habitus (6845, Hawaii); **B**, dorsum, fourth antennal segment (same); **C**, apical organ, third antennal segment (same); **D**, ventral surface, second antennal segment (same); **E**, antenna base and postantennal organ, right side (same); **F**, chaetotaxy, first two thoracic tergites (dotted lines separate the medial, paramedial, and lateral sections of segments) (5198, Kauai); **G**, chaetotaxy, right side, second through sixth abdominal segments (6845, Hawaii); **H**, ventral second abdominal segment chaetotaxy, left side, male (midline dotted line) (5127, Hawaii); **I**, ventral chaetotaxy, male second abdominal segment (5677, Hawaii); **J**, differentiated male second abdominal segment ventral setae (4932, Hawaii); **K**, hind foot complex (6845, Hawaii); **L**, ventral tube seen from side (6845, Hawaii).

6 or 7 + 7 setae. Anal spines absent. Dorsal integument more or less uniformly granulate except for antennal bases, with granules 2.5–3.0 μm in diameter; antennal base granules smaller and irregularly run together. Male ventral organ on posterior margin of second abdominal segment consisting of 4 equally spaced differentiated setae, which vary greatly in form (see Snider 1977). Maximum length 2.2 mm.

Remarks: This is the most common *Onychiurus* found in the Hawaiian Islands. It is quite variable, but the variation shows no obvious spatial or ecological pattern. In an attempt to analyze the variation in chaetotaxy, we counted setae as follows (rare conditions in parentheses): ventral setae on the second abdominal segment, (15)16–18(20); dorsal setae of the first thoracic segment (8)9–10(11); and of the second thoracic segment, medial, 8; paramedial (10)11–12(13); and lateral (5)6–7(8) setae (Pl. 38F). One series of specimens from Kipuka Puu Hulululu differs from all others in several respects, including the presence of only two differentiated setae in the male ventral organ; however, the small size of the sample, which includes only one male, makes it impossible to determine whether it represents a different taxon or merely a part of the intraspecific variation.

Ecology: Found up to 4000 ft. in wooded or brushy areas; generally in litter, soil, or under rocks or bark in damp situations. Its absence from Molokai and Oahu is noteworthy.

Records: Hawaii: 4726, 4727, 4854, 4860, 4861, 4926, 4929, 4930, 4931, 4932, 4934, 4935, 4936, 4937, 4938, 5068, 5116, 5119, 5120, 5127, 5128, 5130, 5138, 5144, 5147, 5148, 5150, 5151, 5153, 5156, 5158, 5266, 5273, 5274, 5275, 5276, 5330, 5336, 5355, 5365, 5371, 5372, 5375, 5411, 5412, 5423, 5469, 5489, 5671, 5673, 5675, 5677, 5678, 5681, 5684, 5688, 5693, 5702, 6391, 6532, 6840, 6845, 6896. Maui: 5159, 5161, 5166, 5175, 5176, 5189, 6677, 6678, 6680. Kauai: 5190, 5192, 5193, 5198, 5201, 5206, 5211, 5262, 5277, 5285. Midway: 5311.

Subgenus **PROTAPHORURA** Absolon, 1901

Type species: *Lipura armata* Tullberg, 1869

In this subgenus the tubercles of the postantennal organ are simple. Three Hawaiian species are placed here.

Onychiurus (Protaphorura) cryptopygus Denis, 1931 (Plate 39)

Boll. Lab. Zool. Gen. Agric. Portici 25:101.—Denis, 1933.—Thibaud and Mas-soud, 1980.

Color white. Body elongate elliptical. Fourth antennal segment without clear blunt setae or apical bulb; subapical sense peg near apex, in a well-developed pit, usually peglike with a slightly expanded apex, but occasionally with spherical apex; sometimes not visible. Apical organ of third antennal segment with 4 guard setae and 4 irregular papillae; sense clubs in the form of 2 small irregular pegs. Tenent hair acuminate, 0.75–0.80 times length of inner edge of unguis. Unguis

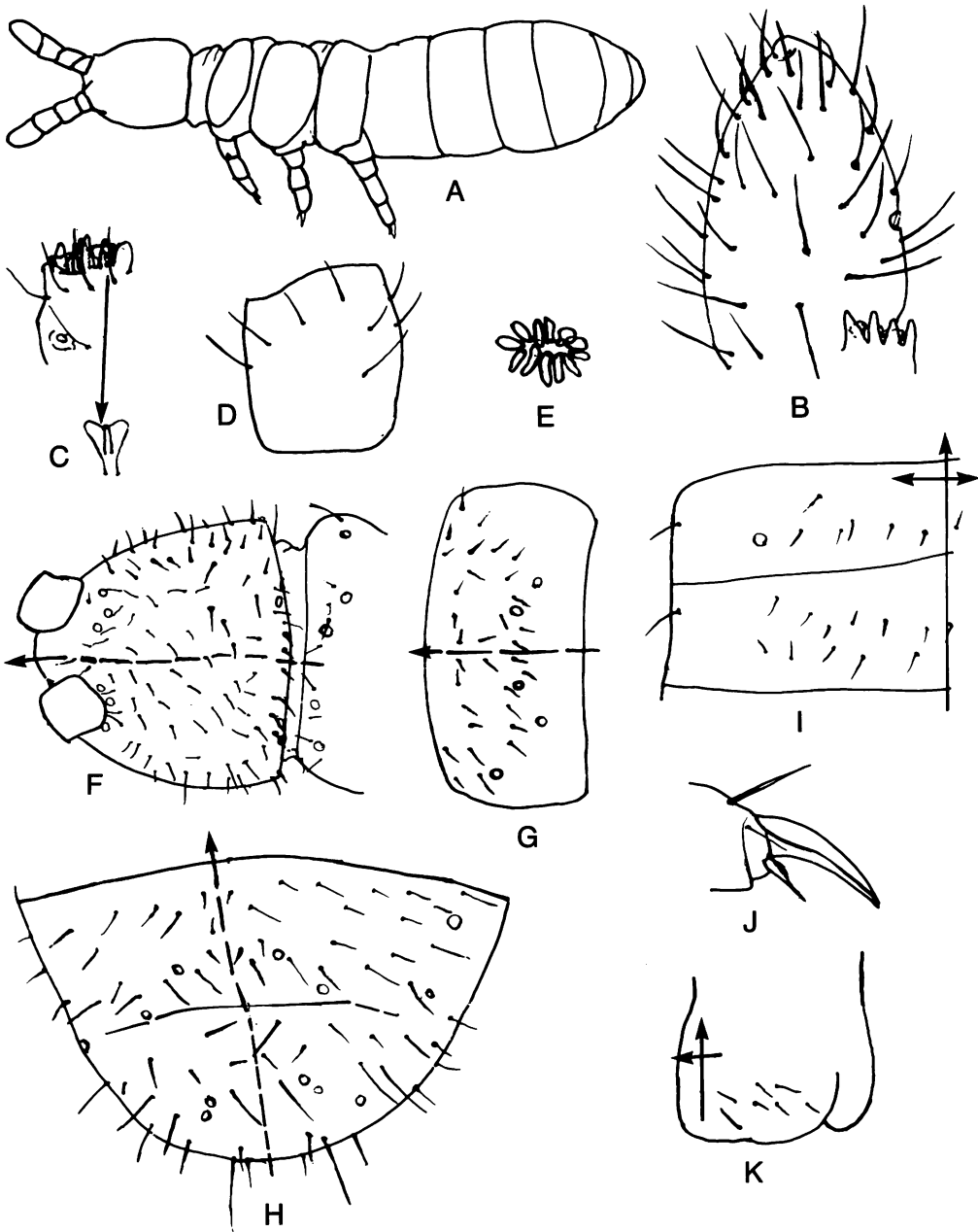
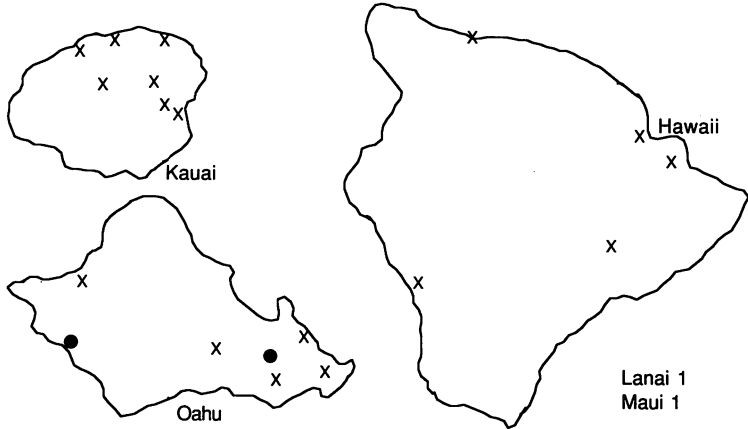


Plate 39—*Onychiurus (Protaphorura) cryptopygus*: A, habitus (6773, Oahu); B, fourth antennal segment (5163, Maui); C, apical organ of third antennal segment (6698, Lanai); D, venter of second antennal segment (6773, Oahu); E, postantennal organ (5009, Hawaii); F, chaetotaxy, dorsum of head and first thoracic segment (5163, Maui); G, same, second thoracic segment; H, dorsal chaetotaxy, fourth through sixth abdominal segments (same); I, ventral chaetotaxy, right side, second and third abdominal segments (6698, Lanai); J, hind foot complex (5009, Hawaii); K, ventral tube (6773, Oahu).

untoothed. Unguiculus basally swollen, slightly less than $\frac{1}{2}$ length of inner edge of unguis. Ventral tube with 6 + 6 setae. Furcula and anal spines absent. Integument uniformly granulate; largest granules about $0.8 \mu\text{m}$ in diameter. Longest abdominal seta 0.28–0.34 mm. Maximum length 0.6 mm.



Remarks: The Hawaiian specimens do not have as abruptly declivous an abdomen end as described by Denis, and the longest body setae are somewhat shorter than shown in his figures. In other respects they agree very well. The small size and poor preservation make it difficult to identify pseudocelli, and the latter may vary somewhat, but when they are clearly visible the formula agrees entirely with Denis's description. Only females were seen; this species is probably parthenogenetic, like *O. encarpatus*. The apical organ of the third antennal segment agrees well with that figured by Thibaud and Massoud (1980) except for the inner rods, which are longer in the Hawaiian material.

Ecology: Mostly in moist disturbed areas in lowland, in litter, soil, rotten wood, low vegetation, and under bark, stones, and debris. Two records from high elevations.

Records: Hawaii: 4724, 4871, 5009, 5111, 5307, 5644. Maui: 5163. Lanai: 6698. Oahu: 4773, 4774, 4807, 4819, 4820, 4832, 6754, 6773, 6774. Kauai: 4730, 4737, 4744, 5204, 5209, 6719, 6728.

***Onychiurus (Protaphorura) encarpatus* Denis, 1931 (Plate 40)**

Boll. Lab. Zool. Gen. Agric. Portici 25:102.—Denis, 1933.—Christiansen and Bellingher, 1980.

Color dull white to yellow. Body elongate oval. Fourth antennal segment without apical bulb or clearly differentiated blunt setae; subapical sense peg small and rodlike, in a deep pit near apex. Apical organ of third antennal segment with 5 guard setae and 5 papillae; sense clubs bilobed, flanged, and crenulate. Tenent hair acuminate, about 0.8 length of inner edge of unguis. Unguis untoothed.

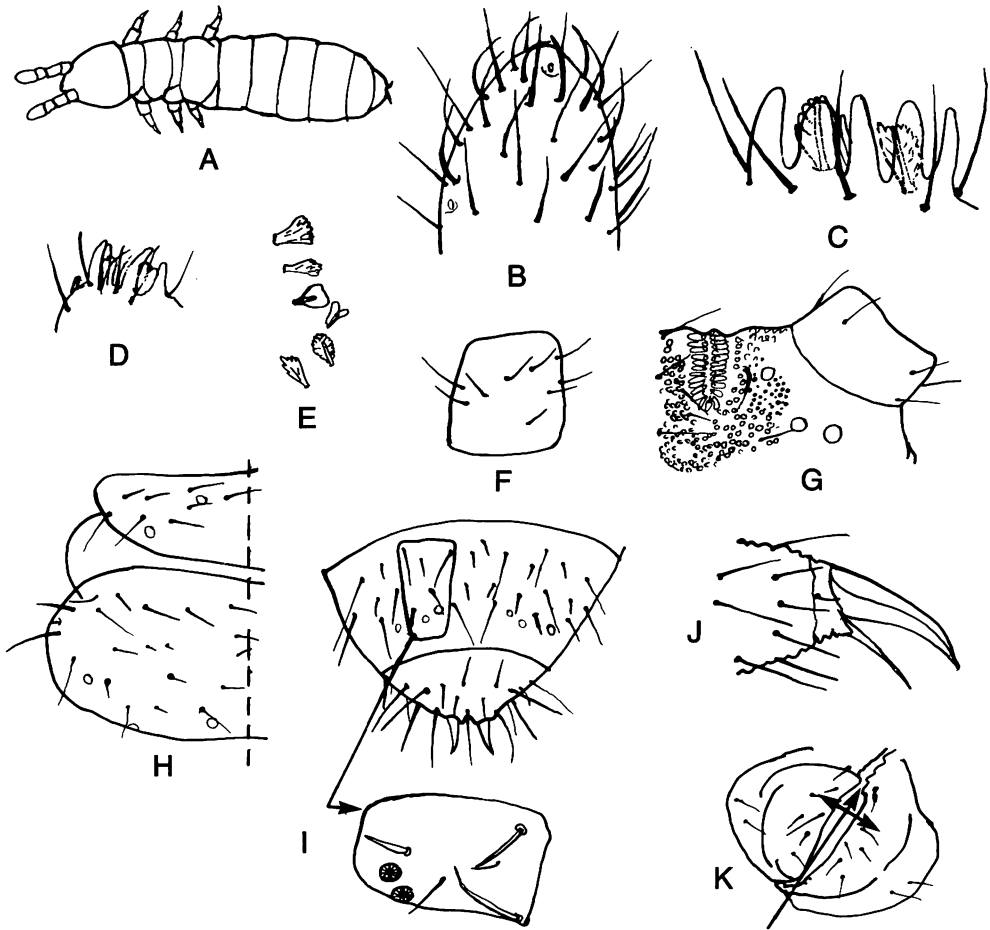
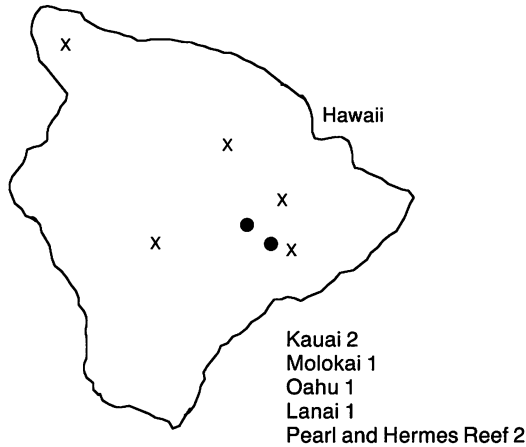


Plate 40—*Onychiurus (Protaphorura) encarpatus*: **A**, habitus (6825, Hawaii); **B**, apical portion, dorsum, fourth antennal segment (same); **C**, apical organ, third antennal segment (after Christiansen and Bellinger); **D**, same (6825, Hawaii); **E**, variations in sense club structure from different Hawaiian specimens; **F**, ventral chaetotaxy, second antennal segment (6825, Hawaii); **G**, postantennal organ and antennal base (same); **H**, dorsal chaetotaxy, left side, first two thoracic segments (same); **I**, posterior dorsal abdominal chaetotaxy (5280, Kauai); **J**, hind foot complex (same); **K**, ventral tube seen from below (5280, Kauai).

Unguiculus gradually narrowed, acuminate, and 0.75–0.9 as long as inner edge of unguis. Ventral tube with 6 + 6 setae. Furcula absent. Anal spines basally expanded and weakly curved, 0.8–1.1 times length of inner edge of unguis. Integument more or less uniformly granulate; granules 0.8–1.5 μm in diameter. Short daggerlike seta between second and third pseudocelli on posterior margin of fifth abdominal segment. Longest posterior setae about 4.5–5.5 μm in length. Maximum length 1.7 mm.



Remarks: The Hawaiian specimens agree quite well with descriptions and nearctic specimens. One specimen from Kauai has a spherical subapical antennal sense peg and may represent a different form. The third antennal segment sense clubs vary considerably in both Hawaiian and North American material. The single specimen from Lanai lacks the short daggerlike seta of the other specimens. No males of this species have been found in Hawaii or elsewhere.

Ecology: Found in litter and soil, or rarely under rocks or on low vegetation, at middle or lower altitudes in nonarid regions.

Records: Hawaii: 4724, 4863, 4867, 4877, 4904, 4932, 5328, 5329, 5667, 6825, 6876, 6913. Molokai: 5716. Lanai: 6701. Oahu: 4781. Kauai: 5280, 5288. Pearl and Hermes Reef: 4911, 4912.

***Onychiurus (Protaphorura) petaloides* Rusek, 1981 (Plate 41)**
Vestn. Cesk. Spol. Zool. 45:63.

Color white. Body fusiform. Fourth antennal segment without apical bulb or blunt setae; “subapical” sense peg actually in a deep apical pit and apically expanded. Apical organ of third antennal segment with 5 papillae and 5 guard setae; sense clubs in the form of curved, flanged pegs. Longest apical tibiotarsal seta dorsolateral, acuminate, and 0.8–0.9 times length of inner edge of unguis. Unguis untoothed; unguiculus basally expanded and slightly less than $\frac{1}{4}$ length of inner edge of unguis. Ventral tube with 6 + 6 setae. Furcula absent. Anal spines

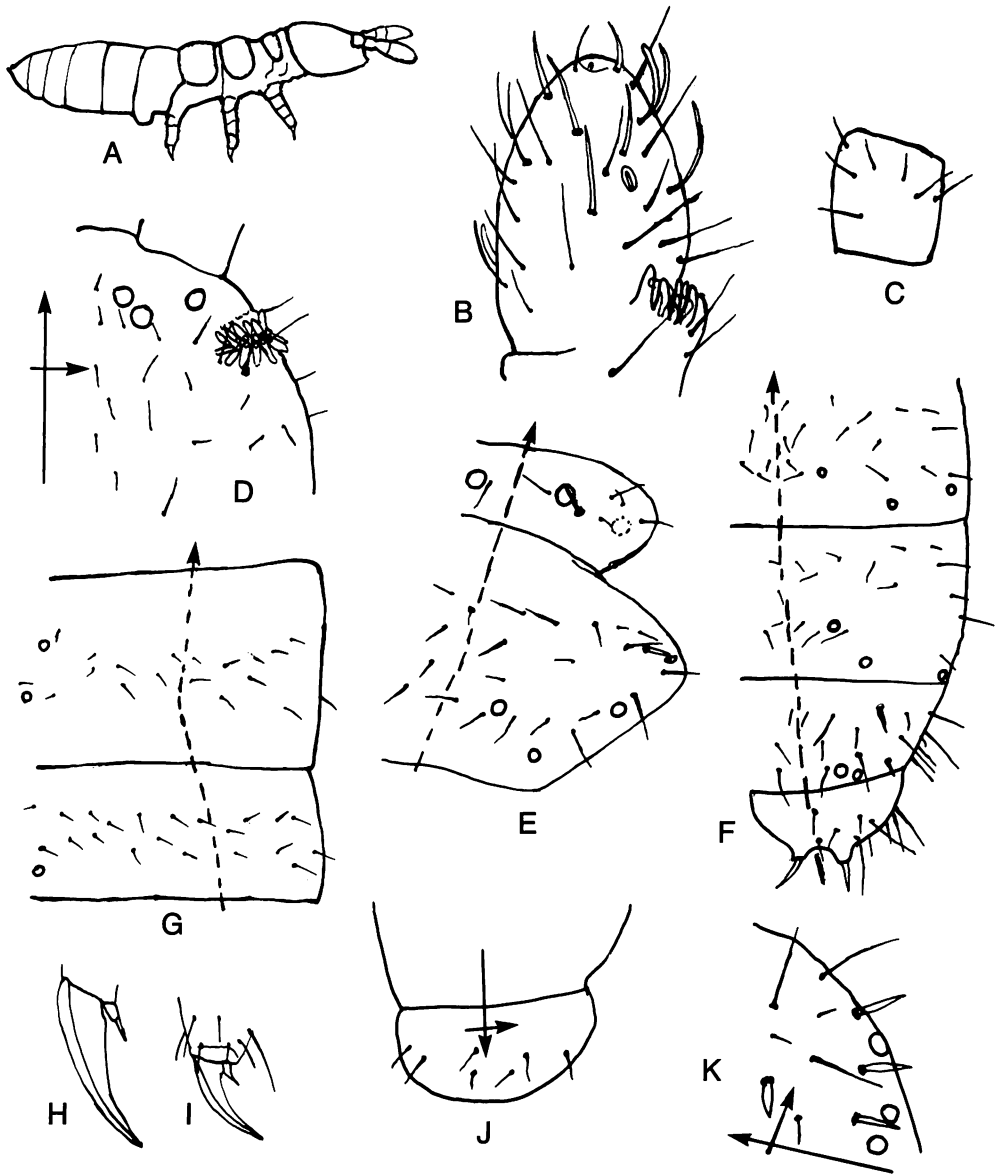
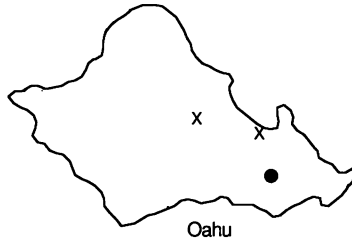


Plate 41—*Onychiurus (Protaphorura) petaloides* (all figures of specimens from Oahu): A, habitus (4786); B, dorsum, fourth antennal segment and apical organ of third (4787); C, venter of second antennal segment (6744); D, postantennal organ and antennal base (4787); E, dorsal chaetotaxy, first and second thoracic segments, right side, dotted pseudocellus absent in some specimens (4787); F, dorsal chaetotaxy, third through sixth abdominal segments, right side (6744); G, chaetotaxy, venter of second and third abdominal segments (6744); H, hind foot (4787); I, fore foot complex (same); J, ventral tube seen from side (6744); K, detail, posterior margin, dorsum, fifth abdominal segment (6744).

curved, gradually tapered, and slightly longer than inner edge of hind unguis. Second and third thoracic segments and first and second abdominal segments each with a pair of flattened, leaflike setae; fifth abdominal segment with 2 + 2 such setae. Maximum length 0.8 mm.



Remarks: The short unguiculus distinguishes this species from almost all *Onychiurus* species, and the expanded setae of the trunk segments are also unusual. Our specimens agree perfectly with the descriptions and figures of *Onychiurus petaloides* Rusek, 1981 from Iraq. In a few specimens it is possible that there are four papillae in the apical organ of the third antennal segment.

Ecology: Found in soil in grasslands and woods.

Records: Oahu: 4786, 4787, 6744, 6762.

Genus **TULLBERGIA** Lubbock, 1876

Type species: *T. antarctica* Lubbock, 1876

This genus includes the Hawaiian onychiurids with small, slender bodies; simple antennal sense organs; and postantennal organ of many simple lobes. The sense organs of the third antennal segment are very similar in all Hawaiian species, consisting of two thick reniform rods curved toward each other, and two shorter inner pegs. The unguiculus is minute.

Tullbergia antarctica and its close relatives in the Southern Hemisphere appear to differ in some respects from most Northern Hemisphere species (e.g., in having the antennal sense organ fully exposed). Northern Hemisphere species with typical antennal sense organs and postantennal organ and with two anal spines may be placed in the subgenus *Mesaphorura* (type species: *M. krausbaueri* Börner, 1901*d*). Groups of species may be recognized within *Mesaphorura*, such as the *krausbaueri* complex, with crescentic ridges on the dorsum of the sixth abdominal segment, and the *collis* complex, with more than two complete rows of postantennal organ tubercles, which includes *T. silvicola*. We do not believe it is necessary or useful to separate these groups into formally defined genera or subgenera.

There are four species of *Tullbergia* recorded from Hawaii: *macrochaeta*, *ruseki*, *silvicola*, and *yosiii*. The first and last are common, the others extremely rare.

Table 10. Characteristics of Hawaiian Species of *Tullbergia* and *Prabhergia*

GENUS	SPECIES	POSTANTENNAL ORGAN		PSEUDOCELLI								SETAE			
		NO. ROWS	NO. TUBERCLES	THORAX			ABDOMEN					HEAD p ₁ /p ₂	ABD. IV p ₁ /p ₂	ABD. V a ₂ /a ₁	
				I	II	III	I	II	III	IV	V				VI
<i>Prabhergia</i>	<i>nayarii</i>	2	6-7	0	1	1	1	1	1	1	1	0	>	>	>
<i>Tullbergia</i>	<i>macrochaeta</i>	2	34-50	0	1	1	1	0	0	1	1	0	>	>	=>
	<i>ruseki</i>	2	28-36	0	1	1	1	0	0	1	1	0	≈	>	=
	<i>silvicola</i>	3-4	42-52	0	1	1	1	1	1	1	1	0	>	>	≈
	<i>yosiii</i>	2	36-40	0	1	1	1	0	0	1	1	0	≈	<<	=

NOTE: no males have been seen in any of the Hawaiian material. Males have been reported in Scandinavian *T. macrochaeta*, but not in any of the other species.

KEY TO HAWAIIAN SPECIES OF TULLBERGIA

1. Postantennal organ with 3 or more rows of tubercles at lateral end (Fig. 34A).....
 **silvicola**
 Postantennal organ with 2 rows of tubercles for entire length (Fig. 34B)..... 2

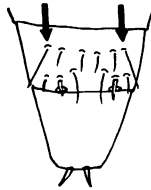


34A

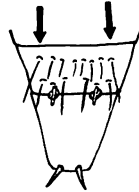


34B

- 2(1). Fifth abdominal segment with 4 setae between anterior macrochaetae (Fig. 35A)
 **ruseki**
 Fifth abdominal segment with 6 setae between anterior macrochaetae (Fig. 35B).... 3

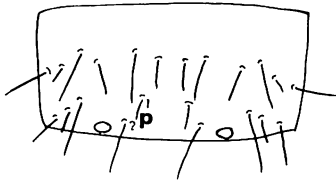


35A

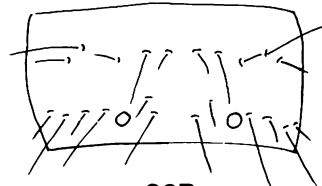


35B

- 3(2). Fourth abdominal segment with short posterior setae nearest midline (Fig. 36A)
 **yosiii**
 Fourth abdominal segment with long posterior setae nearest midline (Fig. 36B)
 **macrochaeta**



36A



36B

Tullbergia macrochaeta Rusek, 1976 (Plate 42)

Can. J. Zool. 54:33 (*Mesaphorura*).—Christiansen and Bellinger, 1980.

Color white. Fourth antennal segment with minute apical bulb, clearly narrower than thickest blunt seta; 4 blunt setae, the thickest about twice the diameter of the thinnest; and 1 clearly differentiated short conical seta. Postantennal organ quite straight, with 2 rows of tubercles. All tibiotarsal setae acuminate and subequal in length. Unguis untoothed; unguiculus about 1/4 as long as inner edge of unguis. Ventral tube with 6 + 6 setae. Anal spines weakly curved, 1.25–1.35 times length

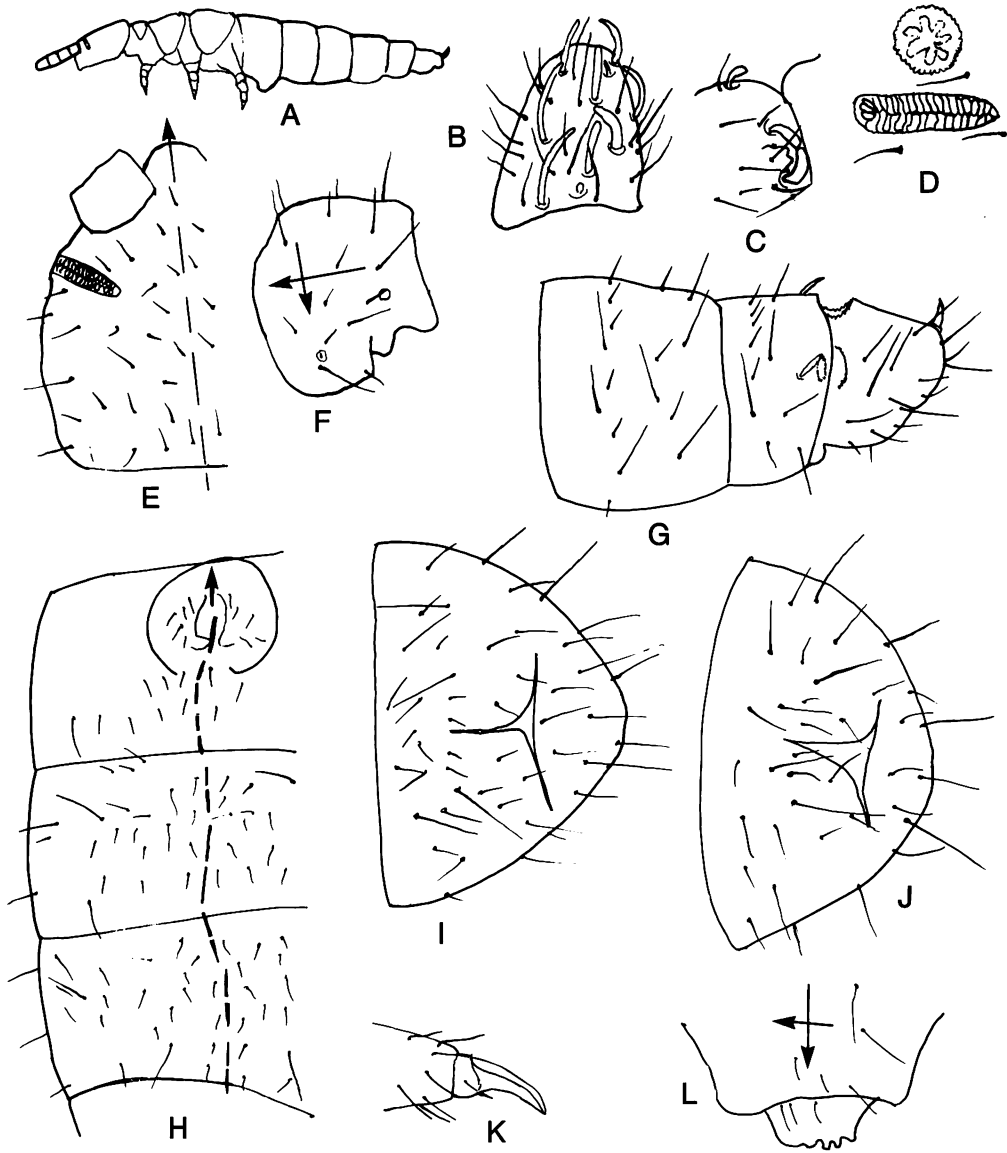
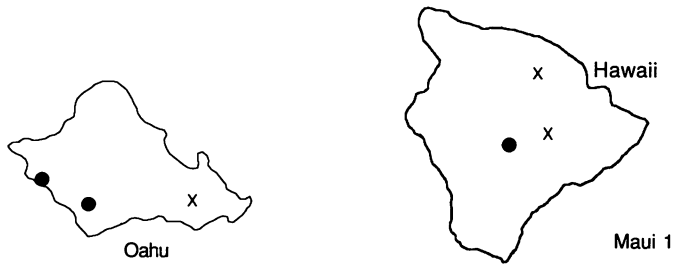


Plate 42—*Tullbergia macrochaeta*: A, habitus (6775, Oahu); B, dorsum, fourth antennal segment (6844, Hawaii); C, apical organ of third antennal segment (6775, Oahu); D, postantennal organ and neighboring pseudocellus (after Christiansen and Bellinger); E, dorsal cephalic chaetotaxy, left side (6844, Hawaii); F, dorsal chaetotaxy, second thoracic segment, left side (6825, Hawaii); G, same, last three abdominal segments; H, ventral chaetotaxy, first three abdominal segments, right side (6844, Hawaii); I, ventral abdominal chaetotaxy, sixth segment (4816, Oahu); J, same (5261, Maui); K, hind foot complex (6775, Oahu); L, ventral tube seen from side (same).

of inner edge of unguis. Pseudocelli stellate, with margins sometimes difficult to differentiate from surrounding granulation. Dorsum of sixth abdominal segment more coarsely granulate than other tergites, with granules about $0.9\ \mu\text{m}$ in diameter, and with a pair of crescentic ridges just behind the pseudocelli of the fifth abdominal segment; a short, blunt sensory seta projects over each of these pseudocelli. Second and third thoracic segments with lateral sensilla (s of Rusek) slender, apically slightly blunted, and much longer than a_5 and m_5 ; lateral sensory rod (s' of Rusek) short and peglike. All other body setae slender and acuminate. Maximum length 0.8 mm.



Remarks: The specimens from Hawaii agree well with nearctic material except that cephalic p_1 is generally slightly longer than p_2 and fifth abdominal setae a_1 and a_2 are subequal. All specimens from Oahu and Hawaii have seta 1_2 present on the anal valves; specimens from Maui lack this, and in this respect are similar to *T. krausbaueri* Börner, 1901. Members of this complex (including also, in Hawaii, *T. ruseki* and *T. yosiii*) differ only in minor details of chaetotaxy. The genetic basis of these differences and the best taxonomic treatment of these forms remain in doubt.

Records: Hawaii: 4857, 4861, 4865, 4914, 6825, 6828, 6844, 6872, 6892, 6897. Maui: 5261. Oahu: 4771, 4794, 4795, 4799, 4816, 6774, 6775.

Tullbergia ruseki Christiansen and Bellinger, 1980 (Plate 43)
The Collembola of North America: 507.

Color white. Fourth antennal segment with obscure apical bulb, clearly narrower than thickest blunt seta, which is about twice as thick as the other 3 and more abruptly blunt. Postantennal organ straight, with 2 rows of tubercles. Tibiotarsal setae all acuminate and subequal in length. Unguis untoothed. Unguiculus about $\frac{1}{4}$ as long as inner edge of unguis. Ventral tube with $6 + 6$ setae. Anal spines curved and 1.25–1.35 times length of inner edge of hind unguis. Pseudocelli stellate with margins sometimes obscure. Sixth abdominal tergite with 2 anterior crescentic ridges; granule diameter $0.9\text{--}1.2\ \mu\text{m}$, which is coarser than on other segments. Short blunt p (s of Rusek) setae project over the pseudocelli of the fifth abdominal segment. Lateral s sensillae of second and third thoracic segments slender, tapered, and apically slightly blunted, but much thicker than neighboring setae; peglike s' setae distinct. Other body setae slender and acuminate. Maximum length 0.6 mm.

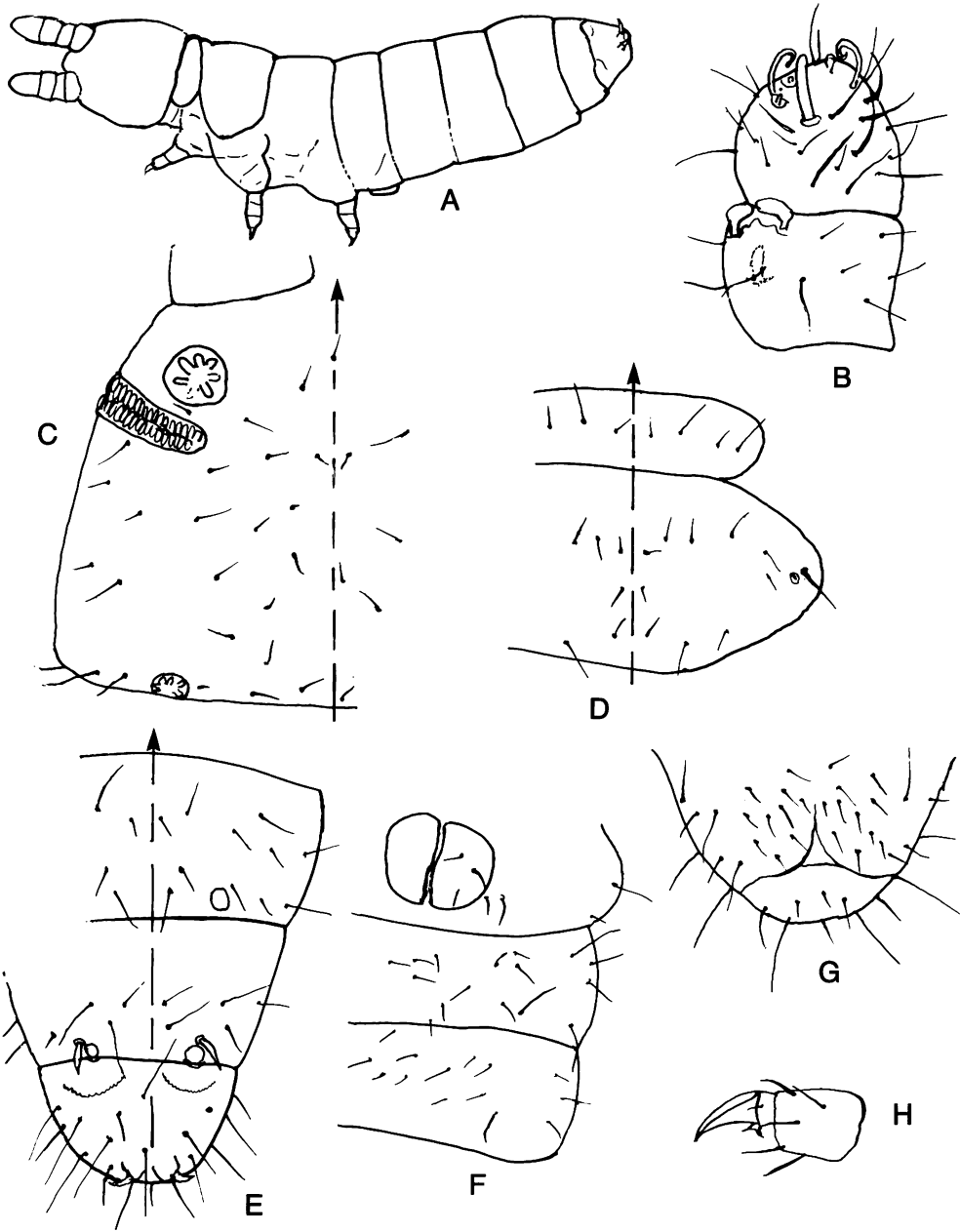


Plate 43—*Tullbergia ruseki* (all figures of 4777, Oahu): **A**, habitus; **B**, dorsal surface, third and fourth antennal segments; **C**, dorsal surface of left side of head; **D**, dorsal chaetotaxy, right side, first two thoracic segments; **E**, dorsal chaetotaxy, last three abdominal segments; **F**, ventral surface, left side, first three abdominal segments; **G**, ventral surface, sixth abdominal segment; **H**, hind foot complex.

Remarks: This is a very questionable element of the Hawaiian fauna. We have only seen five immature specimens of this species, taken in 1966 near Honolulu, but these agree well with North American material except for having slightly smaller maximum granule diameter. This species is one of the *krausbaueri* complex (see remarks under *T. macrochaeta*).

Ecology: The Hawaiian collections are from woodland litter and soil in joint grass.

Records: Oahu: 4777, 4786.

Tullbergia silvicola Folsom, 1932 (Plate 44)

Proc. Hawaii. Entomol. Soc. 8:57.

Tullbergia granulata Mills, 1934, Coll. Iowa: 37. **New synonym.**

Color white. Apical antennal bulb spherical and about as thick as blunt setae; fourth antennal segment with 5 blunt setae, subequal in thickness. Apex of third antennal segment with 2 large oval sense clubs curved toward each other, 2 minute rounded sense pegs between them, and a third sense club, bent toward the animal's midline, on the ventral surface. Postantennal organ of 2 rows of tubercles, with 1 to several extra tubercles forming a third median row toward the outer end. All tibiotarsal setae acuminate. Unguis untoothed. Unguiculus minute. Ventral tube with 3 + 3 or 4 + 4 setae. Anal spines weakly curved, about 1.2 times length of inner edge of hind unguis. Anterior pseudocelli striate. Dorsum of sixth abdominal segment with clear transverse rows of tubercles coarser than those on other segments. The p setae projecting over the pseudocelli of the fifth abdominal segment are long and acuminate, only slightly thicker than other setae. Second and third thoracic segments with seta s only slightly longer than a_4 and p_5 ; s' distinct, in a shallow depression. All other body setae slender and acuminate. Maximum length 1 mm.

Remarks: The synonymy given here is based on examination of two of the type specimens of *T. silvicola*. Pseudocelli were not clearly visible, but the anterior cephalic pseudocelli at least appear to be striate. In other respects they appear to be indistinguishable from the well-known nearctic species *T. granulata*. The only later record is of a single immature specimen.

Type locality: Tantalus, Oahu, soil in native forest.

Additional records: Hawaii: 4857.

Tullbergia yosiii Rusek, 1967 (Plate 45)

Acta Entomol. Bohemoslov. 64:191 (*Mesaphorura*).—Rusek, 1971a, 1971b.—Christiansen and Bellinger, 1980.

Color white. Fourth antennal segment with apical bulb about as thick as thickest of 4 blunt setae, which is abruptly blunt and much thicker than the other 3, which are only slightly blunted. Postantennal organ with 2 straight rows of tubercles. All tibiotarsal setae acuminate and subequal in length. Unguis untoothed. Unguiculus about $\frac{1}{4}$ as long as inner edge of unguis. Ventral tube with 6 + 6 setae. Anal spines

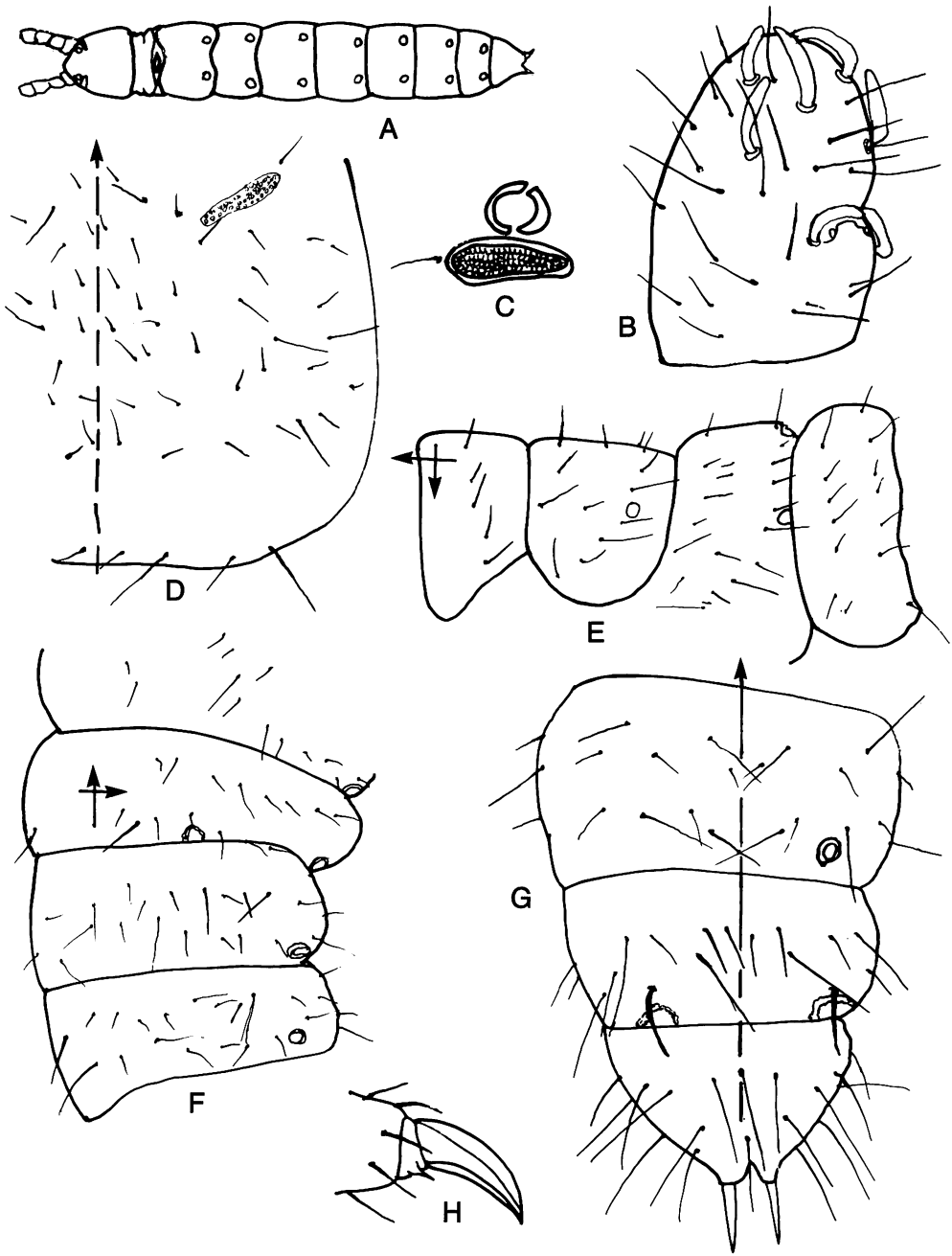


Plate 44—*Tullbergia silvicola*: A, habitus (after Folsom); B, dorsum, third and fourth antennal segments (type specimen); C, postantennal organ and neighboring pseudocellus (after Folsom); D, cephalic chaetotaxy, right side (type specimen); E, dorsal thoracic chaetotaxy, left side (same); F, same, first three abdominal segments; G, dorsal chaetotaxy, last three abdominal segments (same); H, hind foot complex (after Folsom).

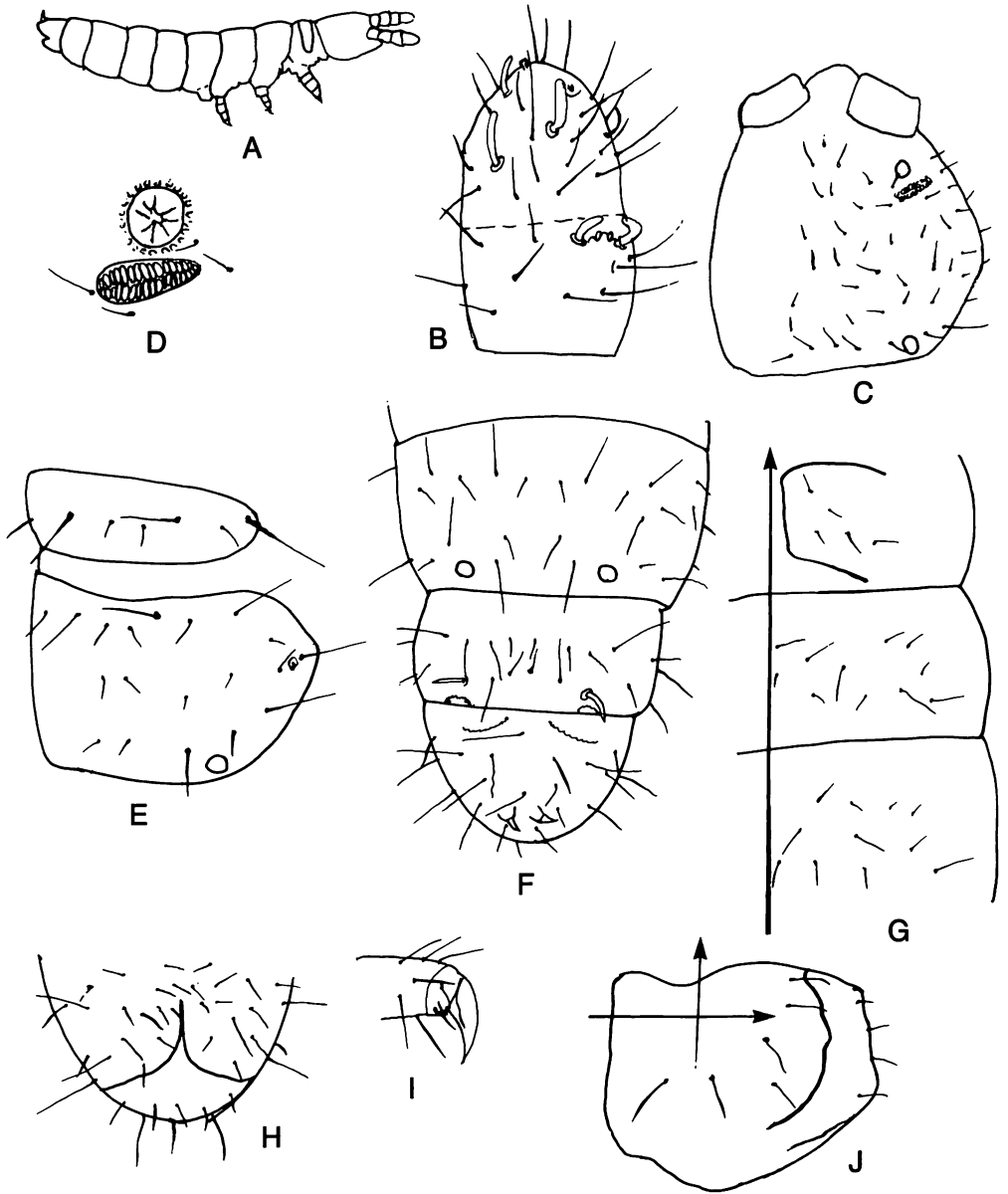
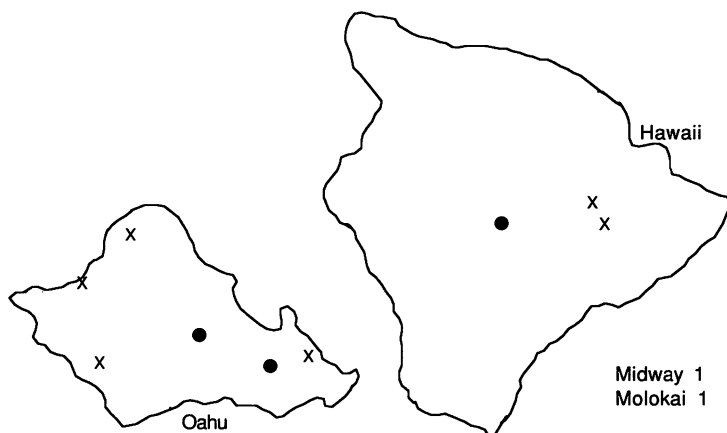


Plate 45—*Tullbergia yosiii*: **A**, habitus (6733, Oahu); **B**, dorsum, third and fourth antennal segments (5072, Oahu); **C**, cephalic chaetotaxy, right side (4812, Oahu); **D**, postantennal organ and nearest pseudocellus (after Christiansen and Bellinger); **E**, chaetotaxy, first two thoracic segments, right side (4812, Oahu); **F**, dorsal chaetotaxy, last three abdominal segments (6863, Molokai); **G**, ventral abdominal chaetotaxy, first three segments, left side (5072, Oahu); **H**, ventral abdominal chaetotaxy, sixth segment (same); **I**, mid foot complex (4812, Oahu); **J**, ventral tube seen from side (same).

weakly curved, 0.8–1.0 times length of inner edge of hind unguis. Pseudocelli stellate; margins sometimes obscure. Sixth abdominal tergite with granules about 0.9 μm in diameter, coarser than on other segments, and with 2 crescentic ridges on anterior margin; a pair of short, blunt p setae project over these ridges and the pseudocelli on the posterior margin of the fifth abdominal segment. Second and third thoracic segments with lateral sensillae s gradually tapered, slightly blunt, and much longer than neighboring setae; small peglike s' setae distinct. Other body setae are slender and acuminate. Maximum length 0.5 mm.



Remarks: This is a common member of the *krausbaueri* complex on Oahu. It is very similar to other members of the group, differing mainly in chaetotaxy.

Ecology: Found in soil and moss in disturbed areas.

Records: Hawaii: 4869, 6866, 6893, 6895, 6897. Molokai: 6863. Oahu: 4766, 4773, 4786, 4796, 4807, 4812, 4813, 4814, 5072, 6733, 6747. Midway: 4944.

Genus **PRABHERGIA** Salmon, 1965

Type species: *P. nayarii* Salmon, 1965

This genus is characterized by the simple postantennal organ of a few tubercles in two rows with their long axes parallel to that of the organ itself. In this respect it resembles the nearctic genus *Sensiphorura*, which, however, has different antennal sense organs and chaetotaxy and lacks visible pseudocelli. Except for the postantennal organ, *Prabhergia* is quite similar to *Tullbergia*. There is a single Hawaiian species, *P. nayarii*.

Prabhergia nayarii Salmon, 1965 (Plate 46)

Trans. R. Soc. N.Z., Zool. 5:228.

Color white. Fourth antennal segment with small, papillate obscure apical bulb, much thinner than the blunt setae, and 5 blunt setae, the 3 distal ones very thick

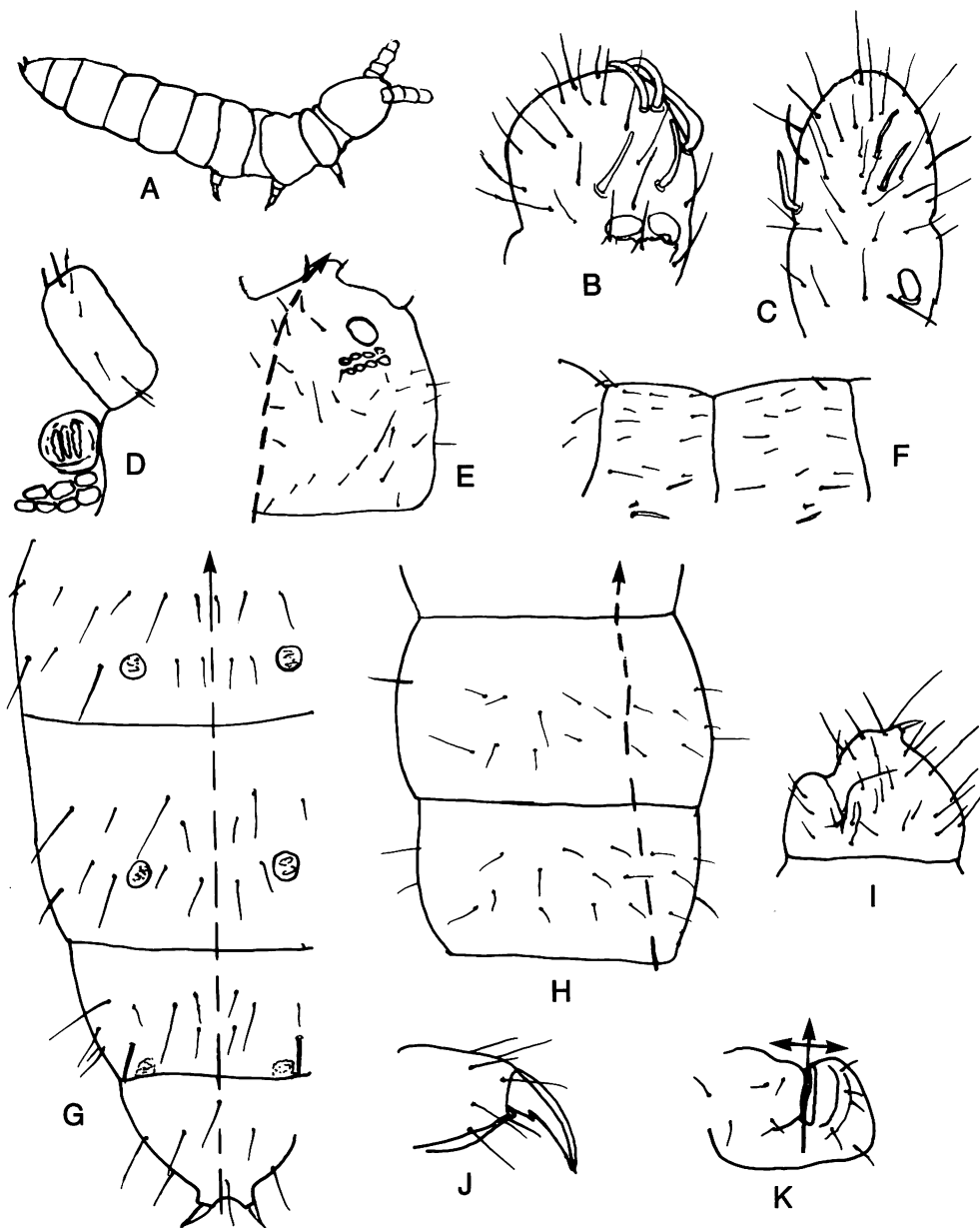


Plate 46—*Prabhergia nayarii*: A, habitus (4786, Oahu); B, dorsal surface of fourth antennal segment and apical organ of third (4733, Kauai); C, ventral surface, third and fourth antennal segments (4724, Hawaii); D, postantennal organ and neighboring pseudocellus (4733, Kauai); E, dorsal cephalic chaetotaxy, right side (4786, Oahu); F, dorsal thoracic chaetotaxy, left side (4733, Kauai); G, dorsal chaetotaxy, last four abdominal segments (4786, Oahu); H, ventral chaetotaxy, second and third abdominal segments (same); I, lateral chaetotaxy, sixth abdominal segment (same); J, hind foot complex (same); K, ventral tube (same).

and curved, the basal 2 thinner and one of these tapered and only slightly blunt. Third and second antennal segments slightly basally constricted; third antennal apical organ with 2 large dorsal broadly elliptical, short-stalked sense clubs, curving toward each other, and 2 minute oval sense rods between them. Median part of venter with a single such swollen club. Postantennal organ of 6 or 7 irregularly elliptical lobes in 2 parallel rows, in a shallow depression. All tibiotarsal setae acuminate and subequal in length. Unguis untoothed. Unguiculus very minute, less than $\frac{1}{6}$ as long as inner edge of unguis. Ventral tube with 5 + 5 setae. Anal spines strongly curved, 1.2–1.4 times as long as inner edge of unguis. Integumental granulation rather uniform, only slightly coarser on sixth abdominal segment than elsewhere; maximum granule diameter about 0.8 μm . Pseudocelli striate; sometimes difficult to see on middle trunk segments. Fifth abdominal segment with 2 + 2 thickened setae on posterior margin, 1 just anterior to pseudocellus and 1 more lateral. No ridges or conspicuous humps except those from which the anal spines protrude on sixth abdominal segment. Lateral sensilla (*s* of Rusek) of second and third thoracic segments not clearly differentiated from other long body setae; all are very slightly blunted apically. Short lateral peglike setae (*s'* of Rusek) of these segments distinct, in a shallow depression. Other body setae acuminate and simple. Maximum length 0.8 mm.

Remarks: Rusek examined specimens of the Hawaiian species and informed us that they were conspecific with specimens of *P. nayarii* he had examined. No males were seen.

Ecology: Found in litter and soil in lowland, mostly in disturbed areas.

Records: Hawaii: 4724, 4871. Oahu: 4786, 4814. Kauai: 4730, 4733.

Section ENTOMOBRYOMORPHA

Linear Collembola without pronotal setae; the pronotum is not always visible. All Arthropleona with scales or multilaterally ciliate setae belong here, and species with simple setae usually have more of them than do Poduromorpha; in particular, the tibiotarsus clearly has more than two rows of setae.

Family ISOTOMIDAE

This family includes Arthropleona with all antennal segments distinct, well-developed mouthparts with a mandibular molar plate, reduced pronotum without setae, unguis with a single inner margin, third and fourth abdominal segments similar in length, and lacking scales or "flexed" setae. A postantennal organ consisting of a single tubercle without peripheral lobes is usually present. All species are plurichaetotic; the clothing may be nearly uniform or strongly differentiated. Many characters are quite variable, as shown in Table 11.

This family is well represented in Hawaii, with 12 genera. It includes some species that are dominant in most habitats and is exceeded in number of individuals only by the Entomobryidae.

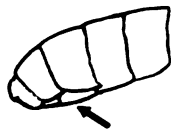
Table 11. Characteristics of Isotomidae Genera

GENUS	RECTRAC- TILE ANTENNAL PAPILLA	POST- ANTENNAL ORGAN	EYE NUMBER	CLAVATE TENANT HAIRS	FUSED ABDOM- INAL SEGMENTS	TENAC- ULAR TEETH	VENTRAL MANUBRIAL SETAE (ADULTS)
<i>Anurophorus</i>	+	+	8	+	V/VI	-	-
<i>Isotomodes</i>	-	+	0	-	-	3	-
<i>Folsomides</i>	-	+	1-2	-	-	3	-
<i>Proisotoma</i>	-	+	6-8	+,-	-	4	0-6
<i>Archisotoma</i>	-	+	6	1	V/VI	4	-
<i>Cryptopygus</i>	-	+	6-8	-	V/VI	4	2
<i>Folsomia</i>	-	+	0-4	-	IV/VI	4	4-27
<i>Folsomina</i>	-	-	0	-	IV/VI	4	2
<i>Isotomiella</i>	-	-	0	-	V/VI	4	10-12
<i>Axelsonia</i>	-	-*	8	-	-	4	many
<i>Isotomurus</i>	-	+	8	-	-	4	many
<i>Isotoma</i>	-	+	3-8	-,+	-,V/VI	4	many

*The table in *The Collembola of North America* is in error here.

KEY TO HAWAIIAN GENERA OF ISOTOMIDAE

1. Furcula absent (Fig. 37A)..... **Anurophorus**
 Furcula present (Fig. 37B)..... 2



37A



37B

- 2(1). Mucro falcate (Fig. 38A)..... **Folsomina**
 Mucro with 2 or more teeth (Fig. 38B)..... 3



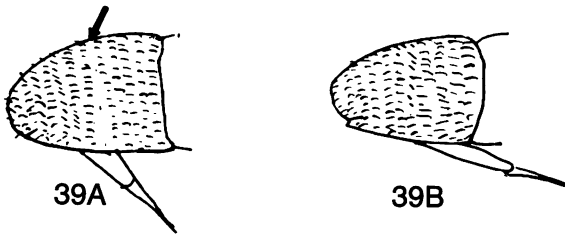
38A



38B

DENS/ MANU- BRIUM	DENTAL SETAE		DORSAL DENTAL SUR- FACE	MUCRO- NAL TEETH	PIG- MENT	BOTHRIO- TRICHA NUMBER	ABDOM- INAL SEGMENTS WITH BOTHRIO- TRICHA	CILIAE SETAE OTHER THAN BOTHRIO- TRICHA
	DORSAL HALF	VENTRAL HALF						
-	-	-	-	-	+	-		-
<	2	1-6	smooth	2	-	-		-
<	3	0	smooth	2	-	-		-
<->	6-10	3-24	humped- crenulate	2-3	+	-		-
<	ca. 5	ca. 8	smooth	3	-?	2,2	V/VI	-
>	6-8	many	crenulate	2	-,+	-		-
>	4-9	many	crenulate	2	-,+	-		-
>	4-6	ca. 20	crenulate	1	-	-		-
>	4	many	crenulate	3	-	-		+
>	many	many	crenulate	5	+	2,2,2	II-IV	-
>	many	many	crenulate	4	+	3,3,1	II-IV	+
>	many	many	crenulate	3(-4)	+	-		-,+

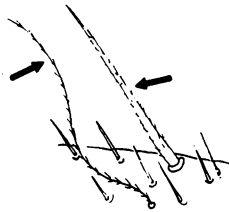
- 3(2). Fourth through sixth abdominal segments fused into a single mass (Fig. 39B) **Folsomia**
 Fourth and fifth abdominal segments at least separated by a nonsetaceous band
 (Fig. 39A)..... 4



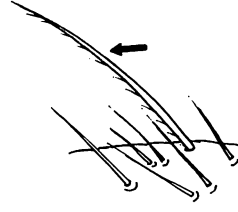
- 4(3). Postantennal organ absent (Fig. 40A)..... 5
 Postantennal organ present (Fig. 40B)..... 6



- 5(4). Eyes and pigment absent. **Isotomiella**
- Eyes and pigment present. **Axelsonia**
- 6(4). Ventral manubrial setae 14 or more. 7
- Ventral manubrial setae 6 or fewer. 8
- 7(6). Some abdominal setae multilaterally ciliate (Fig. 41A). **Isotomurus**
- Abdominal macrochaetae all smooth or unilaterally ciliate (Fig. 41B). **Isotoma**



41A



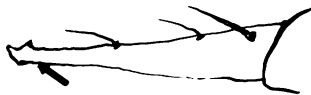
41B

- 8(6). Hind femur with apical spur (Fig. 42). **Archisotoma**
- Hind femur without spur. 9

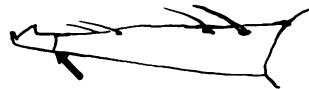


42

- 9(8). Mucro fused to end of dens (Fig. 43A). **Folsomides**
- Mucro distinctly separated from dens (Fig. 43B). 10

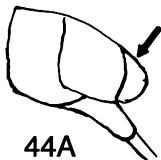


43A

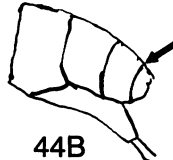


43B

- 10(9). Eyes absent. **Isotomodes**
- At least 5 + 5 eyes present. 11
- 11(10). Fifth and sixth abdominal segments fused (Fig. 44A). **Cryptopygus**
- Fifth and sixth abdominal segments separated at least by a nonsetaceous band (Fig. 44B). **Proisotoma**



44A



44B

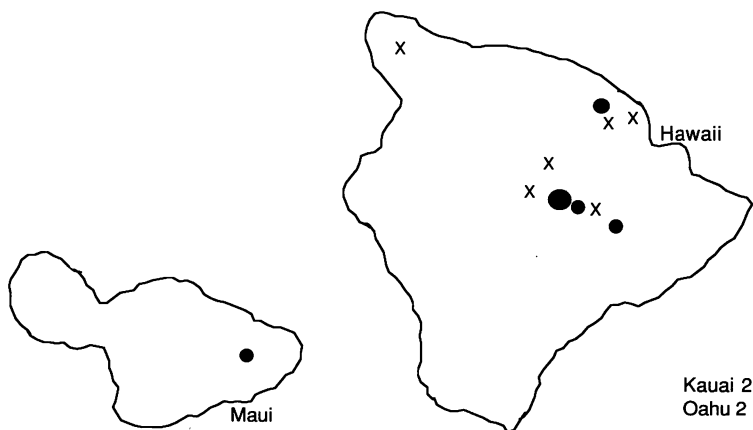
Genus **ANUROPHORUS** Nicolet, 1842

Type species: *A. laricis* Nicolet, 1842

This genus includes the Hawaiian isotomids that lack a furcula entirely. The single Hawaiian species belongs to the typical subgenus.

Anurophorus lohi Christiansen and Bellinger, **new species** (Plate 47)

Color gray to blue with intersegmental membranes and legs paler or unpigmented; antennae more lightly pigmented than body; dorsum of body with a weak to distinct median longitudinal dark stripe and numerous oval or irregular pale spots. Fourth antennal segment with bilobed apical bulb; all setae slender, but many are only slightly tapered and apically blunt. Pin setae simple, flanked by much larger curved blunt setae. Apical organ of third antennal segment of 2 short, curved blunt pegs in separate shallow pits; near the outer edge of the segment is a fifth blunt seta, varying in size and accompanied by a minute peg. Maxillary palp simple, with 3 sublobal setae. Postantennal organ about twice length of nearest eye, broadly oval. Eyes 8 + 8; G much smaller and H slightly to much smaller than others. Clavate tenent hairs variable: one, strongly clavate, is always present ventrally on the first, usually on the second, and rarely on the third leg; dorsal hairs weakly to strongly clavate, most commonly 2-3-3 but 1-2-2 or 2-2-3 on some specimens (absent in one population with 1-1-1 ventral clavate hairs). Unguis untoothed. Unguiculus $\frac{1}{10}$ to $\frac{1}{4}$ as long as inner edge of unguis (rarely more than $\frac{1}{5}$ as long); unguiculi usually subequal, but sometimes the third is as much as twice the length of the first. Ventral tube with 3 + 3 distal and 3-4 posterior setae. All body setae acuminate; longest setae $\frac{1}{27}$ - $\frac{1}{18}$ as long as head and body. Number of rows of setae middorsally on the first 6 trunk segments (less common conditions in parentheses): 7(6-8), 5(6), 4(3), 4(3), 4(5), 5(6). Inner macrochaete of fourth abdominal segment 1.7-2.3 (usually 2-2.1) times length of p_1 of the segment. Fifth abdominal segment with erect posterior median macrochaetae and 4-6 (usually 5)



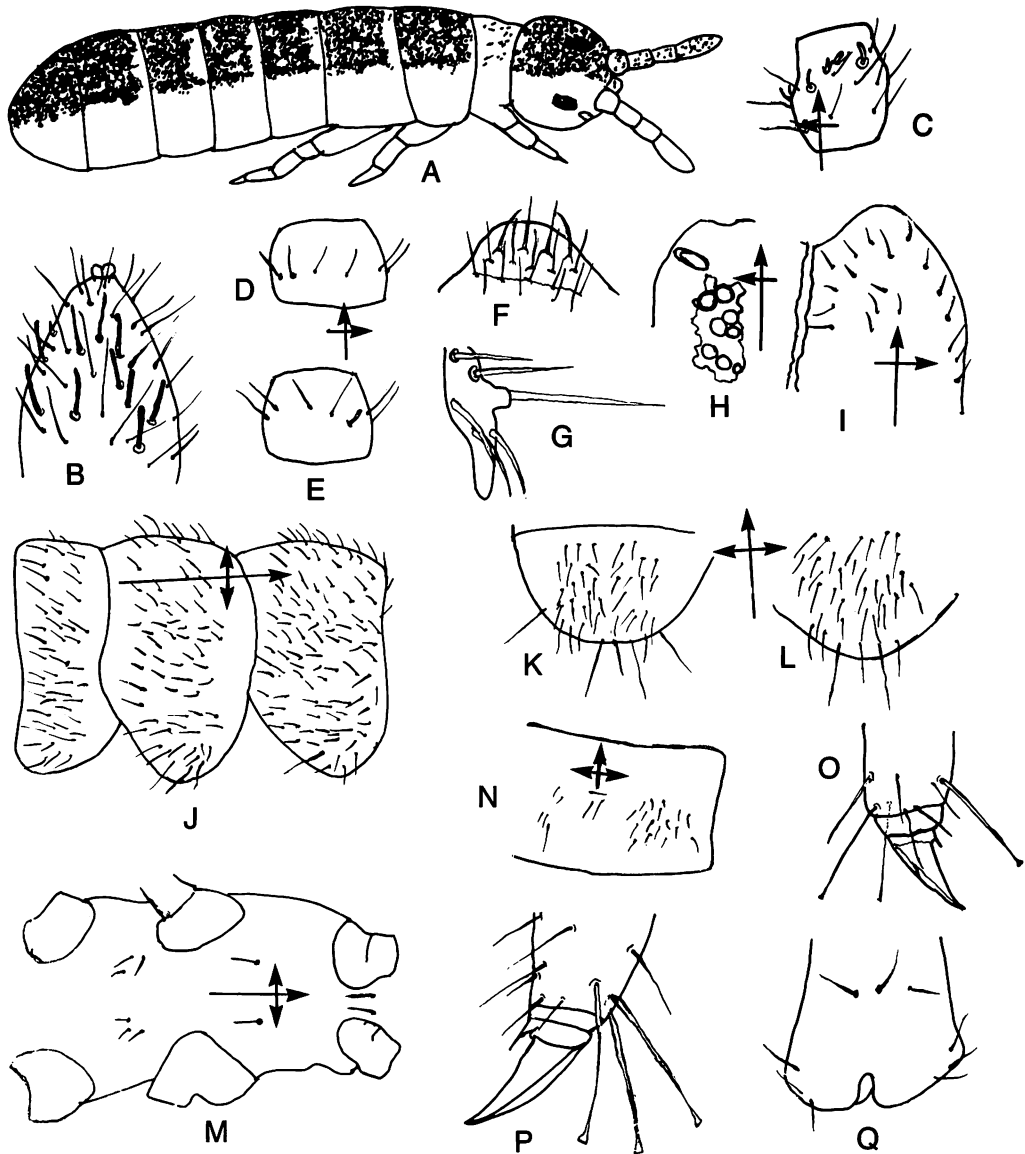


Plate 47—*Anurophorus lohi*: A, habitus (4868, Hawaii); B, apical half of fourth antennal segment (6844, Hawaii); C, dorsum of third antennal segment (6881, Hawaii); D, dorsum of first antennal segment (same); E, venter, first antennal segment (same); F, prelabral setae (6844, Hawaii); G, maxillary palp (4865, Hawaii); H, eyes and postantennal organ (4866, Hawaii); I, ventral cephalic chaetotaxy, left side (6881, Hawaii); J, dorsal and lateral chaetotaxy, second thoracic segment to first abdominal segment (5068, Hawaii); K, median dorsal chaetotaxy, fifth and sixth abdominal segments (typical specimen, 4868, Hawaii); L, same (atypical specimen, 4865, Hawaii); M, ventral chaetotaxy, thoracic segments (4868, Hawaii); N, ventral chaetotaxy, second abdominal segment (4877, Hawaii); O, fore foot complex (same); P, hind foot complex (4877, Hawaii); Q, ventral tube seen from rear (4867, Hawaii).

rows of setae in front of it. Ventral thoracic setae 1 + 1, 1 + 1, 3 + 3, or 4 + 4 (rarely 2 + 2 or 5 + 5). Maximum length 1.2 mm.

Remarks: This species is both locally and individually quite variable. Some Oahu specimens lack ventral setae on the second thoracic segment. The specimens from Maui have the posterior unguiculi clearly larger than the anterior ones; the same condition is seen in specimens from the alpine region of Mauna Loa, and one specimen from this area has atypical chaetotaxy of the fifth abdominal segment, with no clear median macrochaetae. A few specimens from Maui have the apical antennal bulb simple, but others have typical bilobed bulbs. The most divergent population is from a vent on the Steaming Bluff Trail in Hawaii Volcanoes National Park; these very dark animals have no dorsal clavate tenent hairs, and some lack the ventral first thoracic segment setae. The bilobed apical antennal bulb, lack of cuticular reticulations, and ventral thoracic setae distinguish most specimens from all other described species of *Anurophorus*. It is most similar to *A. septentrionalis* Palissa, 1966.

Derivatio nominis: Hawaiian, slow.

Ecology: Found in leaf litter and soil (rarely in moss) at high elevations (over 2000 ft.; only two records below 4000 ft.).

Type locality: Holotype and 12 paratypes, Hawaii, Volcanoes National Park, B.B.M. 00427 (6890).

Additional records: Hawaii: 4863, 4865, 4866, 4867, 4868, 4877, 4881, 4892, 4895, 4897, 4900, 4903, 4905, 4926, 4930, 5068, 5119, 5246, 5313, 5354, 5389, 5390, 5391, 5392, 6392, 6844, 6881. Maui: 5185, 5261, 5263. Oahu: 4816, 5268. Kauai: 4728, 6527.

Genus **ISOTOMODES** Linnaniemi, 1907

Type species: *Isotoma producta* Axelson, 1906

This genus includes all white, blind Hawaiian isotomids with elongate bodies, large macrochaetae on the reduced fifth abdominal segment, and a short furcula with all segments present. The anus is ventrally directed. Setaceous trunk regions are separated by large nonsetaceous areas. The Hawaiian species are all very similar. There are three Hawaiian species of *Isotomodes*: *dagamae*, *denisi*, and *fiscus*.

KEY TO HAWAIIAN SPECIES OF ISOTOMODES

1. Dens with a single ventral seta (Fig. 45A) **denisi**
 Dens with more than 1 ventral seta (Fig. 45B,C) 2
 2(1). Dens with 6 ventral setae (Fig. 45B) **dagamae**
 Dens with 2 ventral setae (Fig. 45C) **fiscus**



45A



45B

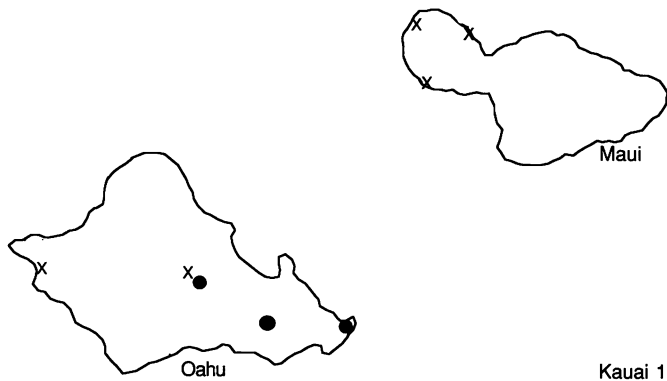


45C

Isotomodes dagamae Prabhuo, 1971 (Plate 48)

Orient. Insects 5:22.

Fourth antennal segment without apical bulb; with pin seta simple and slightly truncate; subapical sense peg curved and in a shallow depression; about 20 thickened, curved, slightly to clearly blunt setae. Apical organ of third antennal segment of 2 broadly oval or spherical pegs completely covered by a fold of integument. First and second antennal segments each with 1 slender curved blunt seta on ventral surface. Postantennal organ broadly elliptical, about as long as width of first antennal segment base, with 6-9 (mostly 8-9) posterior marginal setae. Clavate tenent hairs absent. Unguis and unguiculus untoothed. Ventral tube with 4 + 4 distal and 1 + 1 to 2 + 2 posterior setae. Dens with 2 dorsal and 6 ventral setae. Number of middorsal setal rows on first 6 trunk tergites 11, 7, 5, 5, 4-5, 6-7. Posterior blunt sensory setae fourth from midline in next to last row on thoracic tergites and P_5 on first 3 abdominal tergites. Innermost macrochaetae of fifth abdominal segment clearly basally swollen and spinelike. Seta P_6 on abdominal segment 6 slender, about 0.55 as long as P_1 . Ventral thoracic setae 2 + 2, 2 + 2, 4 + 4. Maximum length 1.2 mm.



Remarks: This species is similar in dental chaetotaxy to *I. trisetosus* Denis, 1923 and *I. venezuelensis* Rapoport and Maño, 1969. According to Gama (1963), the former is similar except for dental chaetotaxy to *I. productus*, which has a dens less than four times as long as the mucro (the dens in *I. dagamae* is over five times as long as the mucro). *I. venezuelensis* resembles *I. dagamae* in most respects, but has one pretarsal seta on the third foot enlarged and spinelike. Our specimens agree very well with the figures and descriptions in Prabhuo (1971).

Ecology: Found in middle and lower elevations in soil and litter, mostly in wooded areas.

Records: Maui: 5174, 6664, 6670. Oahu: 4777, 4786, 4814, 4843, 4846, 5267, 5294, 6731, 6734, 6744, 6753. Kauai: 6708.

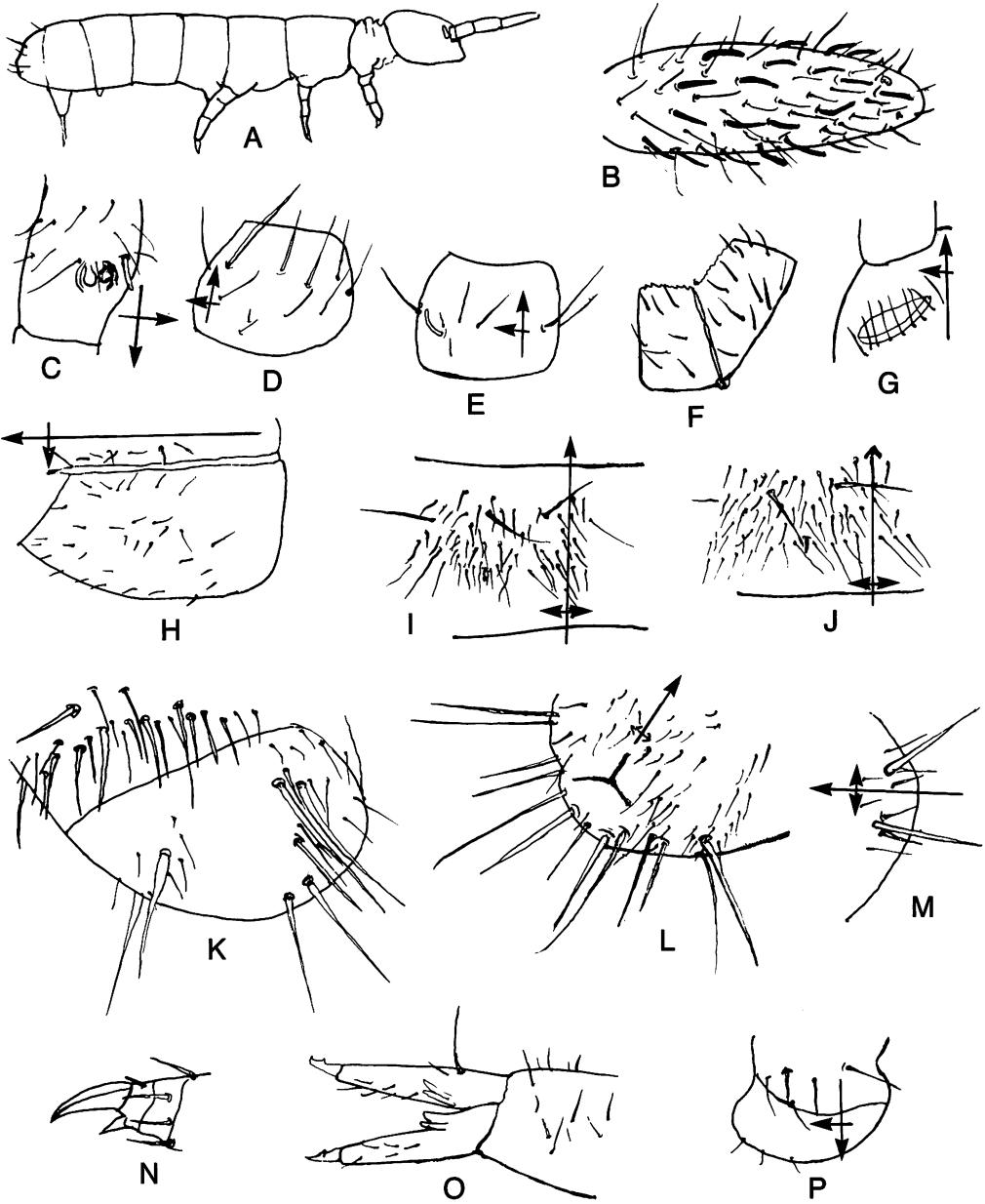


Plate 48—*Isotomodes dagamae*: A, habitus (4814, Oahu); B, fourth antennal segment (4777, Oahu); C, apex of third antennal segment (same); D, dorsum of first antennal segment (same); E, venter, first antennal segment (same); F, labium (6708, Kauai); G, postantennal organ and guard setae (4814, Oahu); H, ventral cephalic setae, right side (5294, Oahu); I, dorsal setae, second abdominal segment (4777, Oahu); J, dorsal setae, third abdominal segment (same); K, posterior abdominal setae seen from side (4786, Oahu); L, sixth abdominal segment setae seen from below (4777, Oahu); M, fifth abdominal segment setae seen from above (same); N, hind foot complex (5267, Oahu); O, manubrium and dens from side (4786, Oahu); P, ventral tube seen from side (4777, Oahu).

Isotomodes denisi Folsom, 1932 (Plate 49)
Proc. Hawaii. Entomol. Soc. 8:59.

Fourth antennal segment without apical bulb; with pin seta heavy and with a medial microseta; subapical peg in a deep depression and slightly curved; with about 10 thickened, curved, slightly to clearly blunt setae. Apical organ of third antennal segment of 2 spherical pegs completely covered by an integumentary fold. Second and first segment each with 1 blunt slender seta. Postantennal organ broadly oval, about $\frac{3}{4}$ as long as width of base of first antennal segment. Clavate tenent hairs absent. Ventral tube with 3 + 3 distolateral and 1 + 1 posterior setae. Dens with 2 dorsal setae and 1 ventral seta. Mucro about $\frac{1}{3}$ as long as dens. Seta P_6 on sixth abdominal segment is thickened and about 0.65 as long as P_1 . Maximum length 1.7 mm.

Remarks: Most of the description above is taken from a single poor immature specimen taken in 1974. The single ventral dental seta is clear on this as well as upon the single very poor lectotype seen by us. Folsom's description is almost certainly composite. Part of the description is probably based on specimens of *I. fiscus* and possibly on *I. dagamae*. The species may attain a much larger size than the other Hawaiian species.

Type locality: Hawaii, Honokaa, XI-5-1928, in cave soil, Van Zwaluwenburg.

Additional record: (Folsom records a number of collections; however, in view of the potential confusion with other species, these are not to be trusted.) Hawaii: 6874.

Isotomodes fiscus Christiansen and Bellinger, 1980 (Plate 50)
The Collembola of North America: 549.

Fourth antennal segment without apical bulb; with pin seta simple and slightly truncate; subapical sense organ curved, peglike, and in a shallow depression; about 20 thickened, curved, slightly to clearly blunt setae. Apical organ of third antennal segment of 2 spherical to broadly oval pegs and 1 curved blunt seta, completely covered by an integumentary flap. Second antennal segment with 1 ventral thickened seta; first segment with 2 such setae, one much smaller than the other. Postantennal organ broadly elliptical, slightly shorter than diameter of first antennal segment, with 7-8 marginal setae. Clavate tenent hairs absent. Unguis and unguiculus without teeth. Ventral tube with 4 + 4 distal and 2 + 2 posterior setae. Tenaculum with 4 teeth and 1 seta. Manubrium with about 22 dorsal and no ventral setae. Dens with 2 dorsal and 2 ventral setae. Head and trunk setae smooth and acuminate. Middorsal setal rows on first 6 trunk segments 8, 6, 4, 4, 4, 5-6. Posterior sensory setae short and rodlike, in the position of P_4 and P_1 on third abdominal segment. The sensory seta is in the location of P_4 on first and second abdominal segments and is located slightly anterior to the position of P_3 on second and third thoracic segments. Seta P_6 on sixth abdominal segment thickened and about 0.40 as long as P_1 . Ventral thoracic setae 2 + 2, 2 + 2, 4 + 4. Maximum length 1 mm.

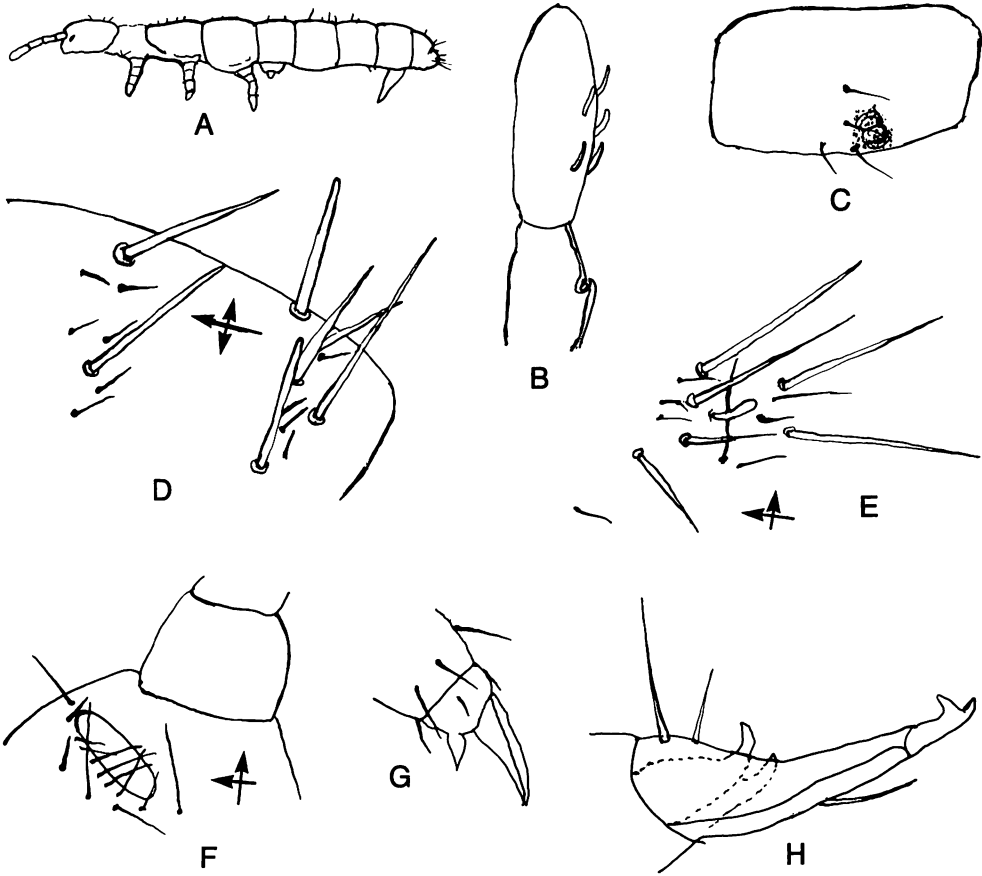


Plate 49—*Isotomodes denisi*: A, habitus (after Folsom); B, third and fourth antennal segments (same); C, apical organ, third antennal segment (6874, Hawaii); D, dorsal setae of fifth and sixth abdominal segments (same); E, lateral setae of sixth abdominal segment (same); F, postantennal organ and guard setae (after Folsom); G, hind foot complex (after Folsom); H, dens and mucro (same).

Remarks: The Hawaiian specimens appear to be indistinguishable from those found in the continental United States. They are also very similar to the other Hawaiian species.

Ecology: Found in grass roots at medium to lower elevations.

Records: Hawaii: 5064. Maui: 5172. Oahu: 4778.

Genus **FOLSOMIDES** Stach, 1922

Type species: *F. parvulus* Stach, 1922

We place here the Hawaiian isotomids having a well-developed furcula with the mucro fused to the dens and with the eyes reduced in number. There is a single Hawaiian species, *F. parvulus*.

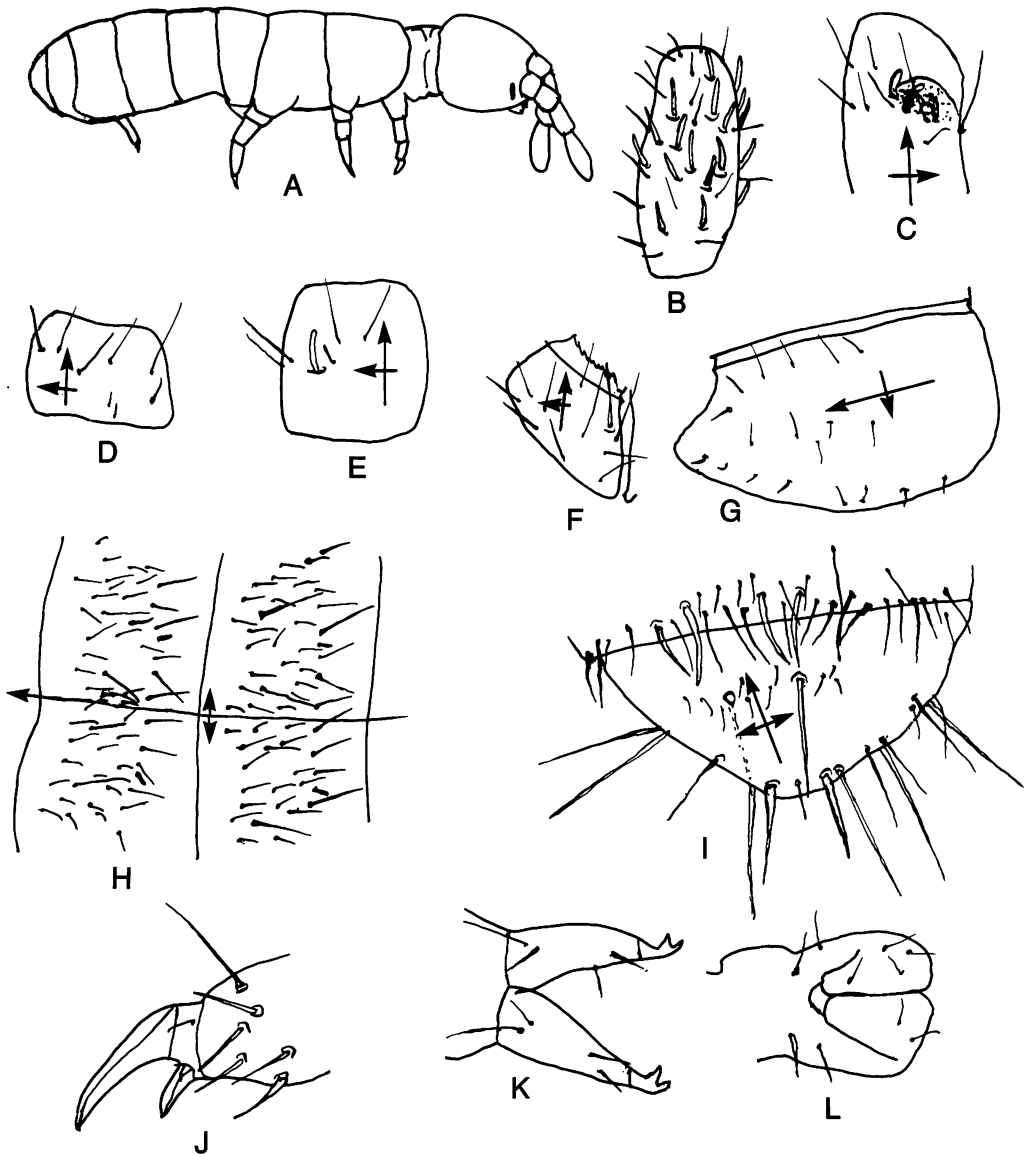


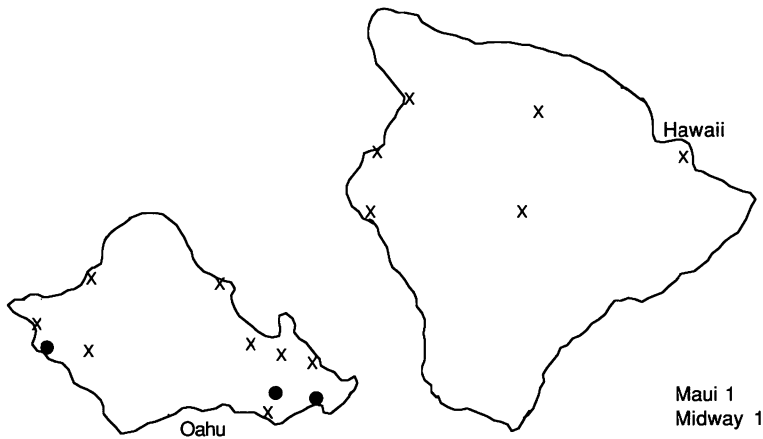
Plate 50—*Isotomodes fiscus*: A, habitus (5064, Hawaii); B, fourth antennal segment (5172, Maui); C, apex of third antennal segment (same); D, dorsum of first antennal segment (5064, Hawaii); E, venter of first antennal segment (5172, Maui); F, right side of labium (same); G, ventral chaetotaxy of head, right side (same); H, dorsal chaetotaxy, first and second abdominal segments (5064, Hawaii); I, posterior abdominal setae from above (5172, Maui); J, hind foot complex (same); K, dentes and mucrones (same); L, ventral tube (after Christiansen and Bellinger).

Folsomides parvulus Stach, 1922 (Plate 51)

Ann. Hist. Nat. Mus. Natl. Hung. 19:17.—Poinsot-Balaguer and Barra, 1982.

Folsomides americanus Denis, 1931, Boll. Lab. Zool. Gen. Agric. Portici 25:126.—Christiansen and Bellinger, 1980.*Folsomides exiguus* Folsom, 1932, Proc. Hawaii. Entomol. Soc. 8:58.

Color white; pigment limited to eyes. Fourth antennal segment without apical bulb; with up to 10 thickened curved setae, 5 of which are usually blunt while the rest are pointed; subapical sense peg at about $\frac{1}{5}$ of segment length from apex, a strong curved short rod projecting over a peg in a deep pit. First antennal segment with 1 blunt seta in distal ventral row. Maxillary palp bifurcate, with 2 sublobal hairs. Prelabral setae 4-5-5-2. Postantennal organ elongate, narrow, and usually sharply constricted in the middle, slightly shorter than the width of the first antennal segment. Eyes 2 + 2 or 1 + 1; the posterior eye, when present, is well separated from the anterior eye and usually about $\frac{2}{3}$ its diameter. Tenent hairs absent. Unguis without teeth. Unguiculus lanceolate, with a small apical filament. Ventral tube with 3 + 3 distal lateral and 1 + 1 posterior setae. Tenaculum with 3 + 3 teeth and no seta. Manubrium 1.5-2 times as long as mucrodens, with 12-14 dorsal setae. Dens with 3 dorsal and no ventral setae, completely fused to the mucro. Integument smooth. All body setae acuminate and smooth; longest setae of fourth abdominal segment 0.5-0.8 times as long as segment at midline. Fifth abdominal segment with 2 + 2 subterminal blunt slender sensory setae. Sixth abdominal segment with a pair of lateral subterminal setae curved toward the midline. Maximum length 0.9 mm.



Remarks: Variation seen in our Hawaiian, nearctic, and Jamaican material of this genus, and in the recent paper by Mendonça (1984), indicates that the number, position, and relative size of eyepatches and corneas in this species are not of taxonomic value; it is therefore impractical to separate *F. exiguus* from *F. americanus*. The separation between *F. parvulus* and *F. americanus* on the basis of eye number

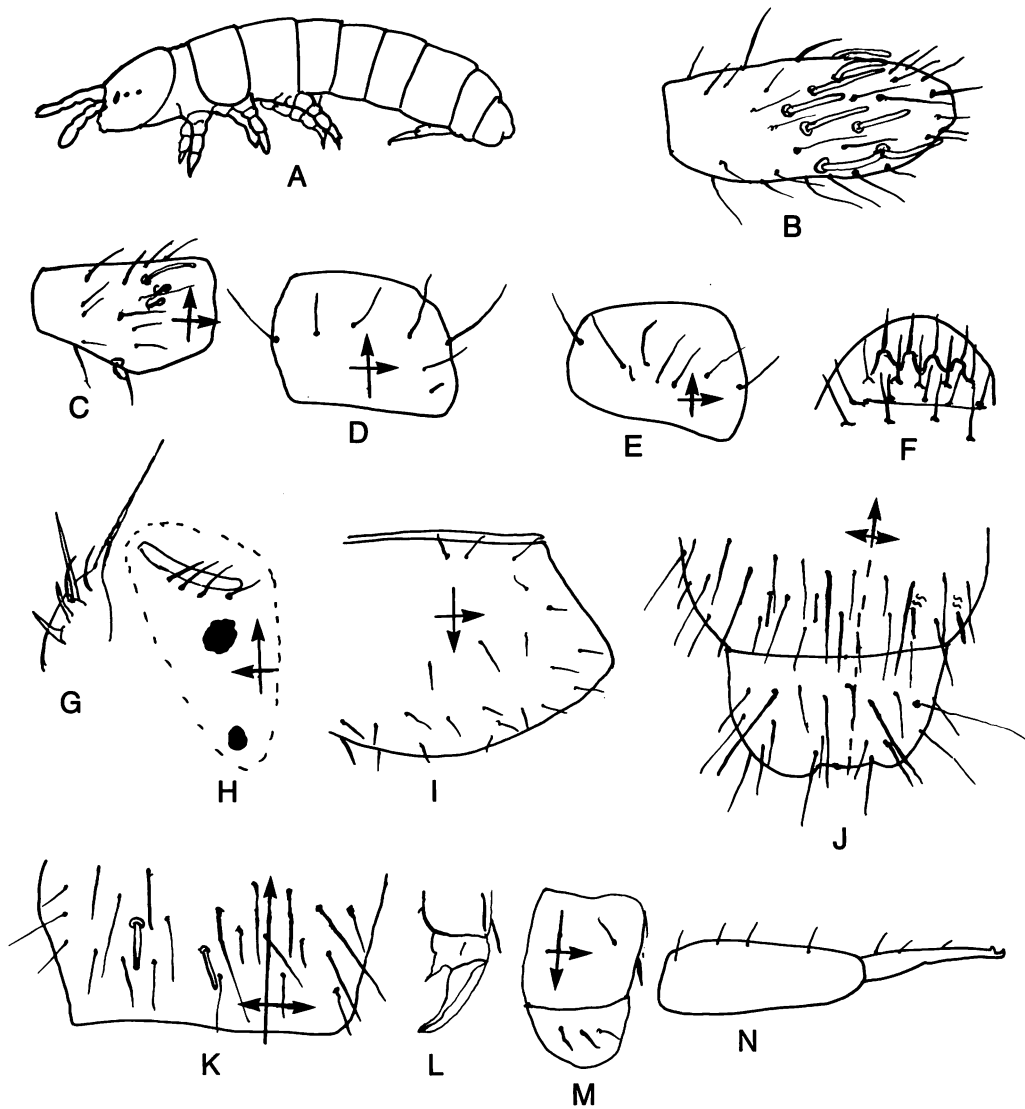


Plate 51—*Folsomides parvulus*: A, habitus (after Folsom); B, fourth antennal segment (6783, Oahu); C, apex of third antennal segment (same); D, dorsal surface, first antennal segment (4813, Oahu); E, ventral surface, first antennal segment (same); F, labrum and setae (6736, Oahu); G, maxillary palp (same); H, postantennal organ and eyes (after Folsom); I, ventral cephalic setae (6736, Oahu); J, dorsum, last two abdominal segments (4774, Oahu); K, detail of chaetotaxy, fifth abdominal segment, showing sensory setae (6782, Oahu); L, hind foot complex (after Folsom); M, ventral tube from side (6736, Oahu); N, furcula (after Folsom).

and position (Poinsot-Balaguer and Barra 1982) is also not supported by our material. On the other hand, it appears from their study and from remarks by Ellis (1976) on the type of *F. parvulus* that the difference between the latter and *F. americanus* used by Christiansen and Bellinger (1980-1981) to separate the two is also a matter of individual variation. It seems best, therefore, to refer all these forms to the same species, for which *F. parvulus* is the oldest available name.

Ecology: Generally found in litter or soil in lowland areas with woods, brush, or cane; one alpine collection.

Records: Hawaii: 4724, 5115, 5307, 5309, 5660, 6910. Maui: 5183. Oahu: 4774, 4783, 4805, 4807, 4813, 4824, 4825, 4830, 4832, 4841, 5232, 6730, 6736, 6766, 6770, 6773, 6782, 6783, 6784. Pearl and Hermes Reef: 4911, 4913. Midway: 6891.

Genus **PROISOTOMA** Börner, 1901

Type species: *Isotoma minuta* Tullberg, 1871

We include in this genus all Hawaiian isotomids with a well-developed furcula having fewer than eight ventral manubrial setae, with 6 + 6 or more eyes, and with the fifth and sixth abdominal segments separate. There are three Hawaiian species of *Proisotoma*: *centralis*, *minuta*, and *nigromaculosa*; one belongs to the subgenus *Ballistura* and two to *Proisotoma* s.str.

Table 12. Characteristics of Hawaiian Species of Genus *Proisotoma*

	<i>CENTRALIS</i>	<i>MINUTA</i>	<i>NIGROMACULOSA</i>
Eyes per side	6	8	8
Clavate tenent hair	0	0	1 + 0
Inner unguual tooth	0	0	1
Ventral manubrial setae	0	1+1	3+3 (3+4) (3+2)
Lateroventral dental setae	3	6	19-24
Mucronal teeth	2	3	2

KEY TO HAWAIIAN SPECIES OF PROISOTOMA S.L.

1. Mucro bidentate. 2
- Mucro tridentate. **P. (P.) minuta**
- 2(1). With 3 ventral dental setae. **P. (B.) centralis**
- With more than 20 ventral dental setae. **P. (P.) nigromaculosa**

Subgenus **BALLISTURA** Börner, 1906

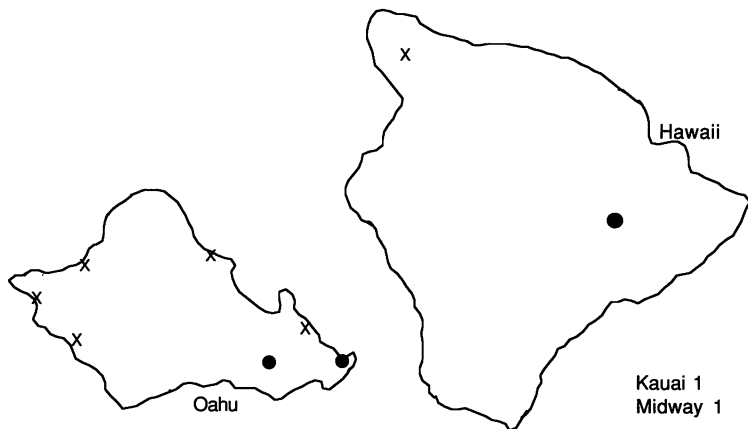
Type species: *Isotoma schoetti* Dalla Torre, 1895

We place here species of *Proisotoma* without dental crenulations or ventral manubrial setae. There is a single Hawaiian species, which resembles *Folsomides* but has the dens and mucro separate: *P. (B.) centralis*.

Proisotoma (Ballistura) centralis Denis, 1931 (Plate 52)

Boll. Lab. Zool. Gen. Agric. Portici 25:111.—Winter, 1967.

Color white to pale gray; eyepatches generally only slightly darker than rest of head. Fourth antennal segment without apical knob; subapical organ as in *P. minuta*; 4 clearly distinguished blunt setae, and some acuminate setae that are thicker than others and slightly truncate apically. Apical organ of third antennal segment of 2 short blunt rods; one of the guard setae thicker than ordinary setae and slightly truncate. Second antennal segment with 1 ventral blunt seta; first antennal segment with 2, the outer longer and thicker than the inner, and 1-2 small acuminate setae medially from these. Labral papillae absent. Prelabral setae 4-5-5-2. Maxillary palp with long apical and shorter subapical seta and 3 sublobal hairs. Maxilla without projecting lamellae. Postantennal organ broadly oval, 2.4-3 times as long as diameter of nearest eye. Eyes 6 + 6, subequal. Tenent hair short and acuminate. Unguis and unguiculus without teeth. Ventral tube with 3 + 3 distal lateral and 2 posterior setae. Tenaculum with 4 + 4 teeth and 1 seta. All furcal segments distinct. Manubrium without ventral setae, 1.4-1.5 times as long as dens. Dens with a few irregular dorsal humps and 6 dorsal and 3 ventral setae. Mucro bidentate and lamellate. Fourth abdominal segment 1.3-1.9 times as long as third. Posterior margin of fifth abdominal segment with 2 + 2 large blunt setae. All trunk setae smooth; longest posterior setae 1.5-1.7 times as long as inner edge of unguis. Maximum length 0.6 mm.



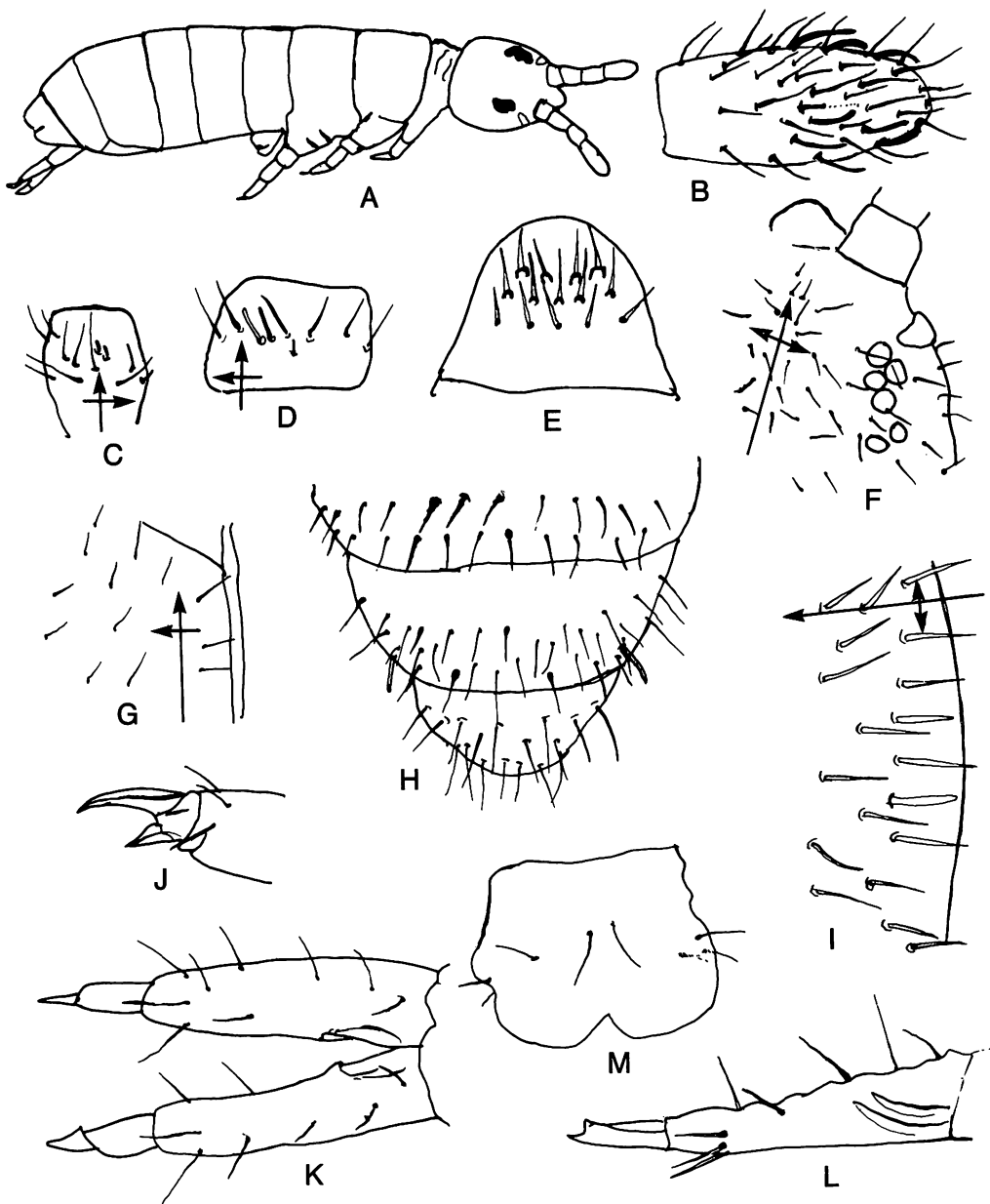


Plate 52—*Proisotoma (Ballistura) centralis*: A, habitus (4724, Hawaii); B, apex of antenna (same); C, apex of third antennal segment (same); D, venter of first antennal segment (same); E, prelabral setae (4948, Hawaii); F, eyes and postantennal organ, right side (4962, Hawaii); G, ventral cephalic setae (same); H, posterior abdominal dorsal setae (same); I, enlargement of setae of fifth abdominal segment (same); J, hind foot complex (same); K, dentes seen from above (same); L, dens seen from side (same); M, ventral tube seen from back (4837, Oahu).

Remarks: This is the species recorded by Bellinger and Christiansen (1974) as *Proisotoma perparva* Jackson, 1927. Although the Hawaiian specimens appear identical to specimens from the Oropuche Cave, Trinidad, the type locality of *P. perparva*, important differences from Jackson's description make it uncertain that this is his species, the types of which are lost. On the other hand, our material matches the descriptions of *P. centralis* by Denis (1931) and by Winter (1967) perfectly.

This species is remarkably uniform in Hawaii. The sublobal hairs of the submaxillary lobe are difficult to see and their number is in question. There is only one record of *P. centralis* since 1971.

Ecology: Mostly found in soil and litter in urban and other disturbed areas. Also in the Steaming Bluffs area of the Hawaii Volcanoes National Park, the Na Pali wilderness area of Kauai, and the Waianae crest on Oahu.

Records: Hawaii: 4724, 4948, 4960, 4962, 4963, 4966, 5014, 5668. Oahu: 4774, 4785, 4806, 4813, 4837, 4838, 4841, 4843, 6773. Kauai: 6717. Midway: 6818.

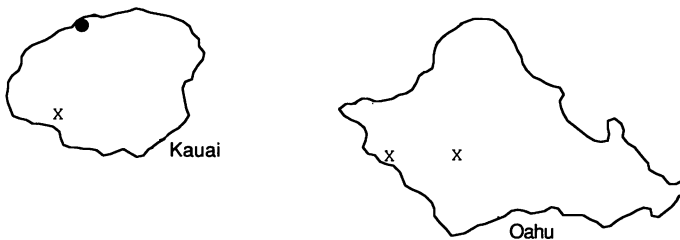
Subgenus **PROISOTOMA** s.str.

Members of the typical subgenus have crenulate dentes and ventral manubrial setae.

Proisotoma (Proisotoma) minuta (Tullberg, 1871) (Plate 53)

Ofver. K. Sven. Vet. Akad. Forh. 28:152 (*Isotoma*).—Stach, 1947.—Christiansen and Bellinger, 1980.

Color pale gray with well-darkened eyepatches. Fourth antennal segment without apical bulb; with a minute subapical knob in a shallow pit, subtended by a stout curved short seta in another shallow pit; typical blunt setae absent, but 6-7 of the curved acuminate setae are somewhat more abruptly tapered than the others. Apical organ of third antennal segment of 2 small pegs in separate shallow pockets. Apical organ of first antennal segment of 2 short acuminate setae on ventral surface. Postantennal organ broadly oval and 2.4-3 times as long as diameter of nearest eye. Eyes 8 + 8; G and H slightly smaller than others. Labral papillae absent. Prelabral setae 4-5-5-4. Maxilla without projecting blades. Maxillary outer lobe simple, with 3 sublobal hairs. Tenent hair acuminate, somewhat longer than other tibiotarsal setae. Unguis and unguiculus without teeth. Ventral tube with 4 + 4 distolateral and 4-5 posterior setae. Tenaculum with 1 seta and 4 + 4 teeth. Manubrium 1.1-1.4 times as long as dens, with 1 + 1 ventral setae. Dens with 6



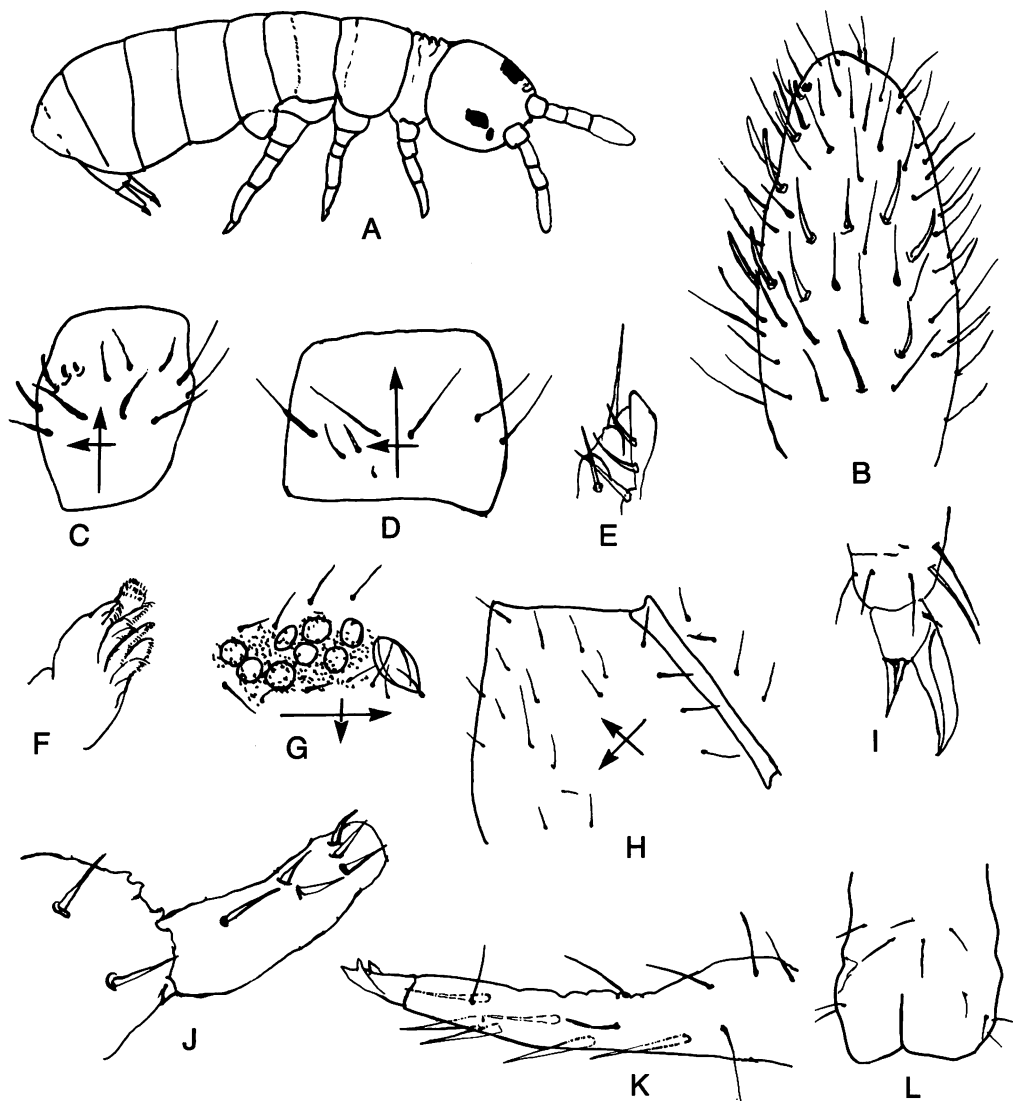


Plate 53—*Proisotoma (Proisotoma) minuta*: A, habitus (4838, Oahu); B, fourth antennal segment (4836, Oahu); C, apex, third antennal segment (4838, Oahu); D, venter, first antennal segment (same); E, maxillary palp (4836, Oahu); F, maxilla, (4838, Oahu); G, eyes and postantennal organ, right side (same); H, ventral cephalic chaetotaxy, right side (4836, Oahu); I, hind foot complex (4838, Oahu); J, apex of manubrium and right dens seen from below (5288, Kauai); K, mucro and dens seen from side (4838, Oahu); L, ventral tube seen from back (5288, Kauai).

dorsal and 6 ventral setae. Mucro with 3 subequal teeth. Fourth abdominal segment 1.2–1.35 times as long as third. All body setae smooth; longest posterior setae 1.75–2.4 times as long as inner edge of unguis. Maximum length 0.9 mm.

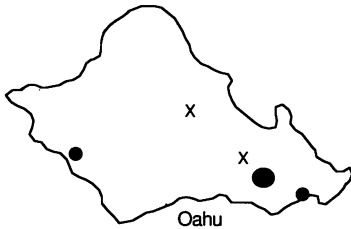
Remarks: Hawaiian specimens have somewhat longer setae and larger eyes than nearctic material, but in general resemble some of the latter so closely that it seems best to consider them conspecific. As we suggested earlier, the name *P. minuta* may actually be applied at present to a complex of several species. According to Fjellberg (1984), *P. minuta* has one sublobal hair on the maxillary outer lobe; this difference might justify separating the nearctic and Hawaiian specimens.

Ecology: Found in and under bark in lowland disturbed areas.

Records: Lanai: 6693. Oahu: 4836, 4838. Kauai: 5288, 6717, 6723.

Proisotoma (Proisotoma) nigromaculosa Folsom, 1932 (Plate 54)
Proc. Hawaii Entomol. Soc. 8:62.

Color white to gray; darker specimens with intersegmental membranes, venter, and appendages pale. Fourth antennal segment with a low apical knob; subapical sense peg minute and withdrawn into a shallow pit, subtended by a short, stout to slender curved seta; anterior to this there is a short to moderate slightly apically swollen seta; typical blunt setae absent, but some of the curved acuminate setae are slightly thicker than others and feebly truncate; pin seta short, simple, and truncate. Apical organ of third antennal segment of 2 small pegs in separate shallow pits with a minute slender supplementary peg external of these. One (rarely 2) apical ventral sensory setae on first antennal segment. Labrum without papillae. Pre-labral setae 4-5-5-4. Maxillary outer lobe simple, with 4 sublobal hairs. Maxilla with 1 blade projecting slightly beyond others. Postantennal organ broadly oval and weakly constricted medially, 2.5–3.7 times as long as diameter of largest eye. Eyepatch usually clear and dark, sometimes pale; eyes 8 + 8, subequal. Tenent hair varying from acuminate to clearly clavate. Unguis with clear inner tooth but no lateral teeth. Unguiculus simple. Ventral tube with 6 + 6 (rarely 5 + 5) distal lateral setae. Tenaculum with 4 + 4 teeth and 1 seta. Manubrium with 3 + 3 (rarely 3 + 2 or 3 + 4) distal ventral setae; 0.8 to 1.0 times as long as dens. Dens dorsally crenulate, with 8–11 dorsal and 19–24 ventral setae. Mucro bidentate, without lamellae. Fourth abdominal segment 1–1.25 times as long as third. Fifth and sixth abdominal segments sometimes separated only by a nonsetaceous band.



Hawaii 2
Kauai 1
Maui 1
Midway 1
Molokai 1

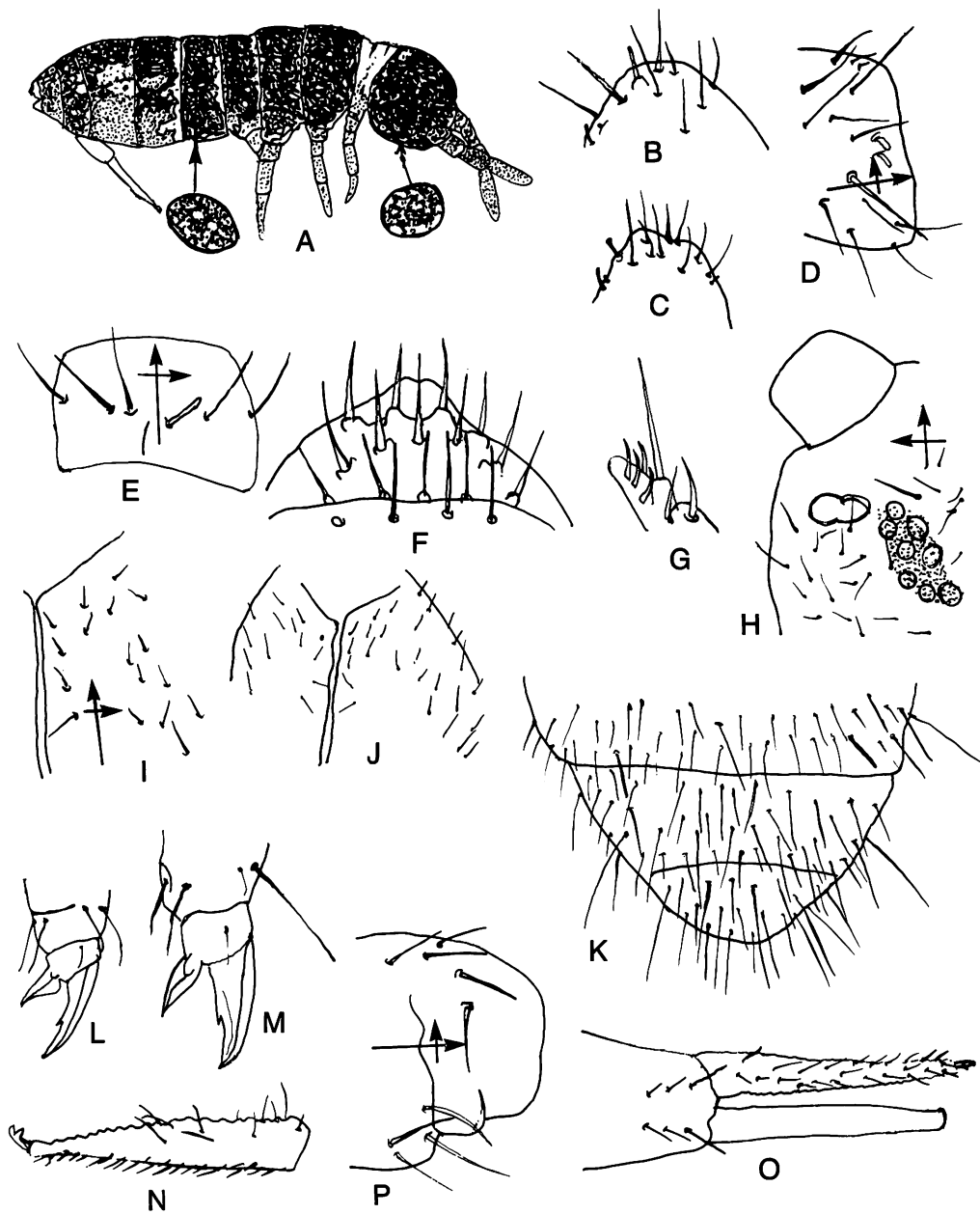


Plate 54—*Proisotoma (Proisotoma) nigromaculosa*: A, habitus (6789, Oahu); B, apex of antenna (5142, Hawaii); C, unusual antennal apex (6789, Oahu); D, apical organ, third antennal segment (5142, Hawaii); E, venter, first antennal segment (6786, Oahu); F, prelabral setae (5142, Hawaii); G, maxillary palp (same); H, postantennal organ and eyes, left side (4774, Oahu); I, ventral cephalic setae, left side (same); J, same (4821, Oahu); K, posterior dorsal abdominal setae (4822, Oahu); L, hind foot complex (after Folsom); M, same (4821, Oahu); N, dens and mucro seen from side (6789, Oahu); O, venter of manubrium and dens (same); P, ventral tube seen from side (5142, Hawaii).

Longest posterior setae 2.6–3.7 times as long as inner edge of unguis. All body setae acuminate and smooth. Maximum length 1.2 mm.

Remarks: The specimens we have seen are remarkably variable, but the variation does not seem to be geographic; extreme conditions can all be found on Oahu. The eyes may be dark and well developed, or pale with weaker corneas; the antennal segments vary greatly in relative length; and in chaetotaxy the tenent hair may be long and clearly clavate, or short and acuminate; the inner unguis tooth may be small or large and prominent. According to Folsom, there may be only 1 + 1 ventral manubrial setae, but we have seen no specimens with fewer than 3 + 2. This may well be a species complex.

Ecology: Found in litter, debris, and soil in disturbed habitats in middle (less than 1000 ft.) and lower habitats.

Records: Hawaii: 5142, 5660. Maui: 6676. Molokai: 6381. Oahu: 4774, 4789, 4821, 4822, 4839, 6737, 6776, 6785, 6786, 6787, 6789, 6790, 6791, 6792. Kauai: 4730. Midway: 6832.

Genus **ARCHISOTOMA** Linnaniemi, 1912

Type species: *Isotoma besselsi* Packard, 1877

This genus is characterized by the presence of bothriotracha; a dens without crenulations or tubercles; a peculiar mucro with two projecting, lamellate basal teeth; and a complex maxilla. There is a single Hawaiian species.

Archisotoma sp. A (Plate 55)

Color white (?). Fourth antennal segment without apical projection; with 10 large, curved, acuminate thick setae. Apical organ of third antennal segment of 2 basally angled blunt rods. Second antennal segment without clear knob (?). Two (?) prelabral setae. Eyes 6 + 6, subequal, poorly pigmented. Postantennal organ about 4 times as long and 1.6 times as wide as largest eye. Unguis untoothed. Hind femur with posterior spine. Hind tibiotarsus with heavy seta at dorsal apex. Ventral tube not seen. Tenaculum unclear but apparently with 2 teeth. Last 2 abdominal segments fused, with 2 + 2 bothriotracha. Dens with about 5 dorsal and 8 ventral setae. Mucro with 3 teeth, basal 2 clearly lamellate; second tooth at about $\frac{1}{11}$ distance from base to apex. Length 0.45 mm.

Remarks: We have seen only a single specimen of this species and prefer not to name it on this basis, especially since the maxilla could not be clearly seen. So far as it was visible, the maxilla was like that of *A. tokiokai* Yosii, 1971a, from which the Hawaiian form appears to differ in the absence of eyes G and H, fewer ventral dental setae, and one more pair of bothriotracha. The bothriotracha and abdominal structure are as in *A. interstitialis* Delamare, 1954. The Hawaiian specimen has a head/body ratio that appears juvenile, but a clear female genital opening.

Record: Oahu: 4834.

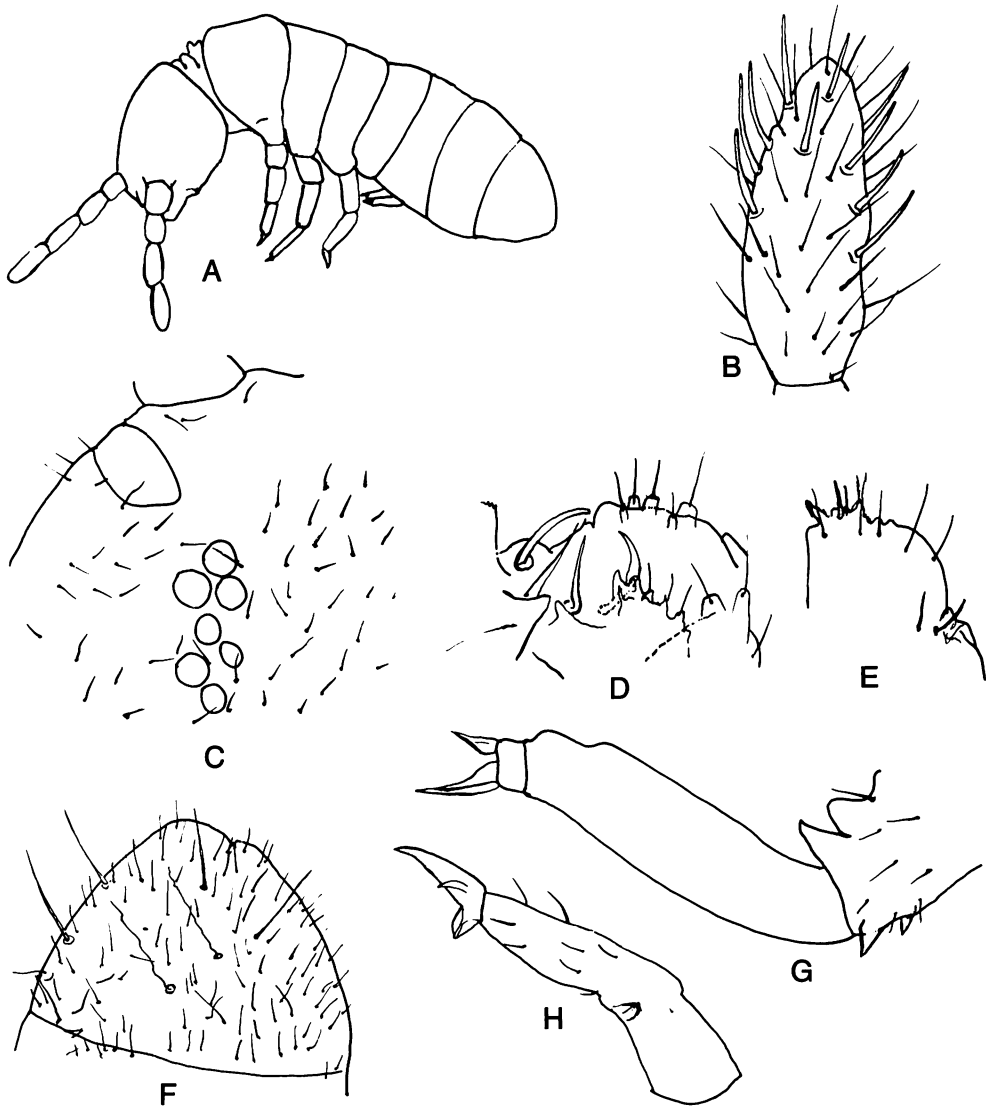


Plate 55—*Archisotoma* sp. A (all figures of 4834, Oahu): **A**, habitus; **B**, dorsum, fourth antennal segment; **C**, left side of head; **D**, labium; **E**, labrum; **F**, posterior abdominal segments; **G**, hind leg; **H**, dens and mucro.

Genus **CRYPTOPYGUS** Willem, 1901

Type species: *C. antarcticus* Willem, 1901

We place here all the Hawaiian isotomids having 1 + 1 ventral manubrial setae, fused fifth and sixth abdominal segments, and a bidentate mucro. There is a single Hawaiian species, *C. thermophilus*.

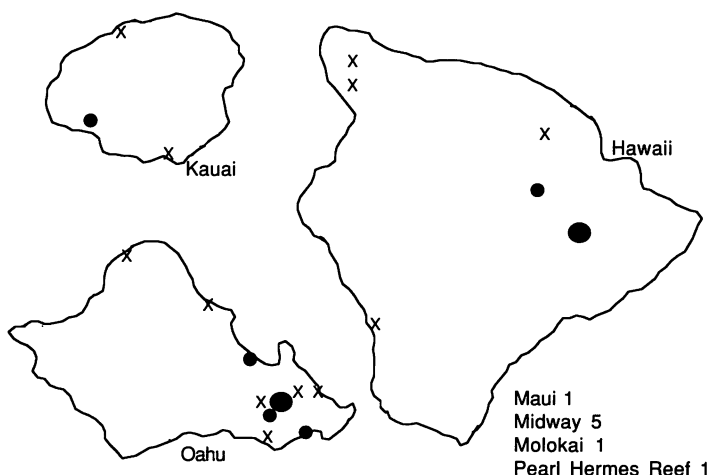
Cryptopygus thermophilus (Axelson, 1900) (Plate 56)

Medd. Soc. Fauna Flora Fenn. 26:113 (*Isotoma*).—Poinsot, 1971.—Christiansen and Bellinger, 1980.

Cryptopygus constrictus (Folsom): Bellinger and Christiansen, 1974:34.

Color white to moderately dark gray; darker specimens paler ventrally. Fourth antennal segment without apical bulb or clearly differentiated blunt setae. Apical organ of third segment with 2 small dorsal pegs, a slender outer seta and very small curved peg. Postantennal organ oval to elliptical, with or without a distinct transverse listel, and 1.9–3.2 times length of eye F. Eyes 6 + 6 to 8 + 8, variable in size, all circular except that eye H is sometimes elliptical. Maxillary palp with 4 sublobal hairs. Tenent hairs usually acuminate, rarely faintly truncate. Unguis varying from untoothed to strongly toothed. Unguiculus untoothed. Ventral tube with 4 + 4 distolateral, 2–4 anterior, and 2 + 2 posterior setae. Dens 9–13 times as long as mucro, with 6–8 dorsal and about 20 (maximum 26) ventral setae. Fused fifth and sixth abdominal segments with a pair of thin-walled blunt setae, weakly differentiated from other setae, and with 7 straight setae having a cluster of short ciliations just beyond the middle. Maximum length 1.3 mm.

Remarks: At first we thought there were several species of this genus in Hawaii; however, it now seems preferable to assign all specimens to this single species, which is already known to be highly variable from the work of Lawrence (unpublished) and Poinsot (1971). Most of the variable features described by those authors



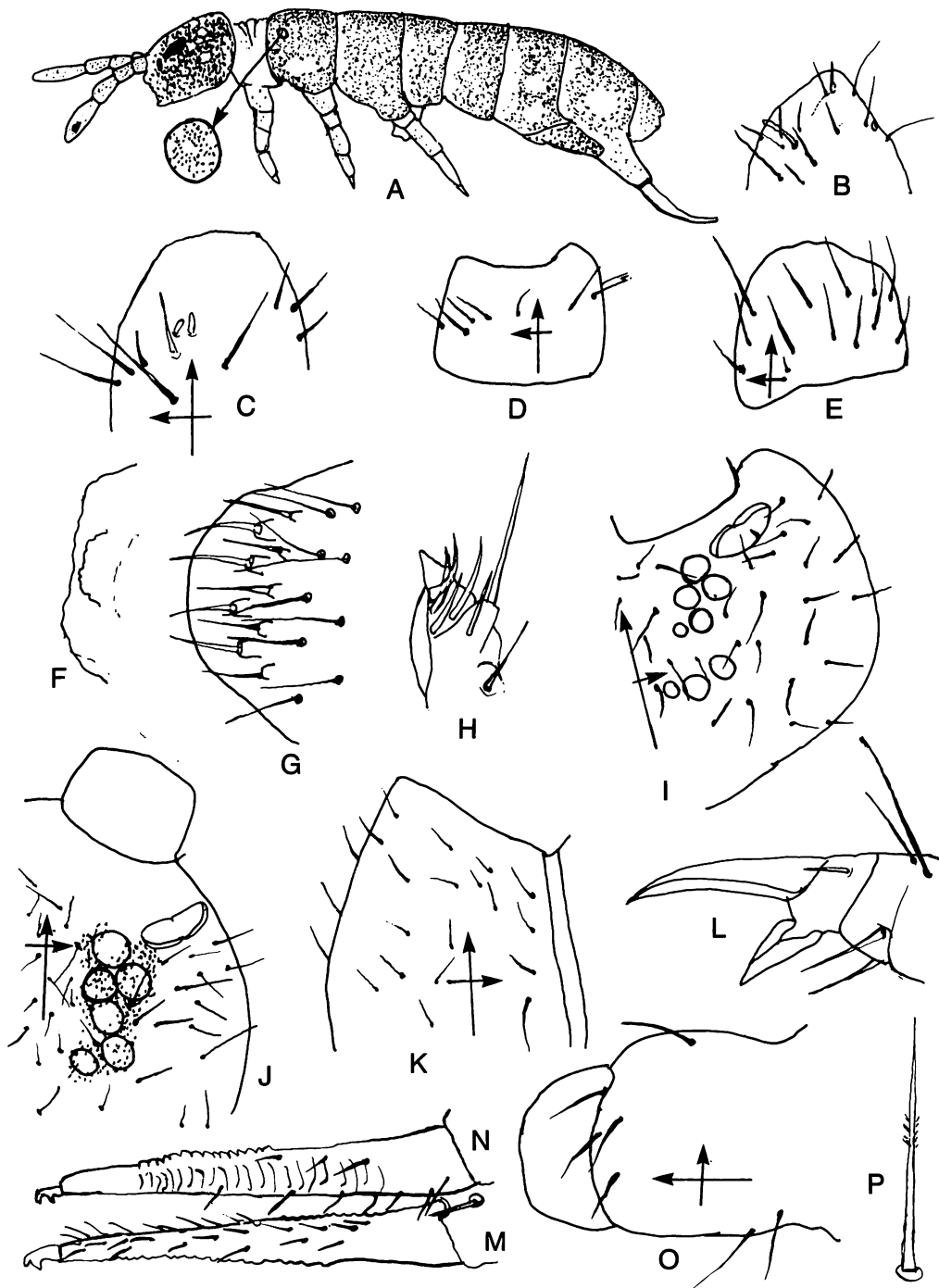


Plate 56—*Cryptopygus thermophilus*: A, habitus (6730, Oahu); B, apex of antenna (4955, Hawaii); C, apical organ, third antennal segment (6789, Oahu); D, dorsal surface, first antennal segment (4751, Maui); E, ventral surface, first antennal segment (same specimen); F, apex of labrum from below (6727, Kauai); G, prelabral setae (same specimen); H, maxillary palp (6731, Oahu); I, eyes and postantennal organ, right side (4955, Hawaii); J, eyes and postantennal organ, right side (5267, Oahu); K, ventral cephalic setae, right side (6789, Oahu); L, hind foot complex (4955, Hawaii); M, ventral surface of dens (6731, Oahu); N, dorsal surface of same dens; O, ventral tube seen from side (6732, Oahu); P, unusual large posterior abdominal seta (5059, Hawaii).

are seen in Island material. In some cases the distribution of eyes is different from the figures given by Poinsoot, but otherwise the specimens are very similar to her description and that of Lawrence.

There does seem to be some localization of the variation seen in the Island forms. The six-eyed forms are found mainly on Oahu, where this is the dominant form. Collections of specimens with eye H strikingly elliptical come mostly from Kauai or from Oahu just above Honolulu. Most specimens with a strongly toothed unguis are from Maui or Oahu. It is possible that there have been several independent introductions of this "tramp" species in Hawaii. One large specimen had 5 + 5 distolateral and 6 posterior setae on the ventral tube.

Ecology: This is one of the most common Collembola near vents in Hawaii Volcanoes National Park. It is found in litter, soil, and bird nests from sea level to 4000 ft.

Records: Hawaii: 4853, 4865, 4882, 4883, 4885, 4887, 4890, 4905, 4906, 4955, 5059, 5142, 5309, 5643, 5668, 6393, 6851, + 58 additional collections from vents in Hawaii Volcanoes National Park. Maui: 4751. Molokai: 6383. Oahu: 4752, 4774, 4778, 4784, 4793, 4805, 4815, 4824, 4827, 4828, 4839, 4841, 4845, 4847, 5219, 5267, 5294, 6730, 6731, 6732, 6735, 6736, 6789. Kauai: 5210, 5287, 5288, 6727. Pearl and Hermes Reef: 4910. Midway: 4942, 4943, 4944, 5306, 5311. Kure: Butler and Usinger (1963a).

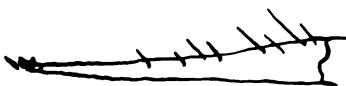
Genus **FOLSOMINA** Denis, 1931

Type species: *F. onychiurina* Denis, 1931

This genus includes isotomids with the last three abdominal segments fused, lacking a postantennal organ, and with a sickle-shaped mucro. In *The Collembola of North America* we followed Gisin (1950) in placing this genus as a synonym of *Folsomia*. However, the latter two characters mentioned above distinguish it, and the studies of Grow and Christiansen (1977) and Deharveng (1979) support an isolated position for the type species. We feel it best, therefore, to separate them again. There is a single Hawaiian species.

KEY TO HAWAIIAN SPECIES OF FOLSOMINA AND FOLSOMIA

- 1. With 4 + 4 eyes and pigment. **Folsomia octoculata**
Without eyes or pigment. 2
- 2(1). Mucro bidentate. 3
Mucro falciform. **Folsomina onychiurina**
- 3(2). Dorsal dental setae 8 (Fig. 46A). **Folsomia candida**
Dorsal dental setae 5 (Fig. 46B). **Folsomia stella**



46A

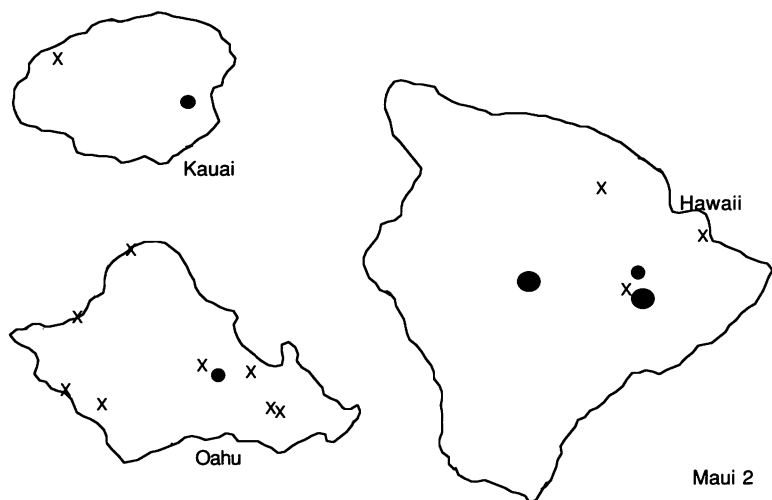


46B

Folsomina onychiurina Denis, 1931 (Plate 57)

Boll. Lab. Zool. Gen. Agric. Portici 25:128.—Grow and Christiansen, 1977.—
Deharveng, 1979.—Christiansen and Bellinger, 1980.

White without trace of pigment or eyes. Fourth antennal segment without apical bulb; with 2 unique sense organs, each having an outer sheath varying from saucer-shaped (rarely) to spatulate, with an opening on the dorsal surface, and containing a sense rod that varies from broadly oval to elongate elliptical, the organs being sunken in pits or (in larger specimens) projecting from the segment; and with 5 blunt setae in the apical quarter and a sixth slightly below midlevel of the segment. Outer maxillary lobe not clearly seen, but apparently with a bifurcate palp and 3 sublobal hairs. Unguis and unguiculus untoothed. Ventral tube with 1 + 1 anterior, 3 + 3 to 5 + 5 lateral, and 2 + 2 posterior setae. Tenaculum with 4 + 4 teeth and 1 seta. Manubrium with 1 + 1 ventral setae. Dens dorsally crenulate in middle, with 4–6 dorsal and about 20 ventral setae. Mucro sickle-shaped. For chaetotaxy see Table 13 and Plate 57.



Remarks: This species is one of the most readily identified of all Collembola. The antennal organ is unique, and the other characters noted in the generic diagnosis serve to distinguish it from other superficially similar small white isotomids. Some published figures show eight blunt antennal setae, but two specimens show only six. Hawaiian and nearctic specimens are indistinguishable.

This is almost certainly the species described by Lawrence (1969) from the Solomon Islands as *F. yosiii*. *F. "onychiurina"* described in the same paper, however, appears to be a second species of the genus, with a shorter furcula and other differences.

Ecology: Mostly found in soil and more rarely in litter in lowland disturbed areas and at middle elevations.

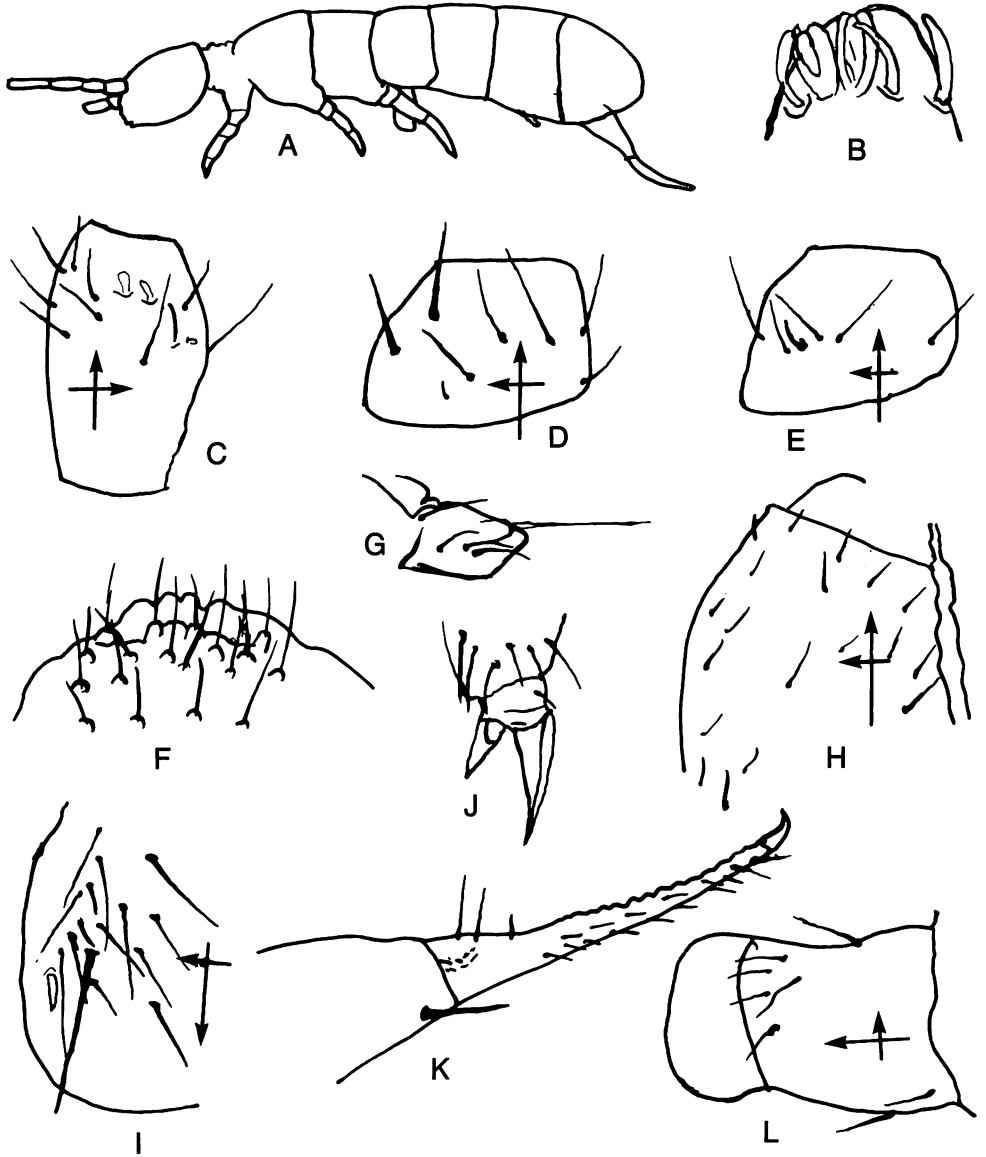


Plate 57—*Folsomina onychiurina*: A, habitus (6735, Oahu); B, apex of antenna (5018, Hawaii); C, apex of third antennal segment (same); D, dorsal surface of first antennal segment (same); E, ventral surface of first antennal segment (same); F, labrum (same); G, maxillary palp (5018, Hawaii); H, ventral cephalic setae, right side (6735, Oahu); I, left outer corner of second thoracic segment (6680, Maui); J, fore foot complex (same); K, furcula seen from side (5018, Hawaii); L, ventral tube (6680, Maui).

Table 13. Characteristics of Hawaiian Species of *Folsomia* * and *Folsomina*

CHARACTER	CANDIDA	STELLA	OCTOCULATA	D	ONYCHIURINA
Pigment	-	-	+	-	-
Eyes per side	0	0	4	0	0
Postantennal organ guard setae	3(4)	3(4)	3	4	0
Ventral manubrial setae	12-27	7-14	2+2	1+1	1+1
Ventral dental setae	23-34	20-28	9	14-16	16-21
Posterior row setae, abd. III	26-34	20-28	20-36	26	18
Longest abd. III setae/segment length	0.39-0.65	0.34-0.47	0.24-0.46	0.35	4.5-5.0
Subapical organ of ant. IV	rod	spherical	spherical	spherical	unique
Specialized extra setae of ant. III; basal microsetae*	-	-	-	-	-
Double seta sensu- alis	-	-	+	-	-
Seta sensu- alis guard	-	-	+	-	-
Pattern of chaetotaxy*					
Ant. I	C ₁	A ₁ A ₂ B ₃ **	A ₁	unique	A ₁
Subterminal row dorsal cephalic setae	C	C	A	B	B
Dorsal body setae	4	4	1	3?	6
Fused abdominal segments	C	D	A	unique	F

*See Grow and Christiansen (1977).

**Not seen clearly on Hawaiian material.

Records: Hawaii: 4724, 5018, 6843, 6848, 6865, 6866, 6867, 6868, 6869, 6871, 6872, 6873, 6877, 6878, 6879, 6882, 6883, 6884, 6885, 6886, 6889, 6895, 6910, 6913. Maui: 6670, 6680. Oahu: 4796, 4813, 4839, 6732, 6734, 6735, 6739, 6751, 6755, 6762, 6779. Kauai: 4741, 4748, 4749. Pearl and Hermes Reef: 4911, 4913.

Genus **FOLSOMIA** Willem, 1902

Type species: *F. candida* Willem, 1902

This includes the Hawaiian isotomids with fourth through sixth abdominal segments fused and having a well-developed furcula with a bidentate mucro. The species have an obvious postantennal organ, well-developed unguiculi, 2 + 2 or more ventral manubrial setae, and dental crenulations; the maxillary outer palp is bifurcate, with four sublobal hairs; clavate tenent hairs are absent. There are three species of *Folsomia* in Hawaii: *candida*, *octoculata*, and *stella*. All are well known elsewhere. A single subadult specimen from Oahu is unplaceable (sp. D).

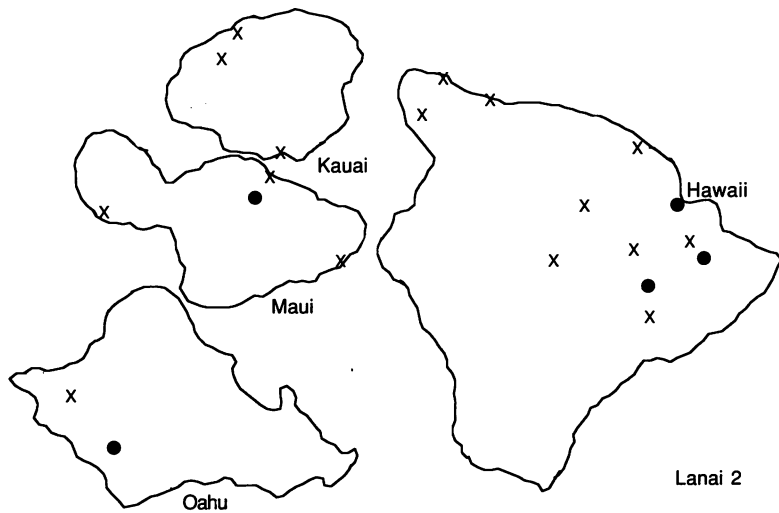
Folsomia candida Willem, 1902 (Plate 58)

Ann. Soc. Entomol. Belg. 46:280.—Stach, 1947.—Grow and Christiansen, 1977.

—Christiansen and Bellinger, 1980.

Folsomia fimetaria (L.): Folsom, 1932:60.

Color white, without trace of pigment or eyes. Fourth antennal segment without apical bulb; subapical sense organ small and rodlike. Apical organ of third antennal segment with 2 slender, elliptical, exposed rods; segment has 2 small supplementary microchaetae in male but none in female. Postantennal organ broadly fusiform to elliptical, with margins indented but no obvious listel. Unguis with or without an obvious inner tooth but without lateral teeth. Ventral tube in adults with 8 + 8 to 13 + 13 (usually 11 + 11 or 12 + 12) distolateral setae. Tenaculum with 4 + 4 teeth and 1 seta. Dens with 9 dorsal setae. Mucro bidentate, $\frac{1}{12}$ – $\frac{1}{8}$ as long as dens. Clothing of acuminate setae, mostly smooth; largest abdominal setae usually very sparsely serrate on distal portions; macrochaetae generally clearly larger than other body setae. Sensory setae of abdomen only weakly distinguished from small acuminate setae. Maximum length 2.5 mm.



Remarks: It is not surprising that specimens of *F. candida* from Hawaii show less variation than those from mainland North America. The first antennal segment chaetotaxy shows some variation, but except for one specimen falls clearly in the C₁ type of Grow and Christiansen (1977). Most specimens have a toothed unguis. The single male seen was from Maui.

Ecology: Found mostly in caves and under stones and debris in disturbed areas. Also found in vegetation and under bark.

Records: Hawaii: 5068, 5126, 5128, 5138, 5150, 5156, 5273, 5345, 5360, 5432, 5446, 5448, 5478, 5647, 5677, 5746, 6893. Maui: 5159, 5163, 5174, 6679, 6680. Lanai: 6698, 6700. Oahu: 4794, 5230, 5529. Kauai: 5190, 5216, 5281.

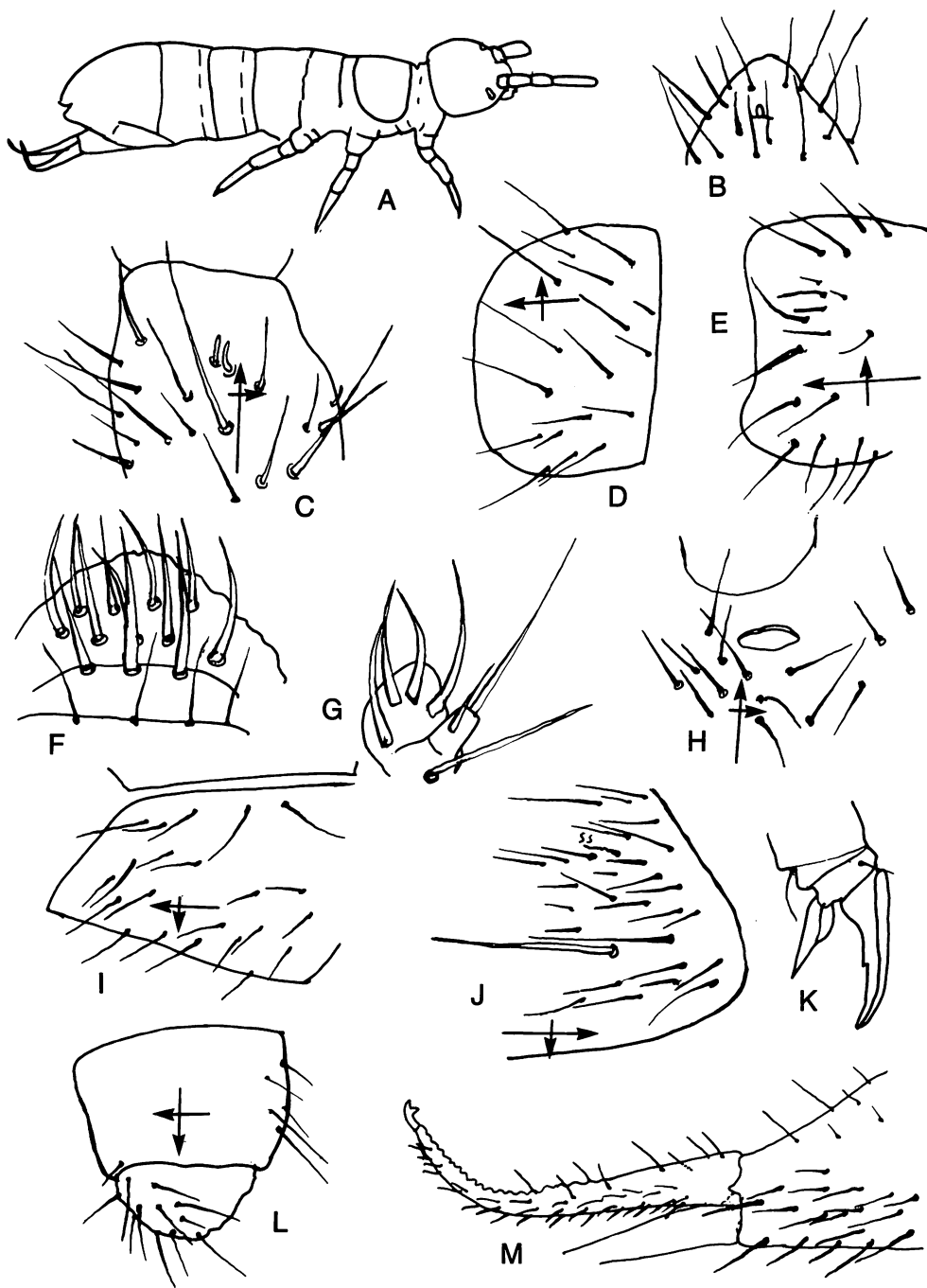


Plate 58—*Folsomia candida*: A, habitus (5432, Hawaii); B, apex of antenna (5216, Kauai); C, apex of third antennal segment (5478, Hawaii); D, dorsum, first antennal segment (same); E, venter, first antennal segment (same); F, labrum (same); G, maxillary palp (5216, Kauai); H, postantennal organ and neighboring setae (5478, Hawaii); I, ventral cephalic chaetotaxy, left side (same); J, anterior corner chaetotaxy, second thoracic segment, left side (same); K, hind foot complex (same); L, ventral tube seen from left side (5216, Kauai); M, furcula seen from angle and below (5432, Hawaii).

Folsomia stella Christiansen and Tucker, 1977 (Plate 59)
Rev. Ecol. Biol. Sol 14:379.

Color white, without trace of pigment or eyes. Fourth antennal segment without apical bulb; subapical sense organ a small stalked sphere in a pit with a subtending curved short blunt seta. Apical organ of third antennal segment of 2 curved blunt rods and a small lateral sensory seta. Second antennal segment without supplementary microchaetae. Postantennal organ narrowly elliptical with a slight median indentation but without listel. Unguis usually with an obvious inner tooth and without lateral teeth. Ventral tube with 5 + 5 to 7 + 7 distolateral setae. Tenaculum with 4 + 4 teeth and 1 seta. Dens dorsally with 5 setae. Mucro bidentate, $\frac{1}{11}$ – $\frac{1}{13}$ as long as dens. Clothing of acuminate smooth setae. Macrochaetae clearly larger than other setae. Sensory setae often very weakly distinguished from normal slender setae. Maximum length 1.1 mm.

Remarks: Overall the Hawaiian specimens agree very well with nearctic ones; however, the range of some features is extended beyond what we have seen before. This is particularly true of the number of ventral manubrial and dental setae. The overall similarity is so strong that we see no need of taxonomic separation of the Hawaiian specimens. This may be a recent introduction into the Islands. Specimens were taken in 1971, 1973, and 1988.

Ecology: So far known from soil and under bark in middle elevations.

Records: Hawaii: 5068, 6864, 6868. Kauai: 6717.

Folsomia octoculata Handschin, 1925 (Plate 60)
Treubia 6:226.—Yosii, 1956*b*.—Rusek, 1971.

Color dark to medium blue with appendages and intersegmental membranes pale; dentes and scattered oval to irregular spots on tergites unpigmented. Fourth antennal segment without retractile apical bulb, but with unpigmented apical knob; pin seta simple and truncate; subapical sense peg spherical, on a projecting stem; 6–7 differentiated setae that are slender, curved, and abruptly tapered at apex; and 3 short blunt curved pegs. Apical organ of third antennal segment of 2 projecting curved pegs; guard setae appear slightly more thin-walled than remaining setae. Males without supplementary setae on third antennal segment. Postantennal organ elongate elliptical, with a median listel or deep pair of indentations, 5–6 times as long as nearest eye. Eyes 4 + 4, with posterior eye well separated from the anterior 3, on eyepatches that are often irregular in outline and poorly distinguished from the remaining head pigmentation. Unguis and unguiculus without teeth. Ventral tube with 3 + 3 distolateral setae. Tenaculum with 4 + 4 teeth and 1 seta. Dens with 4–5 dorsal setae. Mucro bidentate, 0.2–0.25 times length of dens. Normal body setae acuminate and smooth; macrochaetae only slightly larger than other large setae. Median and posterior sensory setae of trunk segments acuminate and difficult to distinguish; dorsal and lateral sensory setae of fused abdominal segments small and blunt, easily recognized. Maximum length 1.5 mm.

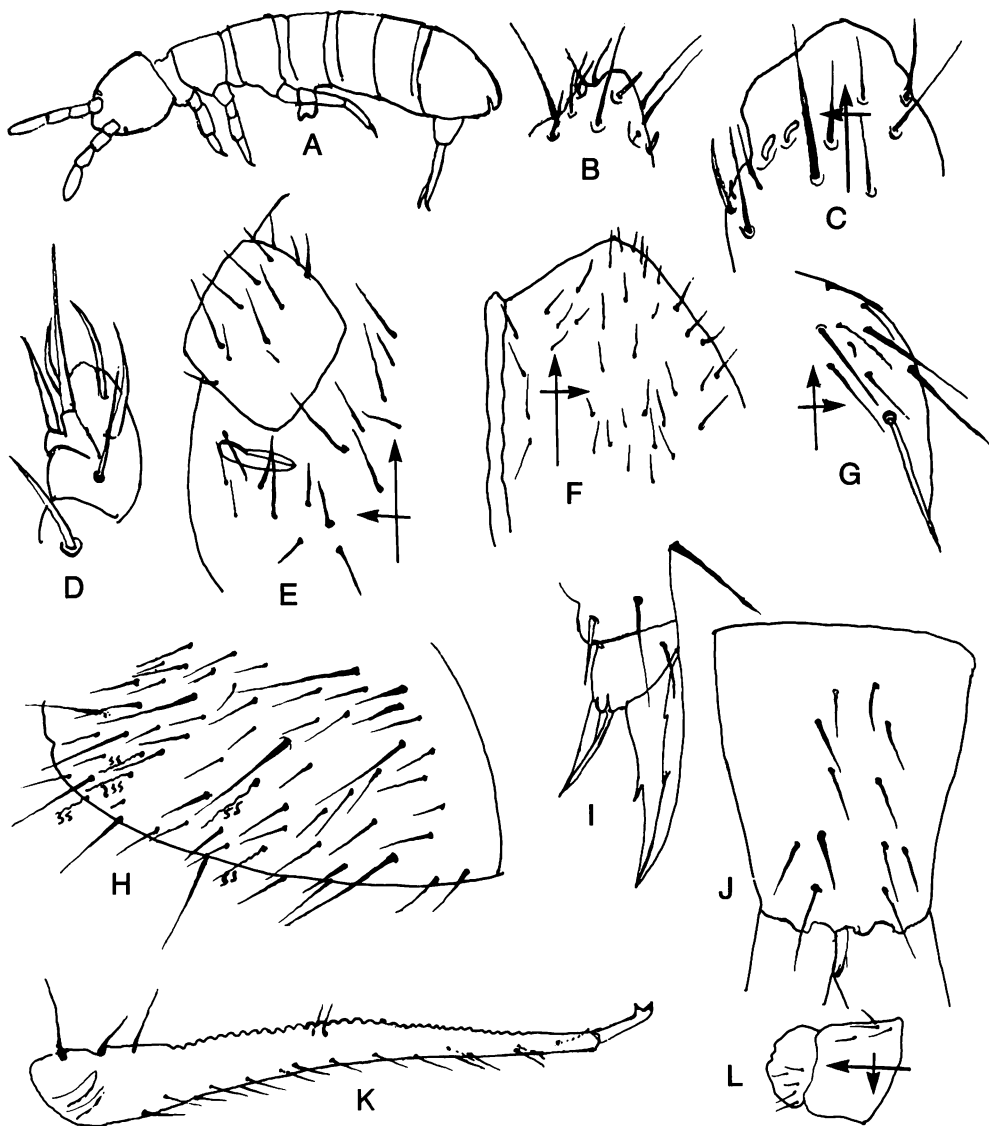


Plate 59—*Folsomia stella*: A, habitus (6717, Kauai); B, apex of antenna (same); C, apex of third antennal segment (same); D, maxillary palp (5068, Hawaii); E, postantennal organ, neighboring setae, and dorsum of first antennal segment, left side (6717, Kauai); F, ventral cephalic chaetotaxy, right side (same); G, anterior marginal chaetotaxy, left side, second thoracic segment (6864, Hawaii); H, dorsal chaetotaxy, last three abdominal segments, left side, midline at top of figure (6717, Kauai); I, hind foot complex (same); J, ventral surface of manubrium (6864, Hawaii); K, mucro and dens (6717, Kauai); L, ventral tube seen from side (6868, Hawaii).

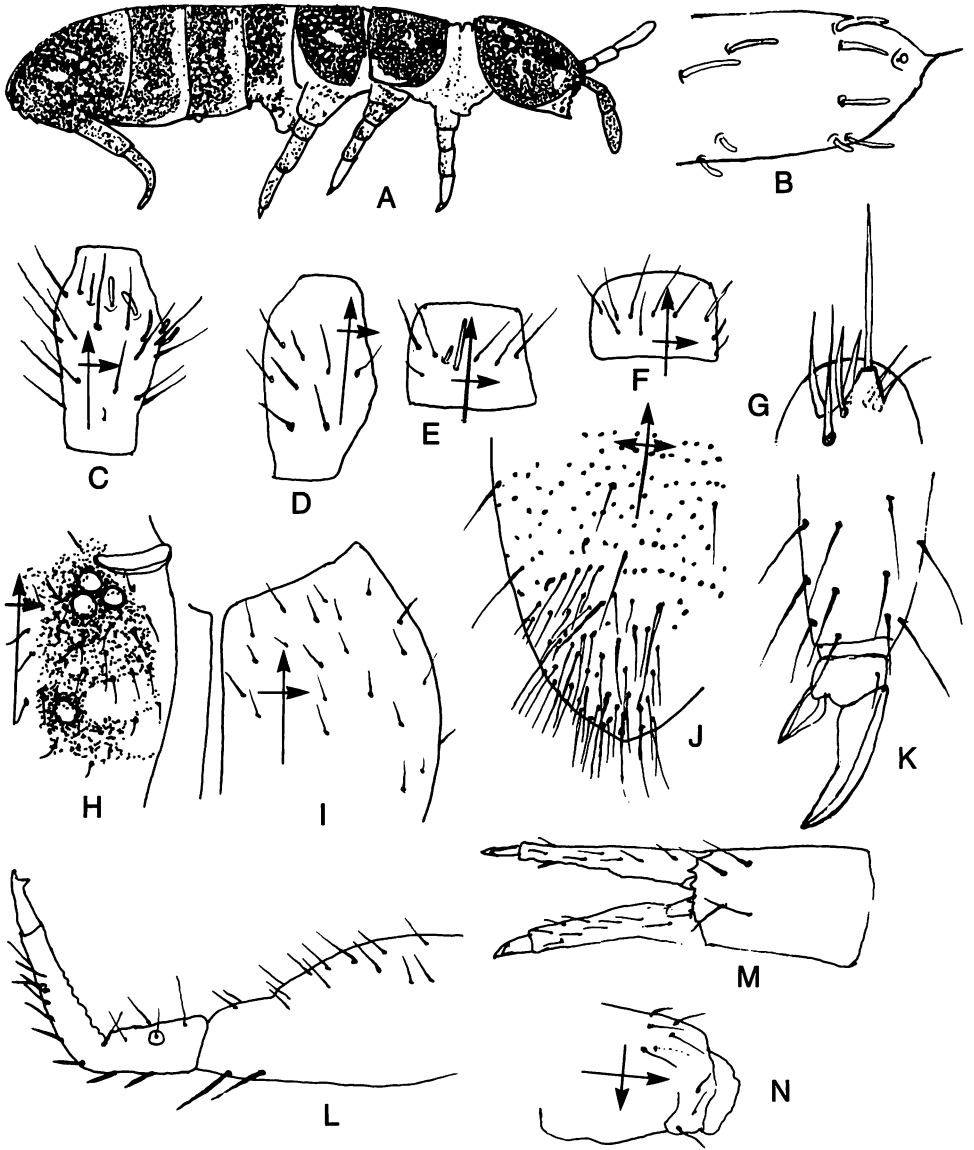
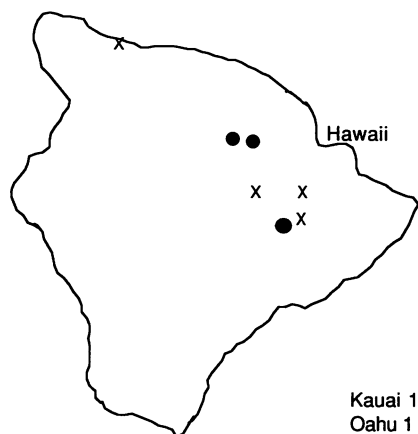


Plate 60—*Folsomia octoculata*: A, habitus (5009, Hawaii); B, fourth antennal segment showing differentiated setae (4853, Hawaii); C, dorsal surface, third antennal segment (4870, Hawaii); D, ventral surface, third antennal segment (same); E, ventral surface, first antennal segment (5274, Hawaii); F, dorsal surface, first antennal segment (same); G, maxillary palp (4853, Hawaii); H, eyes and postantennal organ, right side (5691, Hawaii); I, ventral cephalic chaetotaxy, left side (6710, Kauai); J, partial chaetotaxy, fused abdominal segments (4853, Hawaii); K, hind foot complex (5009, Hawaii); L, manubrium and dens seen from side, encircled seta often absent (same); M, manubrium and dens seen from below (4853, Hawaii); N, ventral tube seen from side (6710, Kauai).



Remarks: Our specimens agree well with the figures and descriptions given by Yosii (1956*b*) and by Rusek (1971), except that they appear to have shorter mucrones and sometimes a more internally angulate unguiculus. The basal microchaete of the third antennal segment is often difficult to see and may sometimes be absent.

Ecology: Found mainly in moss and lichens in disturbed areas; also in litter in woods and in cave entryways.

Records: Hawaii: 4853, 4857, 4870, 4893, 5009, 5274, 5673, 5674, 5675, 5677, 5679, 5681, 5683, 5684, 5691. Oahu: 4807. Kauai: 6710.

Genus **ISOTOMIELLA** Bagnall, 1939

Type species: *Isotoma minor* Schäffer, 1896

This includes the Hawaiian isotomids lacking eyes and postantennal organ and with the fourth abdominal segment at least partly separated from the fifth. The animals have very large blunt setae on the fourth antennal segment; a bidentate or tridentate mucro clearly separated from the long, crenulate dens; and some long, clearly ciliate setae. There are two Hawaiian species of *Isotomiella*: *alulu* and *minor*.

KEY TO HAWAIIAN SPECIES OF ISOTOMIELLA

1. 2 + 2 ventral manubrial setae in adults; mucro bidentate. **alulu**
 4 + 4 or 5 + 5 ventral manubrial setae in adults; mucro tridentate. **minor**

Isotomiella alulu Christiansen and Bellinger, **new species** (Plate 61)

Color white. Fourth antennal segment with 6 swollen sensillae but without cylindrical blunt setae. Apical organ of third antennal segment with 2 short curved pegs, not in grooves or pits. Ventral surface of first antennal segment with 1 slen-

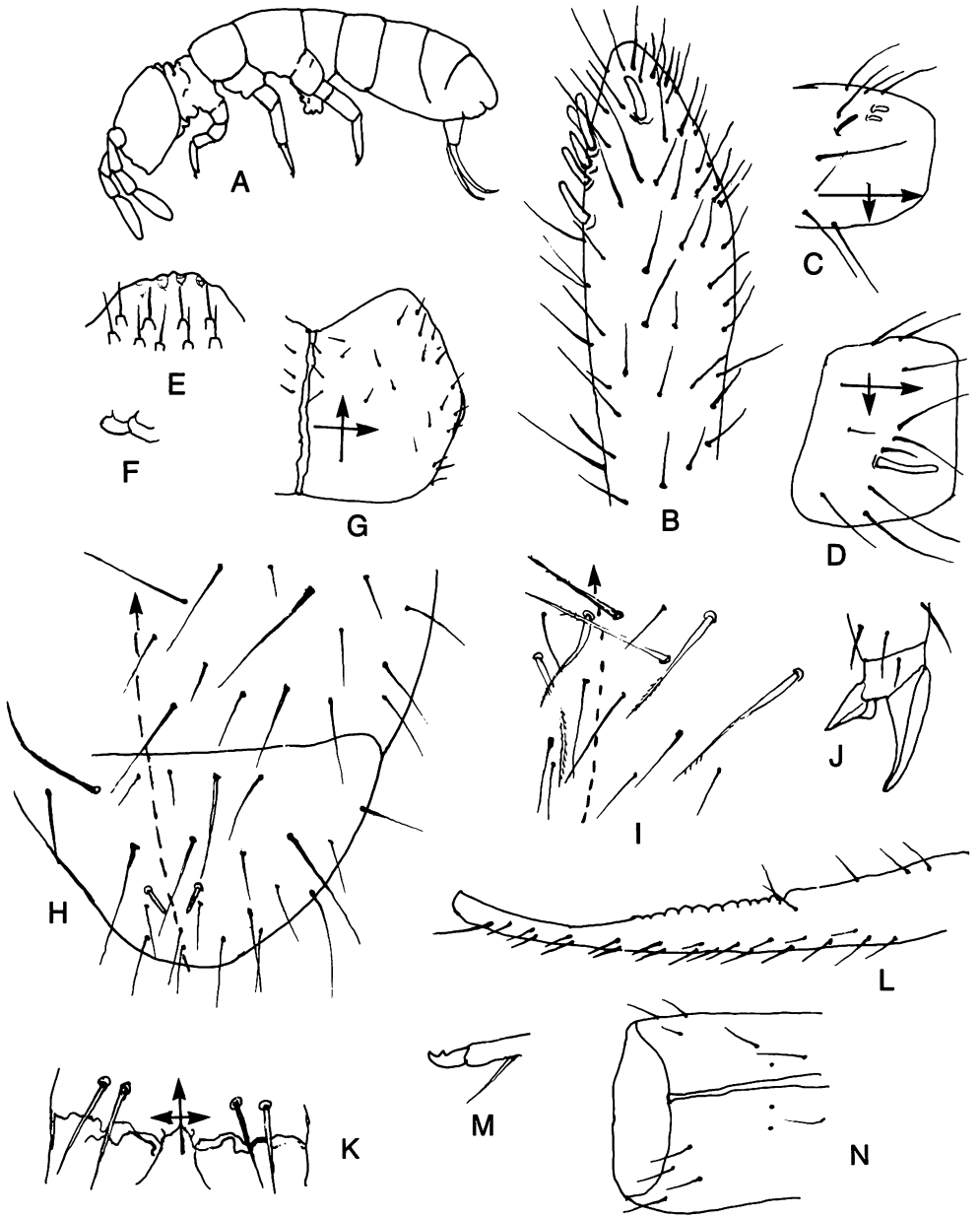
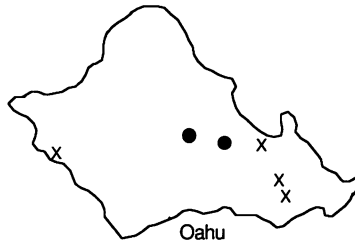
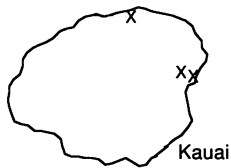


Plate 61—*Isotomiella alulu*: A, habitus (5203, Kauai); B, fourth antennal segment (paratype); C, apex of third antennal segment (same); D, ventral surface, first antennal segment (6770, Oahu); E, labrum (5207, Kauai); F, labral papillae seen from side (same); G, ventral cephalic setae, left side (paratype); H, posterior abdominal chaetotaxy showing blunt setae, midline shown by broken line (4766, Oahu); I, enlarged abdominal setae (same); J, hind foot complex (5203, Kauai); K, apex of venter of manubrium (5207, Kauai); L, dens seen from side (paratype); M, mucro (5207, Kauai); N, anterior face of ventral tube (paratype).

der blunt seta. Labral papillae blunt; inner pair smaller than outer pair; each with a dorsal microseta pointing up. Maxillary palp bifurcate with 4 sublobal setae. Tenent hair acuminate. Unguis and unguiculus without teeth. Ventral tube with 3 + 3 frontal, 4 + 4 distal lateral, and 4–6 posterior setae. Tenaculum with 4 + 4 teeth and 1 seta. Manubrium with 2 + 2 ventral setae. Dens with 21–22 ventral setae. Mucro bidentate, with apical tooth the larger. Fifth and sixth abdominal segments fused, with a dorsolateral pair of blunt setae. All other trunk setae acuminate; some large setae of lateral thoracic corners and abdominal segments sparsely ciliate on apical portions with 1 to 2 rows of ciliations. Maximum length 0.8 mm.



Remarks: This species differs from *I. minor* in mucronal shape, manubrial chaetotaxy, less coarsely ciliate body setae, cephalic chaetotaxy, and fewer blunt antennal setae. It differs from *I. bidentata* Delamare, 1951a in having 2 + 2 rather than 1 + 1 manubrial setae and from *I. delamarei* Barra, 1968 in lacking a pair of large spinelike setae on the labrum. One specimen from Oahu has 3 + 3 ventral manubrial setae.

Derivatio nominis: Hawaiian, quickly.

Ecology: Found in moss, dry soil, tree bark, roots, and soil in wet forest areas.

Type locality: Holotype and 1 paratype, Oahu, Manana Ridge Trail, 3½ miles up, VIII-3-1986, soil, ohia fern scrub forest, berlese, KC (6738).

Additional records: Oahu: 4766, 6738, 6741, 6743, 6745, 6749, 6754, 6764, 6770, 6784. Kauai: 5203, 5207, 6728.

Isotomiella minor (Schäffer, 1896) (Plate 62)

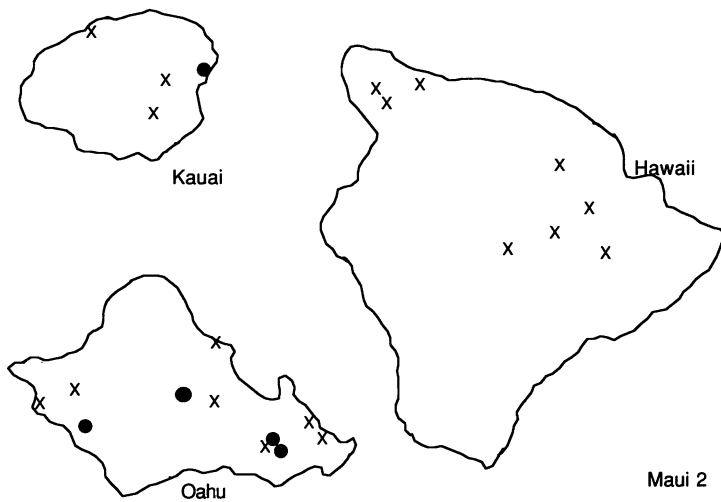
Mitt. Naturhist. Mus. Hamburg 13:182 (*Isotoma*).—Folsom, 1932.—Stach, 1947.

—Christiansen and Bellinger, 1980.

Denisia falcata Folsom, 1932, Proc. Hawaii. Entomol. Soc. 8:61.

Color white, mouthparts amber. Fourth antennal segment with 5–7 (usually 6) large blunt setae and 7–9 slender cylindrical blunt setae. Apical organ of third antennal segment of 2 slender curved pegs on surface of segment. First antennal

segment with 1 slender blunt seta ventrally. Labral papillae 4, pointed and curved upward. Maxillary palp bifurcate, with 4 sublobal setae. Tenent hair acuminate. Unguis and unguiculus without teeth. Ventral tube with 4 + 4 distal lateral, 2 + 2 or 3 + 3 anterior, and 6–8 posterior setae. Tenaculum with 4 + 4 teeth and 1 seta. Manubrium with 8–10 ventral setae arranged in 2 rows of 2, 1–2, and 1 setae. Dens 2.5–3 times as long as manubrium, with many ventral setae. Mucro tridentate, with 1 basal tooth generally smaller than the other. Integument smooth. Trunk setae acuminate except for 1 pair of blunt setae on the fused fifth and sixth abdominal segments. Fourth and fifth abdominal segments separated only on dorsal surface. Larger abdominal setae and large lateral thoracic setae with 2 or more rows of large ciliations. Maximum length 1.1 mm.



Remarks: The Hawaiian specimens of this species agree well with descriptions and specimens from other areas. The type series of *Denisia falcata* is composite, as reported by Lawrence (1969), including specimens of *I. minor* and *F. onychiurina*; Lawrence selected a lectotype that is a juvenile of *I. minor*.

Ecology: Found in litter, soil, moss, rotten wood, and low wet plants in forests or brushy areas, mainly in lowlands but occasionally higher (3 records up to 5400 ft.).

Records: Hawaii: 5068, 5116, 5119, 5313, 5327, 5652, 5664, 6870, 6894. Maui: 5170, 6680. Oahu: 4777, 4786, 4787, 4794, 4795, 4805, 4807, 4814, 4816, 4832, 6741, 6742, 6744, 6755, 6769, 6772. Kauai: 5191, 5202, 5204, 5205, 6717.

Genus **AXELSONIA** Börner, 1906

Type species: *A. thalassophila* Börner, 1907

This genus includes species resembling *Isotoma* but with many sensillae in the apical organ of the third antennal segment, no postantennal organ, filiform lateral

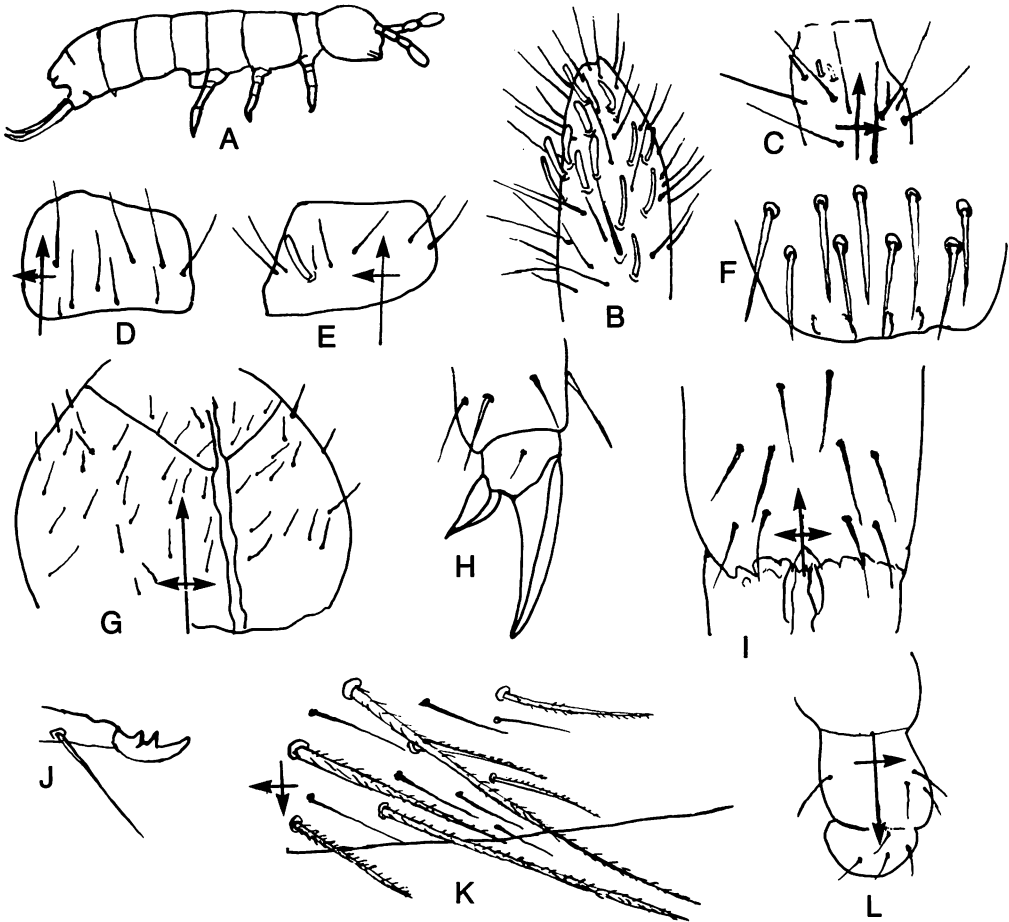


Plate 62—*Isotomiella minor*: A, habitus (after Folsom); B, apex of antenna (6741, Oahu); C, apex of third antennal segment (after Folsom); D, dorsal surface, first antennal segment (4814, Oahu); E, ventral surface, first antennal segment (same); F, labrum (5068, Hawaii); G, ventral cephalic setae (6741, Oahu); H, fore foot complex (4787, Oahu); I, ventral surface, apex of manubrium (4814, Oahu); J, micro (5068, Hawaii); K, large abdominal setae (4787, Oahu); L, ventral tube from side (6772, Oahu).

ungual teeth, and two pairs of trichobothria each on the second, third, and fourth abdominal segments. All are confined to the marine intertidal region. There is a single Hawaiian species, *A. sarahae*.

***Axelsonia sarahae* Christiansen and Bellinger, new species (Plate 63)**

Color pale gray with eyespots and interantennal patch darker and furcula and intersegmental membranes paler. Fourth antennal segment without retractile bulb or blunt setae; subapical sense peg rodlike and deeply withdrawn into a shallow pit, flanked by a truncate seta externally and a minute pin seta internally. A broad

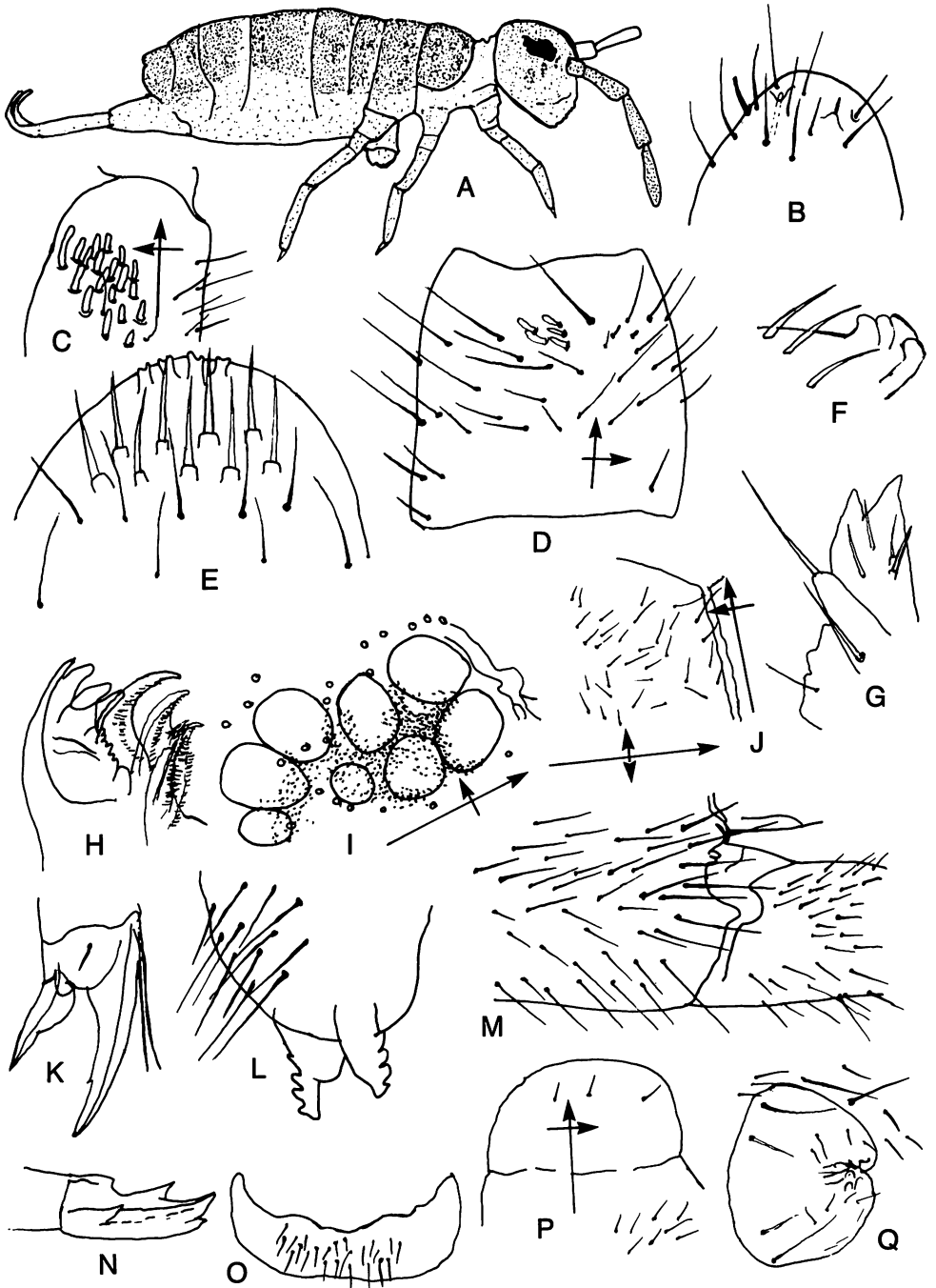
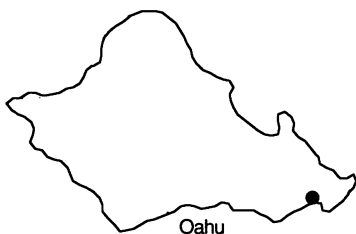


Plate 63—*Axelsonia sarahae*: A, habitus (type specimen); B, apex of antenna (5217, Oahu); C, apical organ, third antennal segment (5130, Hawaii); D, outer surface, first antennal segment (type specimen); E, labrum and prelabral setae seen from above (5217, Oahu); F, labrum seen from side (same specimen); G, maxillary palp (5130, Hawaii); H, maxilla (5217, Oahu); I, left eyepatch (4831, Oahu); J, ventral cephalic setae, right side (type specimen); K, hind foot complex (5130, Hawaii); L, tenaculum (type specimen); M, venter of apex of manubrium and base of dens, left side (type specimen); N, mucro (4831, Oahu); O, lateral surface of ventral tube (5217, Oahu); P, posterior face of same; Q, male genital plate (4831, Oahu).

nonsetaceous knob is usually present on the subapical dorsointernal surface. The dorsal surface has numerous minute curved blunt setae. Apical organ of third antennal segment of 15–19 blunt setae, the 2 most dorsal setae being the largest and the others gradually declining in size ventrally. First antennal segment with 4–5 outer large blunt setae. Maxillary palp with 4 sublobal hairs. Labrum gabled; with 2–3 rows of ventral ciliations. Eyes 8 + 8, with G and H distinctly smaller than others. Tenent hairs absent. Ungues with inner tooth on first pair of legs but tooth absent or minute on others, and with a pair of filiform lateral teeth projecting from dorsal base. Distal internal edge of unguiculus concave. Ventral tube with 3 + 3 setae on apical lobes, 7 + 7 to 10 + 10 on distolateral margins, and 15–22 posteriorly. Tenaculum with 4 + 4 teeth and 8–16 setae on corpus. Dens about twice as long as manubrium, dorsally crenulate and with many ventral setae. Mucro quinquedentate. All trunk setae acuminate and smooth, 0.01–0.04 mm in length. Thorax and anterior abdominal segments without ventral setae. Maximum length 2 mm.



Hawaii 1

Remarks: This species resembles *A. littoralis* (Moniez, 1890) in most respects, but *A. littoralis* has many more ventral tube setae and the extra sensillae of the third antennal segment are of two sharply different sizes. The male genital plate of *A. sarahae* also appears to be different from that figured by Strenzke (1958), but it was seen on only one specimen. The ventral tube setae also distinguish *A. sarahae* from *A. nitida* (Folsom, 1899), and the presence of an inner ungual tooth on the first foot of most specimens is a difference from all previously described species.

Derivatio nominis: Named after Sarah Ludington, whose assistance was essential for this project.

Ecology: Found in rocky littoral zones below high tide mark.

Type locality: Holotype and 3 paratypes, Pearl and Hermes Reef, seal kittery, VIII-10-1983, on raised coral beach, Gagne (6831).

Additional records: Hawaii: 5130. Oahu: 4831, 5217, 5642.

Genus **ISOTOMURUS** Börner, 1903

Type species: *Podura palustris* Müller, 1776

This genus includes the Hawaiian isotomids with bothriotricha, a quadridentate mucro with a small apical tooth, and no patch of extra blunt setae on the third antennal segment. The Hawaiian members of the genus have a maxillary outer

Table 14. Characters of Adults of Some Species of *Isotomurus* (with Mucronal Seta, Simple Unguis, and Smooth Microchaetae)

SPECIES	PATTERN		POST-ANTENNAL ORGAN/EYE	DORSAL UNGUAL TOOTH	UNGUICULAR TOOTH
	BANDS	STRIPES			
<i>afghanicus</i> Yosii, 1966	-	+	<	+	-
cf. <i>aquatilis</i> of Yosii, 1963	(post.)	+	≈	+	+
<i>beskidensis</i> Rusek, 1963	-	-	>?	-	+
<i>bimus</i> Christiansen & Bellinger, 1980*	+	-	<-≈	-	±
<i>parabatteatus</i> Gapud, 1969	+	-	≈	+	-
<i>paraciliatus</i> Cardoso, 1970	+	-	≈	+	-
cf. <i>prasina</i> of Yosii, 1963	-	-	≈	+	-
<i>punctiferus</i> Yosii, 1963	-	+	>	+	+
<i>quadrisetosus</i> Rusek, 1971	+	-	<	-	-
<i>tricolor</i> Packard, 1873	-	+	≈	-	±
<i>tricuspis</i> Börner, 1906	+	-	≈	+	-
<i>yamaquizuensis</i> Winter, 1967	+	-	0.86	+	±
<i>opala</i>	±	+	0.65-1.1	-	±
<i>palustris</i> (Müller, 1776)	+	-	0.7	-	+
sp. C	-	-	≈	2	±

**I. bimus* may be *batteatus* Reuter, 1876; Scandinavian material we have seen has a mucronal seta, unlike *I. batteatus* of Poinsoot.

lobe with a bifurcate palp and four sublobal hairs, and 3-3-1 bothriotricha on each side of the second, third, and fourth abdominal segments. Tenent hairs are acuminate; the unguis has two large lateral teeth. Species C is represented by a single immature specimen from Maui. It is strikingly different from the other species, with solid dark blue pigmentation and a large almost circular postantennal organ, as well as having the inner ungual teeth. We do not name this species here because of the inadequate material. There are three Hawaiian species of *Isotomurus*: *opala*, sp. C, and *palustris*.

KEY TO HAWAIIAN SPECIES OF ISOTOMURUS

- 1. Mucro with seta (Fig. 47A)..... **opala**
- Mucro without seta (Fig. 47B)..... 2



- 2(1). Without inner ungual teeth..... **palustris**
- With 2 inner ungual teeth..... **sp. C**

VENTRAL TUBE SETAE			TENACULAR SETAE	CILIAE MACROCHAETAE	BOTHRIOTRICHA	DENS/MANUBRIUM
ANTERIOR	LATERAL	POSTERIOR				
many	3+3	many	ca. 10	(rugose)	?	1.25
many	3+3	many	ca. 18	+(V,VI)	?	1.8
?	?	?	6-7	+(IV-VI)	- - +	2.15
?	5+5-8+8	?	8-12	+	3 3 1	1.4-1.7
?	5+5-6+6	?	3	(IV,V)	2 2 1	1.7
2+2	3+3	0	4	+	3 3 1	1.55
many	3+3	many	ca. 20	-	?	1.6
ca. 20	10+10-18+18	ca. 30	10-20	+(V,VI)	3 3 1	2.13
?	4+4	?	3-4	-	?	1.77
?	10+10-15+15	?	10-18	+	3 3 1	ca. 2
?	?	?	?	+	?	?
?	3+3-11+11	?	9	+	2 2 1	1.4
10+10-28+28	5+5-8+8	19-26	6-12	+	3 3 1	1.6-1.9
many	3+3	many	10-22	+	3 3 1	1.7-2.1
?	5+5	?	5	-	3 3 1	0.18

Isotomurus opala Christiansen and Bellinger, **new species** (Plate 64)

Folsom, 1932, Proc. Hawaii. Entomol. Soc. 8:63, as *Isotomurus palustris* var. *balteatus* (Reuter).

Background color white to pale yellow. Pattern when most complete of broad anterior bands on trunk segments combined with broken middorsal and lateral lines; the bands may be narrow, faint, and confined to the posterior abdominal segments or absent; the palest specimens have only the middorsal line. Fourth antennal segment with a simple pin seta and no apical bulb or blunt setae. Subapical peg truncate, apically slightly expanded. Apical organ of third antennal segment of 2 basally sharply angled blunt pegs, not in a groove or pit; 2 other less conspicuous sensilla in the same setal row dorsally and ventrally. Labrum with papillae gable-like and about 6 rows of dense ventral "ciliations." Eyes 8 + 8, subequal or with G and H slightly smaller than others. Postantennal organ oval, 0.65-1.1 times length of nearest eye, weakly indented medially. Mid tibiotarsus with 2 ciliate macrochaetae at same level near base. Hind tibiotarsus with 3 such setae, at $\frac{1}{2}$, just less than $\frac{1}{2}$, and $\frac{3}{4}$ of its length from base, the most apical being smaller than others and very weakly ciliate. Unguis with small lateral teeth and no inner tooth. Unguiculus internally rounded, with or without a minute corner tooth. Ventral tube with 10 + 10 to 28 + 28 frontal, 5 + 5 to 8 + 8 distal lateral, and 19-26 posterior setae. Tenaculum in adults with 6-12 setae. Dens 1.6-1.9 times length of manubrium, dorsally crenulate. Mucro with outer basal seta and well-developed lamella.

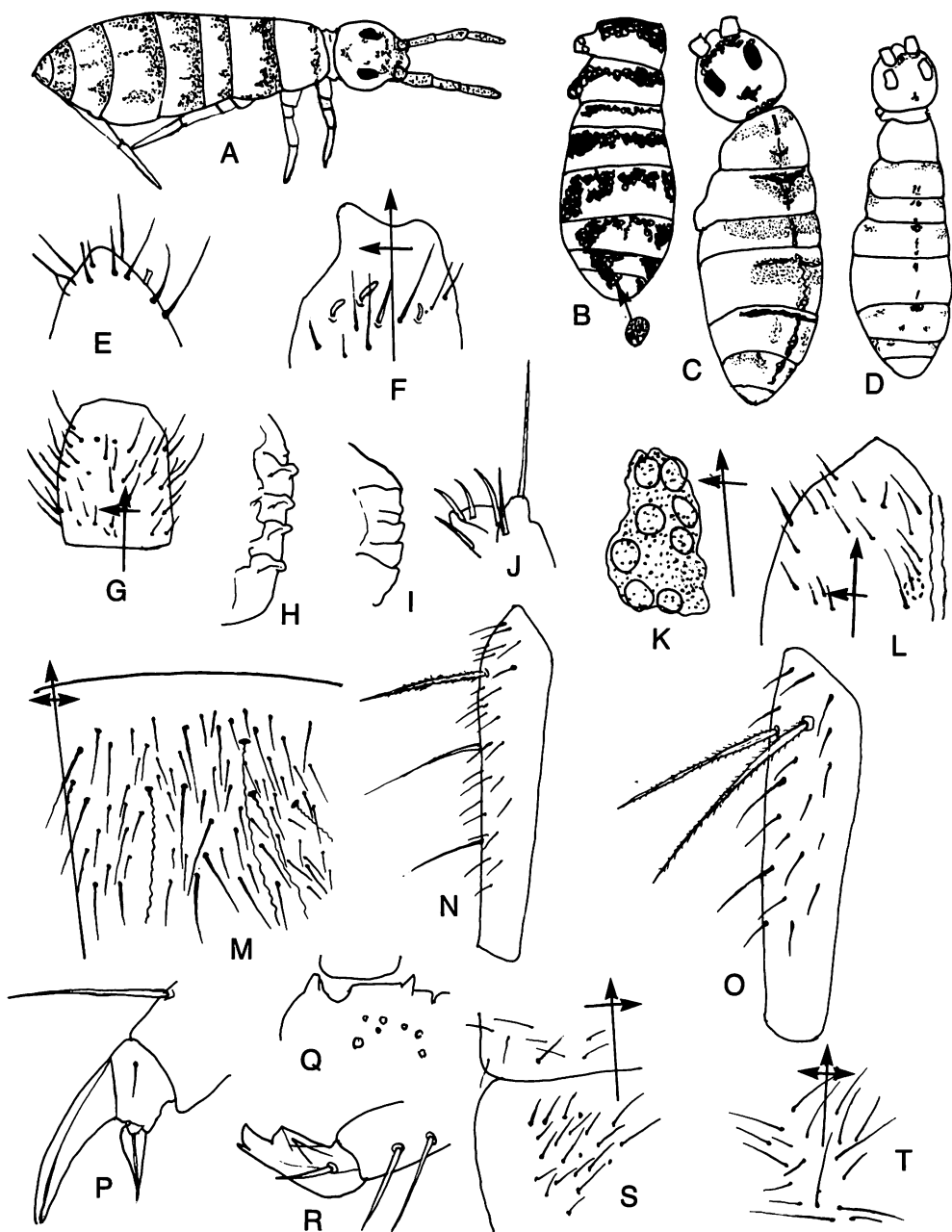
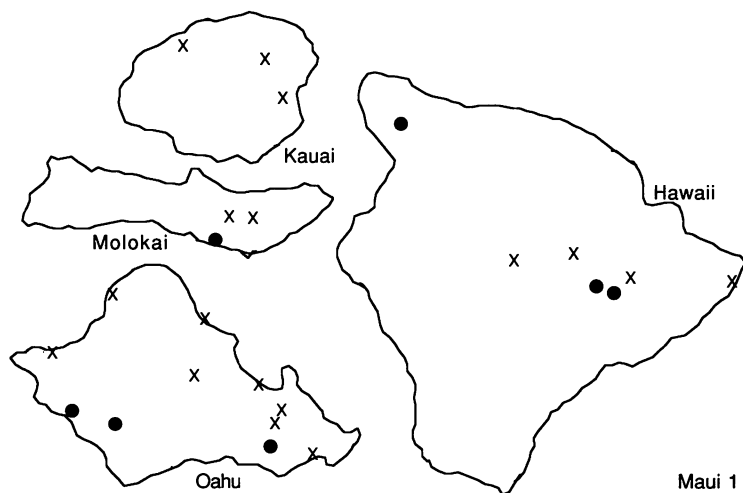


Plate 64—*Isotomurus opala*: A, habitus, pattern type intermediate between 3 and 4 (4754, Oahu); B, pattern type 4 (5132, Hawaii); C, pattern type 1 (4728, Kauai); D, pattern type 2 (5345, Hawaii); E, apex of antenna (paratype); F, apex of third antennal segment from above (same specimen); G, venter, first antennal segment (4729, Kauai); H, labral papillae from above (paratype); I, labral papillae from side (holotype); J, maxillary palp (paratype); K, left eyepatch and postantennal organ (4754, Oahu); L, ventral cephalic chaetotaxy, right side (paratype); M, dorsal chaetotaxy, right side, third abdominal segment (paratype [immature]); N, outer margin, hind tibiotarsus (holotype); O, mid tibiotarsus (same); P, hind foot complex (4754, Oahu); Q, manubrial thickening, right side (4825, Oahu); R, mucro (4741, Kauai); S, lateral and anterior setae, ventral tube (5345, Hawaii); T, posterior face, ventral tube (5725, Molokai).



Bothriotricha 3-3-1. Largest posterior macrochaetae and bothriotricha ciliate; other setae usually smooth, but some ordinary setae may be sparsely ciliate on the second through sixth abdominal segments. Maximum length 2.5 mm.

Remarks: On the basis of available descriptions, the species of *Isotomurus* having mucronal setae and simple untoothed ungues and with most or all ordinary setae smooth show similarities and differences as in Table 14. It must be emphasized that intraspecific variation in the characters listed has hardly been studied, especially since some species have been described on the basis of single collections.

Isotomurus opala is perhaps most similar to the nearctic *I. bimus* and *I. tricolor*, but differs from the former in the presence of longitudinal pattern elements and the limitation of transverse bands to the anterior half of segments in even the most strongly patterned individuals; *I. tricolor* differs in pattern and the number of ventral tube setae.

Specimens from Oahu lack the minute unguicular tooth present in at least some individuals from other localities. Variation in most other characters is not clearly geographic; however, the pattern variation does not appear random. There are five basic pattern types: (1) with complete longitudinal median stripe and transverse bands more or less well developed on thoracic and abdominal segments, (2) longitudinal median stripe only, (3) median stripe present, lateral bands only on posterior segments, (4) lateral bands only, and (5) pigment almost absent except for head and sixth abdominal segment. If we consider the four basic pattern types illustrated and add type 5, then the Island distribution is as shown in Table 15.

Derivatio nominis: Hawaiian, litter.

Ecology: Found at all elevations, primarily on grass and low vegetation, and in litter; rare in wooded areas.

Type locality: Holotype and 5 paratypes, Oahu, Waianae Kai, above Waianae, 20 yards down from ridge at trail jointure, VII-7-1986, scrub forest, ferns under trees, litter and soil, KC (6774).

Table 15. Island Distribution of the Four Basic Pattern Types of *Isotomurus*

ISLAND	PATTERN TYPES				
	1	2	3	4	5
Oahu	0	0	2	4	1
Hawaii	3	4	2	1	2
Kauai	1	2	0	0	1
Molokai	2	2	1	0	0

Additional records: Hawaii: 4727, 4987, 5119, 5132, 5345, 5521, 5659, 5695, 6859. Maui: 6683. Molokai: 5121, 5724, 5725, 5729, 6863. Oahu: 4754, 4757, 4794, 4823, 4825, 5223, 5226, 5232, 5241, 6736, 6739, 6759, 6776. Kauai: 4728, 4729, 4741, 4743.

***Isotomurus palustris* (Müller, 1776) (Plate 65)**

Zool. Danicae prodromus: 184 (*Podura*).—Stach, 1947.—Poinsot-Balaguer, 1976.
—Christiansen and Bellinger, 1980.

Background color dull yellow; pigment varying from irregular middorsal patches and faint lateral patches to lateral patches on sixth segment and middorsal traces near segment margins, and eyepatches, antennal bases, ocellar patch, and posterior margin of head. Fourth antennal segment with simple pin seta and no apical bulb or blunt setae. Apical organ of third antennal segment of 2 basally angled blunt pegs, not in groove or pits, on outer dorsal surface, and 3-4 smaller blunt setae on inner ventral surface; one of these latter is much smaller than the others. Labrum with papillae gablelike with setalike peaks and about 8 rows of ventral ciliations. Postantennal organ sometimes medially constricted, about $\frac{2}{3}$ length of nearest eye. Mid and hind tibiotarsus with 4 large projecting macrochaetae, ranging along the outer and lateral margin of the joints; the distalmost seta is much smaller than the others in each case. Unguis with well-developed lateral teeth but without inner teeth. Unguiculus with a prominent corner tooth. Ventral tube with 3 + 3 distal lateral setae and more than 50 setae each on anterior and posterior faces. Corpus of tenaculum with 10-22 setae. Dens dorsally crenulate, 1.7-2.1 times as long as manubrium. Mucro without clear lamella or seta. Some macrochaetae multilaterally ciliate; small body setae smooth. Maximum length 3 mm.

Remarks: The Hawaiian specimens agree well with North American specimens but with two exceptions: Hawaiian specimens have three to four smaller blunt setae on the inner ventral surface of the third antennal segment, while North American specimens have only one. Hawaiian specimens also have eight rows of labral ventral ciliations, while North American specimens may have fewer.

Ecology: So far found mostly in the Kilauea Forest Reserve in pitfall traps.

Records: Hawaii: 5331, 5332, 5334, 6814.

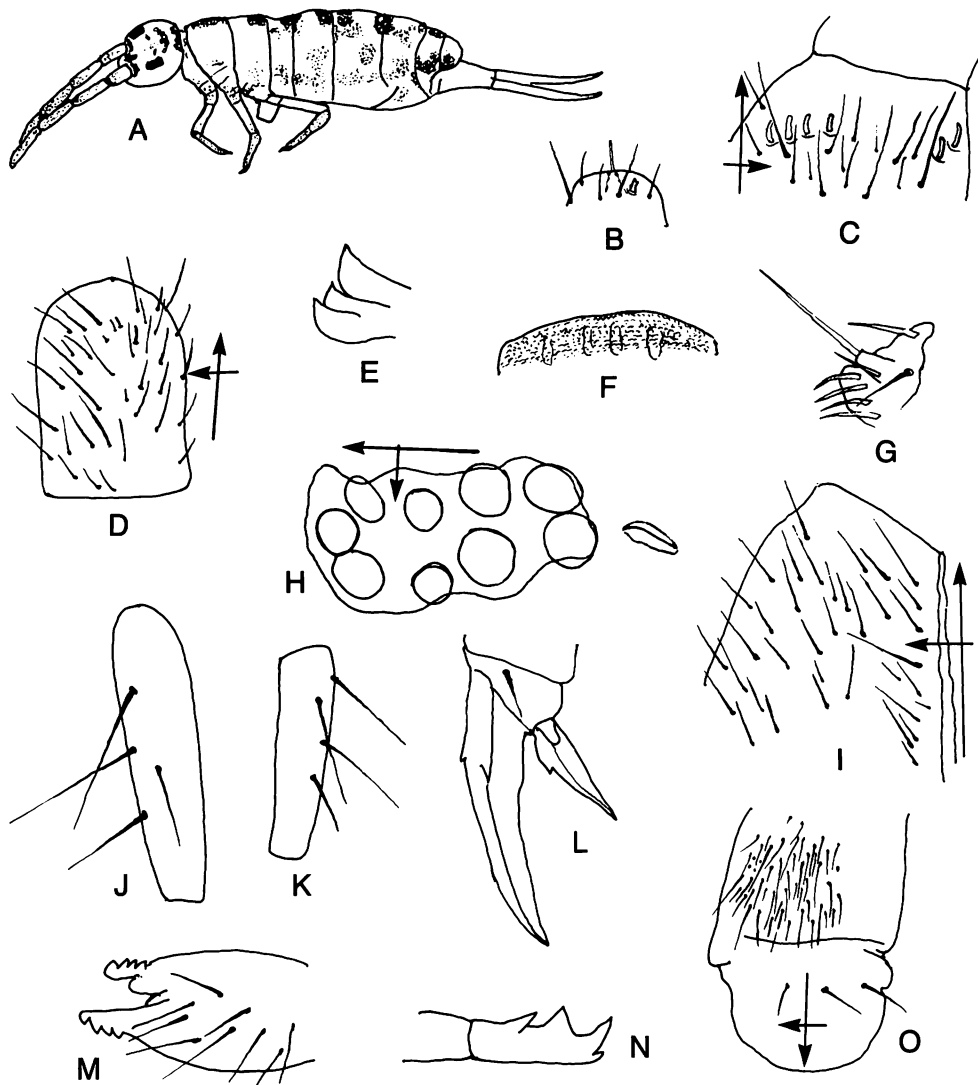


Plate 65—*Isotomurus palustris* (all figures of specimens from Hawaii): **A**, habitus (5331); **B**, apex of antenna (same); **C**, apex of third antennal segment (same); **D**, ventral surface, first antennal segment (same); **E**, labral papillae, side view (5332); **F**, ventral surface of labrum showing ciliations (5331); **G**, maxillary palp (same); **H**, right eyepatch (5334); **I**, ventral cephalic chaetotaxy, right side (5331); **J**, ciliate macrochaetae of hind tibiotarsus (same); **K**, mid tibiotarsus (same specimen); **L**, hind foot complex (5334); **M**, tenaculum (5331); **N**, mucro (5332); **O**, ventral tube from side and angle (5332).

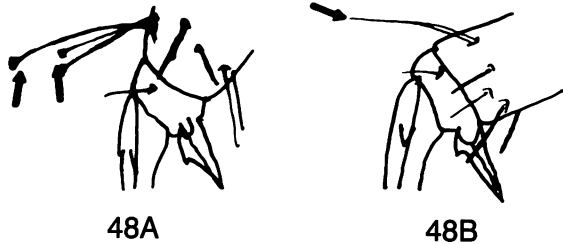
Genus **ISOTOMA** Bourlet, 1839

Type species: *I. viridis* Bourlet, 1839

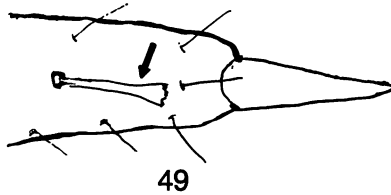
This genus includes all Hawaiian isotomids with many ventral manubrial setae, three mucronal teeth, and lacking bothriotracha. The subgenera *Pseudisotoma* and *Halisotoma* are represented by one species each, and the subgenus *Desoria* by four species; the position of *I. perkinsi* Carpenter cannot be determined from the original description.

KEY TO HAWAIIAN SPECIES OF ISOTOMA S.L.

- 1. Tenent hairs clavate or truncate (Fig. 48A)..... 2
- Tenent hairs acuminate (Fig. 48B)..... 3



- 2(1). Fifth and sixth abdominal segments fused..... **I. (*Pseudisotoma*) sensibilis**
- Fifth and sixth abdominal segments separate..... **I. perkinsi**
- 3(1). Mid tibiotarsus with flattened, serrate seta on outer surface (Fig. 49).....
- **I. (*Halisotoma*) kainui**
- Mid tibiotarsus without differentiated outer seta..... 4



- 4(3). Eyes 8 + 8..... 5
- Eyes 4 + 4 or fewer..... 6
- 5(4). Unguis with 2 inner teeth..... **I. (*Desoria*) bendixenae**
- Unguis without inner teeth..... **I. (*Desoria*) trispinata**
- 6(4). Subapical antennal sense peg spherical (Fig. 50A)..... **I. (*Desoria*) ahiehie**
- Subapical antennal sense peg rodlike (Fig. 50B)..... **I. (*Desoria*) notabilis**

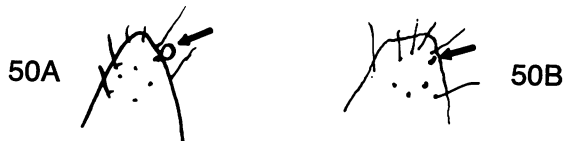


Table 16. Characteristics of Hawaiian Species of *Isotoma*

SUBGENUS SPECIES	ANTENNAL PIN SETA	ANTENNA I SENSORY SETAE	POSTANTENNAL			ROWS LABRAL CILIAATION	ABDOMINAL SERRATE SETAE	TENACULAR SETAE	NO. OF MUCRONAL TEETH	POSITION 2ND TOOTH FROM BASE	SUBAPICAL ANTENNAL ORGAN
			ORGAN/ NEAREST EYE	EYES PER SIDE	EYES G AND H/ OTHERS						
<i>Pseudisotoma sensibilis</i>	simple	8-12 acuminate	1.1-1.6	8	0.2	4	+	6-10	3	medial	spherical
<i>Halisotoma kainui</i>	-	many microsetae	1.0-1.5	8	0.5-0.7	2-3	-	2-5	3	medial	rod
<i>Desoria ahiehie</i>	simple	1-2	3.0-3.6	4(3)	-	-	+	2	3	lateral	large spherical
<i>Desoria bendixenae</i>	simple	1	1.3-1.4	8	0.5-0.7	8	+	4-8	3	medial	rod
<i>Desoria notabilis</i>	simple	1-2	3.5-4.0	3	-	-	+	2	3	medial	rod
<i>Desoria trispinata</i>	simple	1	1.2-1.5	8	1.0-0.75	-	-	5-8	3	medial	peg
<i>perkinsi</i>		?	?	8	?	?	?	?	3	lateral	?

Subgenus **PSEUDISOTOMA** Handschin, 1924

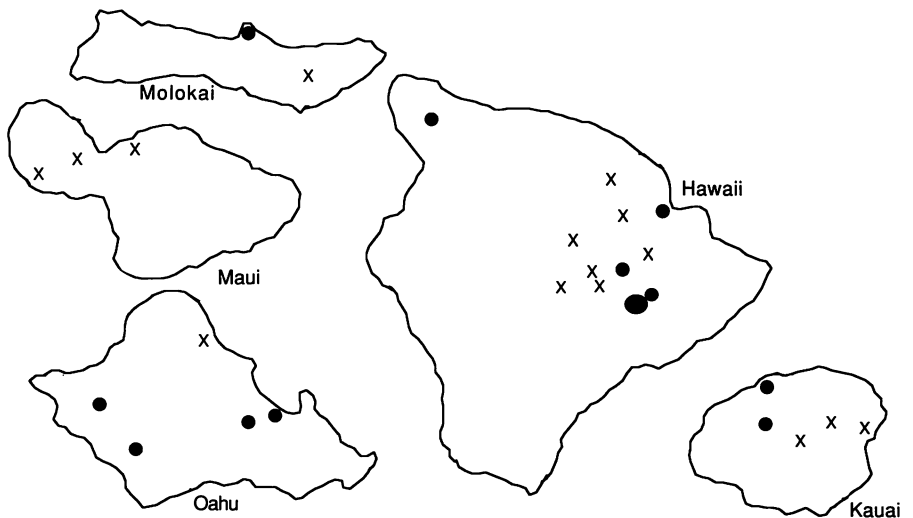
Type species: *Isotoma sensibilis* Tullberg, 1876

This subgenus includes species of *Isotoma* having clavate tenent hairs, fused fifth and sixth abdominal segments, and a tridentate mucro. There is a single Hawaiian species.

Isotoma (Pseudisotoma) sensibilis Tullberg, 1876 (Plate 66)

Ofver. K. Vet. Akad. Forh. 33(5): 36.—Stach, 1947; Christiansen and Bellinger, 1980.

Color blue, most commonly over whole body, with intersegmental membranes, scattered patches, bases of macrochaetae, and furcula unpigmented; antennae usually and legs always paler; dorsum of head usually pale, with pattern varying from median spot to V-shaped markings; posterior segmental margins usually, and mid-dorsal line on body sometimes, darker. Fourth antennal segment with or without apical cone or knob; pin seta simple, subapical sense organ spherical; dorsally with numerous curved, thin-walled setae among the ordinary erect setae. Apical organ of third antennal segment with 2 thick, basally angled sense rods and a much thinner one dorsal to them. First antennal segment ventrally with 8–12 slender, acuminate setae and 2–5 minute blunt setae apically. Labrum with rounded, subequal papillae and 4 obvious rows of ventral ciliations. Maxillary palp trifurcate and 3 or 2 sublobal hairs. Postantennal organ circular to broadly oval, 0.6–1.1 times as long as diameter of nearest eye. Eyes usually 8 + 8, with G and H less than $\frac{1}{2}$ as large as others; rarely G and H are up to $\frac{2}{3}$ size of other eyes, or G is absent. Tibiotarsi with 2-3-3 tenent hairs, varying from truncate to strongly clavate. Unguis with a small inner tooth and strong lateral teeth. Unguiculus with inner tooth strong to weak. Ventral tube with 4 + 4 to 5 + 5 distal lateral setae and 3 + 3 posterior setae.



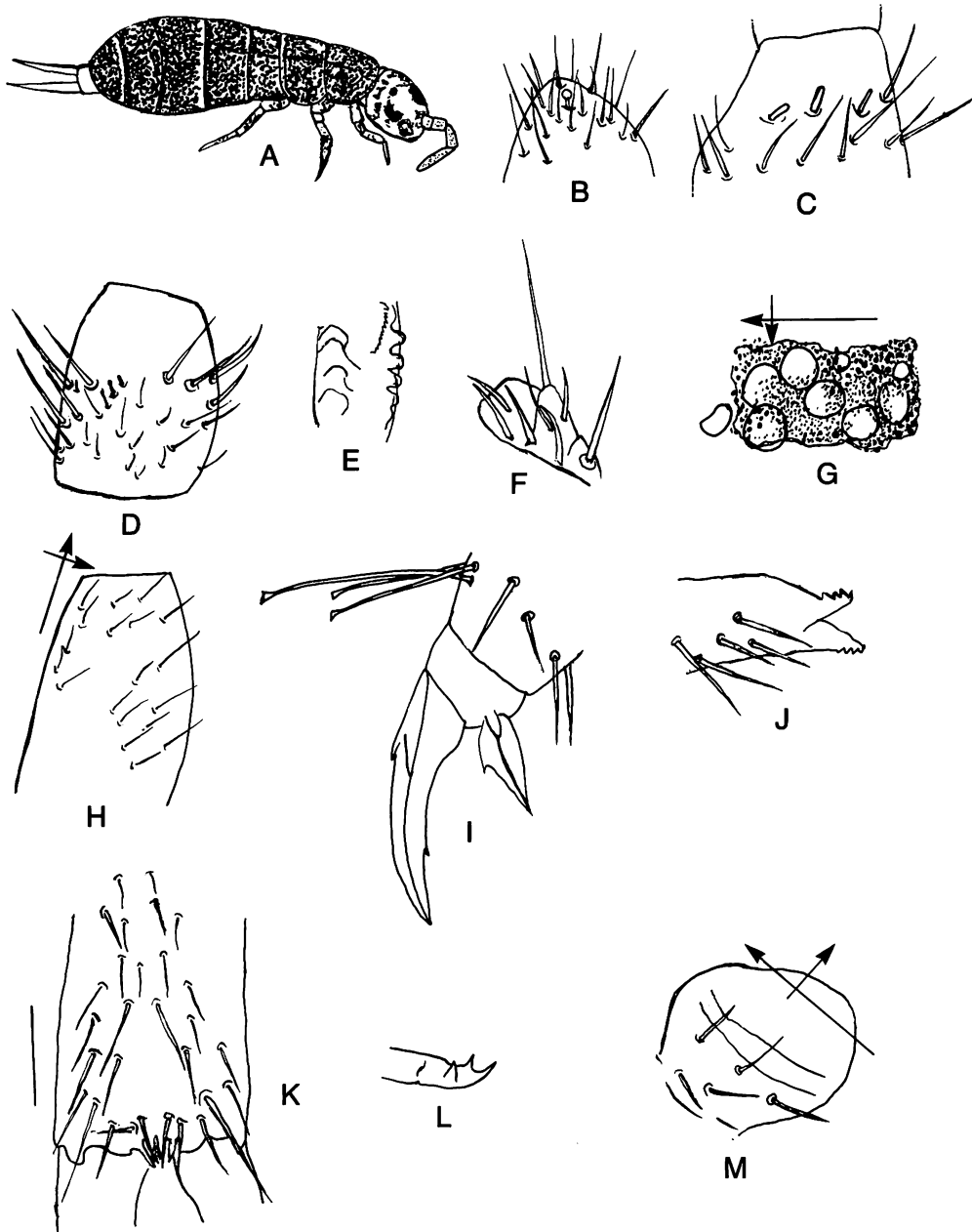


Plate 66—*Isotoma (Pseudisotoma) sensibilis*: **A**, habitus (5208, Kauai); **B**, apex of antenna (6863, Molokai); **C**, apex, third antennal segment (6844, Hawaii); **D**, ventral surface, first antennal segment (4735, Kauai); **E**, labral papillae seen from above and one side (6674, Maui); **F**, maxillary palp (6751, Oahu); **G**, left eyepatch and postantennal organ (4816, Oahu); **H**, ventral cephalic chaetotaxy, left side (5150, Hawaii); **I**, hind foot complex (5281, Kauai); **J**, tenaculum (6844, Hawaii); **K**, apex of venter of manubrium (4816, Oahu); **L**, mucro (same); **M**, ventral tube seen from below with setae of right side shown (6751, Oahu).

Tenaculum with 6–10 setae. Dens 1.9–2.4 times as long as manubrium. Mucro tridentate, with apical teeth the largest and basal teeth not at the same level. Longest abdominal setae unilaterally serrate and 2.9–4.1 times as long as inner edge of unguis. Maximum length 2 mm.

Remarks: The Hawaiian material shows some differences from nearctic forms. Most specimens have two apical manubrial teeth per side instead of one. The post-antennal organ is smaller relative to the nearest eye, and the number of blunt setae on the venter of the first antennal segment is greater (a maximum of two have been seen in nearctic specimens). At present we do not believe these differences justify taxonomic separation of the Hawaiian populations.

Ecology: Found principally on moss (60% of all collections), at middle and higher elevations, rarely below 2000 ft. Also found in litter, grass, and rotten wood.

Records: Hawaii: 4726, 4880, 4881, 4887, 4888, 4903, 4904, 4905, 4948, 4959, 4960, 4962, 4963, 4966, 4976, 4980, 4981, 4985, 4988, 4991, 4997, 4999, 5000, 5003, 5005, 5006, 5010, 5014, 5015, 5016, 5017, 5018, 5021, 5026, 5043, 5050, 5051, 5053, 5054, 5063, 5064, 5066, 5068, 5118, 5119, 5150, 5153, 5244, 5246, 5264, 5316, 5337, 5342, 5671, 5693, 6533, 6844, 6851, 6852, 6892. Maui: 5174, 5263, 6674. Molokai: 5121, 6382, 6863. Oahu: 4801, 4816, 5234, 5243, 5534, 6751, 6754, 6758, 6760, 6765. Kauai: 4735, 4737, 4744, 5203, 5208, 5210, 5280, 5281, 5282.

Subgenus **HALISOTOMA** Bagnall, 1949

Type species: *Isotoma maritima* Tullberg, 1871

Members of this subgenus have a modified seta on the mid tibiotarsus; they are found in the marine littoral zone. There is a single Hawaiian species.

Isotoma (Halisotoma) kainui Christiansen and Bellinger, **new species** (Plate 67)

Color pale gray to white; pigment in the form of distinct black granules. Fourth antennal segment with a clear apical knob, a small rodlike subapical organ, and 4 clear blunt setae. Apical organ of third antennal segment of 2 curved pegs in separate but contiguous pits; guard setae not clearly differentiated from neighboring setae. Venter of first antennal segment with many microsetae, not clearly distinguished from others. Labrum with weak lobes and 2–3 rows of distal ventral cilia-tions. Prelabral setae 4-5-5-4. Maxillary palp trifurcate and 3 sublobal hairs. Post-antennal organ broadly oval and 1.0–1.5 times as long as diameter of nearest eye. Eyepatches poorly delimited. Eyes 8 + 8; eye D 1.5–1.9 times diameter of eye G. Lateral surface of mid tibiotarsus with an apically expanded, serrate, thick seta. Tenent hair thick on hind tibiotarsus and very slender on other legs. Unguis with very small lateral teeth and no inner tooth. Unguiculus without teeth. Ventral tube with 2 + 2 distolateral setae. Tenaculum with 2–5 setae. Dens 2.1 to 2.4 times as long as manubrium. Mucro tridentate, with basal tooth displaced laterally. Fifth

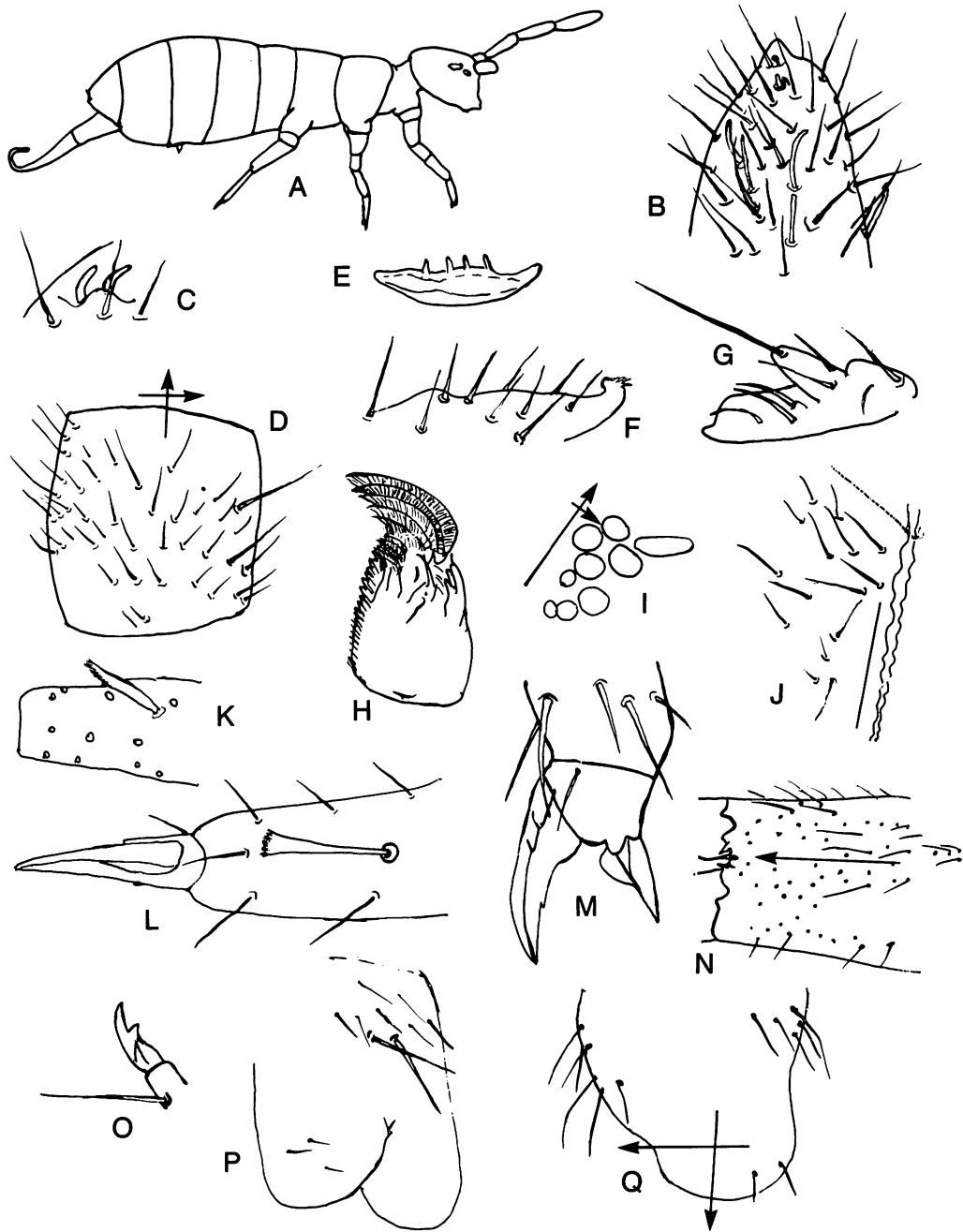


Plate 67—*Isotoma (Halisotoma) kainui* (all figures except F of type specimens): A, habitus; B, apex of antenna; C, apical organ of third antennal segment; D, ventral surface of first antennal segment; E, labral papillae seen from front; F, labral papillae seen from side (5193, Kauai); G, maxillary palp; H, maxilla; I, right eyepatch and postantennal organ; J, ventral apical cephalic setae, right side; K, differentiated seta of mid leg seen from side; L, differentiated seta and unguis seen from front; M, hind foot complex; N, venter of manubrium; O, mucro; P, posterior face of ventral tube; Q, lateral view of ventral tube.

and sixth abdominal segments sharply to weakly separated. All body setae smooth and acuminate; longest posterior setae 1.7–2.4 times as long as inner edge of hind unguis. Maximum length 1.5 mm.

Remarks: This species differs from the European *I. maritima* Tullberg, 1871 in the enlarged tenent hair of the hind tibiotarsus. It differs from *I. marisca* Christiansen and Bellinger, 1988 by the enlarged apex of the ciliate tibiotarsal seta and the blunt labral papillae. From *I. pacifica* Yosii, 1971a, it differs in the structure of the maxilla and in having only one enlarged tibiotarsal seta.

Derivatio nominis: Hawaiian, high tide.

Ecology: Found in littoral debris above high-tide mark.

Type locality: Holotype and 4 paratypes, Hawaii, Whittington Beach Park, between Honuapo and Punaluu, I-26-1982, drift debris, berlese funnel, KC (5146).

Additional record: Kauai: 5193.

Subgenus **DESORIA** Nicolet, 1841

Type species: *D. saltans* Nicolet, 1841

Members of this subgenus lack clavate tenent hairs, modified tibiotarsal setae, and apical manubrial spines. There are four Hawaiian species: *ahiehie*, *bendixenae*, *notabilis*, and *trispinata*.

Isotoma (Desoria) ahiehie Christiansen and Bellinger, **new species** (Plate 68)

Color pale to medium gray, rarely white; pigment in the form of discrete black granules. Fourth antennal segment with weakly developed apical knob, a simple pin seta, a large (about 11 μm in diameter) protruding spherical subapical organ and 6 clearly distinguished thick blunt setae. Apical organ of third antennal segment with 2 slightly curved blunt setae with 2 short lateral guard setae and 1–2 differentiated sensilla lateroventrally. First antennal segment with 1–2 short differentiated setae in apical ventral row. Labrum with 4 papillae; from above, the lateral pair are pointed and distinctly longer than the blunt median pair, while from the side all are seen to project upward, with the outer pair apically blunt and the inner pair curved and clawlike; no ventral ciliations. Prelabral setae 4-5-5-4, with the third row often weakly developed. Maxillary palp not clearly seen but apparently trilobed and with 3 sublobal hairs. Postantennal organ broadly oval, 3–3.6 times as long as diameter of nearest eye. Eyepatches usually clear; eyes 4 + 4 (rarely 3 + 3). Tenent hair short and acuminate. Unguis and unguiculus without teeth. Ventral tube with 2 + 2 to 3 + 3 distal lateral, 3 + 3 frontal, and 2 + 2 posterior setae. Tenaculum with 4 + 4 teeth and 2–3 setae. Mucro tridentate, with basal tooth lateral and outstanding. Fifth and sixth abdominal segments separated only by a weakly demarcated nonsetaceous area. Longest posterior body setae acuminate, unilaterally serrate, and 2.5–3.1 times as long as inner edge of hind unguis. Maximum length 1 mm.

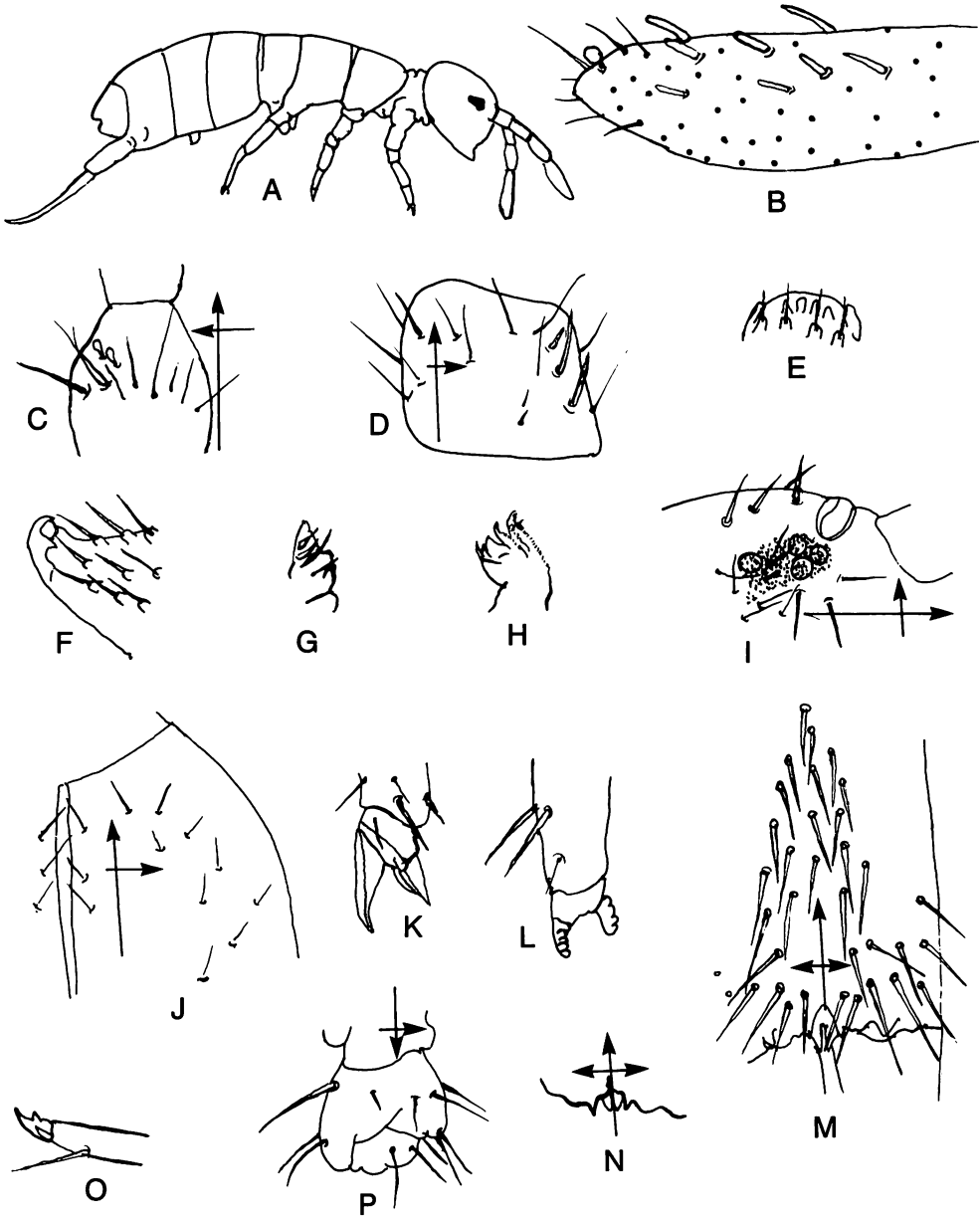
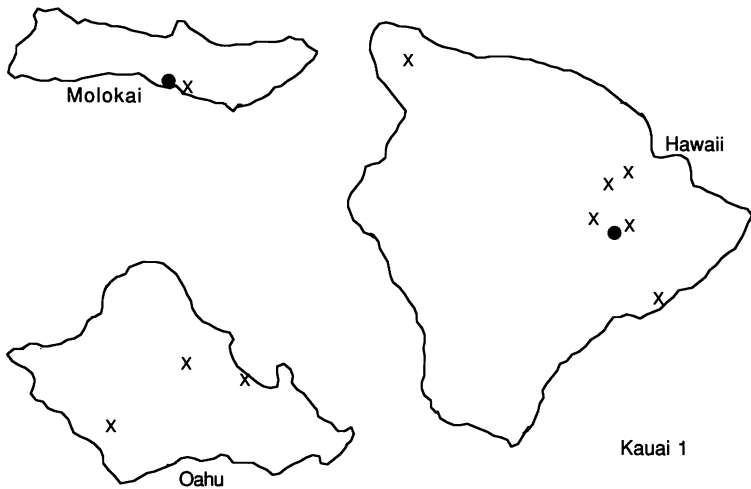


Plate 68—*Isotoma (Desoria) ahiehie*: **A**, habitus (type specimen); **B**, apex of antenna showing differentiated setae but other setae omitted (4904, Hawaii); **C**, apex of third antennal segment (type specimen); **D**, venter of first antennal segment (4796, Oahu); **E**, labral papillae (4904, Hawaii); **F**, labral papillae and prelabral setae seen from side (4904, Hawaii); **G**, maxillary palp (6759, Oahu); **H**, maxilla (4796, Oahu); **I**, left eyepatch and postantennal organ (same); **J**, ventral apical cephalic setae (4904, Hawaii); **K**, hind foot complex (4931, Hawaii); **L**, tenaculum (type specimen); **M**, apex of ventral surface of manubrium (4904, Hawaii); **N**, variant of median manubrial process (6759, Oahu); **O**, mucro and apex of dens (4904, Hawaii); **P**, ventral tube seen from side (type specimen).



Remarks: This species is generally similar to *I. notabilis*, but differs in a number of respects; the spherical subapical antennal organ is the most conspicuous difference, but the number of antennal blunt sensilla and other characters distinguish them. In Hawaii *I. ahiehie* is generally darker than *I. notabilis*. *Isotoma dichchaeta* Yosii, 1969 from Japan is similar in some respects, including the ventral tube setae, but lacks the sensilla of the fourth antennal segment.

Derivatio nominis: Hawaiian, gray.

Ecology: Found in litter and moss in forest land. Except for the coastal collection from Kauai, all material comes from over 3000 ft. and mostly above 3500 ft.

Type locality: Holotype and 6 paratypes, Oahu, summit swamp, Mt. Kaala, X-4-1966, moss, PB (4816).

Additional records: Hawaii: 4870, 4904, 4921, 4931, 4932, 4934, 4947, 4987, 5068, 5119, 5680. Molokai: 5709, 5713, 5731. Oahu: 4796, 6738, 6759. Kauai: 5202.

***Isotoma (Desoria) bendixenae* Christiansen and Bellinger, new species (Plate 69)**

Color medium to dark blue with scattered pale spots; intersegmental membranes and furcula pale. Fourth antennal segment without apical knob; subapical organ rodlike; pin seta simple; blunt setae apparently 3-4, small and difficult to distinguish. Apical organ of third antennal segment of 2 thick blunt rods, basally bent; guard setae undifferentiated. First antennal segment with 1 blunt seta laterally in apical ventral row. Labral papillae gable-shaped with toothed peaks. Labrum with about 8 rows of ventral ciliations. Prelabral setae 4-5-5-4. Maxillary outer lobe bifurcate, with 3 sublobal hairs. Postantennal organ broadly oval and 1.3-1.4 times as long as eye A. Eyepatches heavily pigmented. Eye F 1.4-1.8 times as large as eye G. Tenent hair long, slender, and acuminate. Unguis with 2 inner teeth and prominent lateral teeth. Unguiculus with small corner tooth. Tenaculum with 4-8 setae. Ventral tube with 3 + 3 distal lateral setae; anterior and posterior

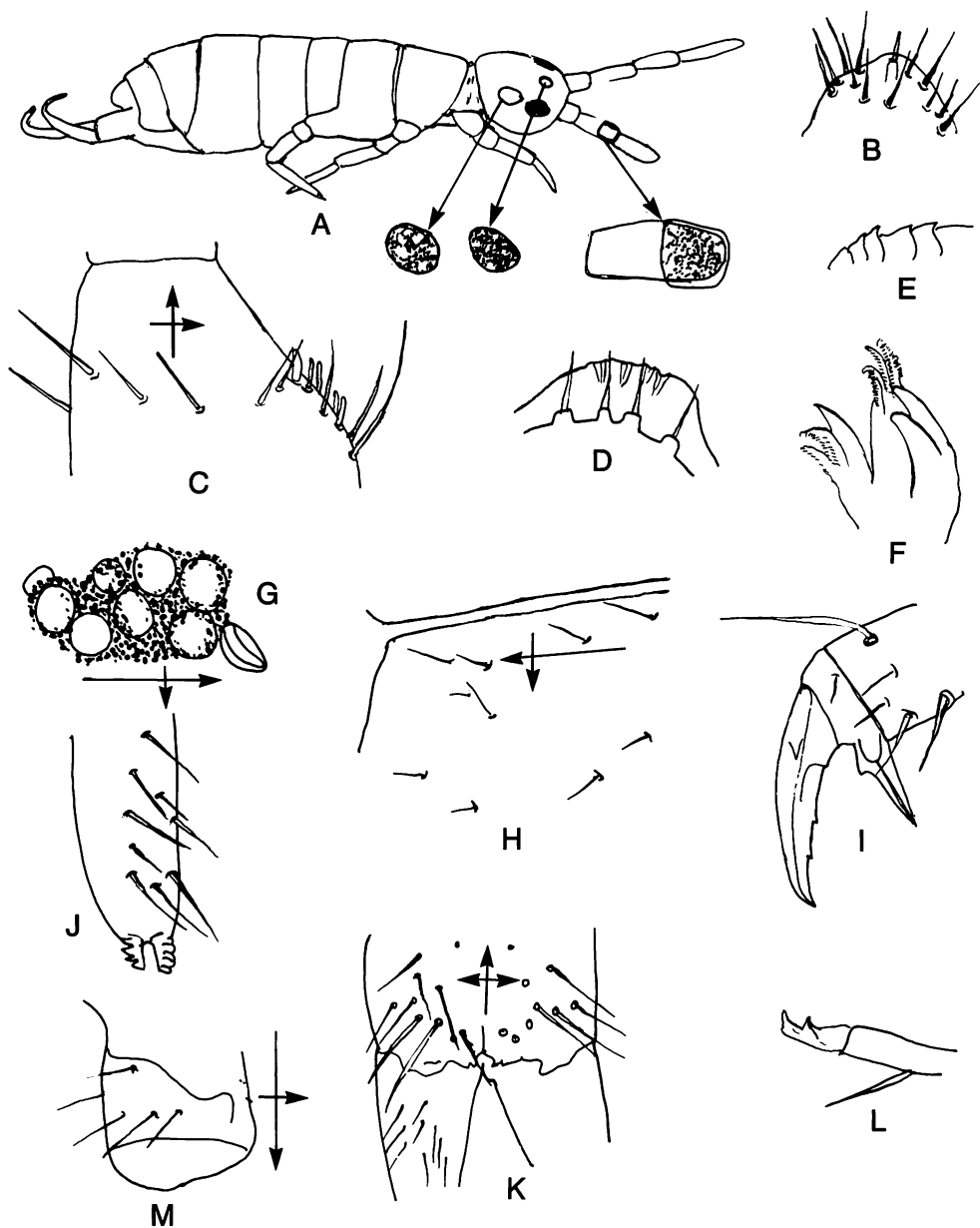


Plate 69—*Isotoma (Desoria) bendixenae* (all figures except M of type specimens): A, habitus, inserts showing pigment distribution seen on head and antennae; B, apex of antenna; C, apex of third antennal segment; D, labrum seen from above; E, labrum seen from an angle; F, maxilla; G, right eyepatch and postantennal organ; H, ventral apical cephalic setae, right side; I, hind foot complex; J, tenaculum; K, apex of ventral surface of manubrium; L, mucro and apex of dens; M, ventral tube seen from side, posterior setae not visible (4844, Oahu).

setae not clearly seen but apparently with only 2 posterior setae and anterior with 2 + 2 small spines and no spinelike setae. Dens 1.92–2.1 times as long as manubrium. Mucro tridentate, with basal tooth lateral and smaller than others; an additional minute apical tooth is sometimes present; a small basal seta on outer side. Fifth and sixth abdominal segments sharply demarcated. Longest posterior abdominal setae sparsely serrate over apical $\frac{1}{2}$ of length and 1.6–2.3 times as long as inner edge of hind unguis. Maximum length 1.6 mm.

Remarks: The mucronal seta and number of sublobal hairs are questionable, since they have not been seen clearly on any specimen. *Isotoma viridis* Bourlet, 1839 and related species with three mucronal teeth and two inner unguis teeth belong to *Isotoma* s.str. and have ventral manubrial spines, lacking in *I. bendixenae*. Other species with this combination of characters cannot be assigned to a subgenus on the basis of their descriptions, but differ from *I. bendixenae* in having the postantennal organ no larger than the nearest eye, or in lacking an unguicular tooth. *Isotoma pallidafasciata* Salmon, 1941 is similar in most described characters, but has the unguicular and basal mucronal teeth differently located.

Derivatio nominis: Named after Kae Bendixen, whose assistance was essential for this project.

Ecology: Known only from three specimens from forest litter.

Type locality: Holotype and 1 paratype, Oahu, Kaupo, base, XII-29-1968, Lee (4837).

Additional record: Oahu: 4844.

***Isotoma (Desoria) notabilis* Schaffer, 1896 (Plate 70)**

Mitt. Naturhist. Mus. Hamburg 13:187.—Stach, 1947.—Christiansen and Belling, 1980.

Color white to pale gray. Fourth antennal segment without apical knob; with a simple pin seta and rodlike subapical organ, 4 dorsal blunt setae, and 2 additional differentiated acuminate setae. Apical organ of third antennal segment with 2 basally bent pegs in a single shallow groove, and 2 more small differentiated setae, 1 blunt and 1 acuminate, more ventrally on outer side. First antennal segment with 1–2 short differentiated setae in apical ventral row. Labrum with 4 similar triangular papillae, without ventral ciliations. Prelabral setae 4-5-5-4. Maxillary palp difficult to see, trifurcate, with 3–4 sublocal hairs. Postantennal organ broadly oval, 3.5–4 times as long as diameter of largest eye. Eyepatch generally with weak pigment or none; eyes usually 3 + 3, sometimes not clear. Unguis and unguiculus without teeth. Tenent hair short and acuminate, ventral tube with 3 + 3 anterior, 3 + 3 distal lateral, and 3 posterior basal setae. Tenaculum with 2 setae. Dens 2–3 times as long as manubrium. Mucro tridentate, with basal tooth lateral and outstanding. Longest posterior setae coarsely unilaterally serrate and 2.6–3.5 times as long as inner edge of unguis. Maximum length 0.9 mm.

Remarks: The fourth antennal segment is described as having five blunt setae and the prelaboral setae as 4 + 4 + 4 in *The Collembola of North America*; these are the result of errors and in these respects the new description applies to nearctic mate-

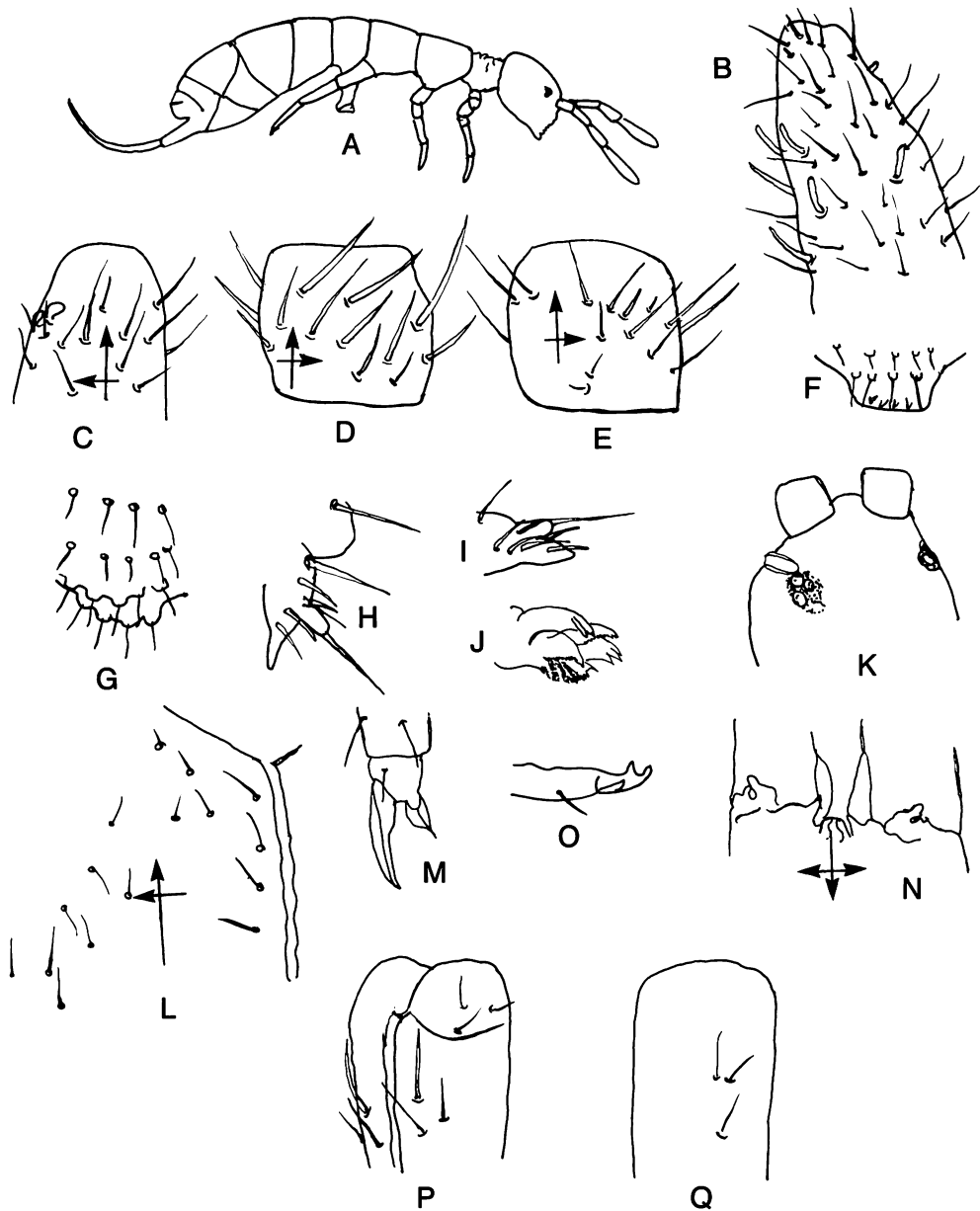
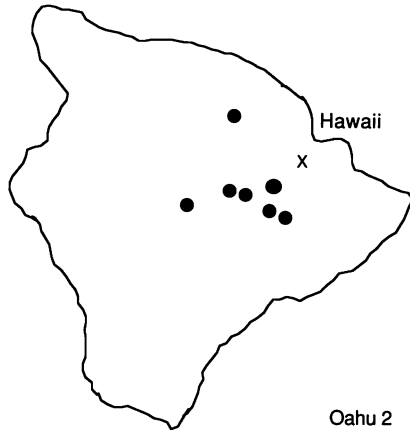


Plate 70—*Isotoma (Desoria) notabilis* (all figures of specimens from Hawaii): **A**, habitus (6839); **B**, apex of antenna (5322); **C**, apex of third antennal segment (same specimen); **D**, dorsal surface, first antennal segment (5341); **E**, ventral surface of first antennal segment (same); **F**, labrum seen from above (5342); **G**, prelabral setae (same); **H**, maxillary palp (5338); **I**, maxillary palp (4857); **J**, maxilla (5342); **K**, eyes and postantennal organ (4865); **L**, ventral apical cephalic chaetotaxy, right side (5342); **M**, hind foot complex (5318); **N**, manubrial thickening (5059); **O**, mucro (5342); **P**, anterior face of ventral tube (4868); **Q**, posterior face of ventral tube (same).



rial as well. However, the Hawaiian specimens differ in the relative size of the post-antennal organ and eyes, in the relative length of the posterior setae, possibly in eye number, and are generally paler in color. It is possible that the Hawaiian populations are specifically distinct.

Ecology: Found in litter, mostly in forested areas above 2000 ft.

Records: Hawaii: 4857, 4863, 4865, 4868, 4877, 4895, 4932, 5059, 5315, 5317, 5318, 5321, 5322, 5324, 5327, 5338, 5339, 5341, 5342, 6839, 6887, 6898. Oahu: 6755, 6763.

***Isotoma (Desoria) trispinata* MacGillivray, 1896 (Plate 71)**

Can. Entomol. 28:50-51.—Christiansen and Bellinger, 1980.

Color normally blue or purplish blue, with intersegmental membranes, legs, and furcula paler; head usually with a dark V-shaped mark. Fourth antennal segment with a simple pin seta, a narrow peglike subapical organ, and 4 dorsal blunt setae that are only weakly differentiated from thicker, short acuminate setae. Apical organ of third antennal segment with 2 straight or weakly bent sense pegs. First antennal segment with a single small differentiated seta on outer side in apical row. Labrum with large lateral lobes and 4 similar microsetae between them, without ventral ciliations. Maxillary palp lobe trifurcate, with 4 sublobal hairs. Postantennal organ broadly oval, 1.25-1.5 times as long as diameter of nearest eye. Eye-patches dark and well developed; eyes 8 + 8, with G from $\frac{3}{4}$ size of eye D to subequal to it. Tenent hair short and acuminate. Unguis with small lateral teeth but no inner tooth. Unguiculus untoothed. Ventral tube with 3 + 3 anterior and 3 + 3 distal lateral setae. Tenaculum with 5-6 setae. Dens 2-2.3 times as long as manubrium. Mucro tridentate, with basal tooth lateral and below level of others. Fifth and sixth abdominal segments weakly separated. All body setae acuminate and smooth; longest body setae 1.3-1.8 times as long as inner edge of unguis. Maximum length 1.3 mm.

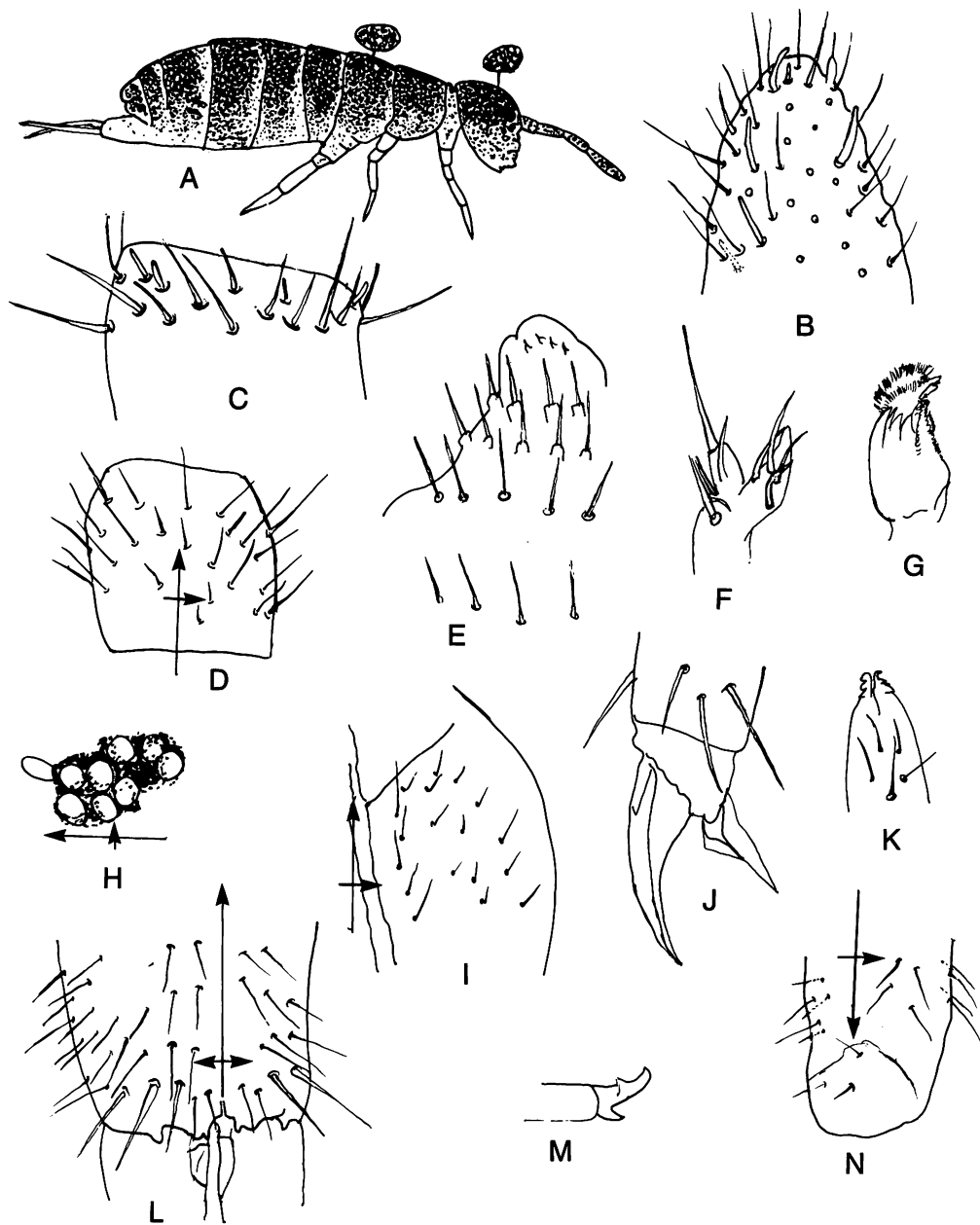
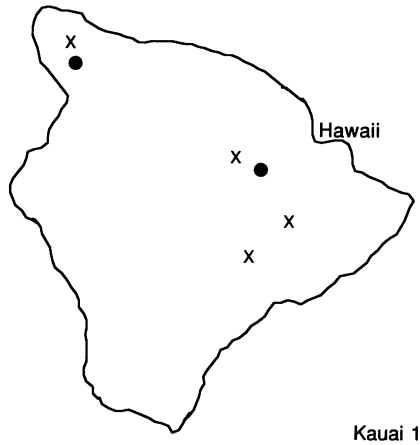


Plate 71—*Isotoma (Desoria) trispinata* (all figures of specimens from Hawaii): A, habitus, with inserts showing pigment distribution (5303); B, apex of antenna (same); C, apex of third antennal segment (same); D, ventral surface, first antennal segment (same); E, labrum and prelabral setae (same); F, maxillary palp (same); G, maxilla (4939); H, right eyepatch and postantennal organ (5303); I, ventral apical cephalic setae, left side (same); J, hind foot complex (same); K, tenaculum (same); L, apex of ventral surface of manubrium (same); M, mucro seen from above (same); N, ventral tube seen from side (same).



Remarks: The Hawaiian specimens are similar to those from the mainland United States except that the body setae tend to be a bit shorter. The two specimens from Kauai have a much larger postantennal organ than those from Hawaii and may represent a separate taxon.

Ecology: Found mainly at middle elevations, in grassland and forest litter.

Records: Hawaii: 4725, 4870, 4939, 5303, 5338, 5650, 5651, 5652, 5659, 6814, 6880. Kauai: 5117.

Isotoma perkinsi Carpenter, 1904 (Plate 72)
Fauna Hawaiiensis 3:302.

“Length 1 mm. Antennae 1.5 times as long as head; relative length of segments as 3:6:4:5. Eight ocelli on each side. Each foot with a tenent hair, upper claw evenly curved and toothless, lower claw with a small tooth. Spring evidently borne on the fourth abdominal segment, elongate; dens three times as long as manubrium; mucro with evenly curved ventral edge, two rather prominent teeth and a small accessory tooth. Color apparently purplish-yellow with the antennae dark, the legs and spring pale.”

Remarks: Carpenter (1904) noted that his description was based on a specimen that had dried up, obscuring some details; it is possible that it is inaccurate in some respects (e.g., the apparent position of the furcula). If it is otherwise correct, the combination of a clavate tenent hair and separate fifth and sixth abdominal segments distinguishes the species from all Hawaiian *Isotoma* species we have seen.

Type locality: Kauai, Koholuamano.

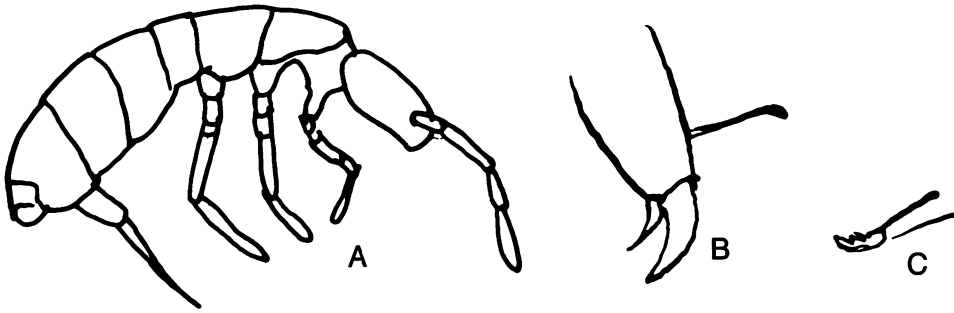


Plate 72—*Isotoma perkinsi* (all figures after Carpenter [1904]): A, habitus; B, hind foot complex; C, mucro.

Family ENTOMOBRYIDAE

This family includes all Hawaiian members of the Arthropleona having a prothorax reduced and without setae, and with scales or multilaterally ciliate setae on all trunk segments. Many species have the fourth abdominal segment much longer than the third. The family is also characterized by the trochanteral organ, a series of short differentiated setae on the inner surface of the trochanter. The distribution of the large, multilaterally ciliate or striate macrochaetae (Fig. 51) is of great taxonomic importance. Except where otherwise indicated we have followed the system of Szeptycki (1979) in describing this distribution (see Figs. 52, 53). Scales, when present, are diagnostic, because they are only found in this family. Almost all species lack a postantennal organ. The ventral surface of the head has several features of taxonomic value, particularly in the Entomobryinae (Figs. 54–56). The unguis and unguiculus are always well developed, and the former has a characteristic lamellar structure (Fig. 57) in most subfamilies. The furcula is always well developed; the form of the dens and mucro is characteristic in the different subfamilies. Sexual dimorphism is absent or slight.

There are five subfamilies in the Hawaiian region, but only one of these has more than a single Hawaiian species. The subfamilies are very distinct and are often accorded family status. Some of their salient features are shown in Table 17.

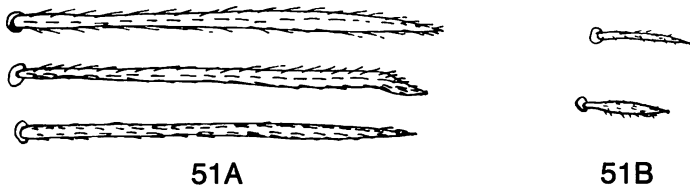


Figure 51—Entomobryid seta types: A, macrochaetae, type 1; B, microchaetae types.

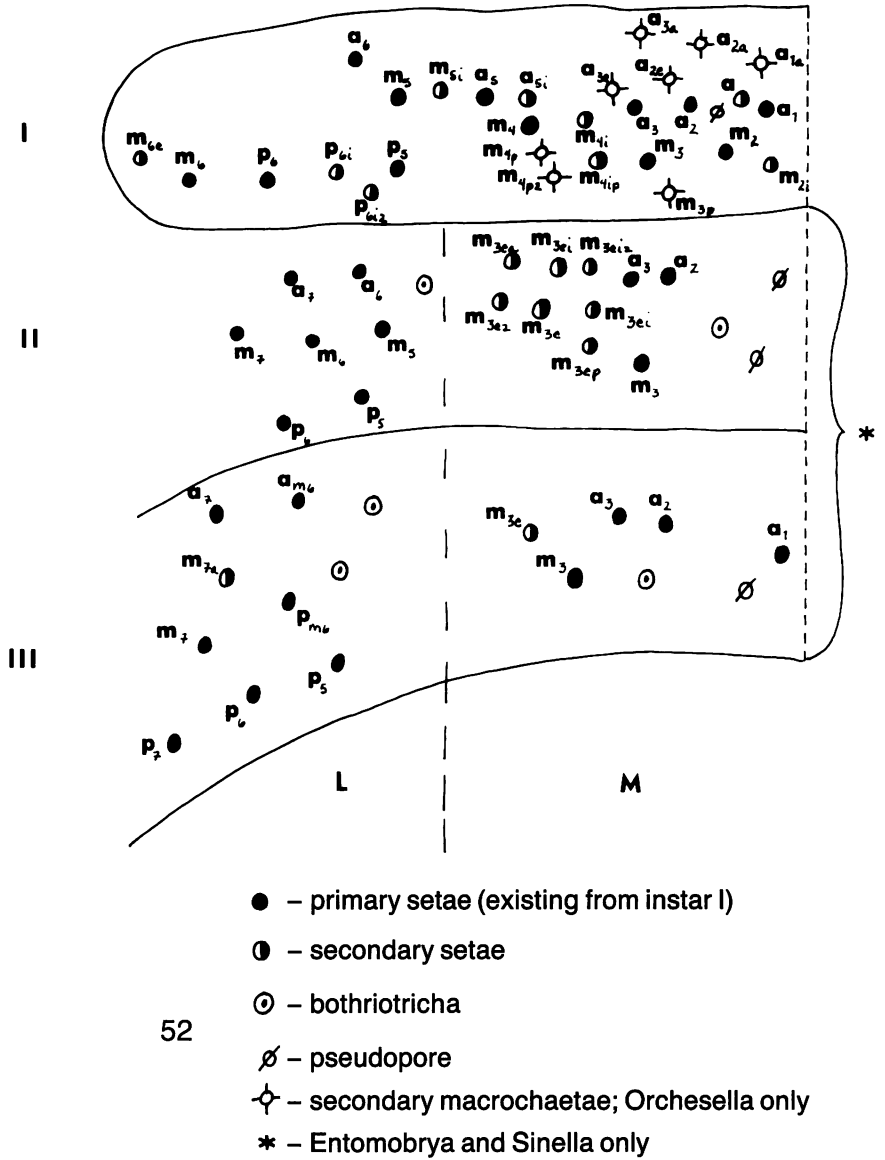


Figure 52—Abdominal dorsal seta designation for Entomobryidae in general (after Szeptycki).

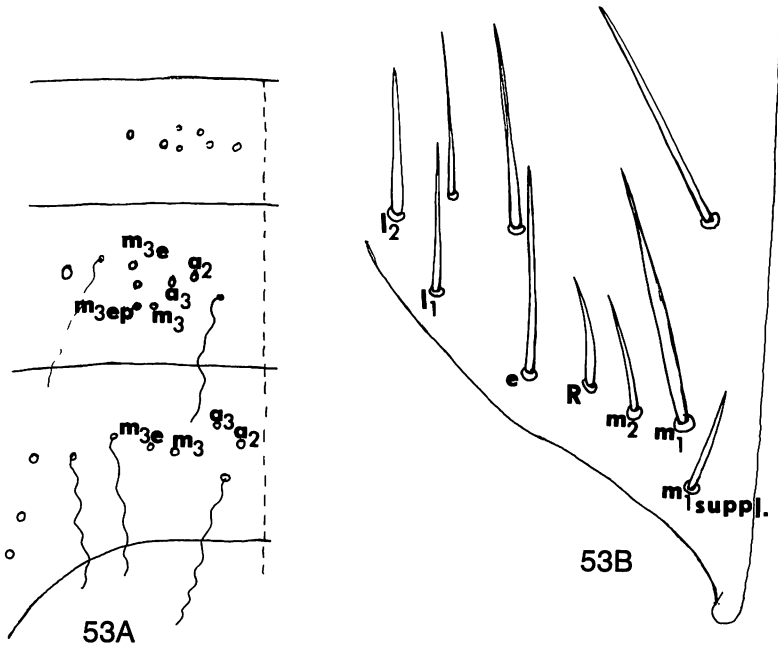


Figure 53—Typical chaetotaxy in Entomobryini: A, dorsal abdominal segments; B, labial triangle.

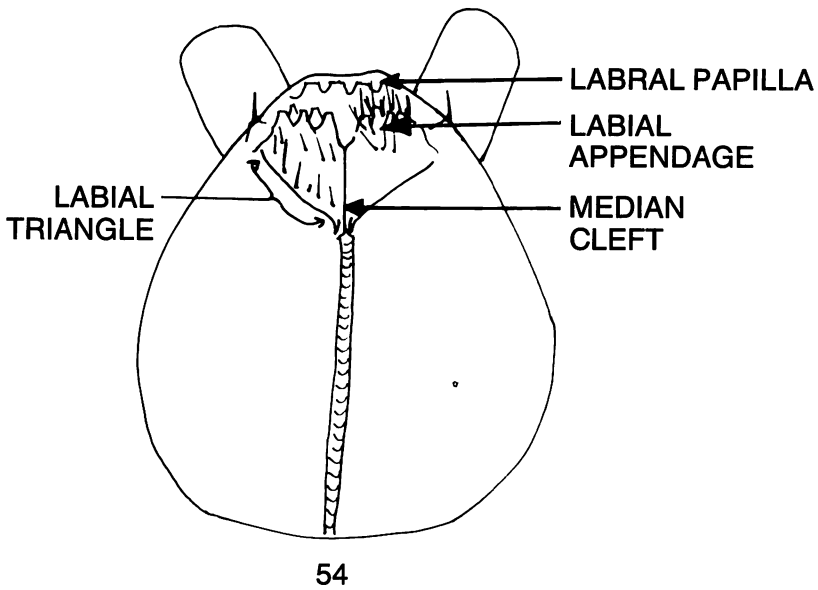


Figure 54—Venter of head in Entomobryinae.



Figure 55—Labral papillae in *Sinella* and *Entomobrya*.

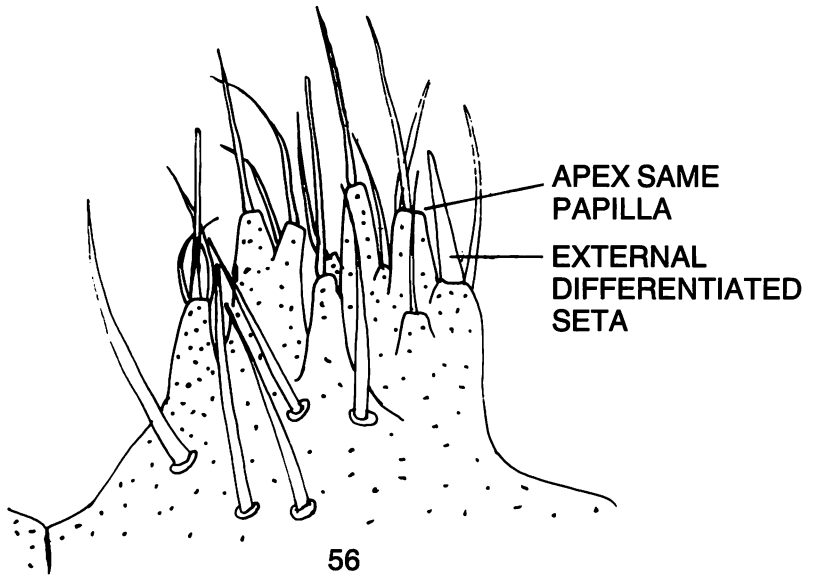


Figure 56—Labial appendage in Entomobryini.

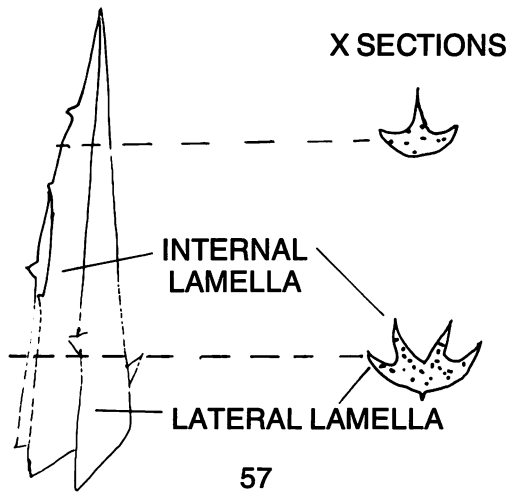


Figure 57—Unguis structure typical of Entomobryidae.

Table 17. Characteristics of Hawaiian Subfamilies of Entomobryidae

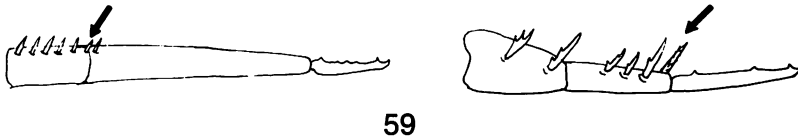
SUBFAMILY	SCALES	MAXIMUM EYE NO.	ADULT POSTANTENNAL ORGAN	DENTAL SPINES	MUCRO
Entomobryinae	+ or -	8	-	+ or -	short, 2 teeth
Cyphoderinae	+	0	-	-	elongate
Paronellinae	-	8	-	-	short, 2-4 teeth
Oncopodurinae	+	4	+	+	elongate
Tomocerinae	+	6	-	+	elongate

KEY TO HAWAIIAN GENERA OF ENTOMOBRYIDAE

- 1. Dentes smooth (Fig. 58B)..... 2
- Dentes crenulate (Fig. 58A) (subfamily Entomobryinae)..... 5



- 2(1). Dental spines absent..... 3
- Dental spines present (Fig. 59)..... 4



- 3(2). Mucro at least 1/3 as long as dens (subfamily Cyphoderinae)..... **Cyphoderus**
- Mucro less than 1/4 as long as dens (subfamily Paronellinae)..... **Salina**
- 4(2). Small, 0.6 mm or less, 4 + 4 eyes (subfamily Oncopodurinae)..... **Harlomillsia**
- Large, adults 3-4 mm long, 6 + 6 eyes (subfamily Tomocerinae)..... **Tomocerus**
- 5(1). Body with scales..... 6
- Body without scales..... 11
- 6(5). Mucro falcate (Fig. 60A)..... 7
- Mucro bidentate (Fig. 60B)..... 8



- 7(6). With eyes..... **Seira**
- Without eyes..... **Hawinella**
- 8(6). Dentes with scales on ventral surface..... 9
- Dentes without scales on ventral surface..... **Willowsia**

- 9(8). Fourth abdominal segment at midline more than twice as long as third. 10
 Fourth abdominal segment at midline less than twice as long as third.
 **Heteromurus**
- 10(9). Eyes 8 + 8. **Lepidocyrtus**
 Eyes 6 + 6 or fewer. **Pseudosinella**
- 11(5). Eyes 4 + 4 or fewer. **Sinella**
 Eyes 8 + 8. 12
- 12(11). Fourth abdominal segment at midline less than 3 times as long as third.
 **Orchesellides**
 Fourth abdominal segment at midline more than 3 times as long as third.
 **Entomobrya**

Subfamily ENTOMOBRYINAE

This subfamily includes the great majority of the Hawaiian entomobryids. It is distinguished from all other subfamilies by the dorsally crenulate dentes and the short hooklike or bidentate mucro. The chaetotaxy of the labium, head, and trunk as well as the structure of the labrum, foot, and mucro, and the eye number are useful for identifying specimens of this subfamily. Many species are brightly colored and have distinct patterns, but this feature must be used with caution because there is much intraspecific variation. Observation of the body chaetotaxy requires well-compressed dorsoventral-mounted specimens. Dark specimens should be sufficiently cleared that the pigment does not obscure the setal bases. The cephalic macrochaetae are unstable until after the fourth instar and should not be relied upon before that stage. We assign the Hawaiian species to nine genera, which are easily recognized.

Genus **ORCHESELLIDES** Bonet, 1930

Type species: *O. boraoui* Bonet, 1930

This genus is distinguished from most other Entomobryidae by the relatively short fourth abdominal segment, the subdivided first antennal segment, and the absence of scales. It differs from the very similar genus *Corynothrix* Tullberg, 1876 in having a pair of basal inner unguis teeth instead of a single such tooth. There is a single Hawaiian species, *O. sinensis*.

Orchesellides sinensis (Denis, 1929) (Plate 73)

Boll. Lab. Zool. Gen. Agric. Portici 22:318 (*Orchesella*).—Mari Mutt, 1986a.

Background color pale yellow; eyepatches dark; pale violet pigment forming interantennal arrow, anterior and lateral marginal marking and weak posterolateral spots on mesothorax, fine median stripes and irregular transverse markings on metathorax and first abdominal segment, solid transverse bands on second, third, and fifth abdominal segments; a fine median and broad lateral stripes on fourth abdominal segment; sixth abdominal segment almost all violet dorsally. Head

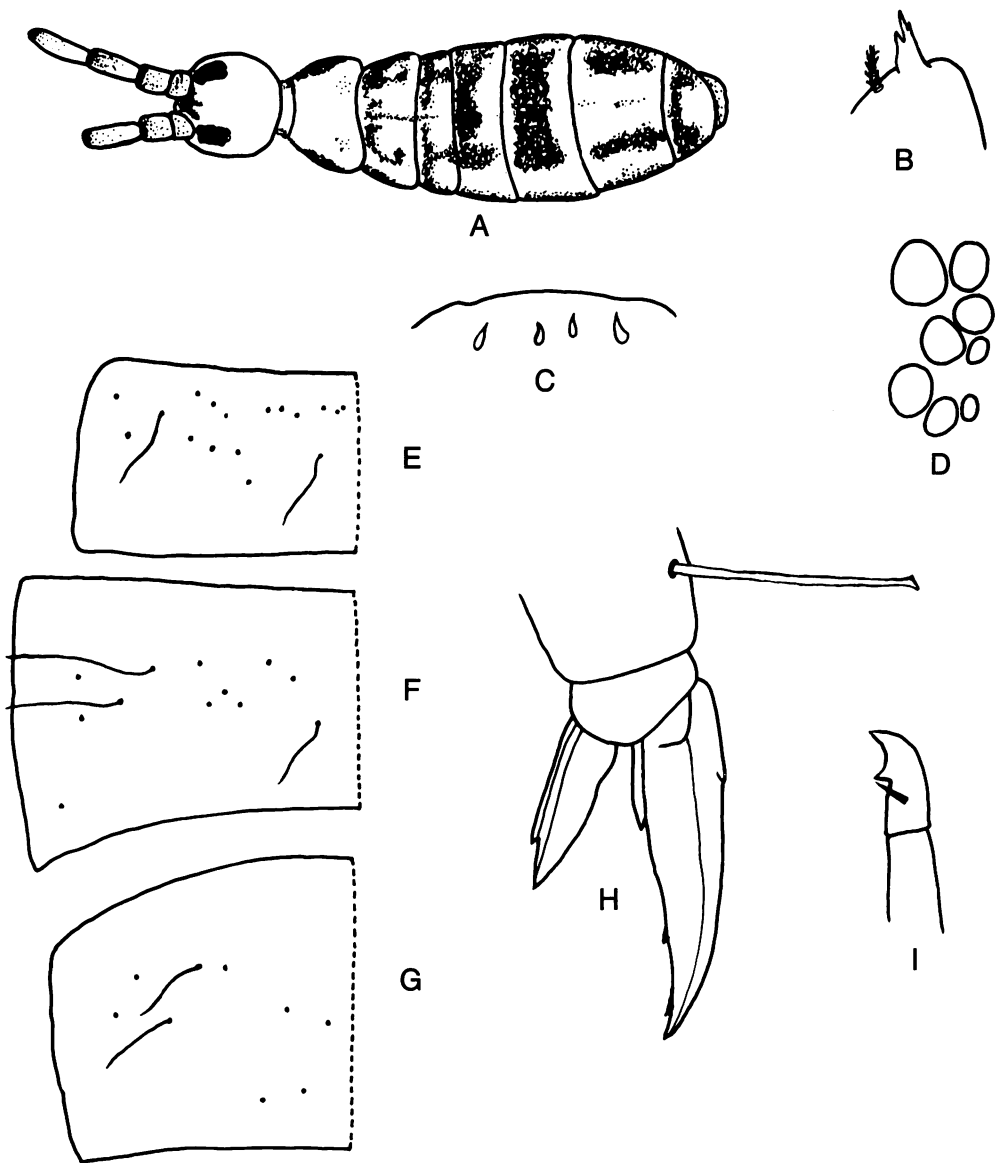


Plate 73—*Orchesellides sinensis* (all Hawaiian specimens from Mauna Loa): **A**, pattern (5345, Hawaii); **B**, apex of antenna (same); **C**, labral papillae (after Mari Mutt); **D**, left eyepatch (5345, Hawaii); **E-G**, dorsal chaetotaxy, left side (after Mari Mutt): **E**, second abdominal segment; **F**, third abdominal segment; **G**, fourth abdominal segment; **H**, hind foot complex (5345, Hawaii); **I**, mucro (after Mari Mutt).

almost circular in dorsal view. Fourth antennal segment pin seta with 2 apical and 1 subapical microsetae (type D [Christiansen and Bellinger 1980–1981:fig. 645]); segment without apical papilla or clearly differentiated blunt setae. Labral papillae are rounded semicircular, flat projections, looking like spines in dorsal view. Prelabral setae all smooth. Labial triangle setae all ciliate; r about $\frac{1}{3}$ as long as others. Eyes 8 + 8; G and H about half as large as F. Trochanteral organ with about 10 smooth setae. Tibiotarsi with 4–5 thick ciliate setae on internal surface, only weakly differentiated from other setae; all setae ciliate except for last ventral seta on third tibiotarsus; tenent hair moderately clavate. Unguis with 1 outer and 2 lateral basal teeth and 4 inner teeth, all small. Unguiculus acuminate, rounded on inner margin, and with small external tooth; slightly more than half length of inner edge of unguis on fore foot and increasing in relative length on posterior feet. Ventral tube with 14–18 setae in each distolateral field, about half ciliate and half smooth, and about 20 subequal ciliate setae on posterior face. Basal mucronal tooth distinctly shorter than apical tooth, with basal spine just attaining its apex. Small common body setae (type 5) not expanded, coarsely ciliate except for extreme base and one side. Maximum length 1.4 mm.

Remarks: Only two collections have been made. It remains to be seen whether this Asiatic species has been established in the Islands.

Records: Hawaii: 5345. Maui: 6794.

Genus **HETEROMURUS** Wankel, 1860

Type species: *H. margaritarius* Wankel, 1860

This genus is the only member of the scaled Orchesellini found in Hawaii. The single local species belongs to the subgenus *Alloscopus* Börner, 1906 (type species: *H. tenuicornis*). *Heteromurus* is distinguished from other scaled Entomobryinae in Hawaii by the relatively short fourth abdominal segment (subequal in length to the third). *Alloscopus* is characterized by the presence of dental spines and the absence of macrochaetae on the posterior half of the head; the subgenus has recently been revised by Mari Mutt (1978).

Heteromurus (Alloscopus) tenuicornis Börner, 1906 (Plate 74)
Mitt. Naturhist. Mus. Hamburg 23:177.—Mari Mutt, 1978; 1982; 1985.

Color white, to brown in preserved specimens (depending on state of preservation). Fourth antennal segment without apical pin seta or subsegments but with clear whorls of setae. First antennal segment subsegmented; basal subsegment about 20% as long as distal. Head subcircular in dorsal view. Labral papillae well developed and conelike. First labial triangle seta smooth or ciliate; third and fourth setae replaced by scales. Eyes 1 + 1 or absent. Trochanteral organ with 13–18 setae. Inner tibiotarsal setae all ciliate except for distal seta of third leg. Tenent hair short and acuminate. Unguis with small paired outer teeth, large paired inner basal teeth, and sometimes with very small distal inner tooth. Unguiculus with

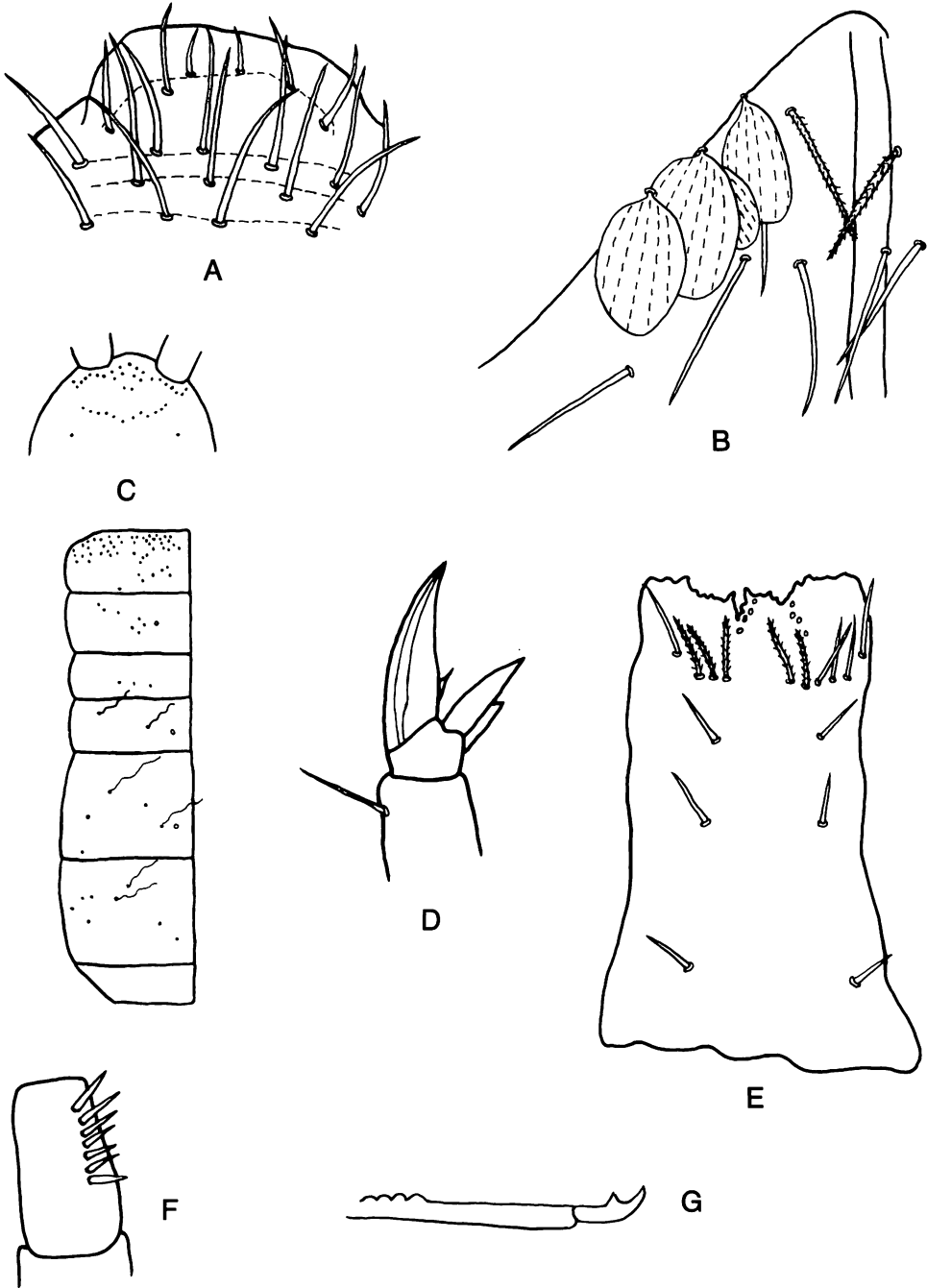
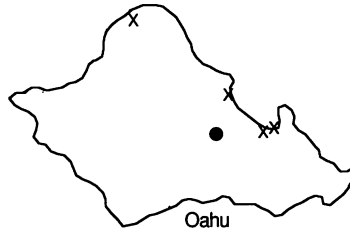


Plate 74—*Heteromurus (Alloscopus) tenuicornis*: **A**, prelabral setae (6766, Oahu); **B**, labial triangle setae, left side (same specimen); **C**, semidiagrammatic drawing of dorsal chaetotaxy (composite); **D**, hind foot complex (6734, Oahu); **E**, dorsal surface of manubrium (specimen from Oahu); **F**, typical basal dental spines (same locality); **G**, mucro and apex of dens (specimen from Oahu).

basal outer tooth. Ventral tube (seen clearly on only 1 specimen) with 12–14 distolateral smooth setae per side; posterior face with 9 subequal ciliate setae. Manubrium with 4 + 4 or 5 + 5 erect smooth setae dorsally. Dens with 1 such seta and 4–7 spines basally. Mucro bidentate, without basal spine; apical tooth more than twice as long as anteapical tooth. Body entirely scaled except for last 2 antennal segments, tibiotarsi, and dorsal surface of furcula. Maximum length 1.7 mm.



Remarks: The Hawaiian specimens of this species that we saw had the most basal labial triangle seta ciliate and lacked eyes. According to some earlier descriptions of the species, a single pair of eyes is present. Our specimens agree well with Mari Mutt's (1982) redescription of the species. Some small specimens have only two dental spines.

Ecology: The Hawaiian records are from litter, soil, and under bark and stones.

Records: Oahu: 4840, 4847, 6387, 6734, 6754, 6766.

Genus **ENTOMOBRYA** Rondani, 1861

Type species: *Degeeria muscorum* Nicolet, 1842

This is by far the largest genus of Collembola in the Islands. The 22 known species may be placed in four subgenera. *Entomobrya* s.str. with 9+ species (about the same number as recorded from Japan) is moderately over-represented. The number of species of subgenus *Homidia* (5) is again similar to the number recorded from Japan, while the 6 species of subgenus *Entomobryoides* are more than are known from any other region. The two species of subgenus *Mesentotoma* are also more than are known from any other region and are further remarkable for being upland rather than littoral species.

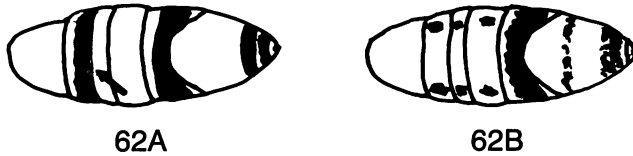
Characters used in this genus are summarized in *The Collembola of North America* (Christiansen and Bellinger 1980–1981). These include the head structures (see Fig. 54–56) and setae of types 1 and 5 (see Fig. 51) and claw structures (see Fig. 57). In addition to the macrochaetae of the anterior abdominal segments (see Fig. 53), identified following Szeptycki (1979) (see Fig. 52), we have used the chaetotaxy of the fourth abdominal segment, especially the medial macrochaetae. In the subgenus *Entomobryoides* we have also used the antennal pin setae and the medial second thoracic macrochaetae.

KEY TO HAWAIIAN SPECIES OF ENTOMOBRYA S.L.

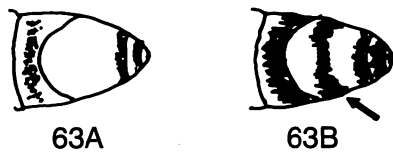
- 1. Anteapical tooth of mucro strikingly larger than apical tooth (Fig. 61A); subadult and adult specimens with dental spines (subgenus *Homidia*) 2
- Anteapical tooth subequal to or smaller than apical tooth (Fig. 61B, 61C) 7



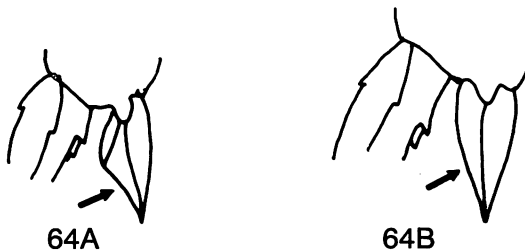
- 2(1). Without obvious pattern; dark pigment absent from trunk or diffuse. 3
- With obvious pattern of bands or stripes and/or irregular dark patches. 4
- 3(2). Large specimens (over 2.5 mm long) with 30 or more dental spines.
- **E. (H.) haikea**
- Large specimens with fewer than 25 dental spines. **E. (H.) socia**
- 4(2). Markings irregular longitudinal stripes. **E. (H.) socia**
- Markings spots and transverse bands. 5
- 5(4). Third thoracic segment with uninterrupted transverse band (Fig. 62A). 6
- Third thoracic segment with band absent or widely interrupted (Fig. 62B)
- **E. (H.) laha**



- 6(5). Fourth abdominal segment with only faint traces of median transverse band (Fig. 63A). **E. (H.) hihiu**
- Fourth abdominal segment with obvious median transverse band (Fig. 63B)
- **E. (H.) sauteri**



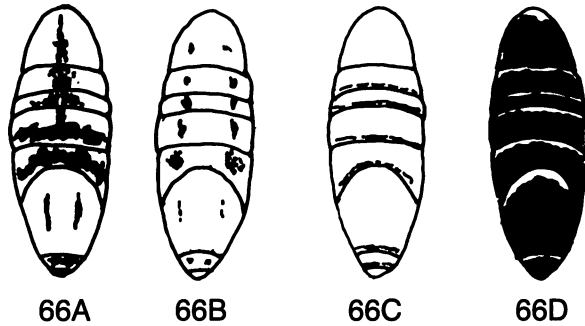
- 7(1). Unguiculus obliquely truncate (Fig. 64A) (subgenus *Mesentotoma*) 8
- Unguiculus tapering (Fig. 64B) 9



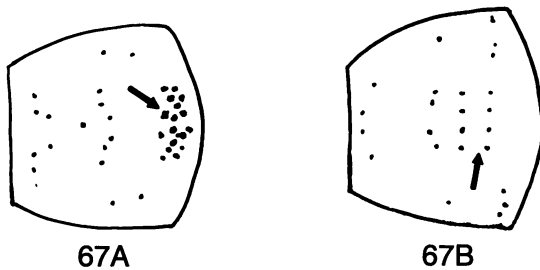
- 8(7). With striking pattern. **E. (M.) nani**
 Without striking pattern. **E. (M.) mauka**
 9(7). Antennal apex with retractile bulb (Fig. 65A) (subgenus *Entomobrya*). 16
 Apex of antenna without retractile bulb (Fig. 65B) (subgenus *Entomobryoides*). 10



- 10(9). With clear pattern including longitudinal markings (Fig. 66A, 66B). 11
 Pattern absent, without contrasting longitudinal markings or consisting only of transverse bands, or dark segmental margins or dark general coloration except for pale intersegmental bands (Fig. 66C, 66D). 12



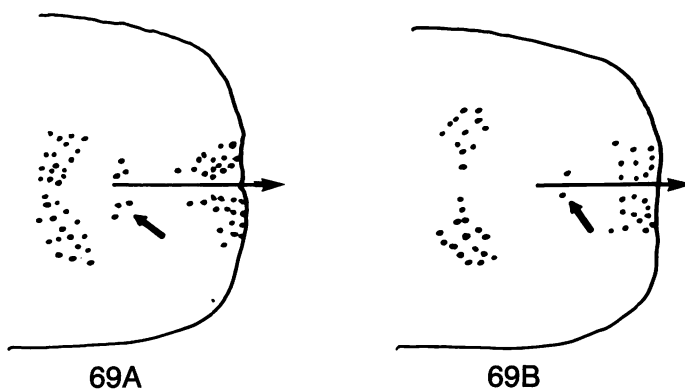
- 11(10). Anterior part of fourth abdominal segment with at least 12 macrochaetae (Fig. 67A). **E. (Entomobryoides) kalakaua**
 Anterior part of fourth abdominal segment with no more than 8 macrochaetae (Fig. 67B). **E. (Entomobryoides) malena**



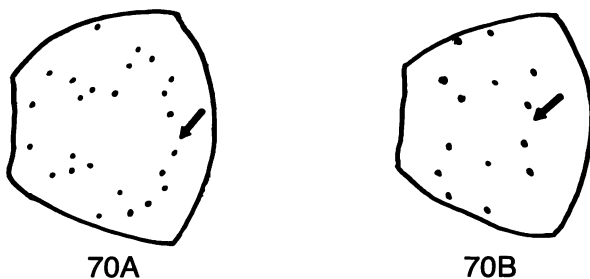
- 12(10). Labial triangle seta L_1 ciliate (Fig. 68A)..... 13
 Labial triangle seta L_1 smooth (Fig. 68B)..... 14



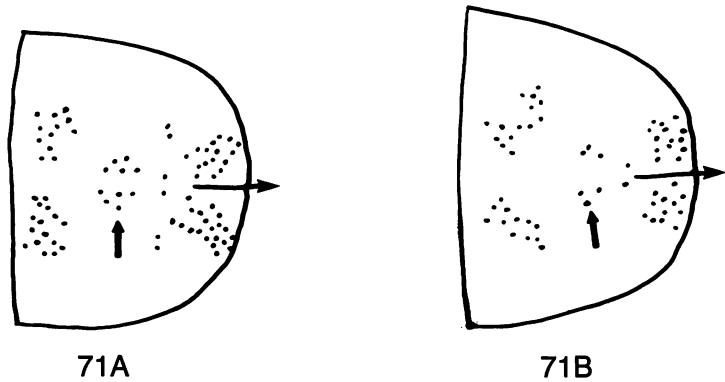
- 13(12). Medial macrochaetae of second thoracic segment 3 + 3 (Fig. 69A).....
 **E. (Entomobryoides) puakea**
 Medial macrochaetae of second thoracic segment 1 + 1 (Fig. 69B).....
 **E. (Entomobryoides) malena**



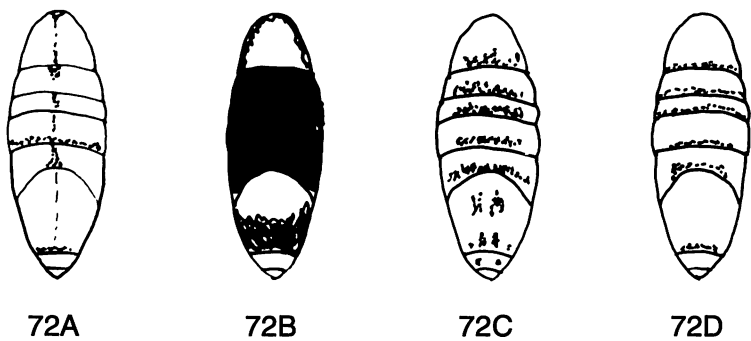
- 14(12). Fourth abdominal segment with 8-10 anterior median macrochaetae (Fig. 70A)..... 15
 Fourth abdominal segment with 4 anterior macrochaetae (Fig. 70B).....
 **E. (Entomobryoides) guthriei**



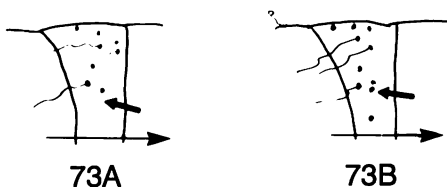
- 15(14). Second thoracic segment with 5 + 5 medial macrochaetae (Fig. 71A).....
 **E. (Entomobryoides) mauna**
 Second thoracic segment with 3 + 3 medial setae (Fig. 71B).....
 **E. (Entomobryoides) kea**



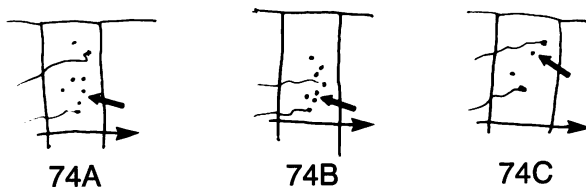
- 16(9). Trunk with at least traces of median dorsal stripe; anteapical mucronal tooth much smaller than apical (Fig. 72A)..... **E. (Entomobrya) unostriata**
 Dark pattern elements of trunk transverse, lateral, or absent (Fig. 72B, 72C, 72D); mucronal teeth subequal..... 17
 17(16). Contrasting dark pigment covering all or almost all of third thoracic segment through third abdominal segment (Fig. 72B)..... **E. (Entomobrya) albocincta**
 Contrasting dark pigment less extensive..... 18
 18(17). With some obvious dorsal markings on fourth abdominal segment (Fig. 72C)..... 19
 Dorsal markings on fourth abdominal segment absent or limited to marginal lines (Fig. 72D)..... 20



- 19(18). Macrochaeta as absent on third abdominal segment (Fig. 73A).
 **E. (Entomobrya) panoana**
 Macrochaeta as present on third abdominal segment (Fig. 73B).
 **E. (Entomobrya) multifasciata**



- 20(18). Second abdominal segment with 5 + 5 macrochaetae between lateral bothriotricha (Fig. 74A). **E. (Entomobrya) griseoolivata**
 Second abdominal segment with at most 4 + 4 macrochaetae between lateral bothriotricha (Fig. 74B, 74C). 21
 21(20). Second abdominal segment with 1 + 1 macrochaetae between lateral bothriotricha (Fig. 74C). **E. (Entomobrya) powehi**
 Second abdominal segment with 3 + 3 macrochaetae between lateral bothriotricha (Fig. 74B). 22



- 22(21). First abdominal segment with 16–20 dorsal macrochaetae.
 **E. (Entomobrya) atrocincta**
 First abdominal segment with 8–10 dorsal macrochaetae.
 **E. (Entomobrya) nyhusae**

Subgenus **HOMIDIA** Börner, 1906

Type species: *E. (H.) cingula* Börner, 1906

New features of this subgenus introduced by Szeptycki (1973) and Lee and Lee (1981) necessitate reexamination of all earlier determinations. Thus it appears that North American "*sauteri*" is not the same as the species figured by Stach (1963) and Szeptycki (1973), but the Hawaiian form is. The abundance of characters available should eventually permit development of a stable classification.

Entomobrya insularis Carpenter, 1904 is clearly a *Homidia*, but the brief description does not permit us to place it more precisely; the single, fragmentary type has a

manubrial thickening like that of *E. laha*, but the pattern described is never seen in the latter. The small number of dental spines is most like that of *E. socia*.

At present we recognize five Hawaiian species [aside from *E. (H.) insularis*]: *E. (H.) haikea*, *E. (H.) hihiiu*, *E. (H.) laha*, *E. (H.) sauteri*, and *E. (H.) socia*.

The characters used by Szeptycki (1973) and by Lee and Lee (1981) are generally straightforward; however, learning to distinguish between coxal macrochaetae, used for the formulae, and the mesochaetae, which are to be ignored, can be difficult. Table 18 gives the state of these characters for the Hawaiian species. The typical distribution of macrochaetae on the anterior and external coxal surfaces is shown in Figure 76; these macrochaetae are difficult to count on undissected specimens, especially because of the occurrence of mesochaetae that can be confused with them. We follow Szeptycki's (1973) system in labeling the labial triangle setae in this subgenus (Fig. 75). The dorsal macrochaetae of the fourth abdominal segment are found in two groups (Fig. 77); their arrangement is characteristic of each species. The dental spines are distributed along the inner dorsal margin of the basal $\frac{1}{3}$ - $\frac{2}{3}$ of the dens.

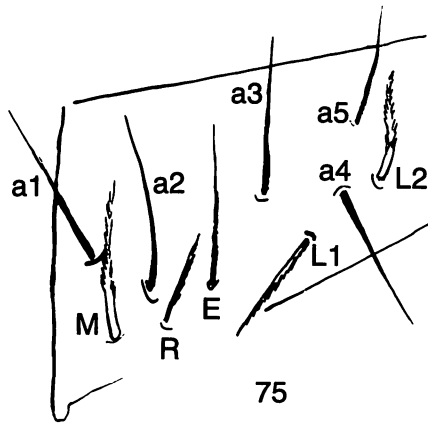


Figure 75—Labial triangle setae of *Homidia* (after Szeptycki).

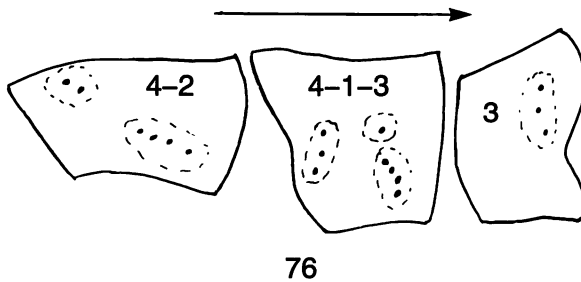


Figure 76—Coxal surfaces of *Homidia* (after Szeptycki).

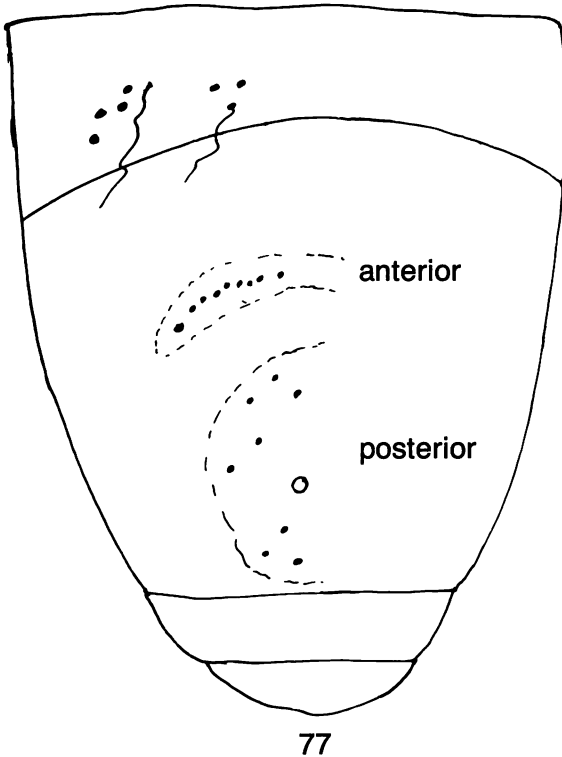


Figure 77—Dorsal macrochaetae of *Homidia*.

Entomobrya (Homidia) haikea Christiansen and Bellinger, new species (Plate 75)

Background white to yellowish; eyepatches and interantennal spot dark; antennae slightly lighter, with basal portions of first 2 segments and intersegmental membranes paler, giving a banded appearance; bluish pigment otherwise normally limited to a wash on sides of head and body, end of abdomen, and legs; rarely with obscure narrow dark bands on the third thoracic and second or third abdominal segments; tibiotarsi may be lightly and evenly pigmented. Antenna with 2 or 3 apical bulbs. Head a rounded hexagon in dorsal view. Labral papillae broad, low, and obscure, without setae. Labial appendage with external seta small, slender, and not reaching apex of same papilla. Tibiotarsus with 2 inner rows of heavy, outstanding setae. Tenent hair heavy and clavate. Unguis with usual 7 teeth; inner teeth smaller than lateral and external teeth, and apical inner tooth minute or absent. Unguiculus very finely serrate externally. Ventral tube with 17–22 distal lateral setae per side; anterior face with 3 + 3 large ciliate setae forming 2 L-shaped figures. Male genital plate with all except basal setae acuminate and strongly recurved. Macrochaetae of thorax apically truncate, expanded, and reflexed. Maximum length 3.5 mm.

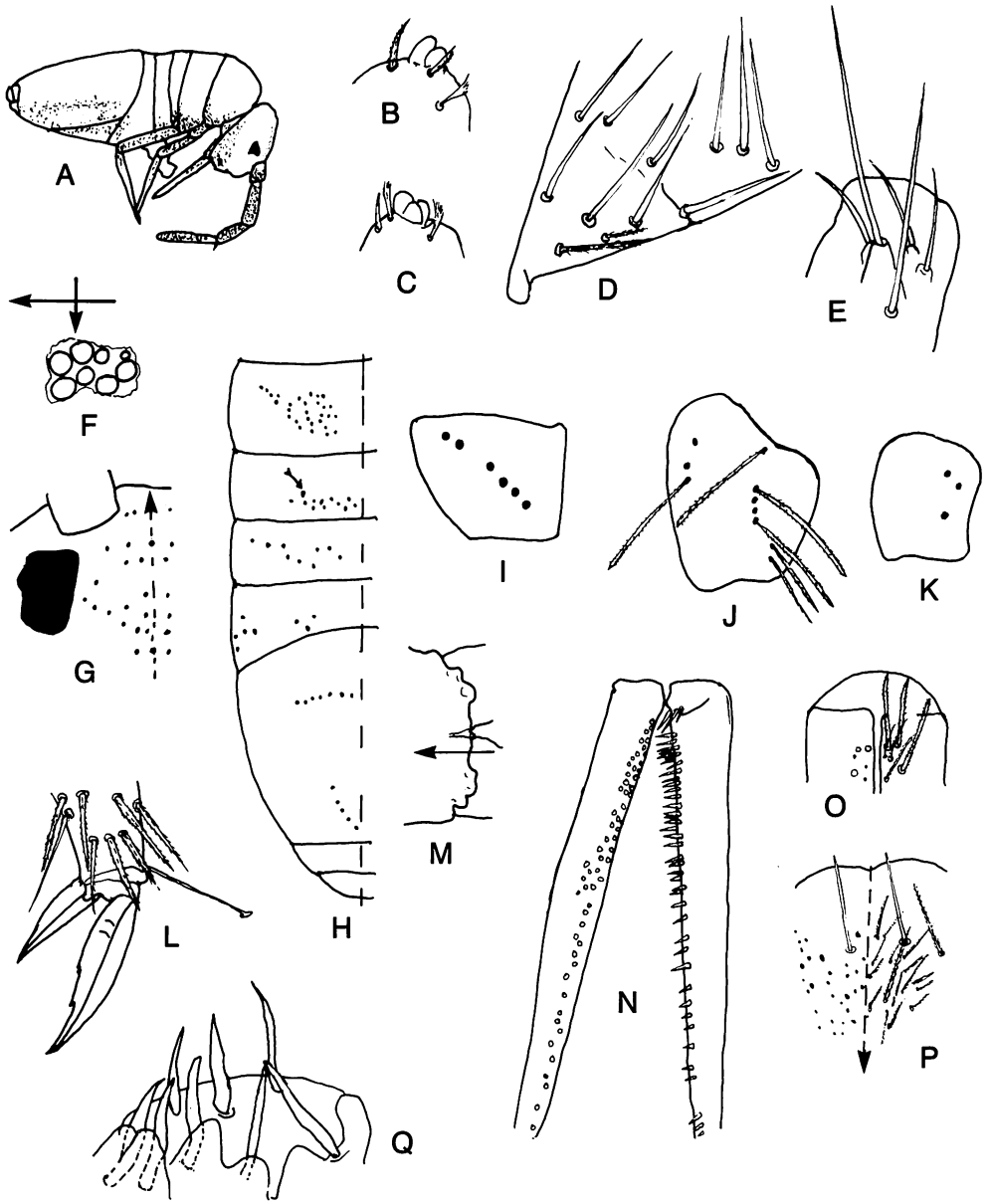
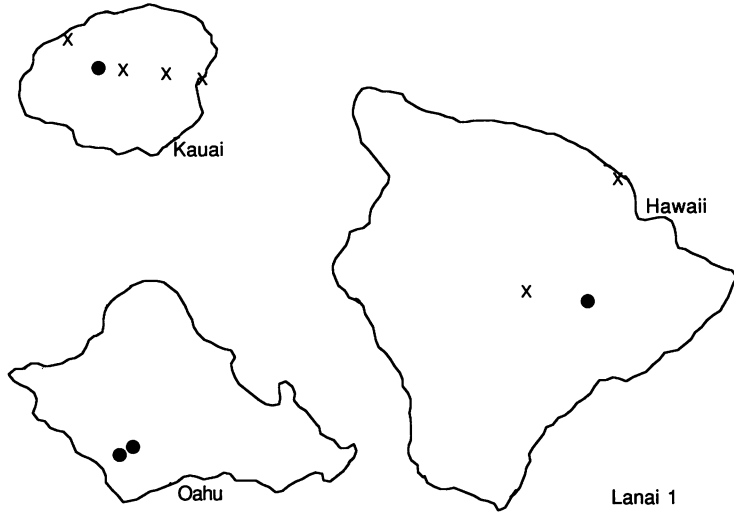


Plate 75—*Entomobrya (Homidia) haikei*: A, habitus (4745, Kauai); B and C, apices of antennae: B, (5238, Oahu); C, (6689, Lanai); D, labial triangle, left side (specimen from Hawaii); E, premaxillary lobe (6689, Lanai); F, left eyepatch (4800, Oahu); G, semidiagrammatic interocular macrochaetae, left side (5206, Kauai); H, semidiagrammatic macrochaetae, third thoracic segment—fourth abdominal segment, composite, seta marked with arrow often absent; I-K, macrochaetae of coxae: I, leg III (same specimen as F); J, leg II, showing mesochaetae (4737, Kauai); K, leg I (same specimen as I); L, hind foot complex (same specimen as J); M, manubrial thickening (same specimen as J); N, dental spines, spines removed from left dens (same specimen as F); O, apex of anterior face, ventral tube, setae removed from left side (4799, Oahu); P, posterior face of ventral tube, setae removed from left side (specimen from Hawaii); Q, male genital plate seen from side (5211, Kauai).

Table 18. Characteristics of Hawaiian Species of *Entomobrya*, Subgenus *Homidia*

SPECIES	LABIAL TRIANGLE SETAE*					COXAL SETAE			ABD. I MACROCHAETAE (PER SIDE)	ABD. IV MACROCHAETAE (PER SIDE)		DENTAL SPINES IN ADULTS (2.5+ mm LONG)	CLEAR PATTERN
	M, r	E	L ₁	L ₂		I	II	III		ANTERIOR	POSTERIOR		
<i>haikea</i>	<i>M</i>	<i>r</i>	<i>E</i>	<i>L</i>	<i>L</i>	3	4-1-3	4-2	(10)11-12	7-9 (10)	5 in V	38-46(-55?)	-
<i>hihiu</i>	<i>M</i>	<i>r</i>	<i>E</i>	<i>L</i>	<i>L</i>	3	4-1-3	3-3	11-13	(8)9-10	7-8 irregular	26-45	+
<i>laha</i>	<i>M</i>	<i>r</i>	<i>E</i>	<i>L</i>	<i>L</i>	3	4-1-3	4-2	10-12	(9)10-11	4-5 in V or U	43-70	+
<i>sauteri</i>	<i>M</i>	<i>r</i>	<i>E</i>	<i>L</i>	<i>L</i>	3	4- ² / ₍₁₎ -3	4-2	11-13	9-13	4-7 irregular	23-53	+
<i>socia</i>	<i>M</i>	<i>r</i>	<i>E</i>	<i>L</i>	<i>L</i>	3	4- ¹ / ₍₃₎ - ² / ₂ - ² / ₃	(2) 4-3	11-15	8-9+1	5-8 irregular	15-20	+(-)

*Larger setae in capitals; ciliate setae in italics.



Remarks: This species resembles *E. (H.) amethystina* Börner, 1909 and *E. (H.) chrysothrix* Yosii, 1942 in some respects, but according to Yosii (1942) these species have fewer, differently shaped dental spines. The chaetotaxy of the fourth abdominal segment distinguishes it from *E. (H.) grisea* Lee and Lee, 1981 and *E. (H.) phjongiangica* Szeptycki, 1973; the former also has very short tenent hairs. The posterior macrochaetae of the fourth abdominal segment are very constant and distinguish it from most Hawaiian forms; the very similar *E. (H.) laha* may easily be distinguished by its strong pattern. Specimens with L_2 smooth may belong to a different species.

Derivatio nominis: Hawaiian, pale.

Ecology: Found in forested regions, in litter, porous lava, or moss.

Type locality: Holotype and 2 paratypes, Hawaii, solid waste transfer station behind town of Volcano, I-10-1983, in mesic rain forest, low vegetation and shrubs in tree hole litter, KC (5700).

Additional records: Hawaii: 5363, 5412, 5693, 5694. Lanai: 6689. Oahu: 4797, 4798, 4799, 4800, 5230, 5232, 5233, 5234, 5238. Kauai: 4735, 4737, 4745, 5206, 5208, 5211, 6722.

Entomobrya (Homidia) hihiu Christiansen and Bellinger, new species (Plate 76)

Background yellow; antennae clear at joints, otherwise uniformly pale purple to pale blue; eyepatches and interantennal band dark; brownish purple pigment along posterior margins of fourth and fifth abdominal segments and forming a very light transverse band covering most of the dorsal surface of the third thoracic segment and a very dark band on the third abdominal segment; a very pale wash forms a median band on the fourth abdominal segment and lateral pigmentation on the second thoracic segment; legs and furcula pale. Antenna with 2 distinct apical bulbs. Head ovoid in dorsal view. Labral papillae conical and clearly uniseta-

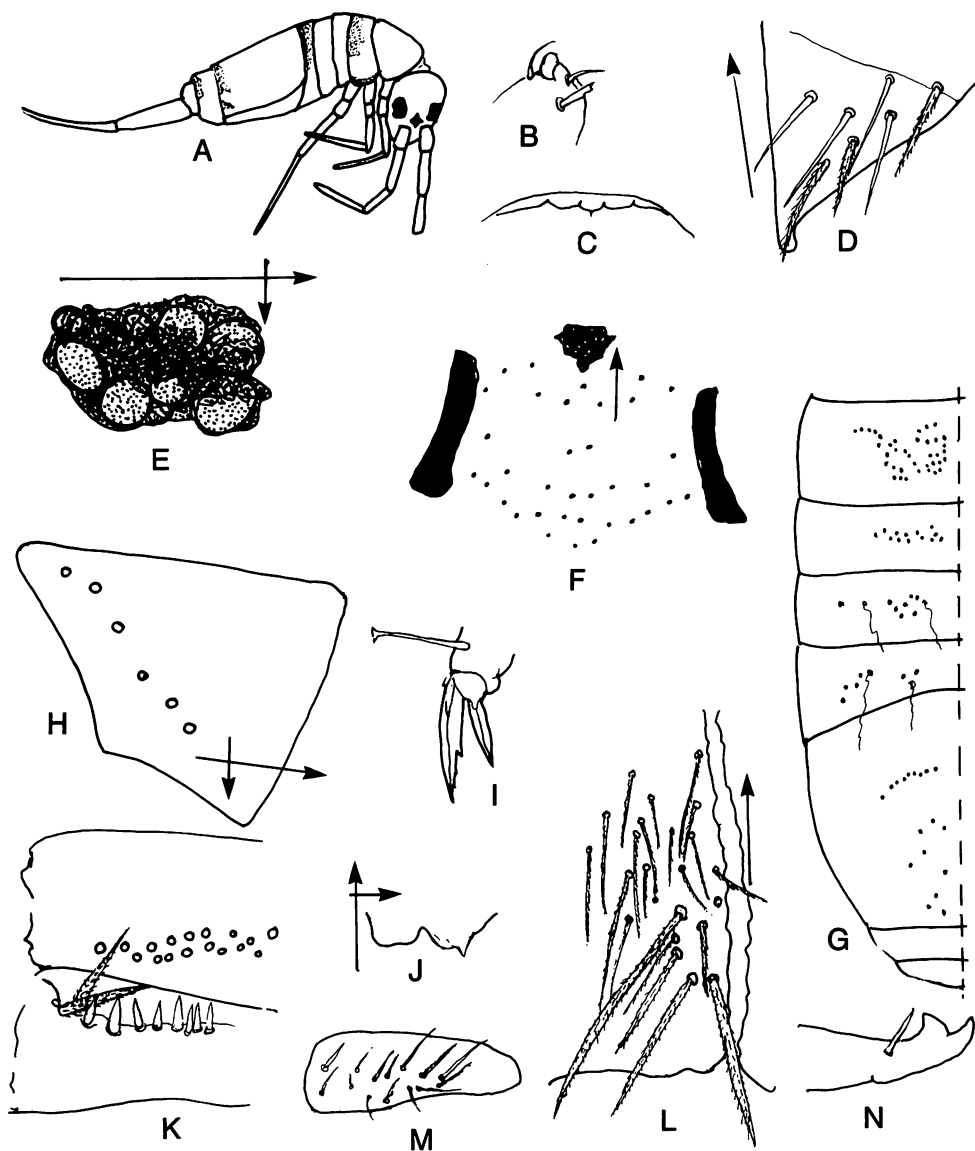


Plate 76—*Entomobrya (Homidia) hihui* (all figures of type specimens): A, habitus; B, apex of antenna; C, labral papillae; D, left side, labial triangle; E, eyepatch of right side; F, interantennal macrochaetae; G, semidiagrammatic macrochaetae, left side, second thoracic segment–fourth abdominal segment; H, coxal base setae, leg III, right side; I, hind foot complex; J, manubrial thickening, right side; K, dental spines and basal setae; L, left side, anterior face of ventral tube; M, distolateral patch of ventral tube; N, mucro.

ceous. Tibiotarsi with 2 rows of heavy outstanding ciliate setae on the inner surface. Tenent hair heavy and clavate. Unguis with usual 7 teeth; apical inner tooth smaller, and lateral teeth larger, than others. Outer edge of unguiculus smooth or very finely serrate. Ventral tube with 16–20 setae on each distolateral patch; 3 macrochaetae on anterior surface forming a right angle. Male genital plate not seen. Maximum length 3.0 mm.

Remarks: This species is very close to *E. (H.) similis* Szeptycki, 1973. The two have the same pattern and body chaetotaxy; however *E. (H.) hihii* has the labral papillae conical and setaceous rather than rounded, eyes G and H much smaller than eye C instead of subequal to it, and differences in the manubrial thickening, coxal setae, and basal setae of the dens. It differs from all other Hawaiian species of the subgenus in the presence of m_{3ci} on the second abdominal segment; this seta and the labral papillae are the only morphological differences from *E. (H.) sauteri*.

Derivatio nominis: Hawaiian, uncommon.

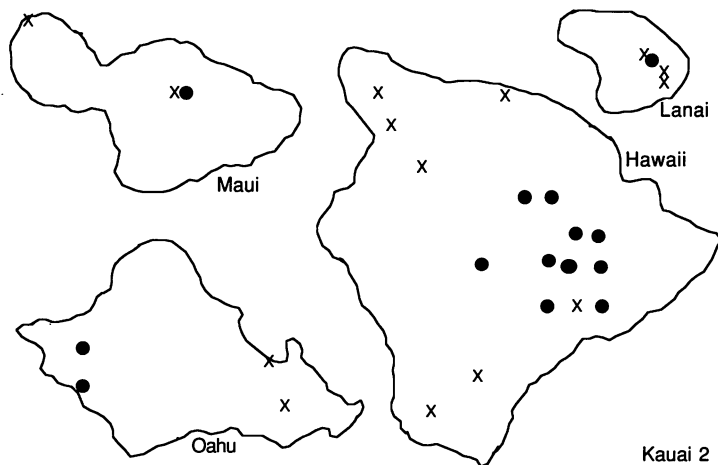
Ecology: Found in soil and debris at intermediate elevations (1000–2000 m).

Type locality: Holotype and 1 paratype, Maui, Silversword Inn, I-28-1967, PB (4751).

Additional records: Hawaii: 4857, 4930.

Entomobrya (Homidia) laha Christiansen and Bellinger, new species (Plate 77)

Background yellow; pigment blue to brownish purple or purple; eyepatches and interantennal band dark; antennae with lighter pigment, absent at base and near first 2 joints, giving a banded appearance; body with lateral pigment, heavier and clearer toward posterior end, and bands covering third, fifth, and sixth abdominal segments; fourth abdominal segment with a wide posterior band and an angled band with posterior (rarely anterior) apex across the middle; occasionally (2 collections) with weak transverse bands on the third thoracic segment and the anterior margin of the second thoracic segment; leg segments banded in middle; furcula



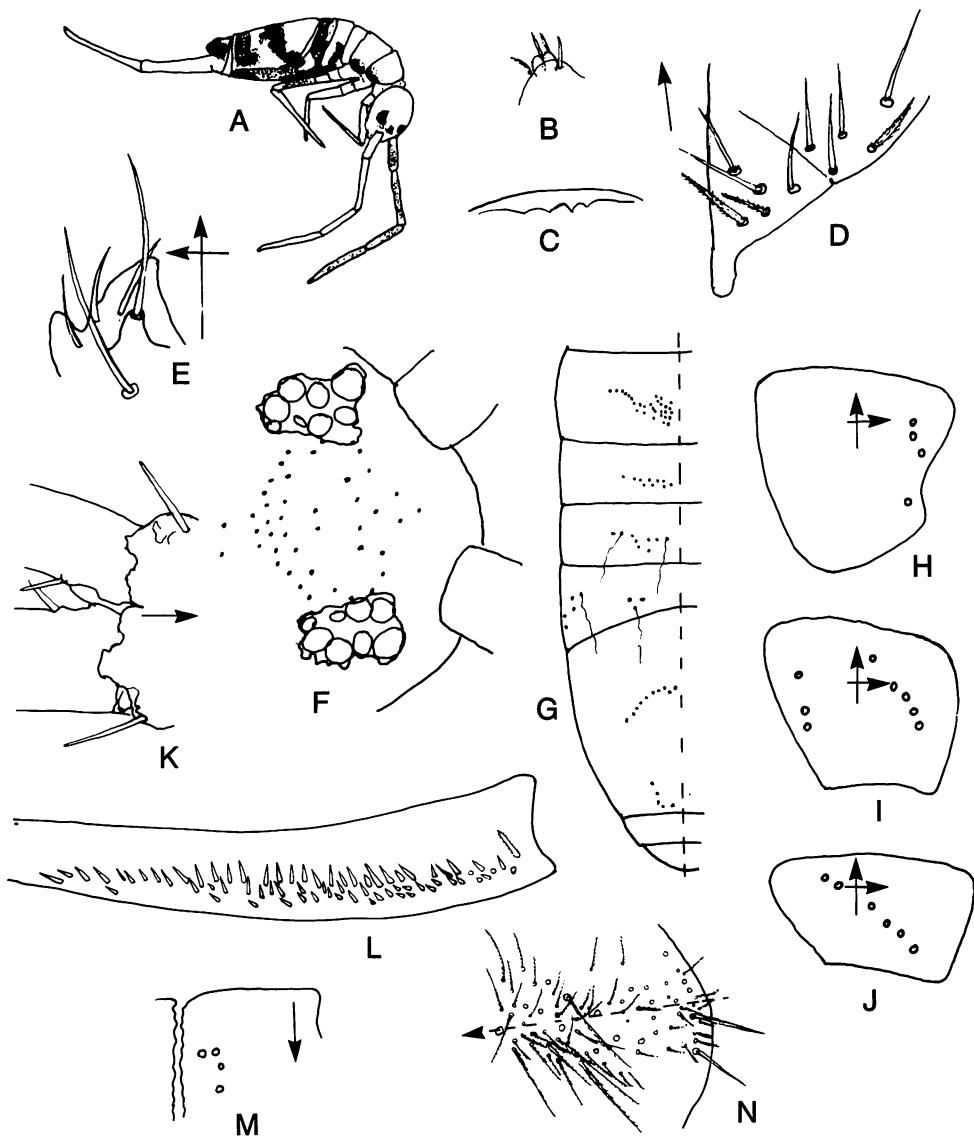


Plate 77—*Entomobrya (Homidia) laha*: A, habitus (4726, Hawaii); B, apex of antenna (6690, Lanai); C, labral papillae (5489, Hawaii); D, left labial triangle (5145, Hawaii); E, premaxillary lobe (6692, Lanai); F, eyepatches and interantennal macrochaetae (5367, Hawaii); G, semidiagrammatic macrochaetae, left side, third thoracic segment-fourth abdominal segment (composite); H-J, coxal base macrochaetae: H, leg I, showing mesochaetae (5367, Hawaii); I, leg II (same specimen); J, leg III (type specimen); K, manubrial thickening (4766, Oahu); L, dental spines, left side, seen from above and to inner side (6692, Lanai); M, anterior face of left side of ventral tube showing macrochaetae bases (5149, Hawaii); N, posterior face of ventral tube, dotted line shows midline (5154, Hawaii).

pale. Antenna with 2 apical bulbs. Head in dorsal view a rounded hexagon. Labral papillae low, rounded, and indistinct. External seta of labial appendage small, slender, and acuminate, not reaching apex of same papilla. Tibiotarsus with 2 rows of heavy ciliate setae along inner surface. Tenent hair heavy and clavate. Unguis with usual 7 teeth; apical inner tooth smaller and lateral teeth larger than others. Unguiculus minutely serrate externally. Ventral tube with 24–29 setae in each distolateral patch; inner pair of macrochaetae project forward or ventrally in a parasagittal plane. Anterior setae of male genital plate moderately recurved in lateral view; lateral and parabasal setae apically angled. Maximum length 3.1 mm.

Remarks: This species is close to both *E. (H.) sauteri* and *E. (H.) chosonica* Szep-tycki, 1973, but differs from both in having labial triangle seta L_1 smooth; from *E. (H.) sauteri* in the typical pattern and fourth abdominal segment chaetotaxy, and from *E. (H.) chosonica* in dental spine number and basal dental spine structure. The chaetotaxy of *E. (H.) laha* resembles that of *E. (H.) grisea* Lee and Lee, 1981, which has different labial chaetotaxy and pattern. The clear pattern also distinguishes this from the similar Hawaiian *E. (H.) haikea*. A few heavily marked specimens of *E. (H.) laha* may be confused with *E. (H.) sauteri*, but the absence of a complete band on the third thoracic segment and the presence of extensive pigment on the lateral portions of all segments will distinguish them. The leg bands are weakly developed in some specimens and difficult to distinguish.

Derivatio nominis: Hawaiian, common, numerous.

Ecology: Primarily a litter animal from forest and scrub areas. Sometimes found under stones or bark or in rotten wood; two records are from low vegetation.

Type locality: Holotype and 8 paratypes, Hawaii, 40 miles from western terminus of Saddle Road, I-4-1983, scrub ohia forest, in lava rock "soil" and on low vegetation, KC (5671).

Additional records: Hawaii: 4726, 4856, 4860, 4870, 4873, 4878, 4928, 4931, 4933, 4934, 4935, 4936, 4938, 4939, 5145, 5149, 5153, 5154, 5276, 5344, 5356, 5367, 5372, 5407, 5448, 5489, 5490, 5649, 5657, 5663, 5668, 5671, 5673, 5675, 5677, 5678, 5679, 5681, 5687, 5690, 5692, 5693, 6394, 6395, 6820, 6834, 6845, 6853. Maui: 6677, 6678, 6688, 6795. Lanai: 6690, 6692, 6693, 6694, 6700, 6701. Oahu: 4766, 5527, 5528, 5529, 6760, 6777, 6778. Kauai: 5216, 6722.

Entomobrya (Homidia) sauteri Börner, 1909 (Plate 78)

Sitzungsber. Ges. Naturwiss. Freunde Berlin 1909:120.—Stach, 1963.—Szep-tycki, 1973.

Background yellow to off white; eyepatches and interantennal band dark; pigment blue to purple-brown, uniform on antennae except that sometimes the base of the first segment is pale, forming pale cheek patches on head; second thoracic segment with pigment along anterior margin and sometimes in a weak middorsal patch; most of third thoracic and third and fifth abdominal segments dark; pigment in broken or paler transverse bands on posterior and sometimes anterior margins of second abdominal segment, a continuous or broken posterior band and a median band varying greatly in position and extent on the fourth abdominal seg-

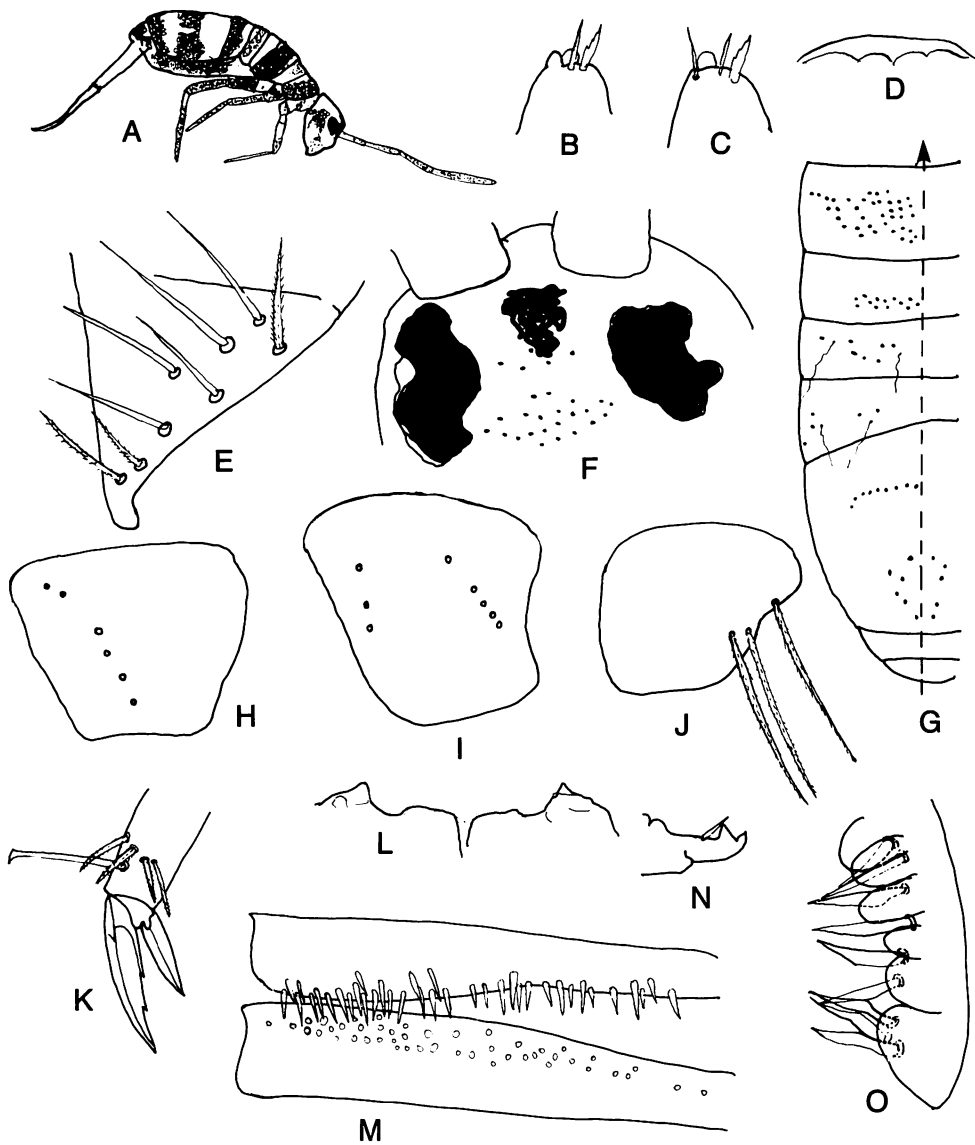
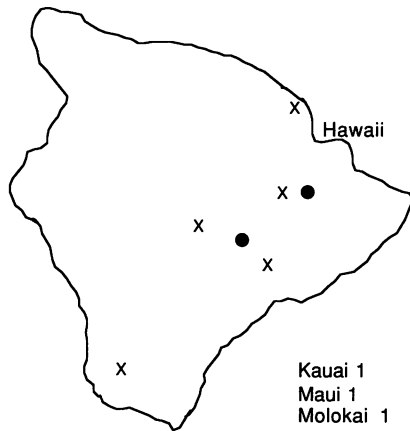


Plate 78—*Entomobrya (Homidia) sauteri*: A, habitus (5691, Hawaii); B and C, apices of antennae, two different specimens (same); D, labral papillae (4937, Hawaii); E, left labial triangle (5691, Hawaii); F, interocular macrochaetae (same specimen); G, semidiagrammatic macrochaetae, left side, third thoracic segment–third abdominal segment (composite); H–I, coxal base macrochaetae (same specimen as E): H, leg III; I, leg II; J, leg I; K, mid foot complex (same specimen); L, manubrial thickening (5367, Hawaii); M, bases of dentes, right side showing some of the spines and left side showing dental spine sockets (5691, Hawaii); N, mucro (after Christiansen); O, male genital plate in profile (5276, Hawaii).

ment, and lateral spots to more or less complete cover on sixth abdominal segment; legs lightly pigmented basally, and also sometimes pigmented on femur and tibiotarsus. Furcula faintly pigmented on the basal dorsum. Antenna with 1 or 2 clear apical bulbs. Head ovoid to hexagonal in dorsal view. Labral papillae obscure, irregular, and nonsetaceous. Inner surface of tibiotarsus with 1-2 rows of differentiated, outstanding ciliate setae. Tenent hair heavy and strongly clavate. Unguis with 6-7 teeth; apical inner tooth minute or absent and lateral teeth much larger than others. Unguiculus finely serrate externally. Ventral tube with 17-27 setae in each distolateral patch; macrochaetae of anterior face forming a right angle. Male genital plate with very short setae, straight or internally sharply angled. Maximum length 3.5 mm.



Remarks: The identity of these specimens and the application of the name *sauteri* are unsettled questions. Hawaiian specimens agree reasonably well with Stach's (1963) description, although he denies the existence of apical antennal bulbs (ours have one or two bulbs), and with Szeptycki's (1973); but the chaetotaxy of the fourth abdominal segment is different from that in the few nearctic "*sauteri*" we were able to examine. It is possible that a number of different species have been included under this name. Since Stach (1963), and probably Szeptycki (1973), saw only material from China and Vietnam, a comparison with topotypical Japanese specimens is needed.

The chaetotaxy of the posterior part of the fourth abdominal segment varies greatly, but the macrochaetae of the posterior part of the abdomen in *Homidia* generally form a V- or U-shaped figure. In the case of *E. (H.) sauteri* there are always macrochaetae inside this figure. One of the collections of the species also contains specimens of *E. (H.) laha*; the two are easily separated.

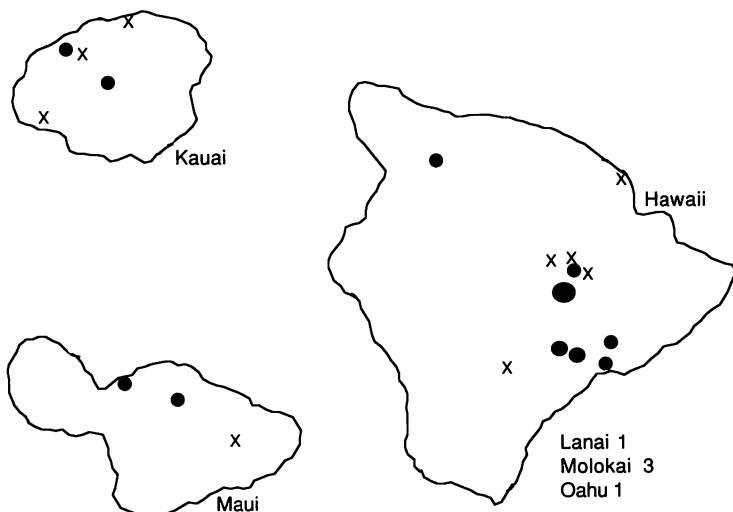
Ecology: In Hawaii found in forested areas, in litter, or on low vegetation.

Records: Hawaii: 4937, 5367, 5407, 5688, 5691, 6797, 6840, 6860. Maui: 5265. Molokai: 5722. Kauai: 5216.

Entomobrya (Homidia) socia Denis, 1929 (Plate 79)

Boll. Lab. Zool. Gen. Agric. Portici 22:310 (*Homidia*).—Yosii, 1942.—Stach, 1965.—Christiansen and Bellinger, 1980.

Background yellowish; blue to black pigment in eyepatches and interantennal band and sometimes forming lateral stripes; a fine or broad and irregular dorsal stripe may also be present; antennae bluish to purplish with first and second segments having less pigment than third and fourth; legs and furcula unpigmented. Antenna with 2 distinct apical bulbs. Head ovoid to nearly round in dorsal view. Labral papillae conical or humped, without setae. Tibiotarsi with 2 rows of heavy outstanding ciliate setae on inner surface. Tenent hair heavy and strongly clavate. Unguis with the usual 7 teeth; apical inner tooth very small and lateral teeth somewhat larger than others. Unguiculus with outer margin smooth to serrate. Ventral tube with 22–27 distolateral setae per side; inner 1–2 pairs of anterior macrochaetae parallel to midline. Male genital plate with setae (except basal setae) short, acuminate, and not recurved. Maximum length 3.0 mm.



Remarks: There is extreme variation in the number and position of posterior macrochaetae of the fourth abdominal segment. Because the number of these setae is generally smaller in populations that lack any pattern, we originally thought that two species were present. However, further study showed that all characters intergrade completely. The unusual chaetotaxy of the fourth abdominal segment is also found in nearctic material and makes the species easy to recognize. The coxal macrochaetae are not easily counted, because of the presence of many mesochaetae of varying sizes.

Ecology: Found in woods or on roadsides, in litter, moss, or grass. This well-marked species is clearly unrelated to the other *Homidia* species and may be a recent introduction. Our first records are from 1967.

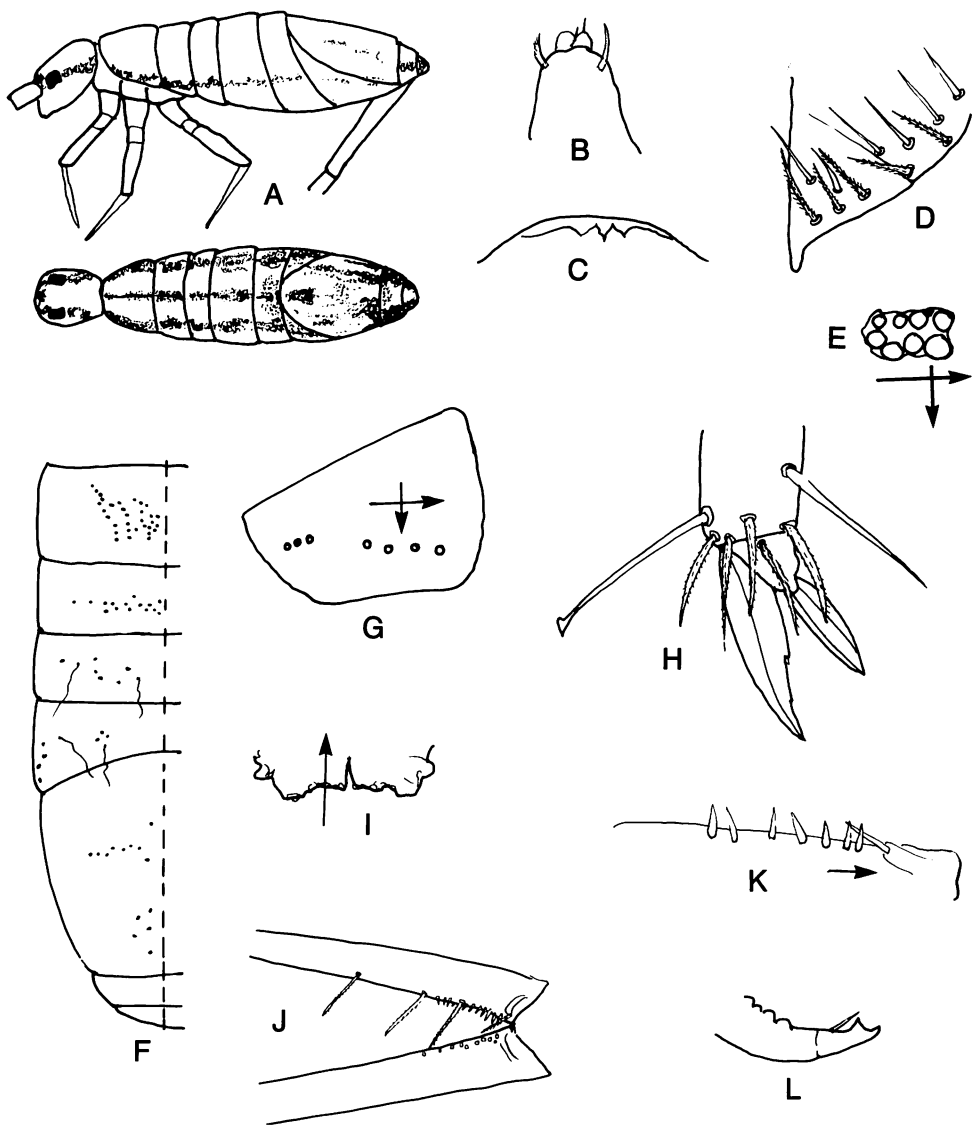


Plate 79—*Entomobrya (Homidia) socia*: A, typical patterns seen from above and side (specimen from Louisiana); B, apex of antenna (4740, Kauai); C, labral papillae (5355, Hawaii); D, left labial triangle (4726, Hawaii); E, left eyepatch (4727, Hawaii); F, semidiagrammatic macrochaetae, third thoracic segment–fourth abdominal segment, left side (composite); G, coxal base macrochaetae, leg III (4740, Kauai); H, hind foot complex (4736, Kauai); I, manubrial thickening (4727, Hawaii); J, base of dentes showing spines and macrochaetae on left side and spine bases on right (same specimen); K, closeup of dental spines (specimen from Louisiana); L, mucro (same specimen).

Records: Hawaii: 4725, 4726, 4727, 4854, 4855, 4856, 4857, 4858, 4859, 4860, 4861, 4862, 4870, 4873, 4874, 4878, 4889, 4904, 4930, 4931, 5148, 5152, 5275, 5355, 5356, 5418, 5469, 5470, 5671, 5703, 6394, 6395, 6396, 6806. Maui: 4750, 6672, 6675, 6677, 6678, 6862. Molokai: 5708, 5725, 5727. Lanai: 6695. Oahu: 5535. Kauai: 4734, 4736, 4740, 4741, 4742, 4744, 5122, 5211, 5213.

Subgenus **ENTOMOBRYA** s. str.

This is the largest subgenus in Hawaii, as it is in general. General discussions are found in Stach (1963) and Christiansen and Bellinger (1980-1981). The discovery of sibling species to the widespread *E. multifasciata* and *E. atrocincta* makes it necessary to reexamine records of these species from other countries; in particular, it is very likely that many determinations of *E. atrocincta* in fact refer to *E. nyhusae*.

There are at least eight Hawaiian species of *Entomobrya* s.str.: *albicincta*, *atrocincta*, *griseoolivata*, *multifasciata*, *nyhusae*, *panoanoa*, *powehi*, and *unostrigata*. An additional species (K), known only from a single specimen, is not described here; it may actually be the nearctic *E. assuta*. Two type specimens of *E. lactea* Folsom, 1932 were examined. They are *Seira terrestris*. In the absence of better material the two must be considered synonyms.

Entomobrya (*Entomobrya*) albicincta (Templeton, 1835) (Plate 80)
Trans. Entomol. Soc. London 1:95 (*Podura*).—Stach, 1963.

Background off white to pale yellow; antennae blue, paler near base of segments; eyepatches and interantennal band dark; posterior of head with irregular V-shaped mark opening forward, sometimes reduced to a median spot; mottled pigment scattered over rest of head, especially on cheek regions; body with dark blue pigment, interrupted by scattered pale spots, except on posterior $\frac{2}{3}$ - $\frac{3}{4}$ of second thoracic segment, anterior $\frac{1}{4}$ - $\frac{1}{2}$ of fourth abdominal segment, and last 2 trunk segments. Apical antennal bulb unlobed or weakly bilobed. Head round to broadly oval in dorsal view. Labral papillae low and uni- or bisetaceous. Trochanteral

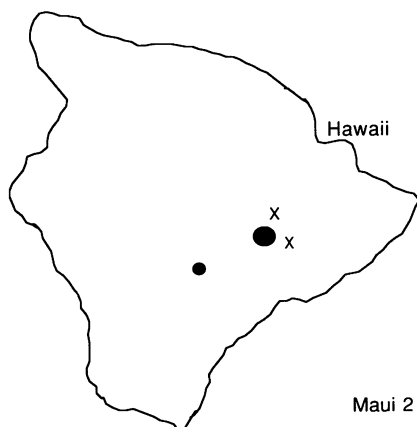


Table 19. Chaetotaxy and Other Features of Hawaiian *Entomobrya* s.str. Species

SPECIES	LOBES OF		LABRAL PAPILLAE NO.	DIFFERENTIATED LABIAL SETAE/ SAME PAPILLA	EYE B/F	INNER DORSAL MACROCHAETAE ANTERIOR ABDOMINAL SEGMENTS								INNER MACROCHAETAE ABD. SEGMENT III					PATTERN
	ANTENNAL BULB	ANTENNA/ HEAD				APICAL SETAE	EYE	I PER SIDE	II						a ₁	a ₂	a ₃	m ₃	
					m ₃				m _{3ep}	m _{3c}	m _{3c2}	m _{3ea}	a ₃	m _{3ci}					
<i>albocincta</i>	1-2	2.0-2.5	1-2	0.9-1.1	(≈)<	5?	+	-	+	-	-	-	-	+	-	-	+	-	+
<i>atrocincta</i>	2-3	2.25-2.35	P*	1.1-1.3	<	8-10	+	-	+	-	+	(±)	-	+	+	+	+	-	+
<i>nyhusae</i>	1	2.6-2.7	P-2	1.15-1.30	(≈)<	4-5	+	-	+	-	-	-	+	+	+	-	+	-	+
<i>powehi</i>	1(2)	1.8-2.0	1-2	0.5-0.8	<	1-2	-	-	-	+	-	-	+	-	-	-	+	-	-
<i>griseoolivata</i>	(1)2	1.8-2.0	P	0.8-0.9	≈	9-12	+	+	+	-	-	+	+	+	+	+	+	+	-
<i>panoanoa</i>	1	2.1-2.4	2-3	0.8-1.0	>	1(2)	+	-	+	-	-	-	-	-	+	-	+	-	+
sp. K	2	2.2	3	0.9	<<	1	+	-	+	-	-	-	-	-	-	+	-	-	-
<i>multifasciata</i>	2(3)	2.40-2.55	P	0.9-1.0	<	7(8)	+	-	+	-	-	+	-	+	+	+	+	-	+
<i>unostrigata</i>	1-2	2.6	1-2	≈	≈	7-8	+	+	+	-	+	+	-	+	-	-	+	-	+

*P with secondary micropapillae.

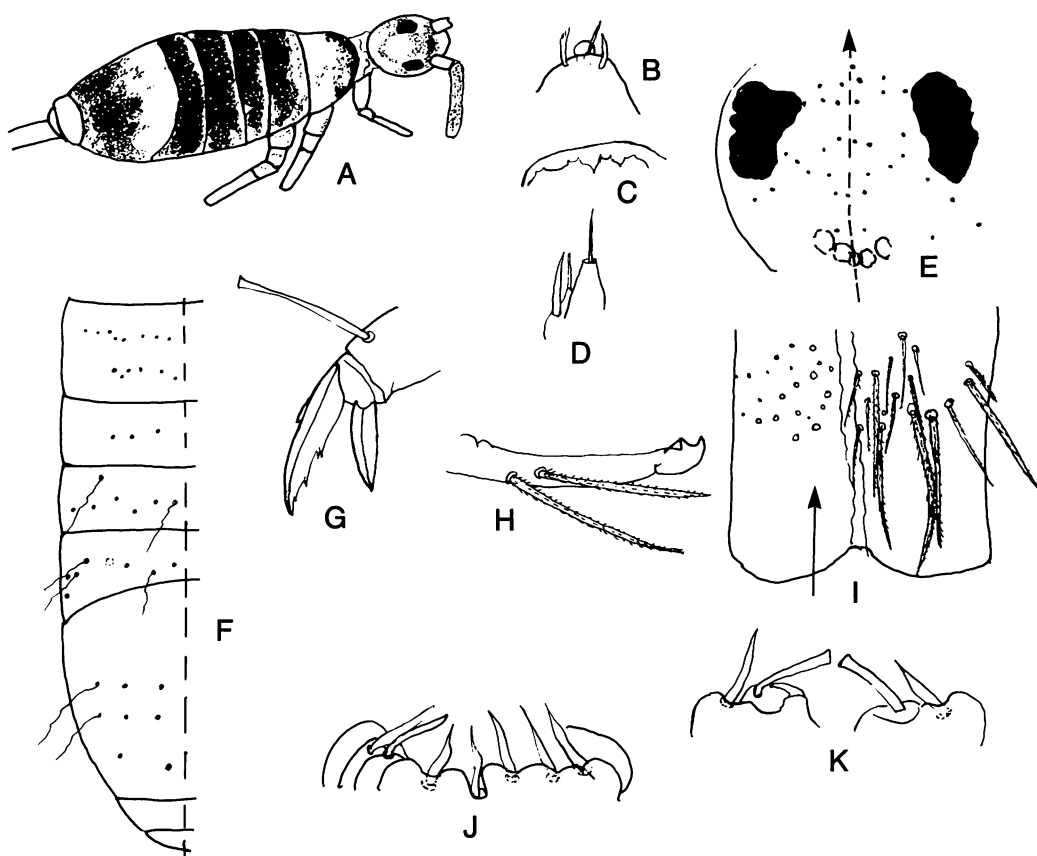


Plate 80—*Entomobrya (E.) albocincta* (all figures of specimens from Hawaii): **A**, habitus (4852); **B**, apex of antenna (6823); **C**, labral papillae (4850); **D**, external differentiated seta of labial appendage (same); **E**, interocular macrochaetae (6823); **F**, semidiagrammatic macrochaetae of left side, third thoracic segment–fourth abdominal segment; **G**, hind foot complex (4852); **H**, mucro and apex of dens (4850); **I**, front of ventral tube, setae removed from right half (5356); **J**, male genital plate seen from front (4852); **K**, differentiated basal setae of male genital plate (5356).

organ with 5–7 setae in arms and 1–3 erratic setae. Tibiotarsus with 1–2 internal rows of large ciliate setae. Tenent hair heavy, prominent, and strongly clavate. Unguis with typical 7 teeth, all small but obvious; basal inner tooth slightly larger than others and at $\frac{1}{2}$ to $\frac{3}{5}$ from base to apex of inner surface. Unguiculus smooth or very finely ciliate externally. Mucro with teeth subequal and basal spine just attaining apex of anteapical tooth. Body setae of type 1 (see Christiansen and Bellinger 1980–1981:817) small, only slightly clavate and straight or very slightly flexed at apex. Body setae of type 5 slender, acuminate, and multilaterally ciliate for apical $\frac{1}{2}$ – $\frac{3}{5}$ of length. Maximum length 2.1 mm.

Remarks: The pattern, labral and labial structure, and claws of Hawaiian specimens are all indistinguishable from the conditions seen in European specimens. Because body setae of type 1 are usually missing, and because of the heavy pig-

mentation of the third abdominal segment, the chaetotaxy is difficult to make out; the usual arrangement is that shown in Table 19, but there may be variation, and possible differences from the European condition are unreliable. Apparent differences in the male genital plate from that figured by Stach (1963) are minor and might be the result of differences in preparation and angle of viewing.

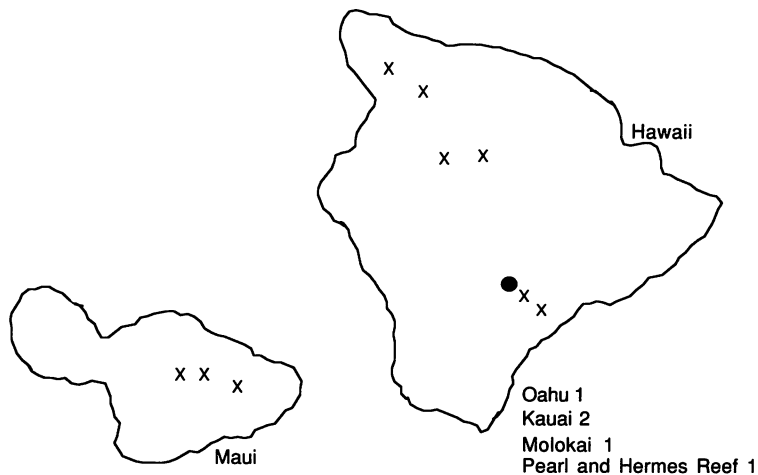
Ecology: So far found only above 3000 ft. elevation in wooded areas, in litter, under stones, and in low vegetation.

Records: Hawaii: 4850, 4852, 4856, 4928, 5154, 5323, 5356, 5358, 5368, 5372, 5375, 6823, 6905, 6906. Maui: 5183, 5364.

Entomobrya (Entomobrya) atrocincta Schött, 1896 (Plate 81)

Proc. Calif. Acad. Sci. (2) 6:181.—Christiansen and Bellinger, 1980.

Background dark to very pale yellow with blue to purplish pigment on antennae, generally limited to apical half of segments, eyepatches, cheek patches, and interantennal band, and on anterior margin of mesothorax; many specimens also have a band on the posterior margin of the mesothorax and all of the 2 following segments. Head ovoid in dorsal view. Labral papillae low, multisetaceous with very minute setae. Trochanteral organ with 5–7 setae in arms and 1–3 intermediate setae. One or 2 rows of weakly differentiated large setae internally on tibiotalar-sus. Tenent hair prominent and clavate. Unguis sharply tapered in apical half; 7 teeth, with inner, especially median, teeth larger than lateral or external teeth, and basal internal teeth slightly beyond middle of internal edge. Unguiculus externally finely ciliate. Mucro elongate; apical tooth distinctly longer than anteapical and basal spine attaining or slightly exceeding apex of latter. Body setae of type 5 short, slender, and coarsely ciliate for apical $\frac{2}{3}$ – $\frac{4}{5}$ of their length. Maximum length 1.8 mm.



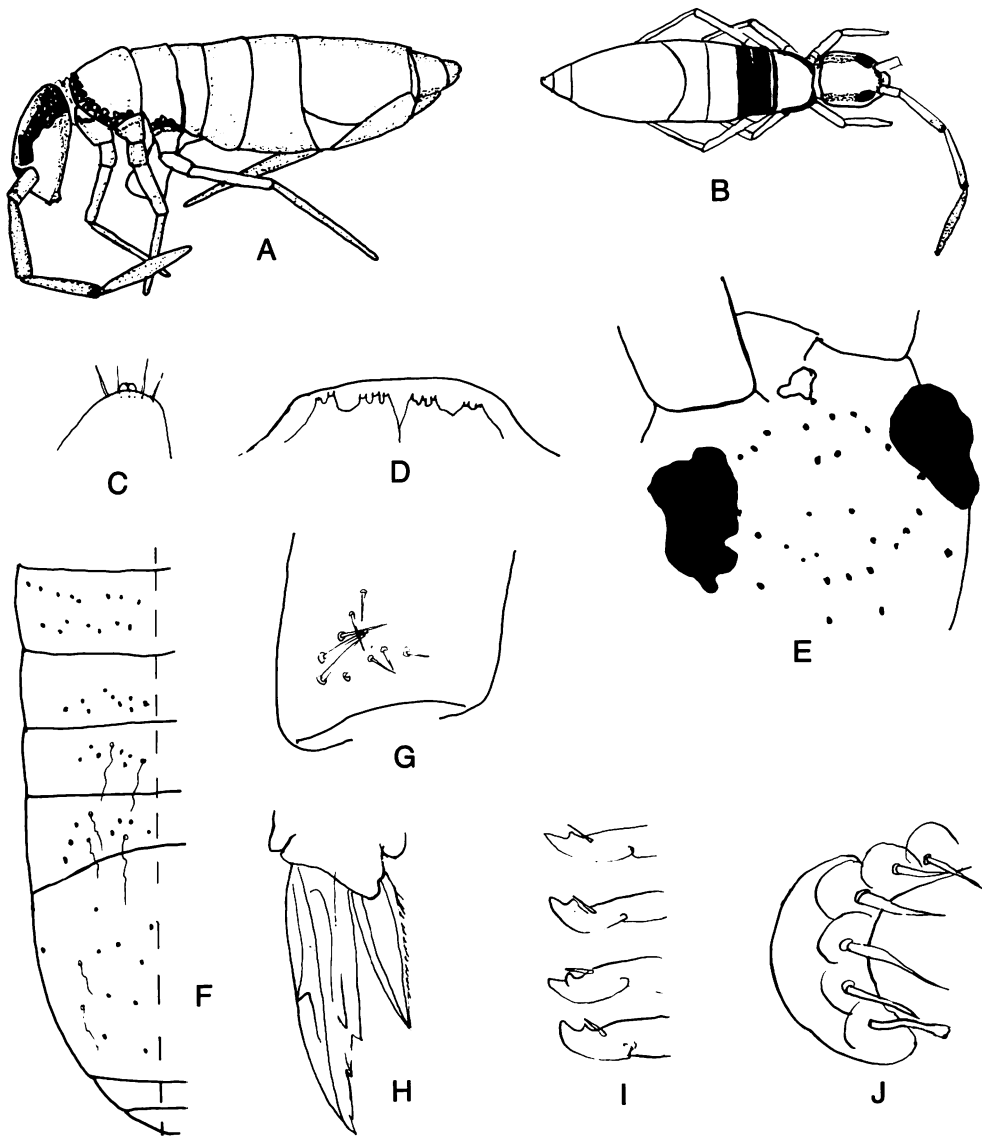


Plate 81—*Entomobrya (E.) atrocincta*: **A**, habitus (after Christiansen); **B**, common pattern variant (after Stach); **C**, apex of antenna (6837, Pearl and Hermes Reef); **D**, labral papillae (after Christiansen); **E**, interocular macrochaetae (6839, Hawaii); **F**, semidiagrammatic macrochaetae, left side, third thoracic segment-fourth abdominal segment (composite); **G**, trochanteral organ (after Christiansen); **H**, hind foot complex (same); **I**, mucro (same); **J**, male genital plate (4751, Maui).

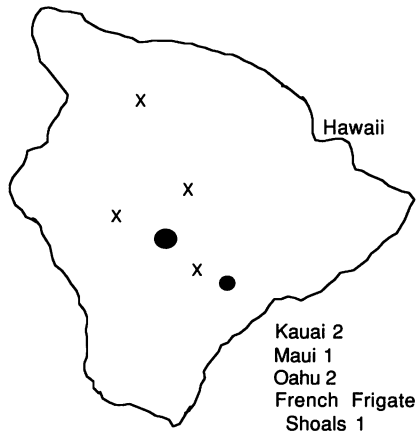
Remarks: This species is so similar to *E. nyhusae* that many of our own records remain in doubt. The two can be distinguished clearly only by the chaetotaxy of the third abdominal segment or the structure of the male genital plate; other features overlap so much that secure identification is impossible. Seta m_{3ca} of the second abdominal segment is displaced posteriorly compared to the position shown in Plate 82G. The patterns seen in Hawaiian specimens are much less varied than those in North American material; almost all Hawaiian examples have one of the two illustrated patterns (Plate 81).

Ecology: Generally found in grass and litter on roadsides, lawns, and other grasslands, and scrub forest. One record under bark and one in a shearwater burrow.

Records: Hawaii: 4860, 4861, 4863, 4865, 4867, 4930, 5135, 5375, 5428, 6839. Maui: 4751, 5373, 6190. Molokai: Chilson (1960). Oahu: 4818. Kauai: 4740, 4741. Pearl and Hermes Reef: 6837.

Entomobrya (Entomobrya) nyhusae Christiansen and Bellinger, **new species** (Plate 82)

Background yellow with blue to purple pigment on antennae, eyepatches, interantennal band, and sometimes a dorsal "V" on head, and in patches just behind eyes; anterior margin of mesothorax, and sometimes its posterior margin and all of the next 2 segments, also pigmented. Head ovoid in dorsal view. Labral papillae varying from papillate with microsetae to broadly rounded with 2-3 setae. Trochanteral organ with 5-7 setae in arms and up to 3 intermediate setae. Tibiotarsus with 2 rows of weakly differentiated large ciliate setae internally. Tenent hair prominent and clavate. Unguis sharply tapered in apical half, with 7 teeth; internal teeth, especially median, larger than others; basal inner teeth slightly beyond middle of inner edge. Unguiculus externally serrate and internally serrulate. Mucro elongate, with apical tooth usually slightly longer than antepical



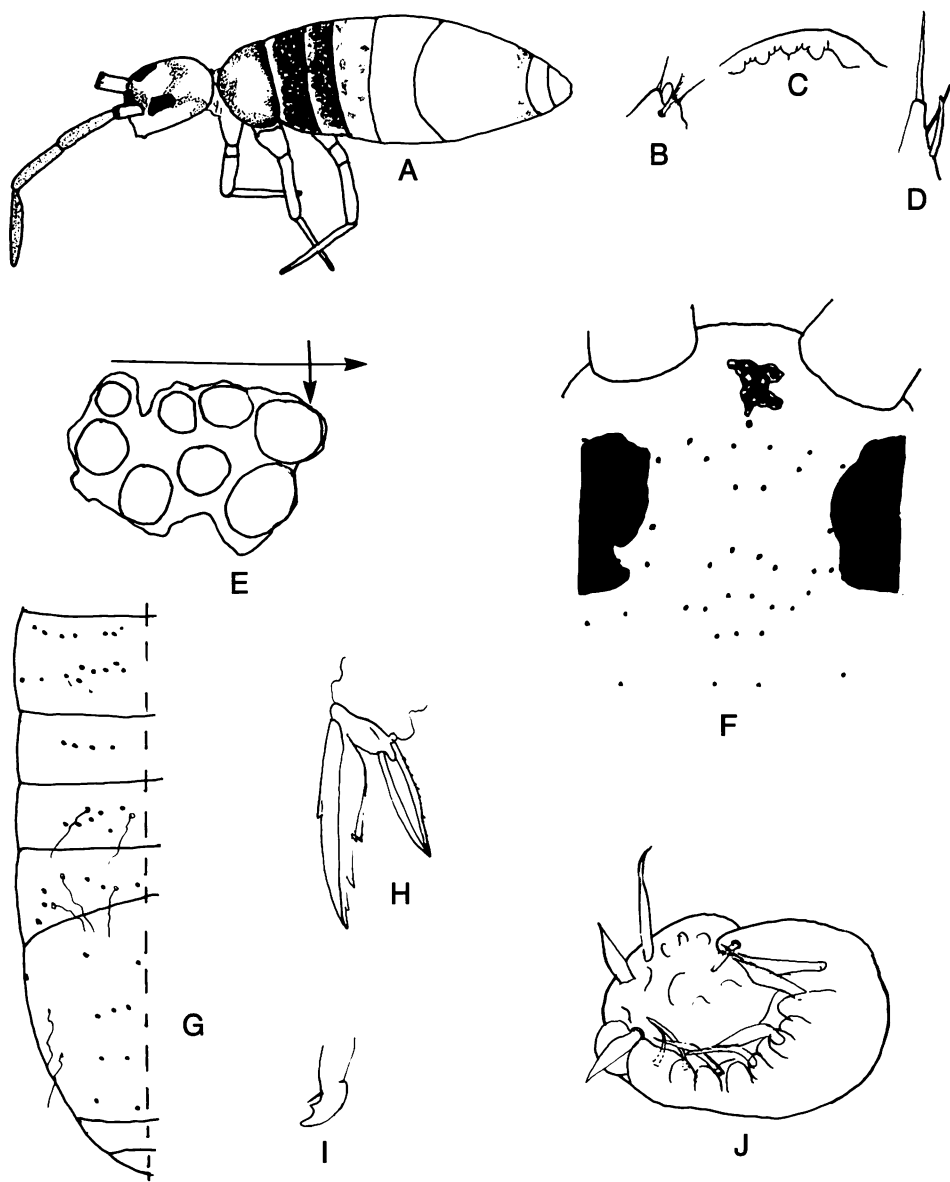


Plate 82—*Entomobrya (E.) nyhusae*: **A**, habitus (type specimen); **B**, apex of antenna (6844, Hawaii); **C**, labral papillae (4853, Hawaii); **D**, differentiated seta of labial appendage (same); **E**, right eyepatch (same); **F**, interocular macrochaetae (6838, French Frigate Shoals); **G**, semidiagrammatic macrochaetae, left side, third thoracic segment-fourth abdominal segment (composite); **H**, hind foot complex (4853, Hawaii); **I**, mucro (same specimen); **J**, male genital plate (same specimen).

tooth, which is exceeded by basal spine. Body setae of type 1 straight or slightly flexed and strongly clavate. Body setae of type 5 slender and multilaterally ciliate for $\frac{3}{4}$ – $\frac{4}{5}$ of length. Maximum length 1.5 mm.

Remarks: This species is extremely similar to *E. atrocincta* in pattern, color, and most other features. The easiest and most reliable character to use in Hawaiian material is the chaetotaxy of the third abdominal segment; a_3 is always absent in *E. nyhusae* and present in *E. atrocincta* (but may be absent in some nearctic *E. atrocincta*). The large difference in number of macrochaetae of the first abdominal segment shown in Table 19 actually reflects minor differences in the size of certain setae and is hard to recognize. The apical antennal bulb is always round and single, but may be withdrawn into the antenna. We first thought the apparent differences were due to intraspecific variation, but these differences are associated with two distinct types of male genital plates; the three heavy, sharply truncate lateral setae on each side of *E. nyhusae* distinguish it clearly from *E. atrocincta*, which has slender, acuminate setae in those positions. In most cases where the two occur together, the patterns of the two species differ strikingly. The relationship and distinction between the species need further study.

This species may be the same as *E. tokunagai* Yosii, 1942. However, Yosii described *E. tokunagai* as having antennae four times as long as the head, while this ratio never exceeds three in *E. nyhusae*.

Derivatio nominis: Named after Karin Nyhus, whose work was essential for this project.

Ecology: In grass, litter, or moss, or under rocks, usually in grassy or scrub areas but occasionally in deep forest.

Type locality: Holotype and 1 paratype, Hawaii, Hawaii Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2040 m, *Metrosideros*, scrub zone, berlese, Goff & Radovsky (4867).

Additional records: Hawaii: 4853, 4859, 4860, 4863, 4865, 4866, 4867, 4868, 4876, 4930, 5059, 5336, 5358, 5368, 5372, 6392, 6844, 6846. Maui: 5172. Oahu: 4825, 5218. Kauai: 4734, 4736. French Frigate Shoals: 6838.

Entomobrya (Entomobrya) powehi Christiansen and Bellinger, **new species** (Plate 83)

Background color off white; eyepatches dark; usually a dark interantennal band; body unpigmented, with a faint bluish wash, or with mottled blue color and regular pale to dark bands across posterior margins of all trunk segments except the first, and with a bluish wash on legs; rarely with a pale pigmented band covering all of the third and the posterior half of the second abdominal segment. Apical antennal bulb simple, often so deeply withdrawn that it appears to be absent. Head ovoid in dorsal view. Labral papillae low, very difficult to see; each with 1–3 minute setae. Trochanteral organ with 3–4 unusually heavy setae in each arm; no erratic setae seen. Tibiotarsus with a row of slightly larger setae along inner margin. Tenent hair prominent and clavate. Unguis with usual 7 teeth, all small; basal inner teeth slightly before middle of inner margin. Mucro with teeth subequal or

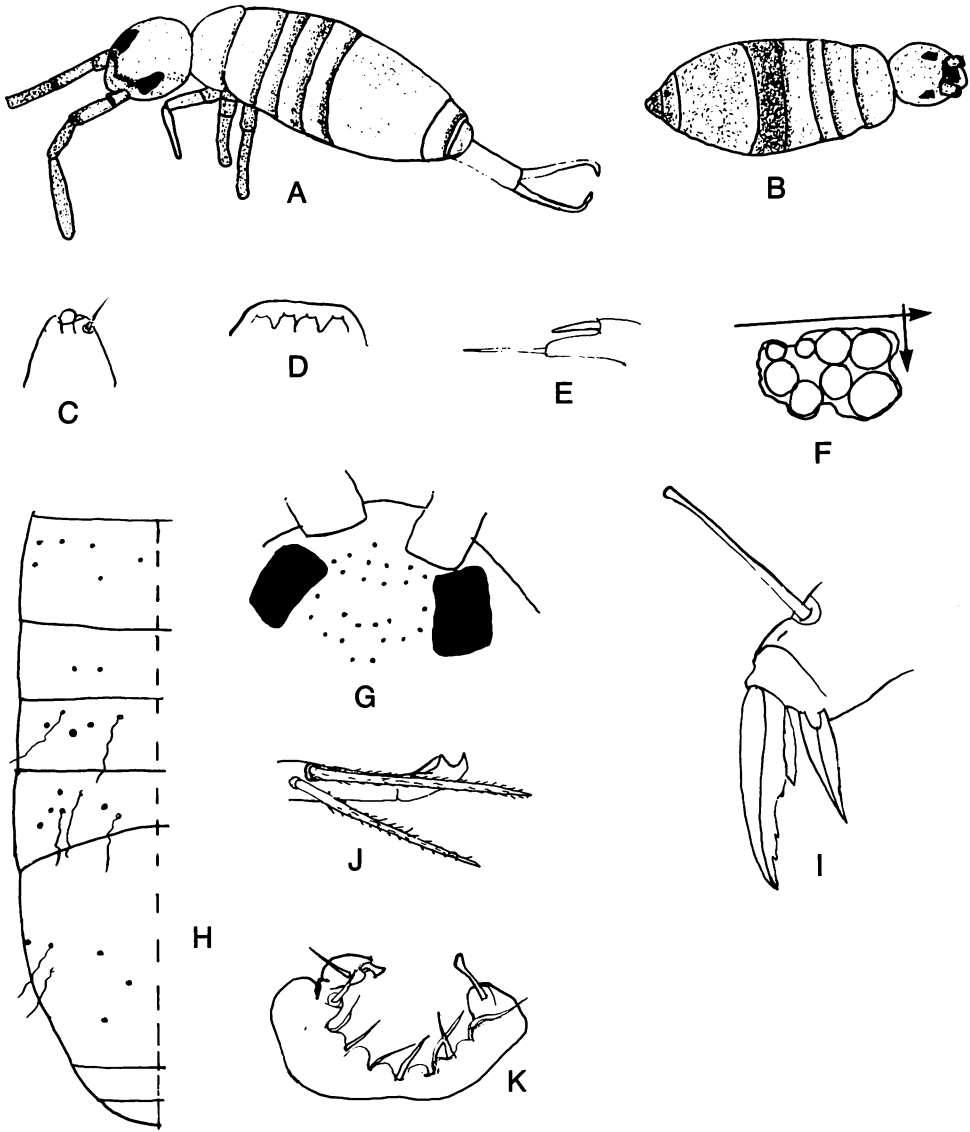
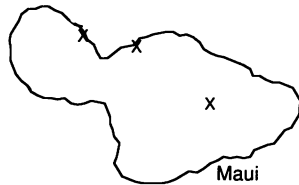
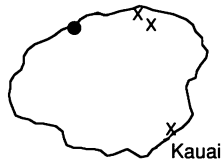


Plate 83—*Entomobrya (E.) powehi*: **A**, habitus (type specimen); **B**, pattern variant (another type specimen); **C**, apex of antenna (type specimen); **D**, labral papillae (6674, Maui); **E**, differentiated seta, labial appendage (type specimen); **F**, right eyepatch (same); **G**, interocular macrochaetae (same specimen as D); **H**, semidiagrammatic macrochaetae, left side, second thoracic segment-fourth abdominal segment (composite); **I**, hind foot complex (type specimen); **J**, mucro and apex of dens (6674, Maui); **K**, male genital plate (same specimen).



Hawaii 1
Molokai 1
Oahu 1

with anteapical tooth slightly larger; basal spine just attaining apex of anteapical tooth; setae of apex of dens strongly ciliate. Body setae of type 1 strongly bent at apex but not greatly expanded. Setae of type 5 slender and multilaterally ciliate for $\frac{5}{6}$ or more of length. Maximum length 1.5 mm.

Remarks: This is the only Hawaiian species with a single macrochaeta on each side of the third abdominal segment. *E. assuta* Folsom, 1924 is similar in the small number of macrochaetae and the range of patterns, but the chaetotaxy of its second and third abdominal segments is different. *E. makaluae* Yosii, 1971a and *E. sineloides* Christiansen, 1958 have similar patterns, but the former has notably heavy tibiotarsal setae and the latter lacks the apical antennal bulb. A single specimen was seen with two apical antennal bulbs. One specimen of *E. powehi* seems to have an indented apical bulb, but generally they are clearly simple.

Derivatio nominis: Hawaiian, obscure.

Ecology: Found in elevations from 250 to 2000 ft. in mixed forests under rocks, bark, and in rotten wood. Also taken from low vegetation.

Type locality: Holotype and 5 paratypes, Oahu, upper Manoa Valley, Anouai Place, VIII-1966, general collecting, PB (4753).

Additional records: Hawaii: 6846. Maui: 5364, 6674, 6684. Molokai: 5499. Kauai: 5192, 6711, 6717, 6719, 6728.

Entomobrya (Entomobrya) griseoolivata (Packard, 1873) (Plate 84)
Rep. Peabody Acad. Sci. 5:39 (*Degeeria*).—Christiansen and Bellinger, 1980.

Background white to pale yellow; antennae pale bluish; eyepatches and interantennal band very dark; body pigment generally confined to lateral and anterior margins of mesothorax, but sometimes with cheek patches and mottled bluish pigment over the whole trunk, occasionally forming dark lines on the posterior segment margins; trunk sometimes without dark pigment. Apical antennal bulb double or single and deeply indented. Head in dorsal view a rounded hexagon. Labral papillae with extremely minute microsetae. Trochanteral organ with 5–6 setae in one arm, 6–7 in the other, and 3–4 erratic setae. Tibiotarsus with 2 inner rows of heavy, ciliate, differentiated setae. Tenent hair heavy and clavate. Unguis with the

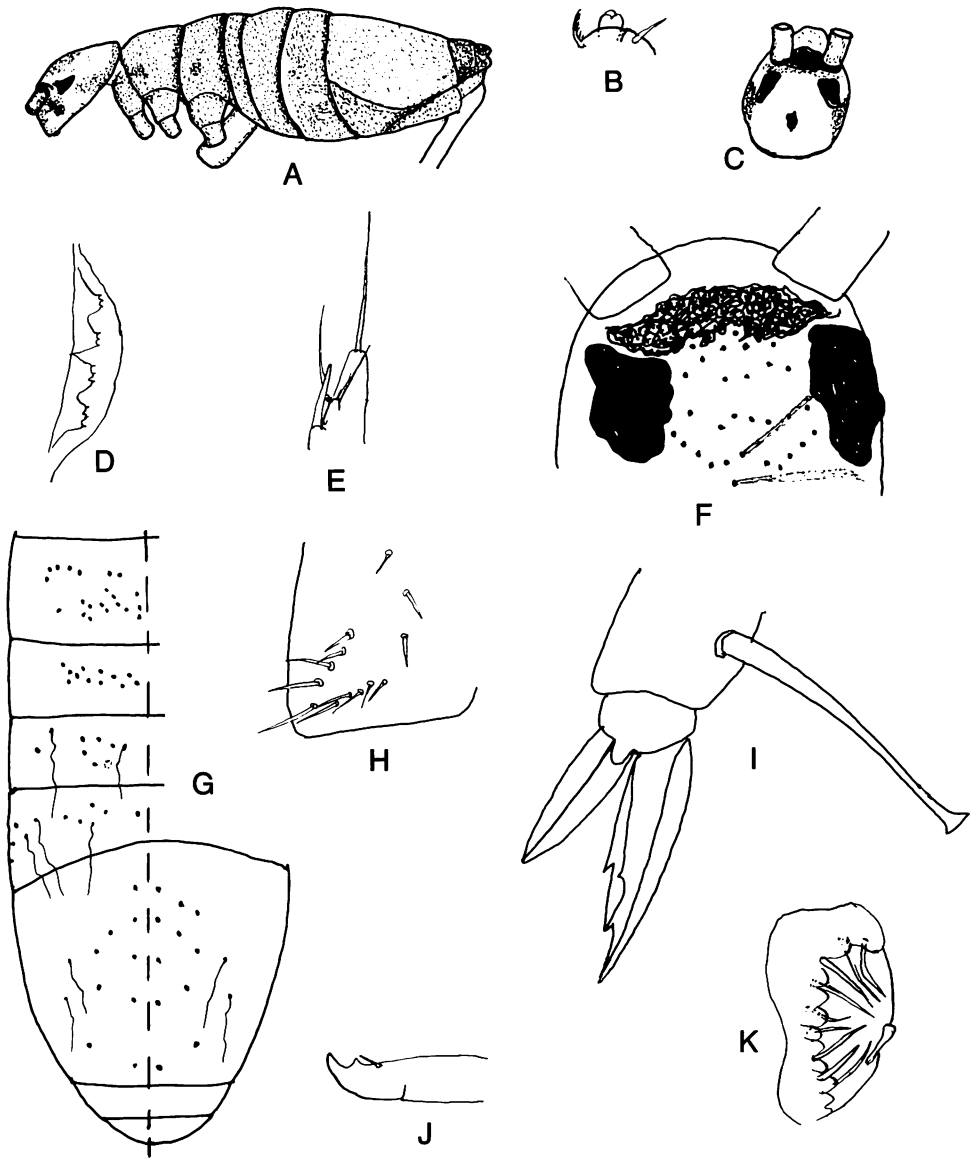
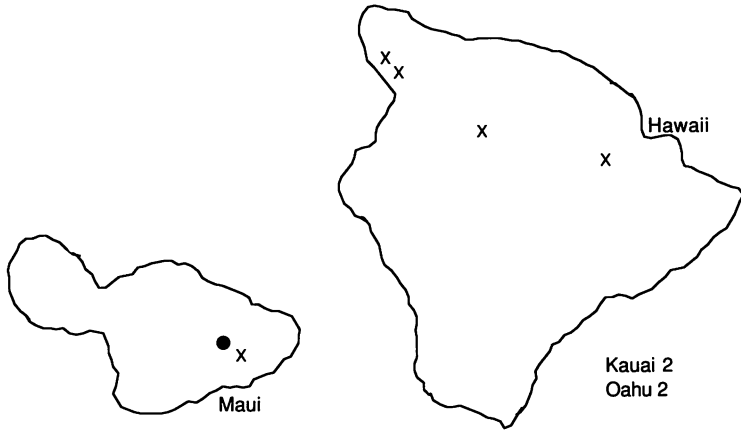


Plate 84—*Entomobrya (E.) griseoolivata*: **A**, habitus (after Christiansen); **B**, apex of antenna (5218, Oahu); **C**, head pattern seen in all Hawaiian specimens (after Christiansen); **D**, labral papillae (same); **E**, differentiated labial seta (same specimen as B); **F**, interocular setae (4733, Kauai); **G**, semidiagrammatic macrochaetae, left side, third thoracic segment—fourth abdominal segment (two different forms shown on fourth abdominal segment [composite]); **H**, trochanteral organ (after Christiansen); **I**, fore foot complex (same specimen as E); **J**, mucro (same specimen); **K**, male genital plate (same specimen).



usual 7 teeth, all small; basal inner teeth just before middle of inner edge. Unguiculus serrate on outer edge. Antepical mucronal tooth subequal to or slightly smaller than apical tooth, with basal spine not quite attaining its apex. Body setae of type 1 heavily clavate and/or strongly flexed. Body setae of type 5 slightly thickened medially and multilaterally ciliate for apical $\frac{1}{2}$ - $\frac{2}{3}$ of length. Maximum length 2.0 mm.

Remarks: This is the only Hawaiian species of *Entomobrya* s.str. with the macrochaetae m_{3ep} on the second abdominal segment and m_{3e} on the third. Some apparent variation in the chaetotaxy of the first abdominal segment may be the result of difficulty in accurate observation of this segment in our material. There are some minor differences in pattern between Hawaiian and North American specimens, and the cephalic patterns are not varied in the Hawaiian populations as they are in the North American specimens, and the male genital plate of Island specimens is more like that of *E. marginata* (Tullberg, 1871) than that of North American *E. griseoolivata*, but for now we prefer to use this name for our Island material. Additional variation includes the occasional presence of a very small m_{3ei} and the more anterior position of m_{3ep} in Kauai specimens. The status of the Island, nearctic, and European forms merits further study.

Ecology: Found under rocks and debris in disturbed areas.

Records: Hawaii: 5654, 5656, 5666, 6846. Maui: 5186, 5366, 6190. Oahu: 5218, 5639. Kauai: 4733, 6717. Laysan I.: Butler and Usinger (1963*b*), as *E. marginata*.[?]

***Entomobrya (Entomobrya) panoanoa* Christiansen and Bellinger, new species**
(Plate 85)

Background white to pale yellow; antennae pale blue; eyepatches and interantennal band dark; head with a more or less obvious **W**-shaped interocular marking, opening posteriorly; body with irregular broken transverse bands on fifth and middle of fourth abdominal segment, narrow dark posterior lines on the third and fourth abdominal and sometimes on the third thoracic segments, and additional

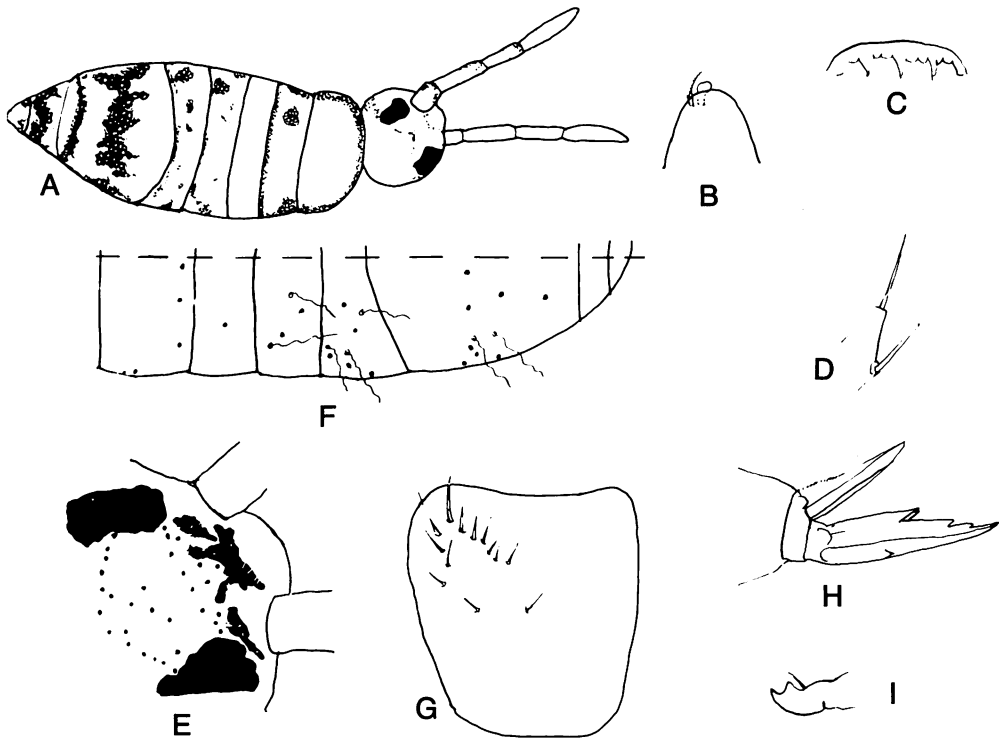
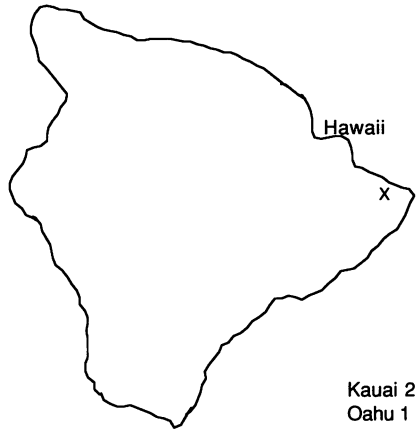


Plate 85—*Entomobrya (E.) panoanoa*: A, habitus (4744, Kauai); B, apex of antenna (4771, Oahu); C, labral papillae (same specimen); D, external differentiated seta of labial appendage (same); E, interocular setae (type specimen); F, semidiagrammatic macrochaetae, left side, third thoracic segment-fourth abdominal segment (composite); G, trochanteral organ (5132, Hawaii); H, hind foot complex (4771, Oahu); I, mucro (same specimen).

irregular spots on the third thoracic and second and third abdominal segments; sometimes with darkened lateral areas on the body. Apical antennal bulb single, slightly displaced from apex. Head in dorsal view roughly circular or slightly broader than long. Labral papillae small, with 2-3 micropapillae each. Trochanteral organ with 4-6 setae in each arm, 1 less in dorsal than in ventral arm, and 0-2 intermediate setae. Tibiotarsus without clearly differentiated larger ciliate setae. Tenent hair prominent and clavate. External unguinal tooth minute or absent; basal inner teeth larger than others and $\frac{1}{3}$ - $\frac{1}{2}$ way from base to apex of inner margin. Outer margin of unguiculus clearly serrate. Mucronal teeth subequal; basal spine not quite attaining apex of anteapical tooth. Body setae of type 1 not strongly clavate, usually straight or weakly flexed at apex. Body setae of type 5 slightly swollen medially and multilaterally ciliate for apical $\frac{1}{3}$ of length. Maximum length 1.5 mm.

Remarks: This rare species has been found with, and can be confused with, the common *E. multifasciata*, but is distinguished by both chaetotaxy and details of the



pattern. There is variation in both features in *E. panoanoa*, and it is possible that this actually includes several species. Unfortunately, no male genital plate has been seen.

Derivatio nominis: Hawaiian, rare.

Ecology: Found on low vegetation in wooded areas.

Type locality: Holotype, Kauai, under Mt. Waialeale, on main tributary of Wailua River, road end near intake house, 16-I-1967, swept from grass, PB (4731).

Additional records: Hawaii: 5132. Oahu: 4771. Kauai: 4744.

Entomobrya (Entomobrya) multifasciata (Tullberg, 1871) (Plate 86)

Ofver. K. Vet. Akad. Forh. 28:148 (*Degeeria*).—Christiansen and Bellinger, 1980.

Entomobrya nivalis (L.) of Bellinger and Christiansen, 1974:34.

Entomobrya multifasciata var. "imminuta" Folsom, 1932, Proc. Hawaii. Entomol. Soc. 8:64.

Background color yellow to blue; antennal segments apically darkened; head in addition to dark eyepatches and interantennal band with blue cheek patches and usually with a blue V opening forward (sometimes with a median line) on the dorsum; blue pigment in irregular bands across posterior margins of all body segments and anterior margin of the mesothorax and the middle of the fourth abdominal segment. Head ovoid in dorsal view. Labrum with clear secondary papillae and small microsetae. Trochanteral organ with 5–8 setae in arms and 2–4 intermediate setae. Tibiotarsus with double row of stout, basally expanded ciliate setae, about 3 times as thick as smallest setae at same level. Tenent hair thick and strongly clavate. Unguis with usual 7 teeth; lateral teeth large and salient; inner teeth small and subequal; basal inner teeth just beyond middle of inner margin. Outer edge of unguiculus smooth. Anteapical mucronal tooth slightly shorter than apical tooth, with basal spine just attaining its apex. Body setae of type 5 gradually tapered from base and coarsely multilaterally ciliate for distal $\frac{3}{4}$ – $\frac{7}{8}$ of length. Maximum length 2.5 mm.

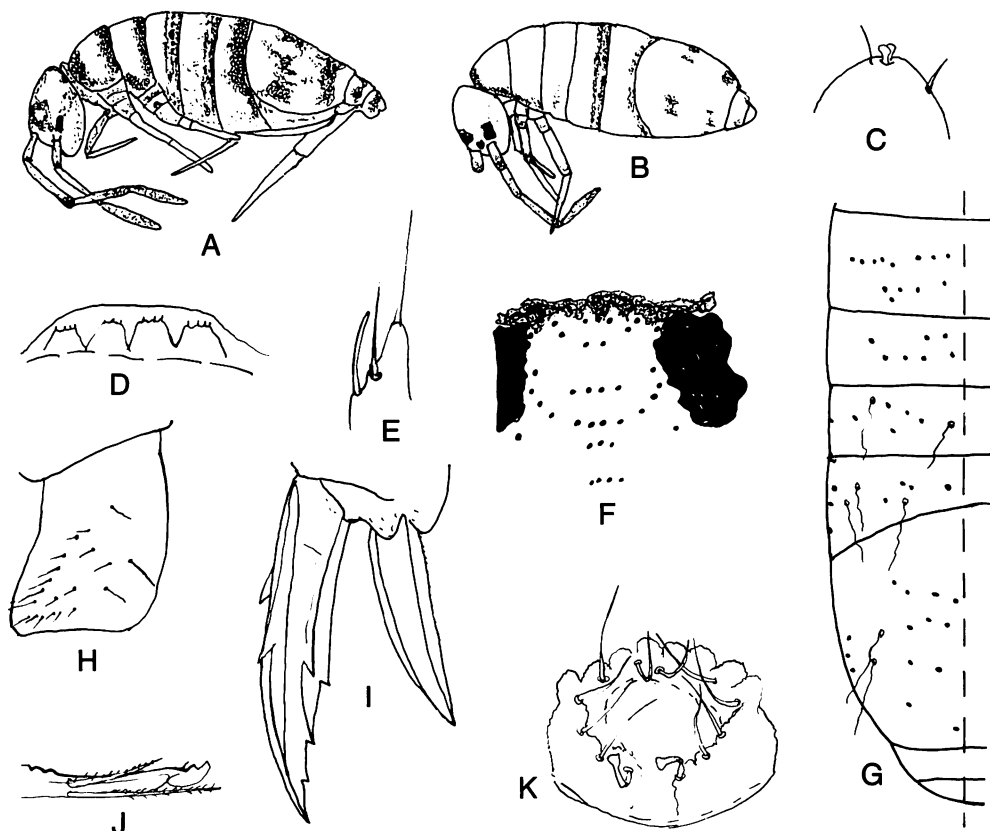
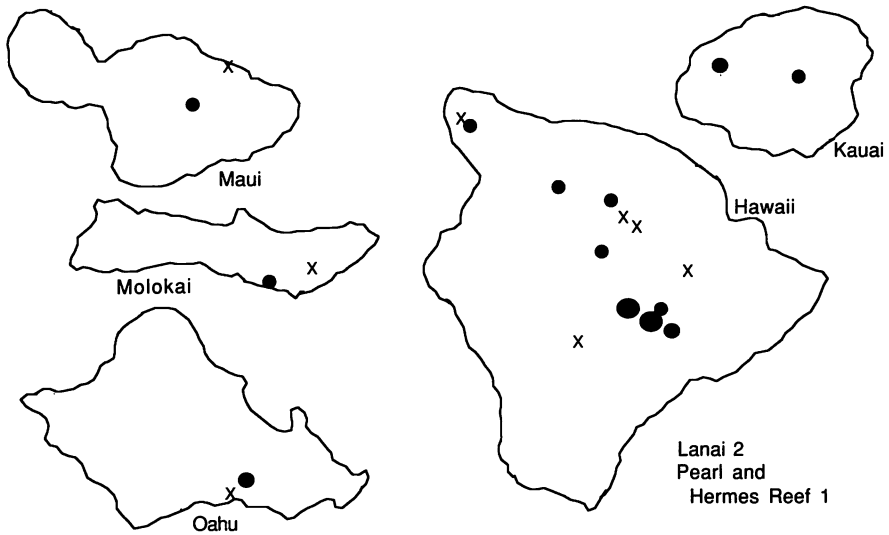


Plate 86—*Entomobrya (E.) multifasciata*: A, habitus (after Folsom); B, habitus, common Hawaiian variant (4734, Kauai); C, apex of antenna (4740, Kauai); D, labral papillae (after Christiansen); E, differentiated labial appendage seta (4740, Kauai); F, interocular macrochaetae (5679, Hawaii); G, semidiagrammatic macrochaetae, left side, third thoracic segment-fourth abdominal segment (composite); H, trochanteral organ (after Stach); I, hind foot complex (after Christiansen); J, mucro and apex of dens (after Folsom); K, male genital plate (after Christiansen).

Remarks: The Hawaiian specimens show much less variation in pattern than do nearctic ones, but one common pattern variant (see Pl. 86B) is rarely seen in nearctic material. Some Island specimens also may have the differentiated labial seta atypically long. However, the Hawaiian specimens appear to fall within the range of nearctic material in the characters analyzed here; although a more thorough study might justify their separation, we are not prepared to carry this out except on the basis of many more collections of this widespread species from other regions. The characters used by Folsom (1932) in erecting his variation "immunita" are unreliable and inconsistent, and its separation on this basis is unjustified.

Specimens from a few collections on Oahu do not show a clearly lobed antennal bulb. The m_3 seta of the second abdominal segment is more anterior than shown (Pl. 86G) in some specimens.



This species can be confused with *E. panoanoa*, but is easily distinguished by the chaetotaxy, notably the more numerous dorsal macrochaetae of the third abdominal segment.

Ecology: Found in litter, moss, soil, and low vegetation in a wide variety of well-traveled habitats. One record from an animal burrow.

Records: Hawaii: 4853, 4854, 4857, 4858, 4859, 4860, 4861, 4863, 4865, 4867, 4868, 4876, 4878, 4900, 4904, 4930, 4931, 5059, 5135, 5136, 5154, 5333, 5336, 5356, 5358, 5359, 5365, 5370, 5375, 5488, 5654, 5655, 5656, 5659, 5666, 5670, 5677, 5679, 5690, 6392, 6839, 6844. Maui: 4750, 5373, 6190. Molokai: 5714, 5727, 6863. Lanai: 6691, 6857. Oahu: 4752, 4783, 4815, 4825. Kauai: 4731, 4734, 4740, 4741, 6527, 6729. Pearl and Hermes Reef: 4910, 4913, 6837.

Entomobrya (Entomobrya) unostrigata Stach, 1930 (Plate 87)

Abh. Senckenb. Naturforsch. Ges. 42:63.—Christiansen and Bellinger, 1980.

Background white; blue pigment on antennae, eyepatches, interantennal spot or wide band, usually a dorsal median spot on head, midline and lateral margins of first 5 trunk segments, in a band across posterior $\frac{1}{4}$ of second abdominal segment, and in pale lateral and incomplete median stripes and a posterior marginal band on fourth abdominal segment. Head almost circular in dorsal view. Labral papillae strongly unisetaceous to bisetaceous. Trochanteral organ with 5–8 setae in arms and 1–3 internal setae; dorsal arm always with 1–2 more setae than ventral arm. Two rows of large setae on inner face of tibiotarsus. Tenent hair prominent and clavate. Unguis with usual 7 teeth; median inner tooth more prominent than others. Unguiculus sparsely serrate externally. Anteapical mucronal tooth very small with apex exceeded by basal spine. Body setae of type 5 tapered from base and multilaterally ciliate for apical $\frac{1}{2}$ – $\frac{3}{4}$ of length. Maximum length 2.5 mm.

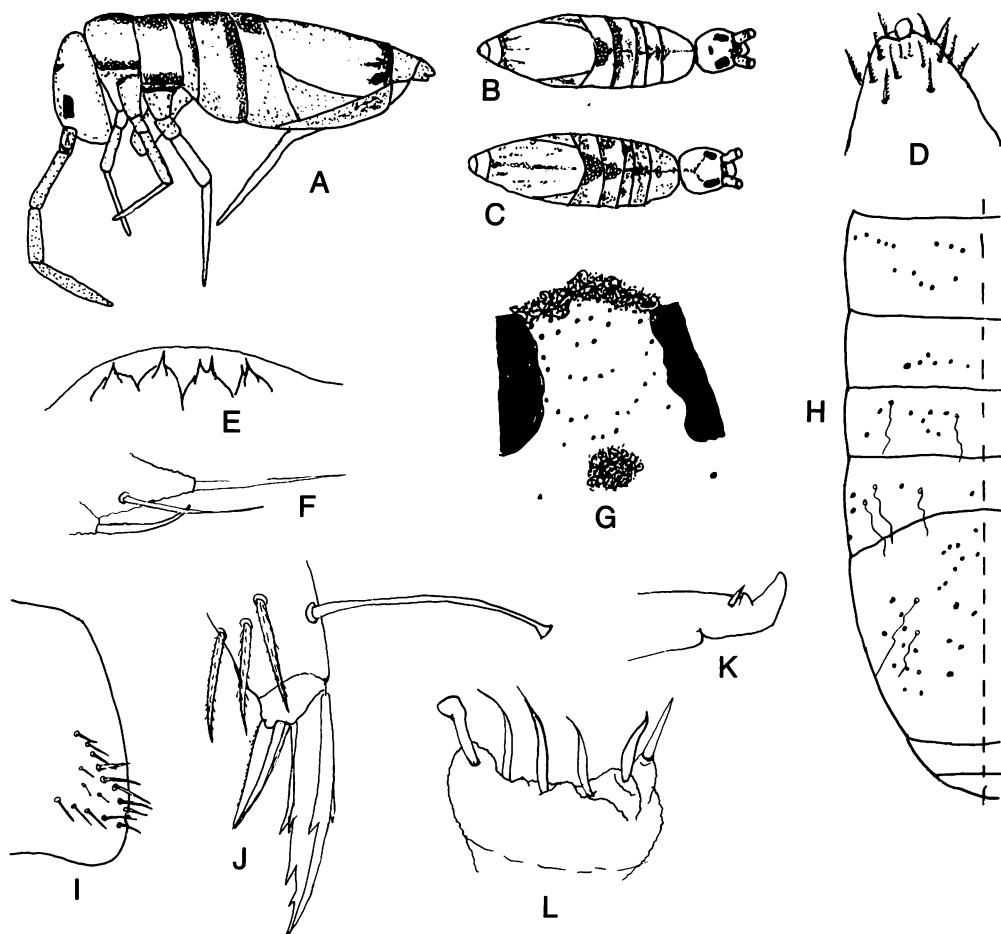


Plate 87—*Entomobrya (E.) unostriata*: A, habitus (after Christiansen); B and C, pattern variants similar to those common in Hawaii (same); D, apex of antenna (after Stach); E, labral papillae (composite); F, differentiated seta of labial appendage (after Christiansen); G, interocular macrochaetae (6194, Midway Atoll); H, semidiagrammatic macrochaetae, left side, third thoracic segment–fourth abdominal segment (same); I, trochanteral organ (same); J, hind foot complex (same); K, mucro (after Christiansen); L, male genital plate (same).

Remarks: These specimens agree well with nearctic material except for the unusually large median and distal inner ungual teeth. Some Hawaiian specimens lack seta 3. on the third abdominal segment, and all have two clear lobes on the antennal bulb.

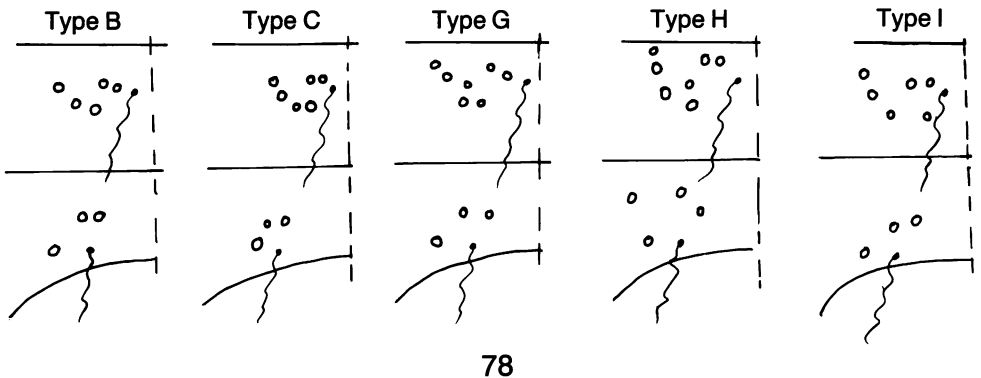
Ecology: This species, of probable Old World origin, has been spreading in the United States since 1932 and has recently been found on Midway Atoll. It survives in a wide variety of habitats, generally closely associated with human disturbance.

Records: Midway: 6192, 6194, 6841.

Subgenus **ENTOMOBRYOIDES** Maynard, 1951

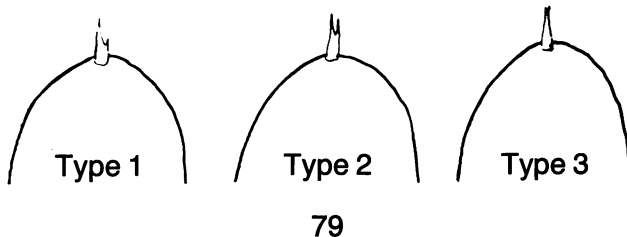
Type species: *Degeeria purpurascens* Packard, 1873

This subgenus is better represented in Hawaii than anywhere else in the world. In addition to the six species discussed here, two probable additional species are each represented by a single specimen, and our *E. guthriei* and *E. kalakaua* will very likely prove to be complexes of several species when fully analyzed. The Hawaiian species all have eyes G and H much smaller than the others and only limited variation in the chaetotaxy of the second abdominal segment, indicating recent common ancestry for all. All except *E. puakea* and *E. kea* have male genital plates similar to the types seen in *E. guthriei* Mills. The group merits much further study. The types of second and third abdominal segment chaetotaxy seen in the Hawaiian specimens are shown in Figure 78. The pin seta of the antenna is also of taxonomic importance and the Hawaiian variations of this structure are shown in Figure 79. We recognize six species of subgenus *Entomobryoides* at present: *guthriei*, *kalakaua*, *kea*, *malena*, *mauna*, and *puakea*.



78

Figure 78—Second and third abdominal segment chaetotaxy types in Hawaiian *Entomobryoides*.



79

Figure 79—Pin seta types in Hawaiian *Entomobryoides*.

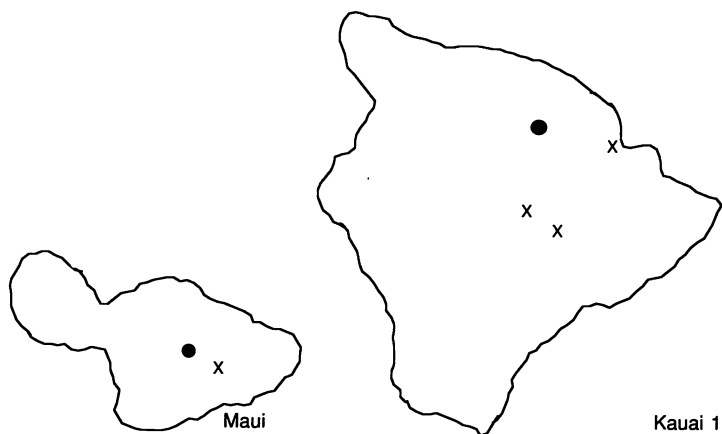
Table 20. Characteristics of Hawaiian Species of *Entomobrya*, Subgenus *Entomobryoides* (see Fig. 78 and 79)

SPECIES	ANTENNAL PIN SETA TYPE	DIFFERENTIATED LABIAL SETA/ SAME PAPILLA	LABIAL TRIANGLE SETAE*					TYPE OF ABD. II-III MACROCHAETE DISTRIBUTION	NO. OF MEDIAL MACROCHAETAE ON ABD. IV	PATTERN OTHER THAN POSTERIOR LINES	LOCATION
			M ₁	M ₂	M ₃	E	L ₁				
<i>mauna</i>	2	1.0-1.25	M	(M) m	(m) m	(E) E	L	B, G, H, I	20-24	+, -	Kauai, Maui, Hawaii
<i>puakea</i>	1, (2-3)	0.9-1.3	M	<i>m</i>	<i>m</i>	<i>E</i> (E)	L	(C), G	16	-	Kauai
<i>malena</i>	2-3	0.85-1.2	M	<i>m</i>	<i>m</i>	<i>E</i> E	L	G	14-19	+, -	Oahu
<i>kea</i>	2	1.0-1.4	M	<i>m</i>	<i>m</i>	E	L	H, I	20-22	+, -	Hawaii, Maui
<i>guthriei</i>	1-2-3	1.0-1.4	(M) M	<i>m</i> <i>m</i>	<i>m</i> <i>m</i>	E	L	C	14-16	-	Kauai, Oahu, Molokai
<i>kalakaua</i>	2	0.7-1.1	M	<i>m</i>	<i>m</i>	(E)	(L)	G	27-31	+	Kauai, Oahu

*Larger setae in capitals; ciliate setae in italics.

Entomobrya (Entomobryoides) mauna Christiansen and Bellinger, **new species**
(Plate 88)

Background white to pale yellow; blue to purple or brownish pigment as a pale wash or light to heavy mottling over legs, antennae, and dorsal and lateral surfaces, or forming distinct transverse bands over the dorsal and lateral parts of trunk segments; furcula and posterior parts of head pale. Antenna with an unpigmented protruding apical knob. Head ovoid in dorsal view. Labral papillae strong, unisetaceous with setae obvious. Trochanteral organ with 8 setae in each arm and 4–8 between arms; 1–4 additional erratic setae may occur outside the arms. Tibiotarsus with 2 rows of large outstanding ciliate setae internally; internal “smooth” setae usually weakly ciliate. Tenent hair heavily clavate. Unguis with the usual 7 teeth; apical inner and external teeth smaller than others, which are subequal. Unguiculus with finely serrate outer margin. Basal mucronal spine just or not quite reaching apex of antepical tooth, which is subequal to or slightly shorter than apical tooth. Maximum length 2.5 mm.



Remarks: There are three Hawaiian species sharing the feature of having most of the labial triangle seta smooth. *E. mauna* is very similar to *E. kea* in most respects but has a strikingly different type of male genital plate. Although there are a number of other features that separate the two species, only the second thoracic segment chaetotaxy is sharply different.

Derivatio nominis: Hawaiian, mountain.

Ecology: Found at 7000 ft. and above, under debris in bare areas, sometimes with scattered trees.

Type locality: Holotype and 2 paratypes, Hawaii, Old Mauna Loa Observatory Road, III-20-1964, 7750 ft., debris under ohia and pukiawe, Haas (5246).

Other records: Hawaii: 5300, 5375, 5384, 5386, 5387, 5389, 5449, 5450, 5456. Maui: 5185, 5187, 5260, 5265, 5483. Kauai: 5214.

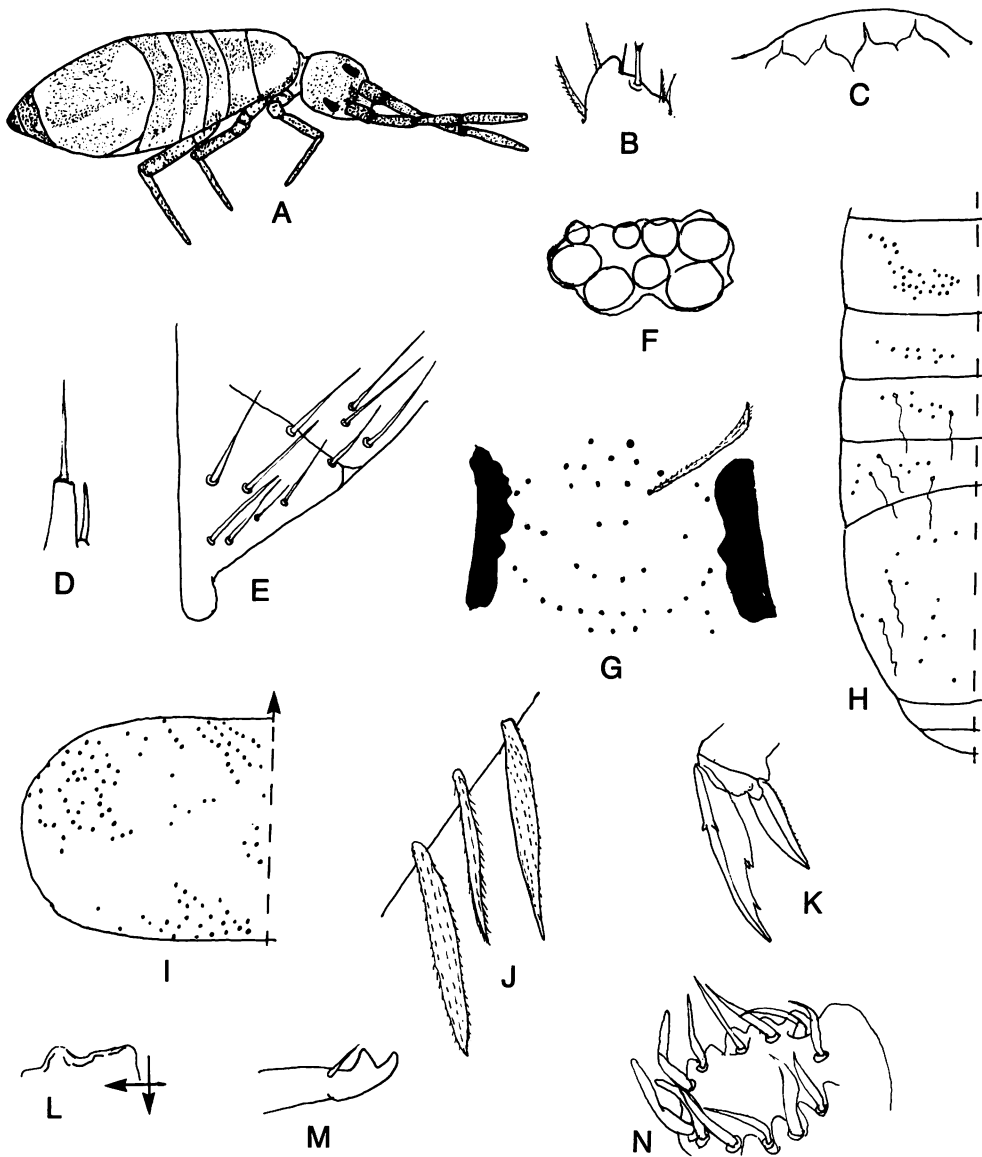
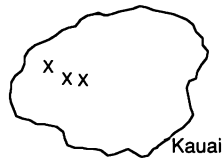


Plate 88—*Entomobrya (Entomobryoides) mauna*: A, habitus (type specimen); B, apex of antenna (5265, Maui); C, labral papillae (same); D, differentiated seta of labial appendage (5260, Maui); E, labial triangle, left side (same specimen); F, right eyepatch (5265, Maui); G, interocular macrochaetae (5187, Maui); H, dorsal macrochaetae, left side, third thoracic segment–fourth abdominal segment (composite); I, detail of left side, second thoracic segment macrochaetae (5449, Hawaii); J, inner tibiotarsal setae showing contrast between “smooth” and ciliate setae (type specimen); K, hind foot complex (5265, Maui); L, manubrial thickening (same); M, mucro (5375, Hawaii); N, male genital plate (type specimen).

Entomobrya (Entomobryoides) puakea Christiansen and Bellinger, new species
(Plate 89)

Background white to yellow; eyepatches and very small interantennal spot dark; antennae usually bluish to purple; body and legs pale or covered with an irregular wash of purplish or brownish pigment, with posterior transverse bands on the last 3 abdominal segments; furcula pale. Apical pin seta of antenna usually unisetaceous. Head nearly circular in dorsal view. Outer pair of labral papillae low and broad; inner pair pointed, with 1-2 microsetae. Differentiated seta of labial appendage heavy and spinelike. Trochanteral organ a rough triangle with arms not clearly delimited. Tibiotarsus with 1 row of large outstanding ciliate setae internally; inner "smooth" setae strongly contrasting with heavily ciliate small setae. Tenent hair heavy and clavate. Unguis with usual 7 teeth; lateral and basal inner teeth larger than others; apical inner tooth minute. Outer margin of unguiculus finely serrate to smooth. Mucronal teeth subequal; basal spine just attaining or surpassing apex of anteapical tooth. Maximum length 2.1 mm.



Molokai 1

Remarks: The labial triangle chaetotaxy of this species will distinguish it from other Hawaiian or North American species of the subgenus except *E. malena* from Oahu, or *E. kalakaua*, which is strongly patterned. The species is unique among Hawaiian forms in the presence of sharply angulate setae on the male genital plate; in this respect it resembles the nearctic *E. dissimilis* (Moniez, 1894) and *E. purpurascens* (Packard, 1873), but it has a much larger basal seta than either of these. Occasionally seta m_3 on the second abdominal segment is unilaterally absent. The apical pin seta and lateral labral papillae show considerable variation.

Derivatio nominis: Hawaiian, pale colored.

Ecology: Found on low plants and lichens.

Type locality: Holotype and 1 paratype, Kauai, Alakai Swamp, about 3 miles from trail head, II-12-1982, under dead wood, KC (5211).

Additional records: Molokai: 5121, 5499. Kauai: 4736, 5109, 5208, 5214.

Entomobrya (Entomobryoides) malena Christiansen and Bellinger, new species
(Plate 90)

Background yellowish; pigment limited to antennae, eyepatches, and interantennal spot, or also forming posterior lines on most segments, or with a pair of broken longitudinal lines from second thoracic to fifth abdominal segment and lateral lines on fourth abdominal segment in addition. Antennal pin seta weakly to strongly bifurcate apically. Head ovoid in dorsal view. Labral papillae weak, low, and minutely unisetaceous. Differentiated seta of labial appendage heavy and

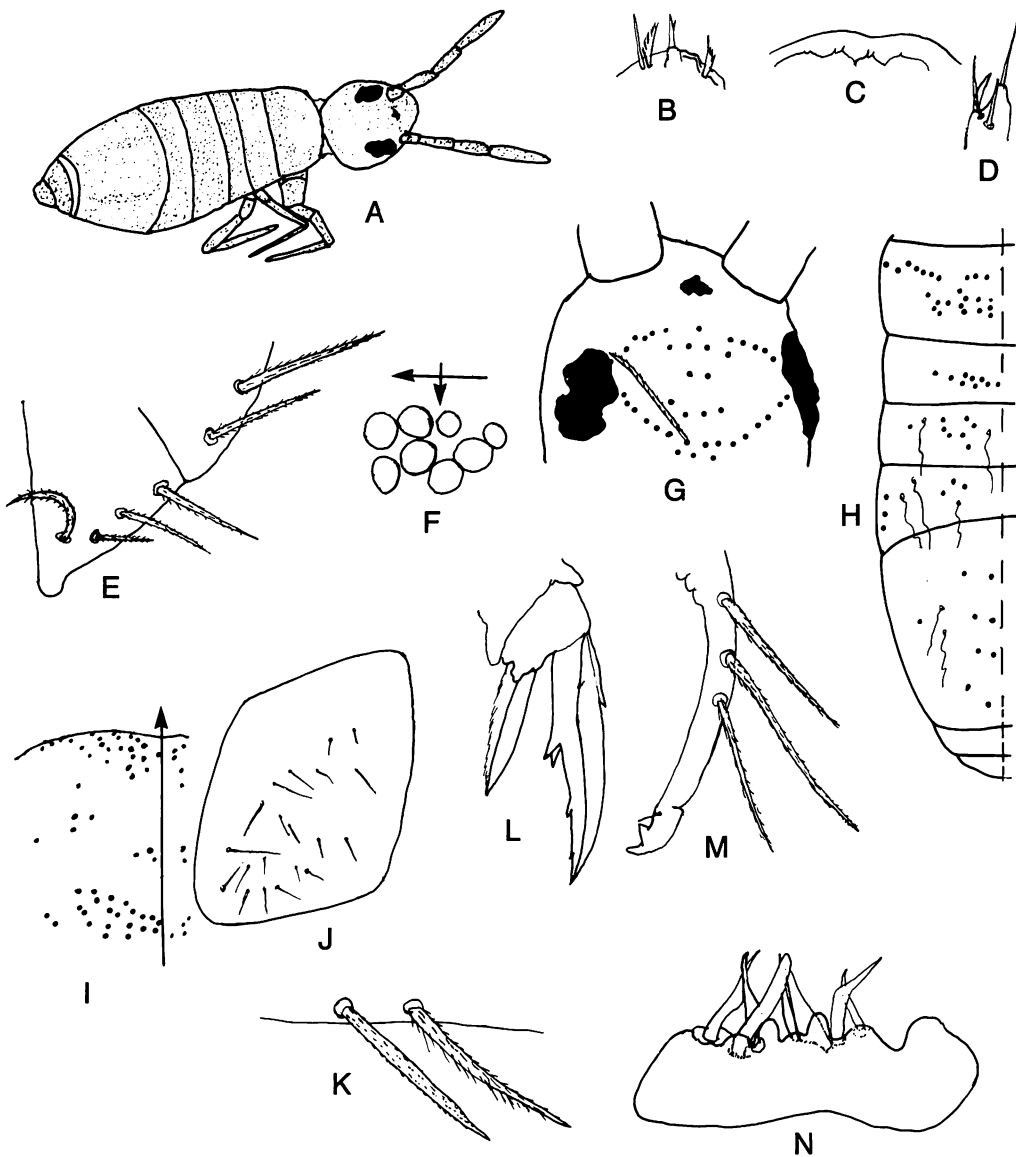


Plate 89—*Entomobrya (Entomobryoides) puakea*: A, habitus (5499, Molokai); B, apex of antenna (type specimen); C, labral papillae (5109, type locality); D, differentiated seta of labial appendage (type specimen); E, basal setae, left labial triangle (same); F, left eyepatch (5109, type locality); G, interocular macrochaetae (type specimen); H, semi-diagrammatic macrochaetae, left side, third thoracic segment–fourth abdominal segment (composite); I, second thoracic segment macrochaetae, left side (type specimen); J, trochanteral organ (5109, type locality); K, inner tibiotarsal setae showing contrast between “smooth” and normal setae (same); L, hind foot complex (same specimen); M, apex of dens and mucro (type specimen); N, male genital plate (same).

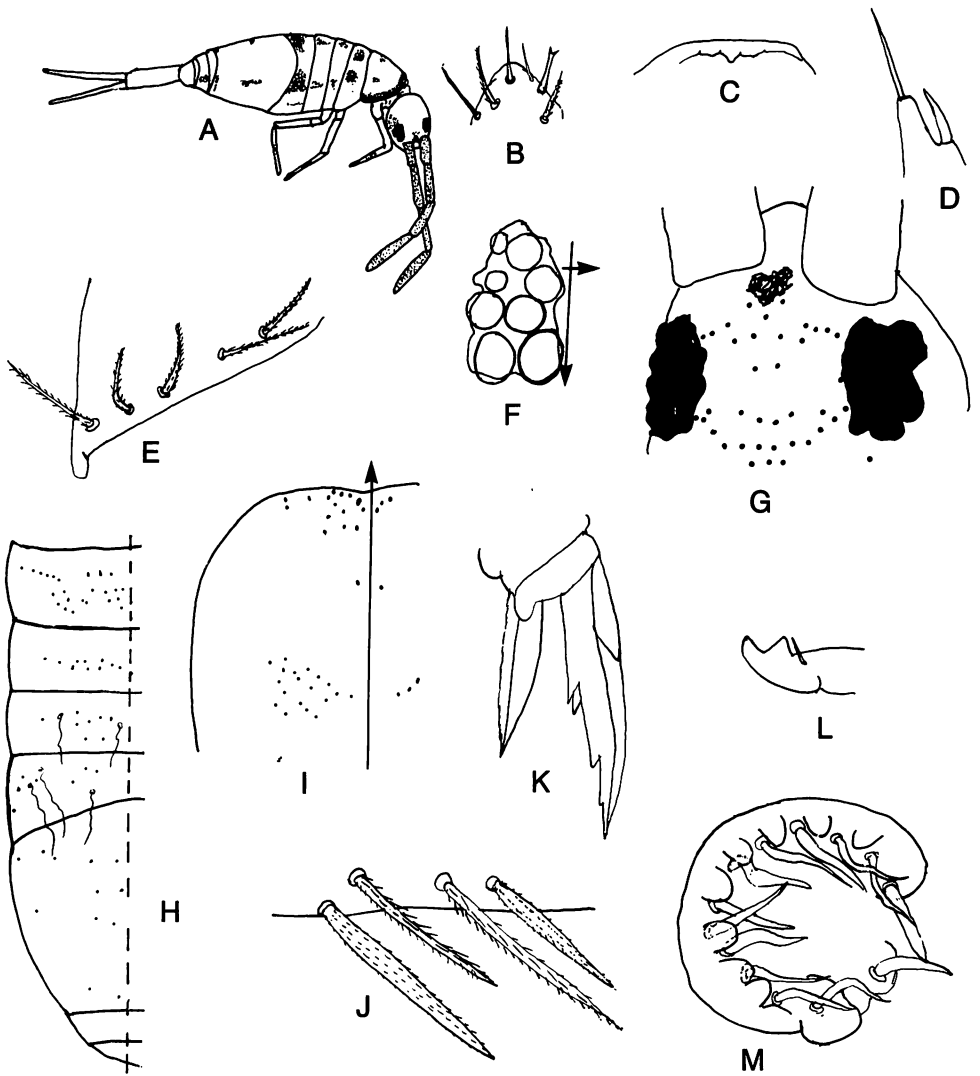


Plate 90—*Entomobrya (Entomobryoides) malena* (all figures of type specimens): **A**, habitus; **B**, apex of antenna; **C**, labral papillae; **D**, differentiated seta of labial appendage; **E**, basal setae of left labial triangle; **F**, left eyepatch; **G**, interocular macrochaetae; **H**, semidiagrammatic macrochaetae, left side, third thoracic segment-fourth abdominal segment; **I**, macrochaetae, second thoracic segment, left side; **J**, inner tibiotarsal setae showing "smooth" and normal setae; **K**, hind foot complex; **L**, mucro; **M**, male genital plate.

spinelike. Trochanteral organ with 6–8 setae in arms, 5–9 setae between them, and 3–7 erratic setae elsewhere. Tibiotarsus with 2 rows of outstanding larger ciliate setae internally; “smooth” inner setae clearly differentiated from the most heavily ciliate setae. Tenent hair outstanding, heavy and clavate. Unguis with usual 7 teeth; outer and apical and subapical inner teeth smaller than others. Outer margin of unguiculus distinctly serrate. Mucronal teeth subequal; basal spine just reaching apex of anteapical tooth. Maximum length 2.0 mm.

Remarks: The peculiar labial triangle chaetotaxy allies the form to *E. puakea* and *E. kalakaua*. The antennal pin seta and male genital plate are generally more like those of *E. mauna*; the former structure is clearly bifurcate only in large specimens. Patterned specimens, on the other hand, resemble *E. kalakaua* and *E. mineola* from North America; they differ from the former in the labial appendage and chaetotaxy, and from both in the occurrence of plain and patterned specimens in the same population. *Entomobrya malena* resembles *E. puakea* in many respects but is strikingly different in the second thoracic segment macrochaetae and the male genital plate.

Derivatio nominis: Hawaiian, yellow.

Ecology: Found in litter and rotten wood.

Type locality: Holotype and 1 paratype, Oahu, valley NE of Palikea, Waianae Mts., X-20-1966, PB (4801).

Additional records: Hawaii: 5351. Oahu: 4774.

***Entomobrya (Entomobryoides) kea* Christiansen and Bellinger, new species**
(Plate 91)

Background color white to pale yellow. Pigment dark to moderate blue to purple-blue over dorsal and lateral surfaces of antennae, anterior half of head, and body segments, except for intersegmental membranes; remainder of animal, except for furcula, lightly pigmented with same color; dark areas with numerous small pale spots; dark areas often paler toward anterior margins of segments. Antenna without obvious apical knob. Head ovoid in dorsal view. Labral papillae strong, unisetaceous, with setae obvious. Trochanteral organ with 6–7 setae in

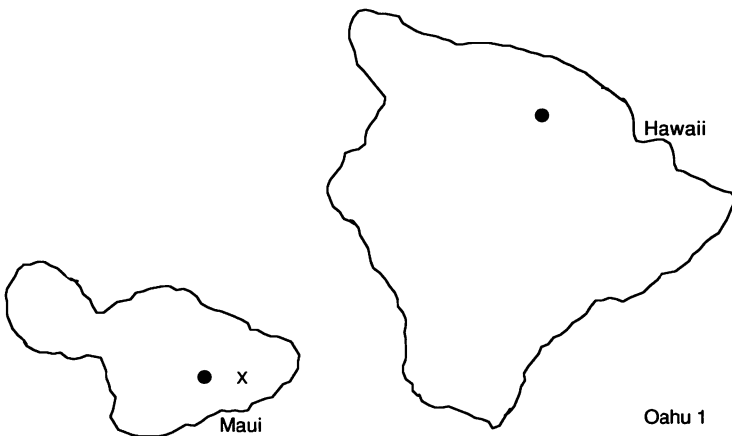




Plate 91—*Entomobrya (Entomobryoides) kea*: **A**, habitus (type specimen); **B**, apex of antenna (same); **C**, labral papillae (5455, Hawaii); **D**, differentiated labial appendage seta (same specimen); **E**, left labial triangle (same specimen); **F**, right eyepatch (6844, Hawaii); **G**, interocular macrochaetae (type specimen); **H**, semidiagrammatic macrochaetae, left side, third thoracic segment-fourth abdominal segment (composite); **I**, macrochaetae, left side, second thoracic segment (type specimen); **J**, trochanteral organ (type specimen); **K**, inner tibiotalarsal setae showing "smooth" and normal setae (same); **L**, hind foot complex (same); **M**, manubrial thickening, left side seen from below (same); **N**, mucro and apex of dens (same); **O**, male genital plate (same).

ventral arm and 7–8 in the dorsal arm; 4–6 setae occur between arms and 2–4 additional setae outside the arms. Tibiotarsus with 2 rows of large outstanding ciliate setae internally; internal “smooth” setae only weakly differentiated from normal setae. Tenent hair heavily clavate. Unguis with usual 7 teeth; inner basal 3 slightly larger than others. Unguiculus with outer margin clearly serrate. Basal mucronal spine just or not quite reaching apex of antepical tooth, which is subequal to or slightly shorter than apical tooth. Maximum length 2.5 mm.

Remarks: This species is very similar to *E. mauna*. The only consistent features that we can find to separate the two are the male genital plate and the second thoracic segment macrochaetae; however, where the two species occur together *E. mauna* is always lightly pigmented whereas *E. kea* appears dark. The angulate genital plate setae of this species resemble those seen in the nearctic *E. purpurascens*; however, the two species differ markedly in chaetotaxy as well as other features.

Derivatio nominis: Hawaiian, clear.

Ecology: Found mostly above 9000 ft. elevation. Mostly taken in pitfall traps but also under stones or in litter.

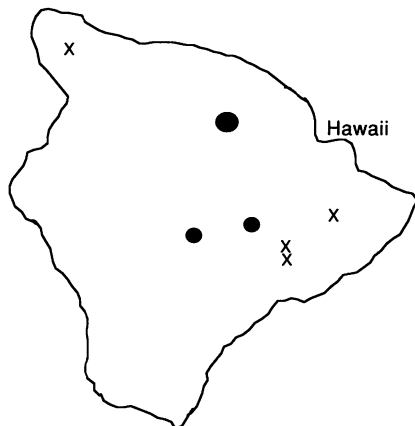
Type locality: Holotype and 8 paratypes, Hawaii, Mauna Kea, plateau N of Puu Hau Kea, V-22 to VII-10-1982, 450 m, pitfall trap 8, Howarth (5456).

Additional records: Hawaii: 5389, 5449, 5452, 5455, 5462, 6844. Maui: 5185, 5187, 5492. Oahu: 4762.

Entomobrya (Entomobryoides) guthriei Mills, 1931 (Plate 92)

Am. Mus. Novit. 464:4.—Christiansen and Bellinger, 1980.

Background off white to yellow. Antennae bluish to purple; eyepatches and interantennal spot dark; body unpigmented, or covered with a slight to moderate wash, or with distinct lines along posterior segment margins; lateral lines and legs may be pigmented. Antenna with or without weak apical knob; apical pin seta varying from strongly bisetaceous to unisetaceous. Labral papillae varying from low and rounded to conical; always unisetaceous. Trochanteral organ with 7–8 setae in rows, 2–5 setae between them, and up to 4 erratic setae outside. Tibiotar-



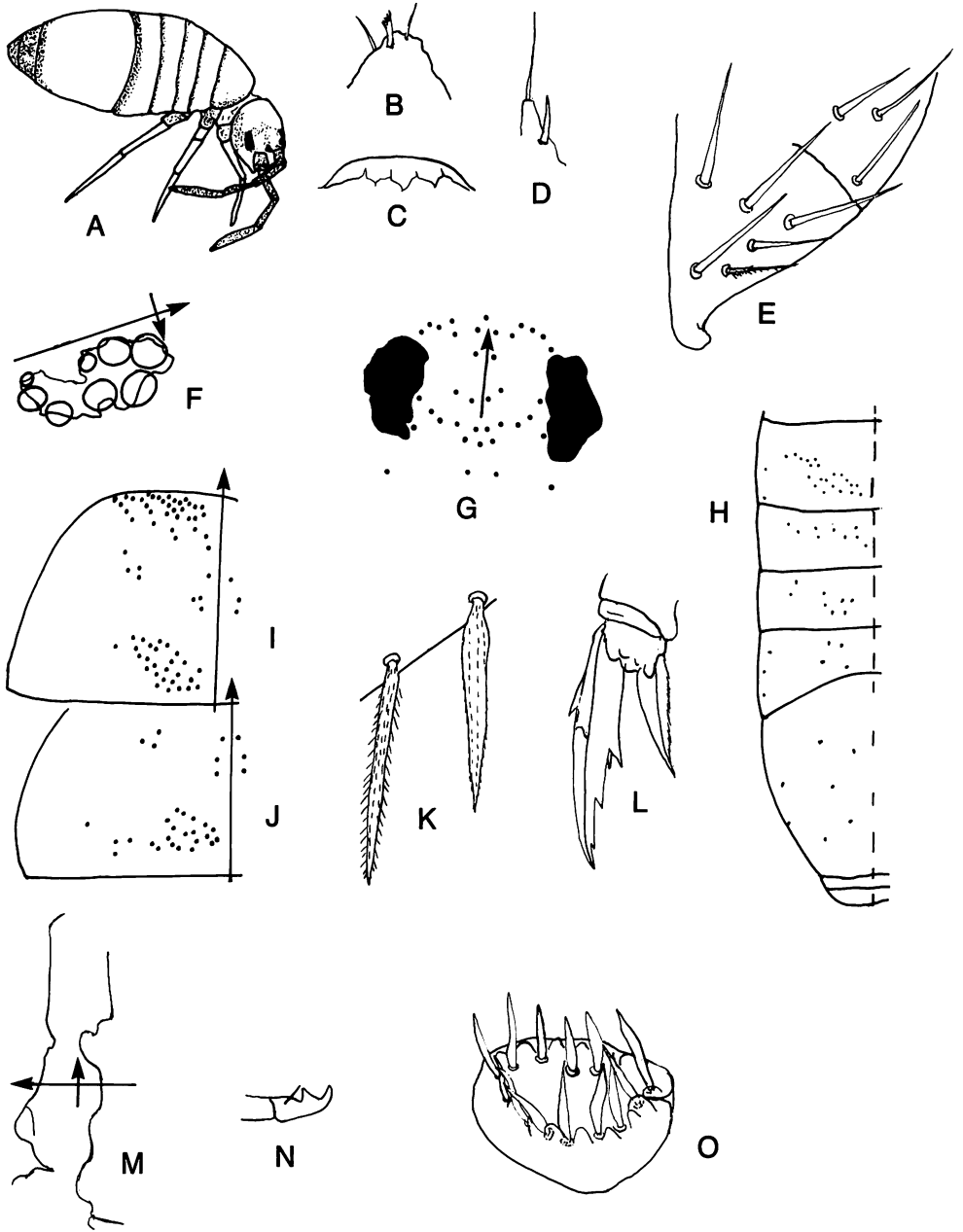


Plate 92—*Entomobrya (Entomobryoides) guthriei*: A, habitus, characteristic of Hawaiian forms (6855, Hawaii); B, apex of antenna (4782, Oahu); C, labral papillae (5458, Hawaii); D, differentiated seta of labial appendage (same specimen); E, left labial triangle (5458, Hawaii); F, right eyepatch (4782, Oahu); G, interoocular macrochaetae (5456, Hawaii); H, semidiagrammatic macrochaetae, left side, third thoracic segment–fourth abdominal segment (composite); I, detail of macrochaetae, left side, second thoracic segment (5348, Hawaii); J, median and posterior macrochaetae, left side, second thoracic segment (4865, Hawaii); K, inner tibiotarsal setae showing contrast between “smooth” and normal setae (4782, Oahu); L, hind foot complex (5341, Hawaii); M, manubrial thickenings of two types (specimens from two different Hawaii localities); N, mucro (6805, Hawaii); O, male genital plate (4865, Hawaii).

sus with 2 rows of outstanding larger ciliate setae internally; "smooth" setae varying from very slightly to sharply differentiated from the smallest heavily ciliate setae. Tenent hair heavy and clavate. Unguis with usual 7 teeth; external, inner apical, and sometimes inner median teeth smaller than others. Unguiculus minutely serrate externally. Mucronal teeth subequal or anteapical tooth shorter, with basal spine just or almost reaching apex of anteapical tooth. Maximum length 2.8 mm.

Remarks: This is the most problematic species of the subgenus found in the Islands. In most respects it resembles the nearctic *E. guthriei* Mills, but it has features such as the labial triangle chaetotaxy that are variable, though constant in *E. guthriei*, while some variation found in *E. guthriei* does not occur in Hawaii. Because we are unable to consistently separate the Hawaiian and nearctic forms, we treat them as one taxon. Future work will probably show them to be separate taxa. The Hawaiian specimens are quite variable; however, little pattern variation is seen. Several species may be combined here, but we have not been able to find congruent variation of different characters and therefore have not been able to separate them.

Ecology: Found in litter and occasionally under stones, mostly at high elevations (one exception) in scrub forest and open areas.

Records: Hawaii: 4855, 4865, 4866, 4868, 4895, 4903, 5295, 5298, 5299, 5341, 5348, 5350, 5371, 5383, 5385, 5386, 5387, 5388, 5392, 5451, 5452, 5453, 5456, 5457, 5458, 5461, 5658, 5685, 6805, 6827, 6828, 6855, 6856, 6858, 6861, 6900, 6903. Maui: 5263, 6707. Molokai: 5113, 5304. Oahu: 4782, 6525. Kauai: 5285.

Entomobrya (Entomobryoides) kalakaua Carpenter, 1904 (Plate 93)
Fauna Hawaiiensis 3:301.

Background white to yellow; antennae purple with paler areas basally and pigment more concentrated near distal ends of segments; eyepatches and interantennal band dark; head with lateral cheek patches and sometimes triangular markings on the posterior median field; second and third thoracic segments with lateral margins and sometimes anterior margin and complex median marking dark; first abdominal segment unmarked or with lateral spots or posterior lateral line and/or median or paired longitudinal markings; second and third abdominal segments with varied patterns, concentrated in midthird of segments, varying from a blotchy rectangle to a series of spots forming a complex pattern; fourth abdominal segment usually with a central U-shaped marking and adjacent anterolateral stripes; sometimes with a solid medial band covering posterior $\frac{2}{3}$; fifth abdominal segment with an irregular posterior band, lateral spots, or unpigmented; sixth abdominal segment pale; legs and furcula pale, or femora distally banded, or with tibiotarsi pigmented. Antenna without clear apical bulb, though the apex may protrude a bit, especially in young specimens. Head ovoid in dorsal view. Labral papillae low and unisetaceous. Trochanteral organ with 4–6 setae in each arm and up to 2 erratic setae. Tibiotarsi with 2 rows of outstanding large ciliate setae internally; finely ciliate "smooth" setae varying from weakly to clearly distinguished from smaller

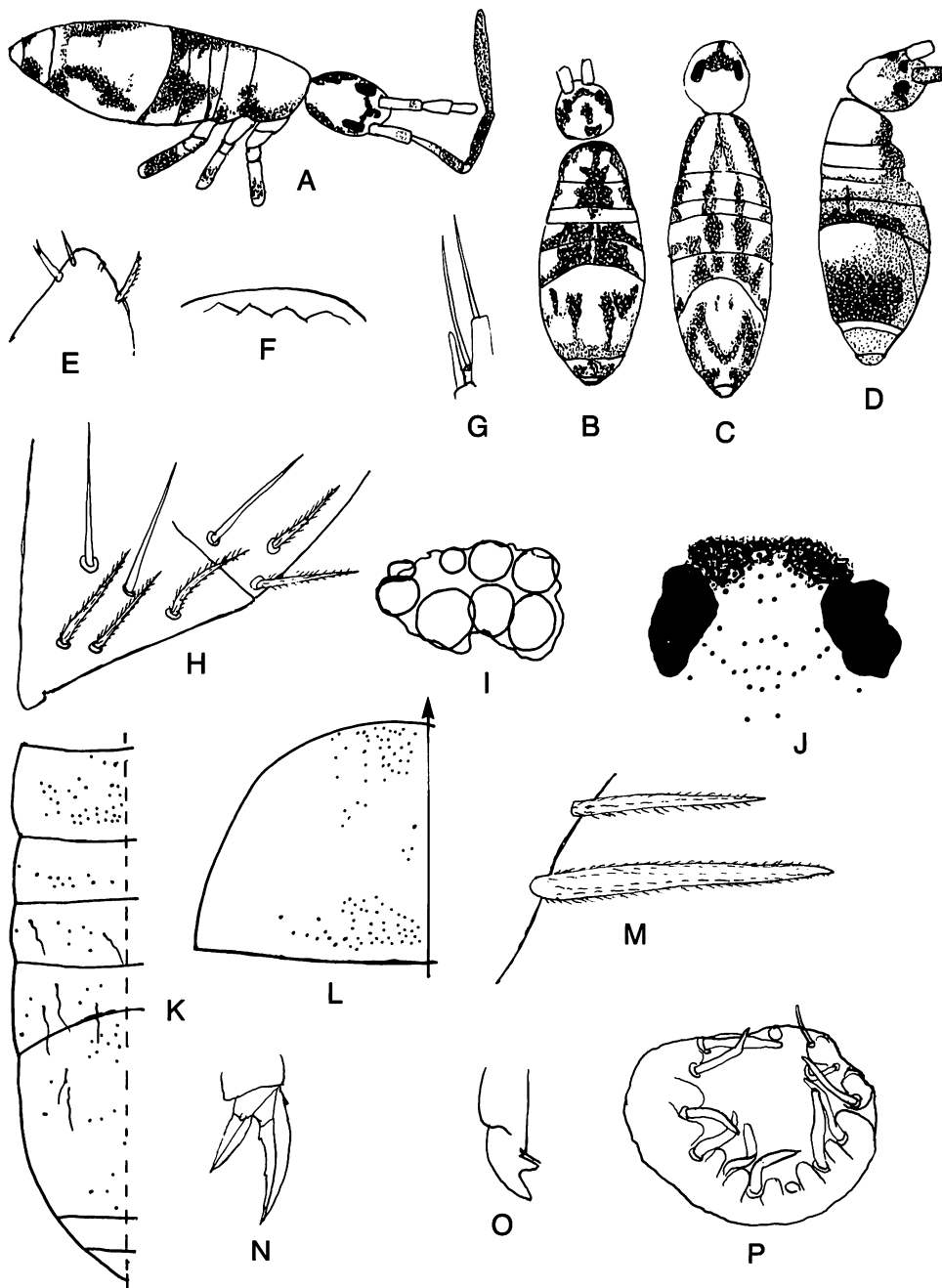
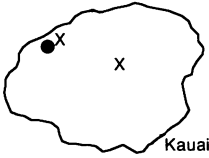


Plate 93—*Entomobrya (Entomobryoides) kalakaua*: A, habitus (4762, Oahu); B, another common pattern type (5308, Kauai); C, pattern type (5492, Maui); D, pattern type (6904, Hawaii); E, apex of antenna (same specimen as A); F, labral papillae (same); G, differentiated seta of labial appendage (same); H, left labial triangle (same); I, right eyepatch (4762, Oahu); J, interoocular macrochaetae (6794, Maui); K, semidiagrammatic macrochaetae, left side, third thoracic segment–fourth abdominal segment (composite); L, second thoracic segment macrochaetae, left side (5492, Maui); M, inner tibiotarsal setae showing distinction between “smooth” and normal setae (4762, Oahu); N, hind foot complex (same specimen); O, mucro (same specimen); P, male genital plate (6904, Hawaii).



Hawaii 1
 Maui 1
 Oahu 1

heavily ciliate setae. Tenent hair prominent and clavate. Unguis with usual 7 teeth; external and inner teeth small, lateral teeth large and projecting. Unguiculus finely serrate externally. Mucronal teeth subequal or with antepical tooth slightly shorter and basal spine just reaching or slightly exceeding its apex. Body setae of type 1 weakly clavate to acuminate and straight or very slightly flexed apically. Body setae of type 5 slender and multilaterally ciliate for apical 1/5-2/3 of length. Maximum length 2.5 mm.

Remarks: In spite of Carpenter's (1904) statement that there is no clavate tenent hair, the agreement between his description and this species is so good that there is little doubt that they are the same. The weakly differentiated "smooth" tibiotarsal setae of some specimens at first led us to place this in *Entomobrya* s.str., but the intermediate condition of these setae in some populations suggests that the species belongs here.

The species shows much variation, some of it geographic. Table 21 summarizes some of this variation. In addition to this variation the pattern varies (see Pl. 93A-D) and the number of abdominal macrochaetae varies, although this is often hard to determine in the heavily pigmented specimens. Unfortunately, all samples except those from Kauai consist of one or two collections, and all are small (one to four specimens). A male was seen only from Hawaii. All collections share the features of some ciliate labial triangle setae, a clear pattern, and the features shown in Table 20. We feel it best to retain all these forms in one taxon pending better samples.

Ecology: All recorded collections are from litter in ohia or bamboo stands.

Type locality: Kauai, Koholuamano.

Additional records: Hawaii: 6904. Maui: 5492, 6794. Oahu: 4762. Kauai: 5109, 5122, 5290, 5308, 6539.

Table 21. Variation in *Entomobrya kalakaua*

LOCATION	CILIAE LABIAL TRIANGLE SETAE					DIFFERENTIATION BETWEEN SMOOTH AND NORMAL TIBIOTARSAL SETAE
	M ₁	M ₂	M ₃	E	L	
Hawaii	+	+	+	+	+	strong
Kauai	+	+	+	+	(-)	moderate
Maui	(-)	+	+	(-)	(-)	moderate-weak
Oahu	+	+	+	+	+	weak

Subgenus **MESENTOTOMA** Salmon, 1942

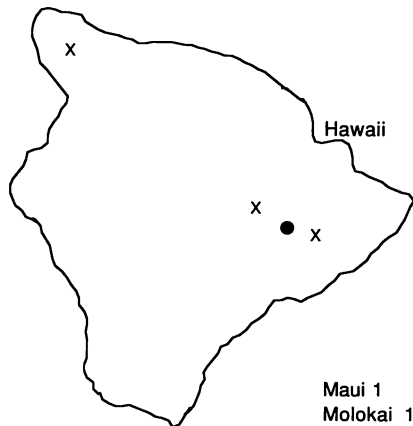
Type species: *Mesentotoma exalga* Salmon, 1942

This subgenus is exclusively littoral in other parts of the world, but in Hawaii has been found only above 3800 ft. in mountainous regions. Like other members of the subgenus, Hawaiian specimens have the unguiculus angled on the inner edge and lack the basal mucronal spine; unlike the nearctic species, they lack subdivision of the second antennal segment. Both Hawaiian species have peculiar curved heavy articular processes on the ventral surface of the dentes. These structures are seen in the nearctic *E. (M.) laguna* but are more pronounced in the Hawaiian species. The subgenus was reviewed by Christiansen (1956).

The first species we describe here is well represented in collections. The second species is known from only two specimens.

Entomobrya (Mesentotoma) mauka Christiansen and Bellinger, new species
(Plate 94)

Background white to pale yellow, pigment limited to eyepatches, interantennal band, sometimes a pair of lateral spots on the fifth abdominal segment, and occasionally a faint wash on the antennae. Apical antennal bulb apically indented. Head roughly circular in dorsal view. Labrum with broad, low, rounded papillae; prelabral setae 4-5-5-4, the posterior row ciliate. Labial appendage with external differentiated seta at most reaching apex of same papilla. Labrum and labium project downward into a truncate cone, making the labial triangle difficult to see. Eyes G and H less than half as large as eye F. Trochanteral organ with 11-22 setae in 2 unequal arms and irregular inner setae. Tibiotarsus without a row of clearly differentiated "smooth" setae on inner face. Tenent hair very large and projecting, at least 1.5 times as long as inner edge of unguis. Unguis with 2 large basal outer teeth, 2 basal inner teeth on a lamella that are transverse to the vertical longitudinal axis of the unguis, and a third distal inner tooth that may be minute. Inner margin of unguiculus sharply angulate. Ventral tube with 6 large and 7-10 small



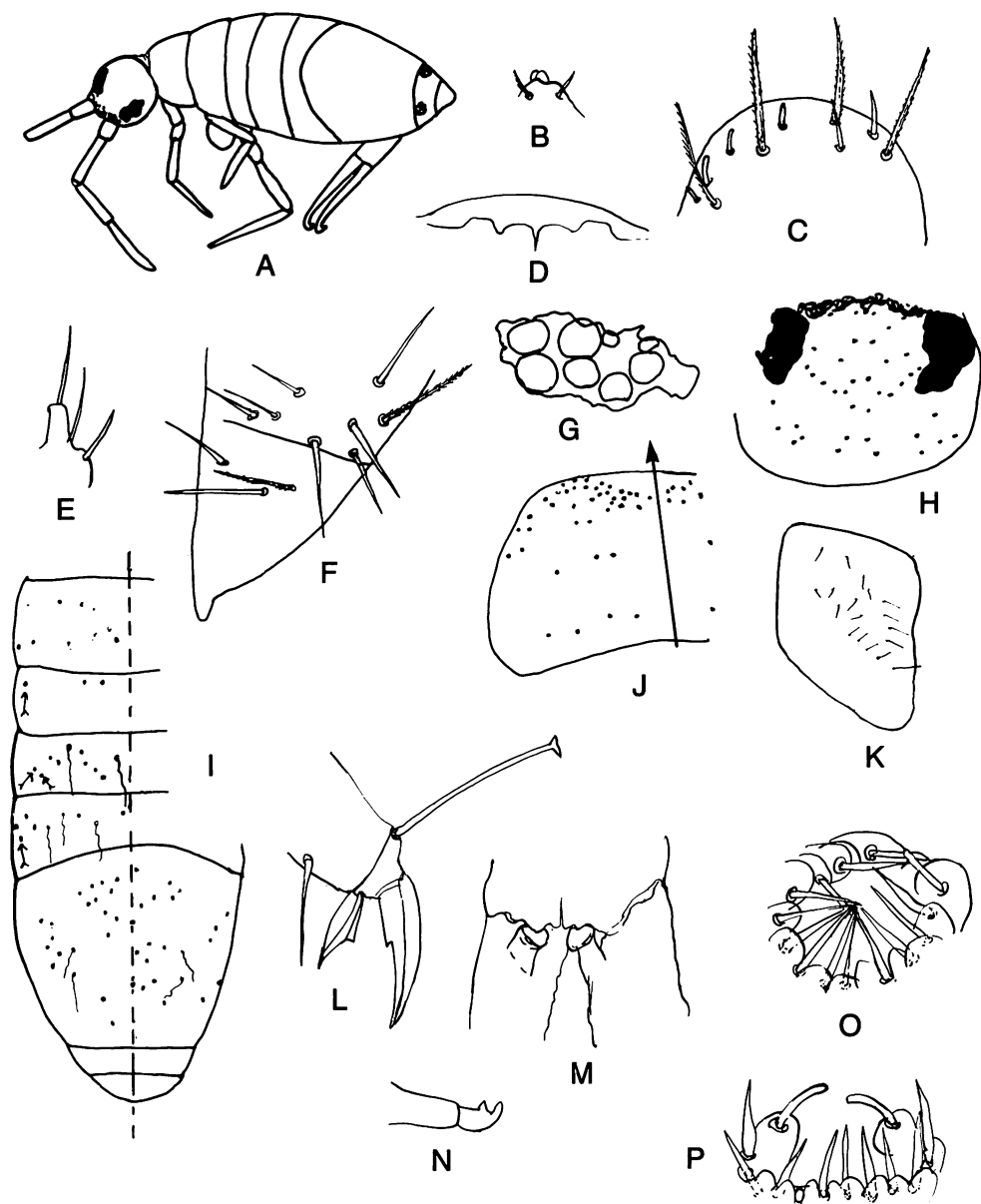


Plate 94—*Entomobrya (Mesentotoma) mauka*: A, habitus (5149, Hawaii); B, apex of antenna (4851, Hawaii); C, apex of third antennal segment (same specimen as A); D, labral papillae (4851, Hawaii); E, differentiated seta of labial appendage (same); F, left labial triangle (type specimen); G, left eyepatch (same specimen as A); H, interocular macrochaetae (type specimen); I, semidiagrammatic macrochaetae, left side, third thoracic segment–fourth abdominal segment with fourth segment repeated to show major variation in pattern, setae marked with arrows sometimes absent (composite); J, second thoracic macrochaetae, left side (type specimen); K, trochanteral organ (same specimen as B); L, hind foot complex (same); M, dental articular process (6862, Maui); N, mucro (same); O, male genital plate (type specimen); P, male genital plate (6862, Maui).

ciliate setae per side on the anterior face, 6-10 on each distolateral patch, and 1 + 1 on the posterior face. Mucro bidentate with teeth subequal. Maximum length 2.5 mm.

Remarks: This species is consistent in the absence of conspicuous pattern as well as foot complex structure, labral and labial features, and antennal structures. The chaetotaxy varies greatly, particularly on the fourth abdominal segment. The male genital plate was seen on only two specimens. It appears that the setae may be shorter on the Maui specimens (see Pl. 94I and O) than on the type; however, this may merely be the result of the angle of viewing.

Derivatio nominis: Hawaiian, inland.

Ecology: Generally found on vegetation in mixed ohia stands.

Type locality: Holotype and 7 paratypes, Hawaii, Volcanoes National Park, near Thurston Lava Tube, X-16-1971, 3900 ft., ohia forest, spray sample, Howarth (4848).

Additional records: Hawaii: 4851, 5149, 5155, 6531. Maui: 6862. Molokai: 5710.

Entomobrya (Mesentotoma) nani Christiansen and Bellinger, **new species** (Plate 95)

Background color yellow; pigment blue-black, covering most of dorsal and lateral surfaces of head, thorax, and first three abdominal segments. Pale areas consisting of scattered irregular patches, the median posterior quadrant of the head, and a central oval to triangular pale patch with its base in the first abdominal segment and apex in the center of the second thoracic segment. Fourth abdominal segment with a posterior transverse band and arms extending forward outward to the margin of the third segment. Fifth and sixth abdominal segments dark with varied anterior medial pale patches. Apex of antennae not seen. Labrum with broad, low-rounded, rectangular papillae, with a few minute apical corrugations. Prelabral setae 4-5-5-4, the posterior row ciliate. Labial appendage with differentiated seta not reaching apex of same papilla. Labrum and labium project downward. Eye G less than half as large as F and distinctly smaller than eye H. Trochanteral organ with 22 setae. Tibiotarsus with all setae coarsely ciliate. Tenent hair large, about 1.8 times as long as inner unguis. Unguis with 4 inner teeth, all small and apical 2 minute. Unguiculus with inner margin sharply angulate and outer margin serrate.

Table 22. Characteristics of Hawaiian *Entomobrya* (*Mesentotoma*)

SPECIES	CLEAR PATTERN	DORSAL MACROCHAETAE OF ANTERIOR ABDOMINAL SEGMENTS											
		II										III	
		m ₃	m _{3ep}	m _{3c}	m _{3e2}	m _{3ea}	a ₃	m _{3ci}	a ₁	a ₂	a ₃	m ₃	m _{3e}
<i>mauka</i>	-	+	+	+	-	+	-	-	+	-	-	+	-
<i>nani</i>	+	+	+	+	-	-	-	-	+	+	3	-	

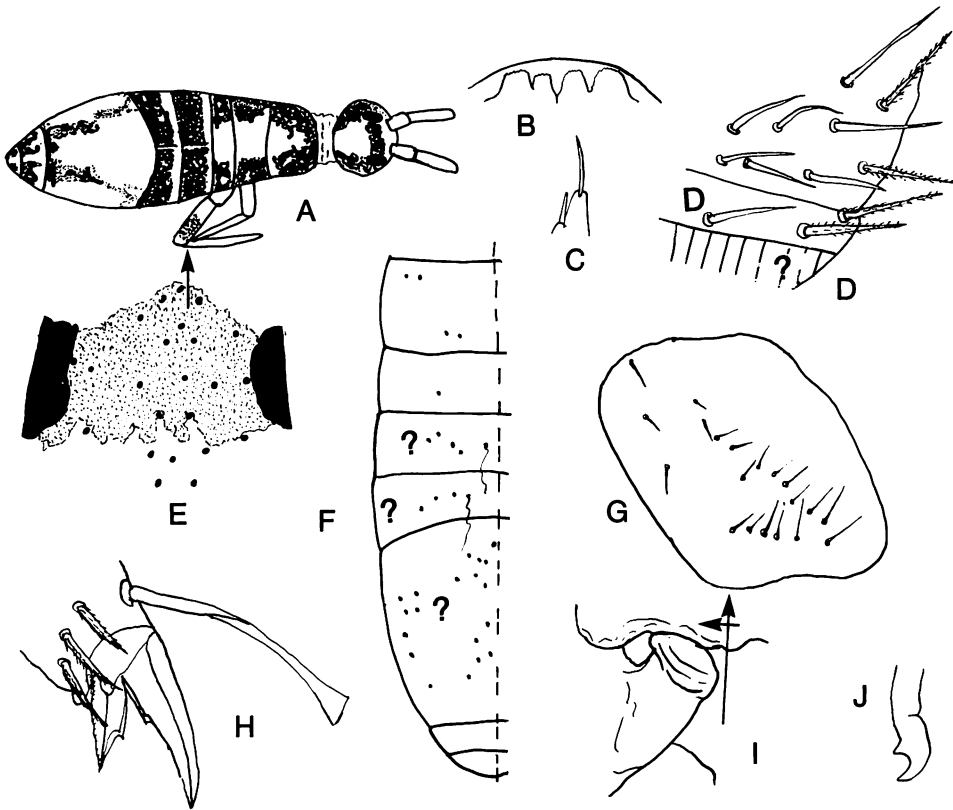


Plate 95—*Entomobrya (Mesentotoma) nani*: A, habitus (5304, Molokai); B, labral papillae (holotype); C, external differentiated seta of labial appendage (same); D, outer two-thirds of labial triangle, left side (holotype); E, interocular macrochaetae (composite); F, semidiagrammatic macrochaetae, left side, third thoracic segment–fourth abdominal segment (composite); G, trochanteral organ (holotype); H, mid foot complex (holotype); I, right dental articular process and manubrial thickening (holotype); J, mucro (5304, Molokai).

Ventral tube heavily pigmented, setae not analyzable. Mucro bidentate, lacking basal spine. Length 1.79 mm.

Remarks: We have only two specimens of this well-marked, remarkable species. The two are almost identical in pattern. One was taken in the cloud forest on Lanai in 1966, the other at 3000 ft. on Molokai in 1963. The heavy pigment on some parts of the body makes it very difficult to analyze the chaetotaxy; nevertheless it is clear that there are very few macrochaetae. This, along with the heavy pigment and striking pattern, makes it easy to distinguish from *E. mauka* (see Table 22).

The species has not been collected since 1966, in spite of extensive collections by the senior author both near the Lanai locality and in the mountains of Molokai. It may well be extinct. Neither collection is documented as to habitat.

Derivatio nominis: Hawaiian, beautiful.

Type locality: Holotype, Lanai, Lanaihale, III-25-1966, KC (6857).

Additional record: Molokai: 5304.

Genus **SINELLA** Brook, 1882

Type species: *S. curviseta* Brook, 1882

Characteristics of the genus are as described in *The Collembola of North America*. A significant taxonomic feature in the genus is the degree of differentiation of the "smooth" setae on the inner surface of the tibiotarsus; these are generally somewhat thicker than other setae and striate or finely ciliate, and the contrast with the coarser ciliations of smaller setae, which may be slight or striking, is characteristic of each species (see Table 23). Other features of importance are the chaetotaxy of the abdomen (Fig. 80A), the labial triangle setae (Fig. 80B), the blunt setae of the fourth antennal segment, the shape of the claw, and the thoracic macrochaetae. We recognize seven Hawaiian species in two subgenera.

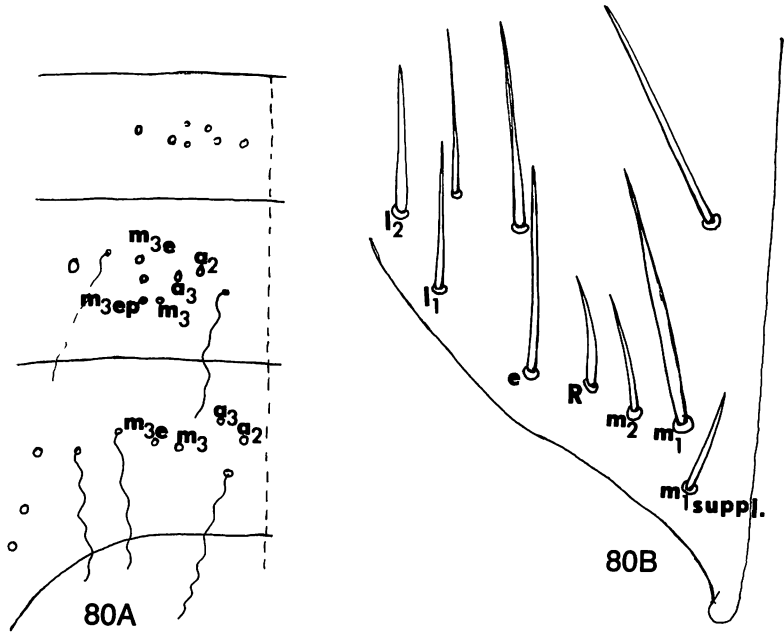


Figure 80—Characters of *Sinella*: A, typical dorsal abdominal chaetotaxy, first three segments; B, labial triangle.

KEY TO HAWAIIAN SPECIES OF *SINELLA* S.L.

- 1. Mucro bidentate (Fig. 81A) (subgenus *Sinella*) 2
- Mucro sickle-shaped (Fig. 81B) (subgenus *Coecobrya*) 3



Table 23. Characteristics of Hawaiian Species of *Sinella*

SPECIES	ANTENNA/ CEPHALIC DIAGONAL	DIFFERENTIATED TRUNCATE SETA ON ANT. SEGMENT II	NO. OF EYES	CONTRAST BETWEEN SMOOTH AND CILIATE TIBIOTARSAL SETAE	WING TOOTH OF UNGUICULUS	MUCRONAL TEETH	CHAETOTAXY				
							TH. II CENTRAL MACROCHAETAE	ABD. I MACROCHAETAE	ABD. III		
									m ₃	a ₂	a ₃
<i>borerae</i>	1.3-2.0	+	0	weak	+	1	3+3	5+5	+*	-	-
<i>kukae</i>	1.9-2.0	+(weak)	0	weak	+	1	2+2(3+3)	5+5	+*	-	-
<i>lua</i>	1.6-1.9	-	0	weak	+	1	3+3	4+4	+	-	-
<i>caeca</i>	1.4-1.7	+	0	strong	+	1	3+3	5+5	+*	-	-
<i>curviseta</i>	1.2-1.8	-	2	strong	-	2	2+2	6+6	+	-	-
<i>nupa</i>	>6	-	0	weak	+	1	2+2	4+4	+	-	-
<i>yosiia</i>	1.8-2.8	-	6-8	strong	-	2	4+4	6+6	+	+	+

*The single seta seen on this segment is probably m₃ but might be a₃.

- 2(1). Two distinct eyes per side (Fig. 82A)..... **curviseta**
 Six to 8 indistinct eyes or eyespots per side (Fig. 82B)..... **yosiia**

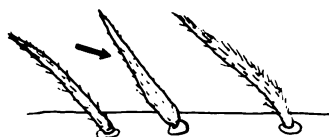


82A

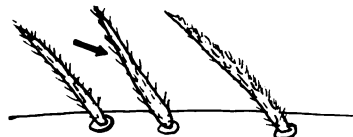


82B

- 3(1). One row of inner tibiotarsal setae contrastingly smooth (Fig. 83A)..... **caeca**
 No striking difference in ciliation between rows of tibiotarsal setae (Fig. 83B)..... 4

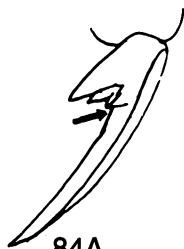


83A



83B

- 4(3). Antennae more than 4 times as long as head..... **nupa**
 Antennae less than 3 times as long as head..... 5
 5(4). Unguis with inner apical tooth before midpoint of inner margin (Fig. 84A)..... **lua**
 Unguis with inner apical tooth at or beyond midpoint of inner margin (Fig. 84B).... 6

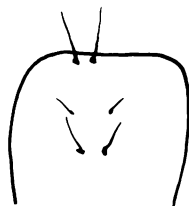


84A



84B

- 6(5). Ventral tube with posterior face setae not in files, with subapical more than 1/2 as long as apical (Fig. 85B); cave on Maui..... **kukae**
 Ventral tube with posterior face setae in 2 files, with subapical less than 1/2 as long as apical (Fig. 85A); surface species..... **borerae**



85A



85B

Subgenus **COECOBRYA** Yosii, 1956a

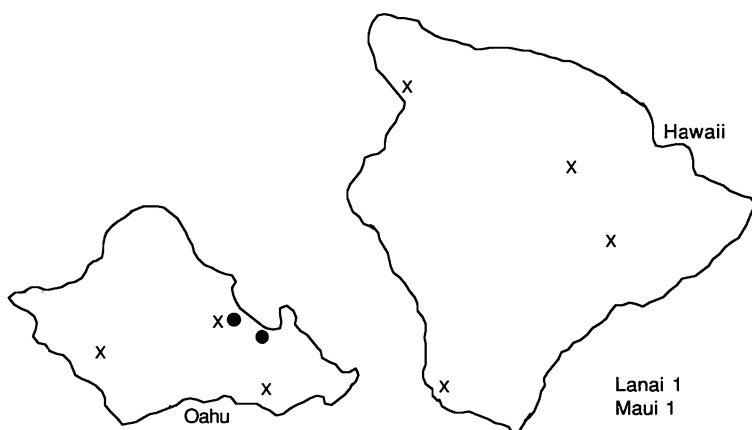
Type species: *Sinella* (*C.*) *akiyoshiana* Yosii, 1956a

Members of this subgenus have smooth dorsal manubrial setae and a falcate mucro. Hawaiian species of *Coecobrya* are *borerae*, *caeca*, *kukae*, *lua*, and *nupa*.

Sinella* (*Coecobrya*) *borerae Christiansen and Bellinger, new species (Plate 96)

Color white without trace of pigment. Antenna without apical bulb. Fourth antennal segment with about 8 curved blunt setae, slightly thicker than and about as long as largest ciliate setae. First antennal segment with 2, second with 1 outstanding clavate setae. Head roughly circular in dorsal view. Labral papillae obscure. Prelabral setae 4-5-5-4, all smooth. External differentiated seta of labial appendage normally exceeding apex of same papilla for $\frac{1}{4}$ - $\frac{1}{2}$ of its length. Labial triangle setae smooth; M_2 absent; R $\frac{1}{2}$ to $\frac{2}{3}$ as long as others. Eyes absent. Trochanteral organ with 8-10 setae in 2 irregular rows and up to 3 additional irregular setae. Hind tibiotarsus with a heavy, truncate ciliate seta on inner surface at $\frac{1}{4}$ - $\frac{1}{3}$ of its length from base; inner tibiotarsal "smooth" setae slightly more slender and lightly ciliated than external setae. Tenent hair usually acuminate, rarely weakly clavate. Unguis with a small outer tooth, 2 basal lateral teeth, and 3 inner teeth; basal inner pair large, and 1 winglike and projecting. Unguiculus with a strong outer wing tooth. Ventral tube with 6 + 6 smooth setae on the distolateral patches; posterior face with 3 + 3 setae, the distal pair the longest and the middle pair the shortest. Manubrium with both smooth and ciliate setae dorsally. Mucro falcate; basal spine reaching from just before to just beyond apex. Maximum length 1.6 mm.

Remarks: This species is very similar to *S. dubiosa* Yosii, 1956a; however, the latter differs in having 4 + 4 posterior ventral tube setae, two distolateral ventral tube setae ciliate, the tenent hair always acuminate, and in details of position of thoracic macrochaetae. Because *S. dubiosa* is known only from Japan and Korea, we prefer to keep the two separate. A few specimens from Oahu have the M and E labial tri-



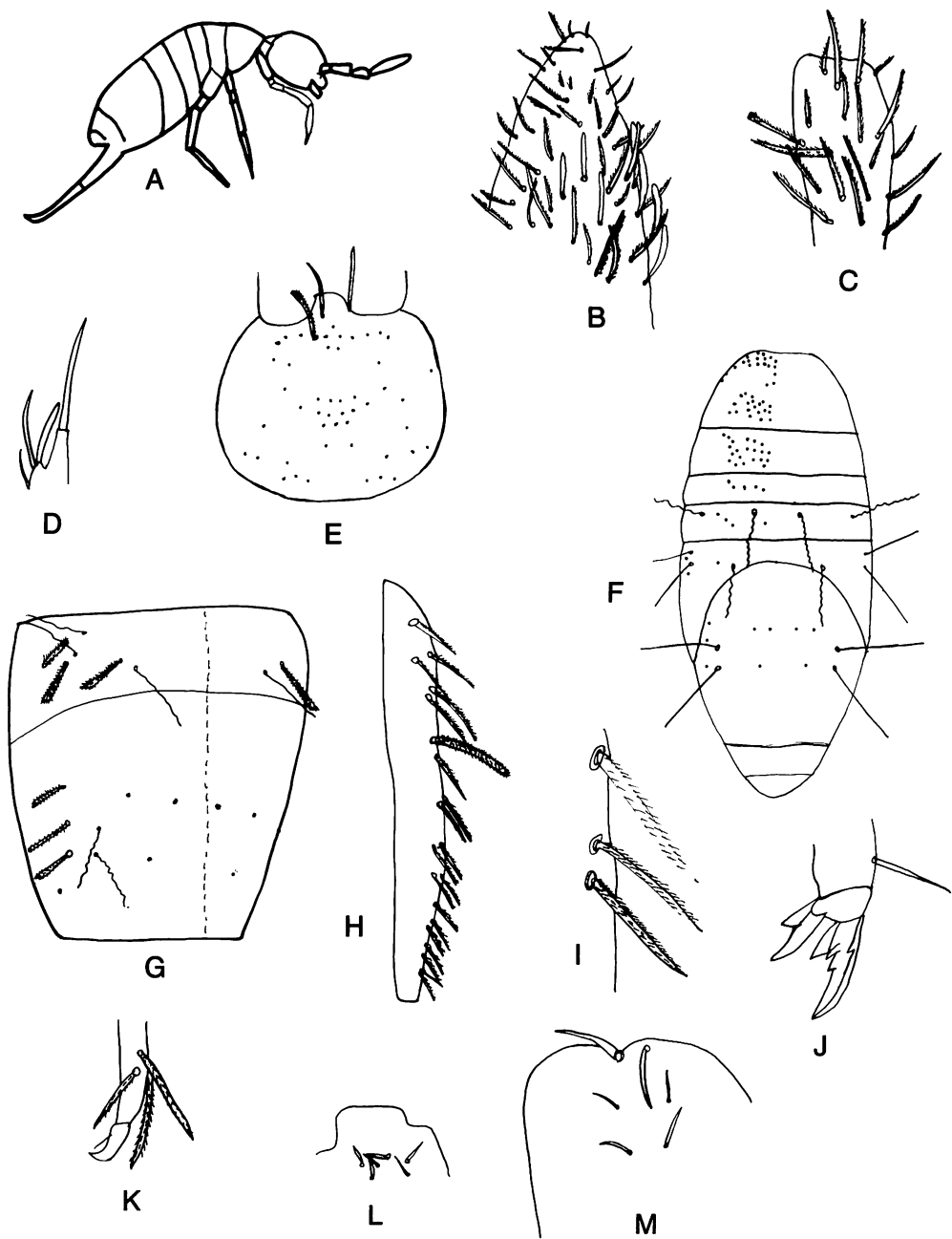


Plate 96—*Sinella boreae*: A, habitus (6693, Lanai); B, dorsal surface, apex of antenna (type specimen); C, dorsal surface, second antennal segment (6761, Oahu); D, differentiated seta of labial appendage (5170, Maui); E, cephalic macrochaetae (same); F, semidiagrammatic macrochaetae of left side of body (composite); G, detail of chaetotaxy, left side, dorsum, third and fourth abdominal segments (paratype); H, inner surface, hind tibiotarsus (paratype); I, detail of difference between least ciliate and normal setae of inner tibiotarsus (5170, Maui); J, hind foot complex (same); K, mucro and end of dens (paratype); L, distolateral setae of ventral tube (same); M, posterior face of ventral tube (paratype).

angle setae feebly ciliate. This is the most widespread species of the genus, being found on four major islands. Cave populations referred to *S. kukae* in this work are very similar but show enough consistent differences to merit specific separation.

Derivatio nominis: Named after Catherine Borer, who worked on this project.

Ecology: Found in litter, in low vegetation in wooded areas, and on lava rock.

Type locality: Holotype and 6 paratypes, Oahu, Mauna Kapu, Waianae Mountains, X-20-1966, litter under *Casuarina*, PB (4797).

Additional records: Hawaii: 5144, 5460, 5644, 5682. Maui: 5170. Lanai: 6693. Oahu: 4777, 4794, 6753, 6756, 6761, 6762.

Sinella (*Coecobrya*) *kukae* Christiansen and Bellinger, new species (Plate 97)

Color white without trace of pigment or eyes. Antenna without apical bulb but with broad apical knob. Fourth segment with numerous weakly differentiated slender blunt setae on dorsal surface, all smaller than largest ciliate setae. Second antennal segment with weakly differentiated truncate setae on dorsal surface. Head roughly circular in dorsal view. Labral papillae bluntly conical without clear setae. Prelabral setae 4-5-5-4, all smooth. External differentiated seta of labial appendage exceeding apex of same papilla by $\frac{1}{5}$ - $\frac{1}{6}$ of its length. Labial triangle setae smooth; M_2 absent; R 0.6-0.75 as long as M_1 . Trochanteral organ with 5 setae in ventral arm and 3-4 in an irregular dorsal arm, as well as 2-4 extra setae. Hind tibiotarsus with differentiated inner seta, at end of basal $\frac{1}{4}$ - $\frac{1}{3}$ of joint, acuminate and only slightly larger than remaining setae. Inner tibiotarsal "smooth" setae slender and only slightly different from others in ciliation. Tenent hair usually clearly clavate. Unguis with a small external tooth, 2 small lateral teeth, and 3 inner teeth, 1 of the basal pair being winglike and projecting. Unguiculus with a strong outer tooth. Ventral tube with 5 + 5 to 6 + 6 distolateral smooth setae; posterior face with 2 large distal setae and 4-5 proximal setae at least $\frac{2}{3}$ their length, all similar in diameter and irregularly arranged. Manubrium dorsally with both smooth and ciliate setae. Mucro falcate, with basal spine reaching or slightly exceeding apex. Maximum length 2 mm.

Table 24. Characters Differentiating *Sinella borerae* and *Sinella kukae*

CHARACTER	BORERAE	KUKAE
Smallest/largest ventral tube seta	0.40-0.58	0.75-0.90
Median setae of thoracic segment II	3+3	2+2(3+3)
Differentiated setae of inner third tibiotarsus divided by length of joint	0.15-0.24	0.14-0.18
Differentiated labial appendage exceeds apex of same papilla by:	$\frac{1}{4}$ - $\frac{1}{2}$ of length*	$\frac{1}{8}$ - $\frac{1}{6}$ of length
Maximum length	1.6 mm	2.0 mm

* One specimen from 300 m in the Waianae Mountains has this seta exceeding the papilla by only $\frac{1}{6}$ of its length.

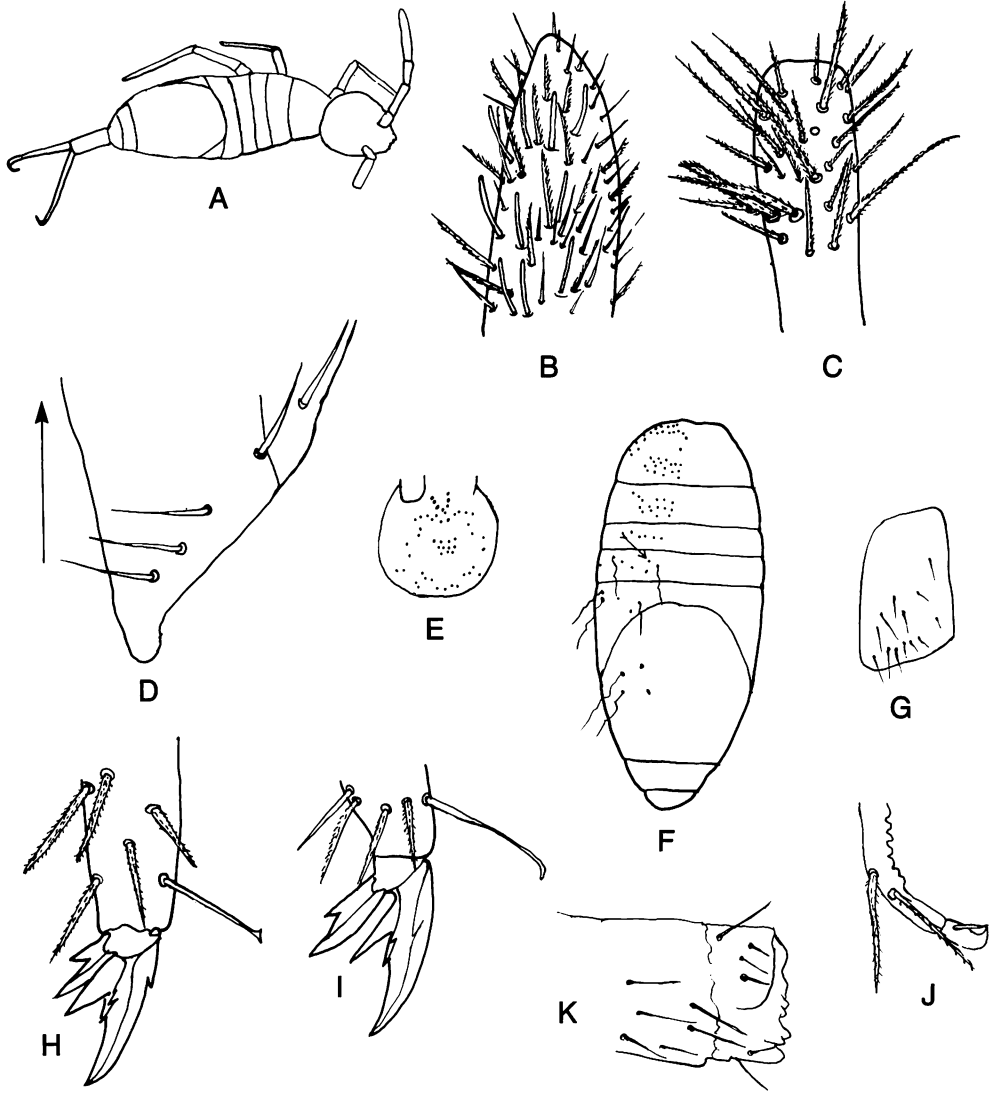


Plate 97—*Sinella kukae* (all figures of type specimens): **A**, habitus; **B**, apex of dorsal surface of fourth antennal segment; **C**, apex of dorsal surface of second antennal segment; **D**, basal setae of left side of labial triangle (holotype); **E**, cephalic macrochaetae; **F**, semidiagrammatic dorsal macrochaetae of left side, setae marked with arrow sometimes absent (composite); **G**, trochanteral organ; **H**, apex of hind tibiotarsus and foot complex (holotype); **I**, fore foot complex (same specimen); **J**, apex of dens and mucro; **K**, posterior and lateral surface of ventral tube (holotype).

Remarks: Although the first antennal segment is not intact in any specimen, it can be seen to have two truncate setae. This species was originally considered part of the variation of *S. borerae*, but new material makes this placement unsatisfactory, and we now believe it is best to separate them. The two species overlap in almost all characters, but the ventral tube setae will always distinguish them. Table 24 shows the differences between the two.

Derivatio nominis: Hawaiian, dung.

Ecology: Known only from the type-locality cave.

Type locality: Holotype and 8 paratypes, Maui, Ulupalakua Cave, VIII-27, 28-1977, deep in cave, rat dung, Howarth (5444, 5445).

***Sinella (Coecobrya) lua* Christiansen and Bellinger, new species (Plate 98)**

Color white without trace of pigment. Antenna without apical bulb. Fourth segment with about 40 blunt curved setae on dorsal surface, about as long as largest ciliate setae. Without clearly differentiated ciliate setae on second antennal segment. Head roughly circular in dorsal view. Labral papillae obscure. External differentiated seta of labial appendage about as thick as acuminate setae and exceeding apex of same papilla for $\frac{1}{10}$ – $\frac{1}{9}$ of its length. Labial triangle setae all smooth; M_2 absent; R about $\frac{2}{3}$ as long as M; supplementary R setae occasionally present. Eyes absent. Trochanteral organ with 3 setae in dorsal arm and 5 in ventral arm, and 3 irregular setae. Hind tibiotarsus with a weakly differentiated ciliate seta at about $\frac{2}{3}$ of length of inner surface from base. Inner "smooth" setae only weakly differentiated from others. Tenent hairs all slender and acuminate. Unguis with small basal lateral and external teeth; 3 inner teeth all clustered together, with 1 basal winglike tooth. Unguiculus apically angulate (see Pl. 98I) and with a prominent wing tooth. Ventral tube with 6 + 6 distolateral setae; posterior face with a pair of large distal setae and 2 pairs of minute, subequal basal setae. Manubrium with both smooth and ciliate setae dorsally. Mucro falcate with basal spine surpassing apex. Maximum length 1.5 mm.

Remarks: The structure of the unguis, combined with the moderately short antennae, readily distinguishes this from other Hawaiian species. The chaetotaxy of the second thoracic segment and ventral tube is unique.

Derivatio nominis: Hawaiian, cave.

Ecology: Known only from type-locality cave.

Type locality: Holotype and 8 paratypes, Oahu, Pupukea Lava Tube, IX-4-25-1981, IX-30-79, XI-10-1979, pitfall trap, and rotting wood, Howarth (5436, 5437, 5438).

***Sinella (Coecobrya) caeca* (Schött, 1896) (Plate 99)**

Proc. Calif. Acad. Sci. (2) 6:178 (*Entomobrya*).—Christiansen and Bellinger, 1980.

Sinella hoefti Schäffer: Folsom, 1932:66.

Color white without trace of pigment. Antenna without apical bulb. Fourth segment with numerous weakly differentiated slender blunt setae, but only 5 are clearly differentiated from others. First antennal segment with 2 clavate setae and

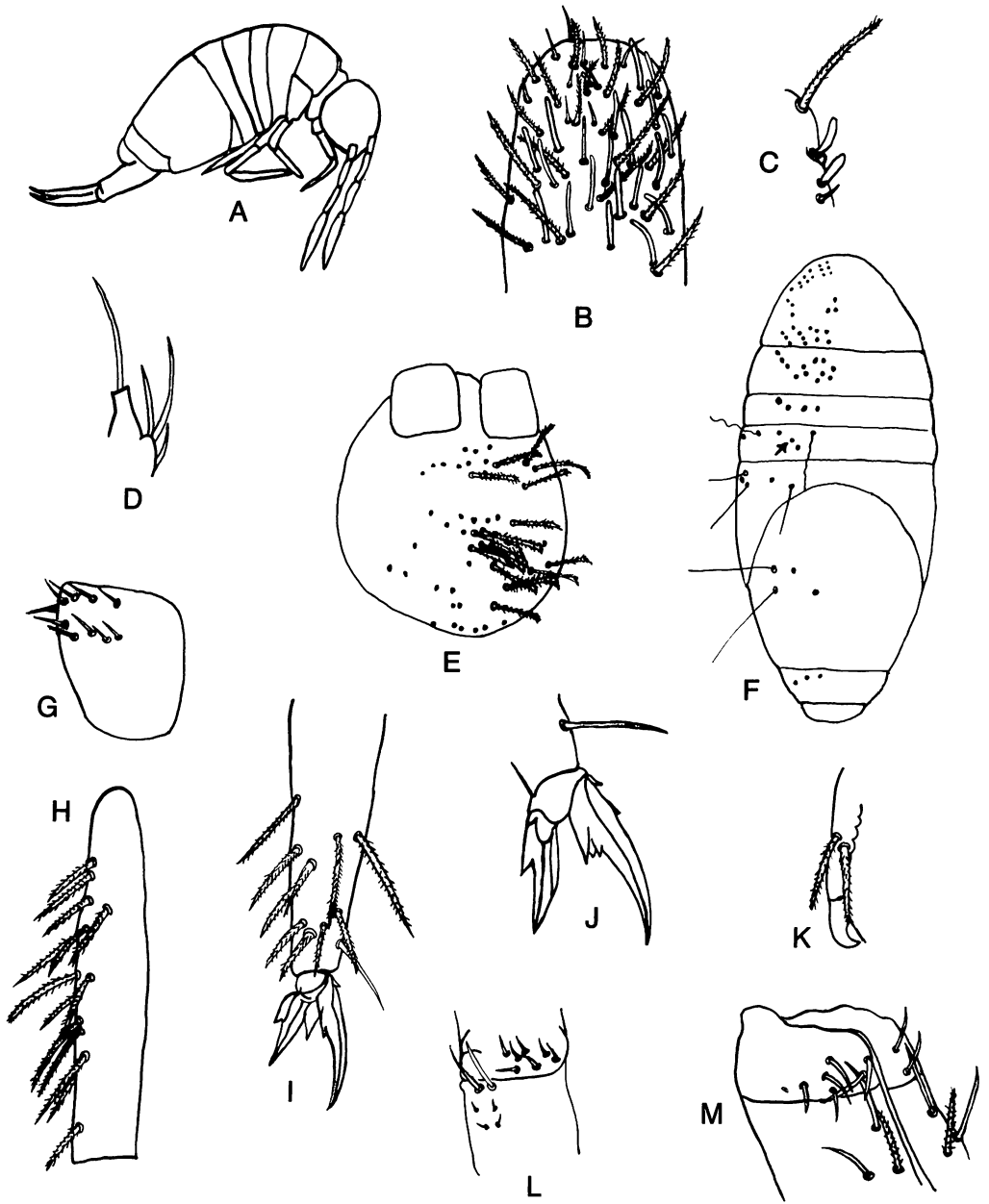


Plate 98—*Sinella lua* (all figures of type specimens): A, habitus; B, apex of antenna, dorsal surface; C, apical organ of third antennal segment; D, differentiated seta of labial appendage; E, dorsal cephalic macrochaetae; F, semidiagrammatic dorsal body macrochaetae of left side; G, trochanteral organ; H, inner setae of basal $\frac{1}{3}$ of hind tibiotarsus; I, apex of hind tibiotarsus and foot complex; J, mid foot complex; K, mucro; L, posterior and lateral setae of ventral tube; M, anterior surface of ventral tube.

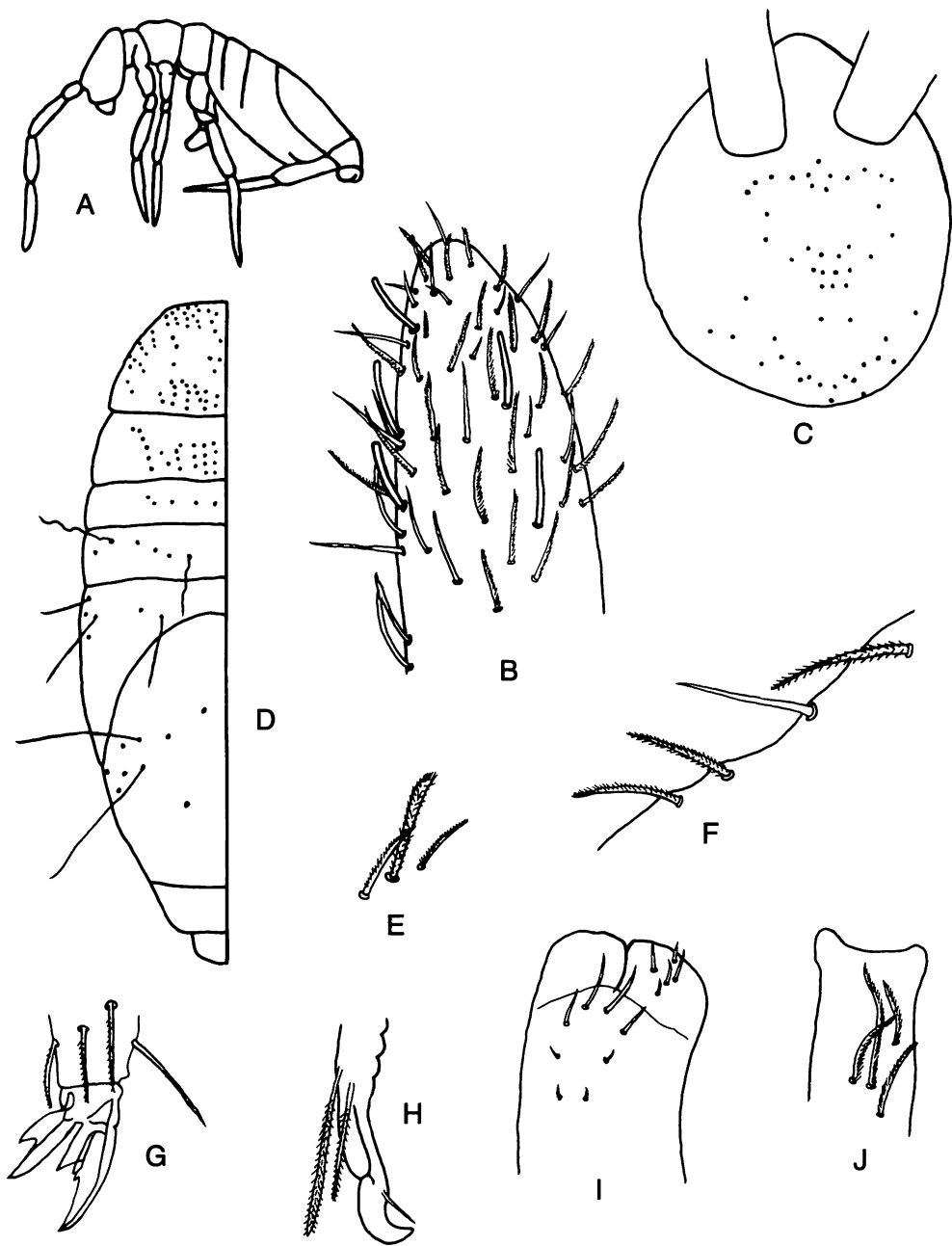


Plate 99—*Sinella caeca*: **A**, habitus (after Gisin); **B**, apex of antenna (5398, Hawaii); **C**, macrochaetae of dorsum of head (3138, Hawaii cave); **D**, semidiagrammatic macrochaetae, left side of body (composite of Hawaiian specimens); **E**, clavate seta of second antennal segment (5398, Hawaii); **F**, inner tibiotarsal setae showing contrast between "smooth" and normal setae (3138, Hawaii cave); **G**, hind foot complex (after Folsom); **H**, mucro (after Folsom); **I**, posterior face of ventral tube (3138, Hawaii cave); **J**, anterior face of ventral tube (same).

second segment with 1 such seta. Labral papillae obscure. Prelabral setae 4-5-5-4, all smooth. External differentiated seta of labial appendage exceeding apex of same papilla for $\frac{1}{5}$ - $\frac{1}{3}$ of its length. Labial triangle setae all smooth; M_2 absent; R about $\frac{2}{3}$ as long as other setae. Eyes absent. Trochanteral organ with 6-8 setae in 2 unequal arms, and 5 or 6 irregular setae between or outside the arms. Hind tibiotarsus with a heavy, truncate, ciliate seta on inner surface about $\frac{1}{3}$ of its length from base, and an inner row of "smooth" setae, strongly differentiated from the ciliate setae. Tenent hair acuminate in Hawaiian specimens. Unguis with 1 outer, 2 lateral, and 3 inner teeth, all small except for 1 of the inner basal pair. Unguiculus with inner margin weakly angled toward apex and a large outer wing tooth. Ventral tube with 6 + 6 smooth distolateral setae and 4 + 4 smooth setae on the posterior face; the 2 most basal setae on each side $\frac{1}{7}$ - $\frac{1}{3}$ as long as longest distal setae. Manubrium dorsally with both smooth and ciliate setae. Mucro falcate; basal spine just, or not quite, attaining apex. Maximum length 2.0 mm.

Remarks: The Hawaiian specimens are indistinguishable from nearctic material.

Ecology: Found in litter, and in caves on Hawaii and Oahu (Bellinger and Christiansen, 1974).

Records: Hawaii: 3138, 5398, 6860. Oahu: 3101.

***Sinella (Coecobrya) nupa* Christiansen and Bellinger, new species (Plate 100)**

Color white without trace of pigment. Fourth antennal segment without apical bulb or blunt setae but with enlarged lateral sense pegs; third and fourth antennal segments with whorled setae and weak constrictions between whorls; antenna without clavate setae, and about 6.5 times as long as cephalic diagonal. Head ovoid in dorsal view. Labral papillae obscure. Prelabral setae 4-5-5-4, all smooth. Labial appendage with differentiated seta slightly thicker and shorter than acuminate setae and exceeding apex of same papilla for about $\frac{1}{8}$ of its length. Labial triangle with 1 M seta; all setae smooth and r about $\frac{1}{2}$ as long as M. Eyes absent. Trochanteral organ with 16 setae in a rough triangle. Hind tibiotarsus elongate, with 1 outstanding ciliate seta at about 0.15 length of inner surface from base. Tenent hair less than half as long as inner edge of unguis, slender and acuminate. Unguis with lateral teeth minute and no external teeth; 3 inner teeth all together near base, 1 being greatly expanded with a clear network of surface markings. Unguiculus with a strong wing tooth. Ventral tube with 6 + 6 distolateral setae and 7 + 7 posterior setae. Mucro falcate, with basal spine just exceeding apex of organ. Length 2.0 mm.

Remarks: This unique species is the most highly troglomorphic cave collembolan in Hawaii and one of the most troglomorphic members of the genus *Sinella*. Only one specimen has been seen.

Derivatio nominis: Hawaiian, deep cave.

Ecology: Known only from type-locality cave.

Type locality: Holotype, Maui, Waikau Cave, Koolau Gap, XII-4-1976, 1980 m, deep zone, Howarth (5440).

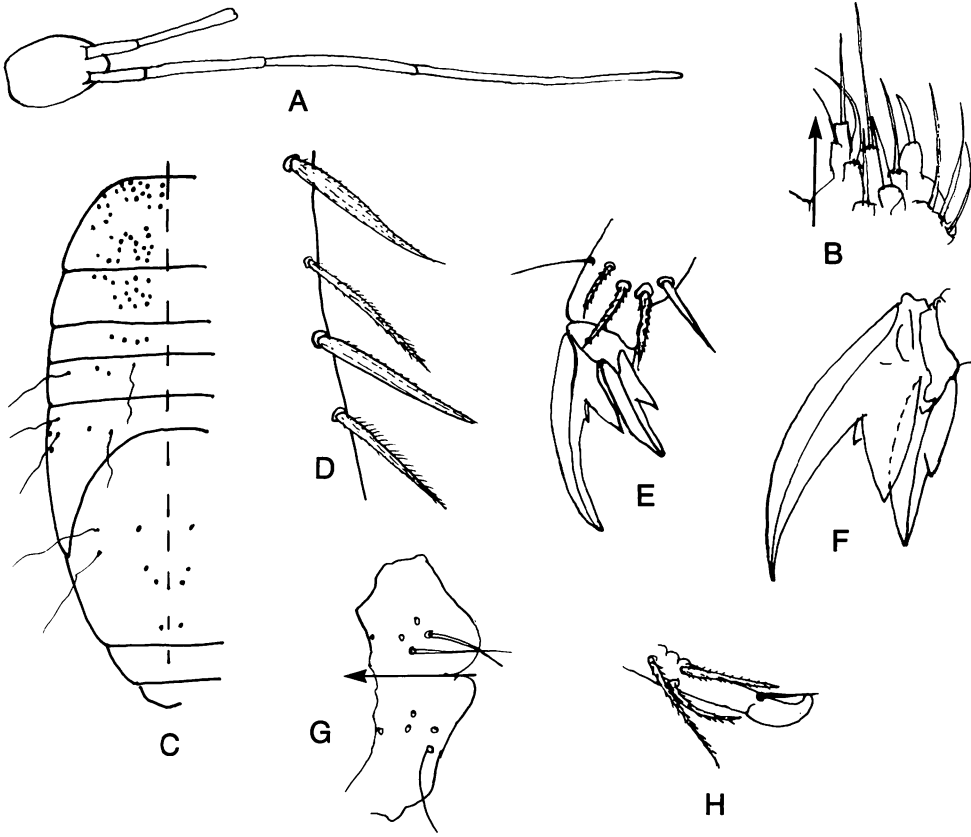


Plate 100—*Sinella nupa* (all figures of holotype): **A**, outline of head and antennae; **B**, left labial appendage seen from below; **C**, semidiagrammatic dorsal body macrochaetae; **D**, inner surface of hind tibiotarsus near distal end; **E**, hind foot complex; **F**, detail of hind unguis and unguiculus; **G**, manubrial plaque area; **H**, mucro and apex of dens.

Subgenus **SINELLA** s.str.

Members of the typical subgenus have ciliate dorsal manubrial setae and a bidentate mucro. There are two Hawaiian species of *Sinella* s.str.: *curviseta* and *yosii*.

Sinella* (*Sinella*) *curviseta Brook, 1882 (Plate 101)

J. Linn. Soc. London Zool. 16:544.—Christiansen and Bellinger, 1980.

Color white with pigment limited to eyes. Antenna without apical bulb. Fourth segment with numerous slender, curved, blunt setae. Antennae without clearly differentiated clavate setae. Head ovoid in dorsal view. Prelabral setae 4-5-5-4, all smooth. Differentiated seta of labial appendage exceeding apex of same papilla for

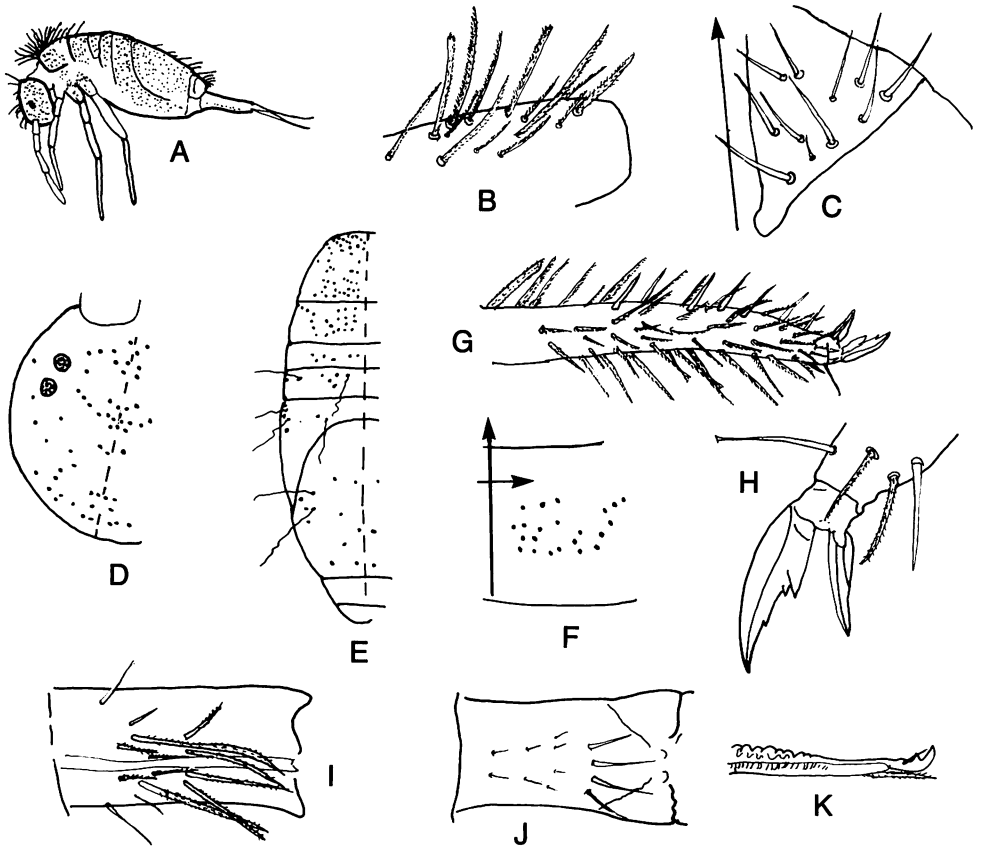
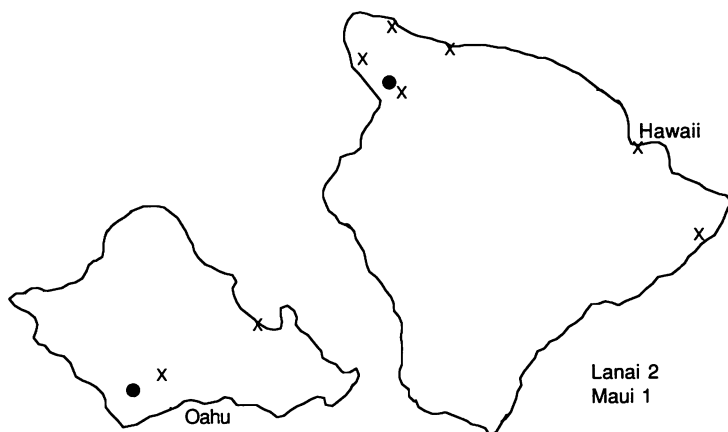


Plate 101—*Sinella curviseta*: A, habitus (after Delamare); B, apex of dorsum of second antennal segment (5667, Hawaii); C, left labial triangle (6694, Lanai); D, cephalic macrochaetae, left side (same); E, semidiagrammatic macrochaetae of body dorsum (composite); F, macrochaetae of left side, third thoracic segment (6693, Lanai); G, hind tibiotarsus and foot (after Delamare); H, hind foot complex (6693, Lanai); I, anterior face of ventral tube (after Yosii); J, posterior face (same); K, apex of dens and mucro (after Folsom).

$\frac{1}{3}$ – $\frac{1}{2}$ its length. Labial triangle seta M_2 absent; r small and smooth or sparsely ciliate. Eyes 2 + 2, individually darkly pigmented, one behind the other. Trochanteral organ with 12–15 setae in 2 arms, with scattered setae between. Hind tibiotarsus with 2 heavy, acuminate, ciliate setae at $\frac{1}{4}$ – $\frac{1}{3}$ length of inner surface from base and a single row of clearly differentiated “smooth” setae. Tenent hair truncate or clavate. Unguis with small outer and lateral teeth and 3 inner teeth, the apical tooth much smaller than the basal pair. Unguiculus acuminate, symmetrically tapering, sometimes externally serrate. Ventral tube with 7 + 7 to 9 + 9 distolateral setae, all smooth, and 6 + 6 or 7 + 7 posterior setae of varying lengths. Dorsal manubrial setae all ciliate. Mucro bidentate, with apical tooth slightly longer than anteapical tooth; basal spine almost reaching apex of organ. Maximum length 2.0 mm.



Remarks: Some Hawaiian records are questionable, since this species is a common contaminant in our collections. Specimens are similar to those seen previously, except that they lack all pigment except in the eyes, and most have the labial triangle seta smooth. There is a great deal of variation in the chaetotaxy of the body in Hawaiian specimens. The first two antennal segments have a number of truncate ciliate setae; however, these are not clearly differentiated from other large ciliate setae.

Ecology: Generally found in debris, litter, rotten wood, or under stones in deep woods, or along shorelines.

Records: Hawaii: 5130, 5132, 5138, 5273, 5647, 5667, 5670. Maui: 5166. Lanai: 6693, 6694. Oahu: 5231, 5232, 5236, 6754, 6777.

Sinella (Sinella) yosiia Bellinger and Christiansen, 1974 (Plate 102)

Pac. Insects 16:35.

Color entirely white except for pigmented eyespots (sometimes almost absent) to orange-red (in alcohol) or blue (in mounted specimens) because of scattered pigment granules; pigmented specimens with granules concentrated on sides and dorsum of body and usually forming a triangular patch between the eyes and dark posterior marginal bands on the third and fourth abdominal segments, and with antennae uniform pale blue. Fourth antennal segment without apical bulb and with numerous slender blunt setae about $\frac{2}{3}$ as long and less than half as thick as large ciliate setae. First segment with about 10 large clavate ciliate setae, weakly differentiated from pointed ciliate setae. Second segment without such. Head ovoid in dorsal view. Labral papillae obscure. Differentiated seta of labial appendage variable, from not nearly attaining apex of same papilla to exceeding apex by $\frac{1}{4}$ its length. Eyes lacking corneas, indicated only by 6 (rarely 8) pigment spots per side, with scattered pigment granules between them; eyes sometimes absent, with only faint granules in eyepatch region. Trochanteral organ with 33–43 setae in roughly triangular patch. All tibiotarsi with a single row of clearly differentiated “smooth” setae, and with 1 heavy outstanding ciliate seta, much larger than other

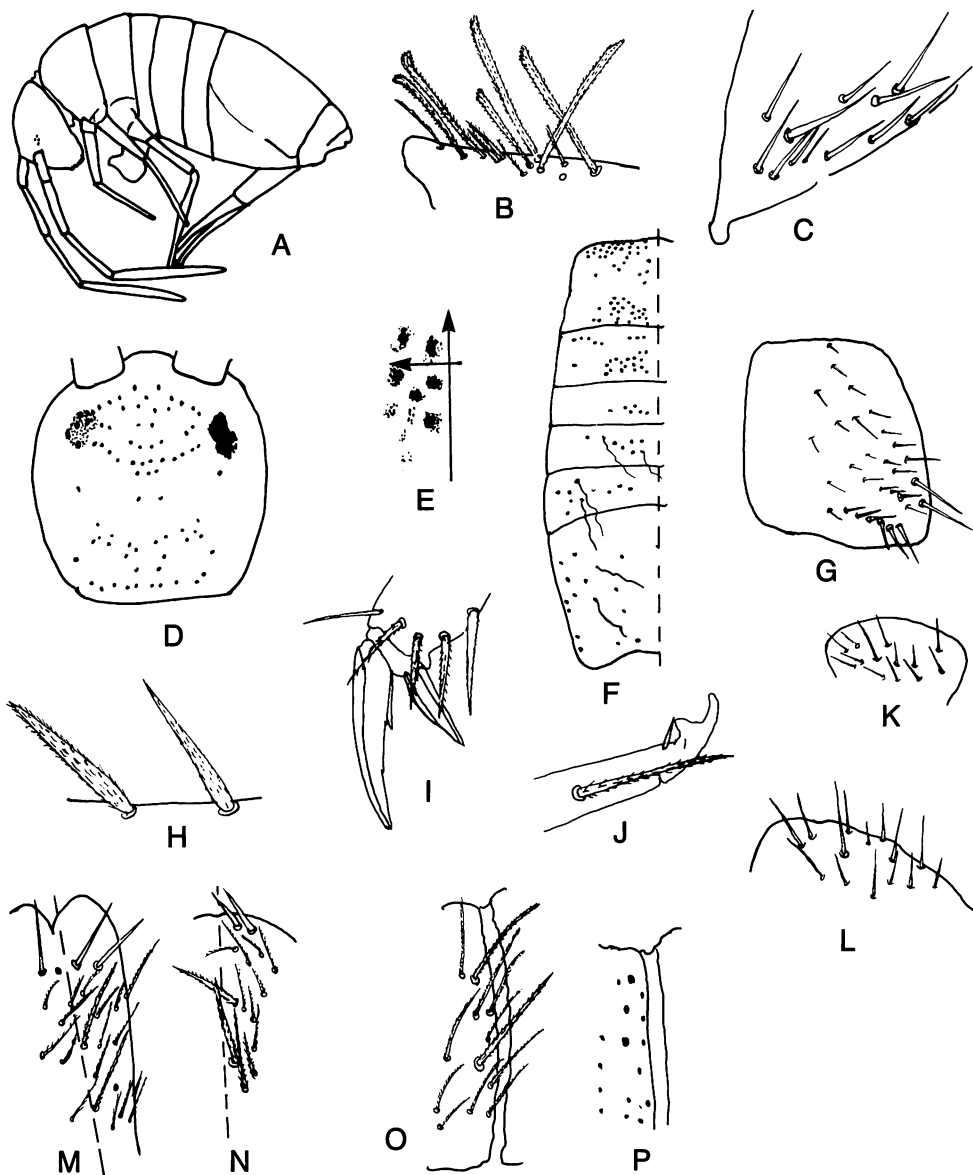
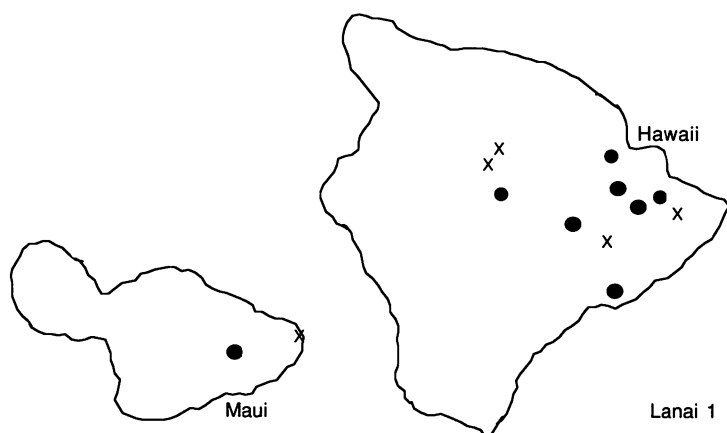


Plate 102—*Sinella yosia*: A, habitus (5476, Hawaii cave); B, dorsum of apex of first antennal segment (5443, Maui); C, left labial triangle (5410, Hawaii); D, dorsal cephalic macrochaetae (5410, Hawaii); E, eyes, left side of head (type specimen); F, semidiagrammatic macrochaetae of body dorsum (composite); G, trochanteral organ (5423, Hawaii); H, inner setae of hind tibiotarsus, near apex (type specimen); I, fore foot complex (type specimen); J, mucro and apex of dens (5430, Hawaii). K-P all of ventral tube: K, distolateral setae (5420, Hawaii); L, same (5440, Maui); M, posterior face setae (5430, Hawaii); N, same (5440, Maui); O, anterior face setae of left side (same specimen); P, setal bases, as above (5476, Hawaii cave).



setae, at about $\frac{1}{4}$ – $\frac{1}{3}$ length of inner surface from base. Tenent hair varying in length, acuminate to weakly truncate. Unguis with 3 very small inner teeth and no lateral or external teeth. Unguiculus acuminate, with inner margin oblique toward apex. Ventral tube with 12 + 12 to 14 + 14 distolateral setae, usually smooth but with up to 5 small setae sometimes ciliate, and with 10 + 10 to 16 + 16 posterior setae. All dorsal manubrial setae ciliate. Mucro with antepical tooth 0.8 as long as apical tooth and with basal spine just attaining its apex. Maximum length 5.0 mm.

Remarks: This is the dominant cave springtail of the island of Hawaii. It is quite variable in antennal length, eye structure and pigmentation, and ventral tube setae, but quite constant in foot structure and dorsal chaetotaxy. The ventral tube not only shows variability, but some of it appears to be asymmetrical. Specimens from Maui differ from those from Hawaii in having stronger remnants of eyes G and H and differently patterned distolateral ventral tube setae, but are otherwise so similar that we do not believe they should be placed in a separate taxon at this time. More detailed analysis of the extensive variation in this taxon may show that there is a species complex.

Ecology: Found at all levels in caves; a single surface record.

Type locality: Hawaii, Mountain View, Kazumura Cave, VI-22-1972, 400 m, Howarth.

Additional records: Hawaii: 2996, 3100, 3138, 3139, 5316, 5361, 5408, 5410, 5411, 5413, 5414, 5416, 5420, 5421, 5422, 5423, 5424, 5425, 5427, 5429, 5430, 5434, 5435, 5447, 5463, 5464, 5465, 5467, 5471, 5472, 5474, 5476, 5477. Maui: 3102, 5440, 5441, 5443, 5480. Lanai: 6694.

Genus **WILLOWSIA** Shoebbotham, 1917

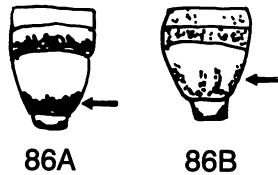
Type species: *Seira nigromaculata* (Lubbock, 1873)

General characters of the genus are as described in *The Collembola of North America*. Chaetotaxy is difficult to study in this genus because of intergradation between mesochaetae and macrochaetae; counts of macrochaetae depend on sub-

jective judgments of setal socket sizes. All Hawaiian species have heavily striate scales on the body and distinct patterns. There are three distinct Hawaiian species of *Willowsia*: *kahlertae*, *mekila*, and *jacobsoni*. A single specimen from near Kamuela probably represents a fourth species.

KEY TO HAWAIIAN SPECIES OF WILLOWSIA

- 1. Fourth abdominal segment with blue pigment in complete transverse band (Fig. 86A)..... **jacobsoni**
- Fourth abdominal segment with blue band broken in middle or with stripes (Fig. 86B)..... 2



- 2(1). Apical antennal bulb bilobed (Fig. 87B)..... **kahlertae**
- Apical antennal bulb simple (Fig. 87A)..... **mekila**



Willowsia kahlertae Christiansen and Bellinger, **new species** (Plate 103)

Color: background white to yellow; blue pigment in an irregular band over the third abdominal segment and sometimes on the posterior margin of the second, in irregular stripes along the lateral margins of all body segments except the sixth abdominal segment, and in a pair of L-shaped dorsal markings on the fourth abdominal segment; interocular spot clear; eyepatches dark and squarish; antennae and legs faintly washed with bluish purple. Body scales brownish, pointed, and broadly fusiform. Manubrium densely setaceous and lacking scales. Apical antennal bulb distinct and bilobed. Head a rounded pentagon in dorsal view. Labral papillae conical and unisetaceous. Prelabral setae 4-5-5-4; posterior row sparsely ciliate. Eyes G and H much smaller than F. Trochanteral organ with 14-17 setae in an irregular triangle. Tenent hair very heavy and clavate. Unguis with 4 small inner and 2 small lateral teeth. Unguiculus acuminate, not ciliate externally. Mucronal teeth subequal; basal spine barely attaining apex of anteapical tooth. Mesothorax with 2 + 2 to 3 + 3 median and 5 + 5 to 8 + 8 posterior large macrochaetae; metathorax with 6 + 6 anterior and 5 + 5 posterior macrochaetae in 2 clear rows. Maximum length 2 mm.

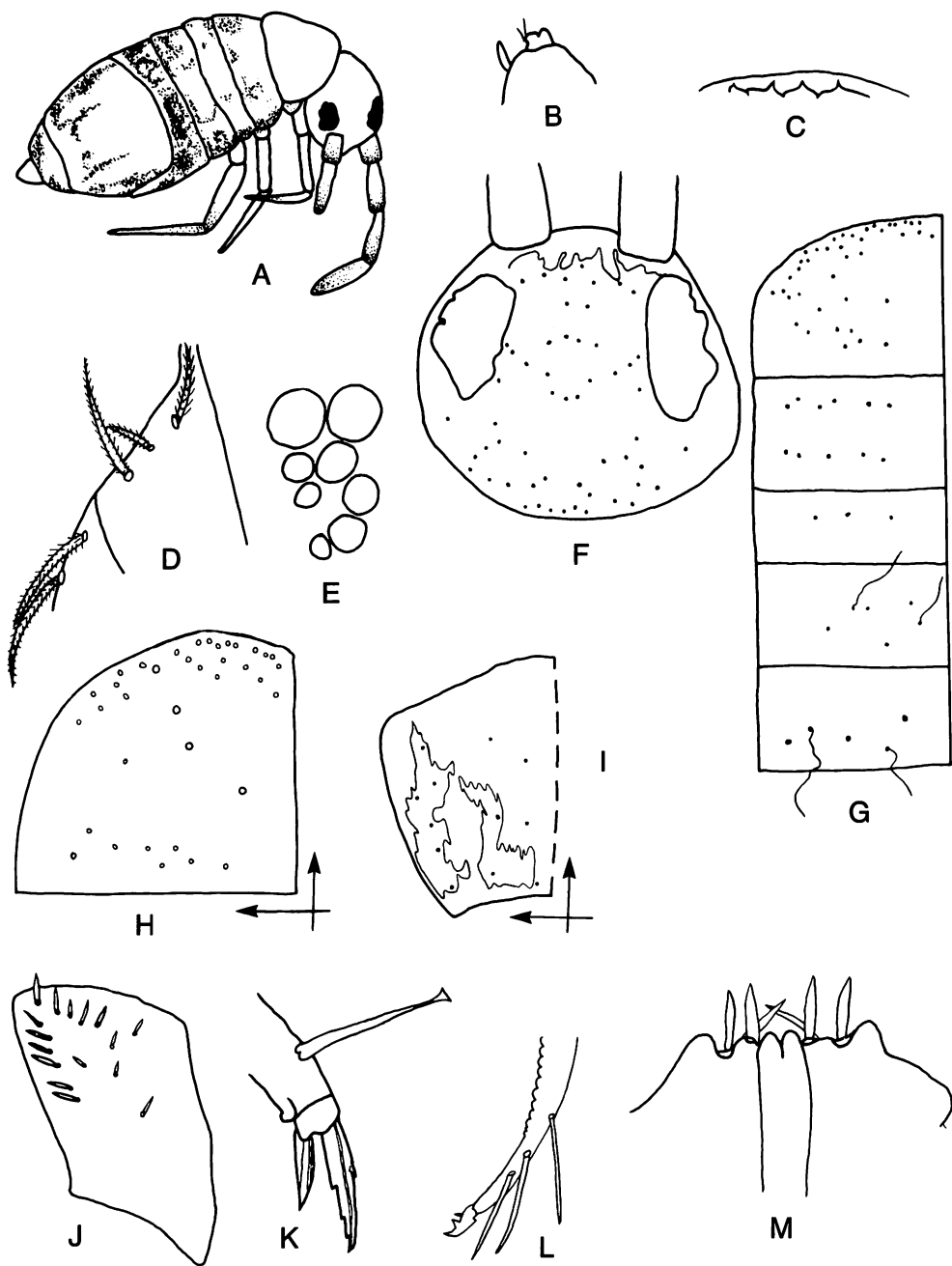
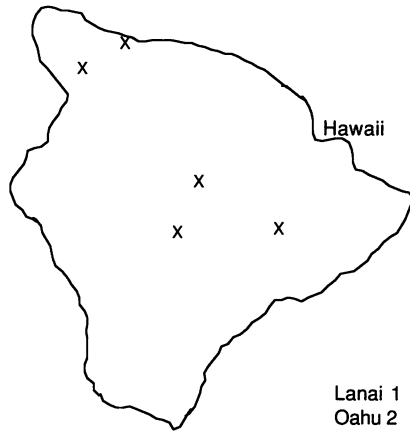


Plate 103—*Willowsia kahlertae*: **A**, habitus (4725, Hawaii); **B**, apex of antenna (5152, Hawaii); **C**, labral papillae (paratype); **D**, basal labial triangle setae, right side (5152, Hawaii); **E**, right eyepatch (4725, Hawaii); **F**, dorsal cephalic macrochaetae (5152, Hawaii); **G**, semidiagrammatic dorsal macrochaetae (composite); **H**, dorsal second thoracic macrochaetae, left side (5152, Hawaii); **I**, fourth abdominal macrochaetae (same); **J**, trochanteral organ (holotype); **K**, fore foot complex (same specimen as B); **L**, mucro and apex of dens (6843, Hawaii); **M**, male genital plate (5152, Hawaii).



Remarks: The bilobed apical antennal bulb distinguishes this from other Hawaiian species. It may possibly be a synonym of *W. bimaculata* Börner, 1909 from Japan, but that species has a more complete pattern, with the third abdominal segment all dark; the chaetotaxy of *W. bimaculata* has not been described. There is considerable variation in the macrochaetae because of enlargement of the mesochaetae in larger specimens. No scales were seen on the manubrium even in relatively intact specimens.

Derivatio nominis: Named after Martha Kahlert, whose work was essential for this project.

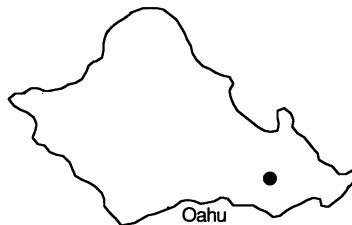
Ecology: Found in a variety of habitats (under bark, in ferns, grass roots, in bird nest), but not in litter or soil.

Type locality: Holotype and 6 paratypes, Hawaii, Kukuihaele, XII-14-1961, bird nest (inactive), Wilson (5111).

Additional records: Hawaii: 4725, 4857, 4858, 5152, 5648, 6843. Lanai: 6695. Oahu: 4773, 4776.

***Willowsia mekila* Christiansen and Bellinger, new species (Plate 104)**

Color: background yellow; blue pigment in 3 irregular longitudinal stripes on the fourth abdominal segment and lateral spots and patches on other trunk segments and a posterior band on the third abdominal segment; head with lateral, dorsal, and interantennal spots in addition to eyepatches; legs and basal 2 antennal



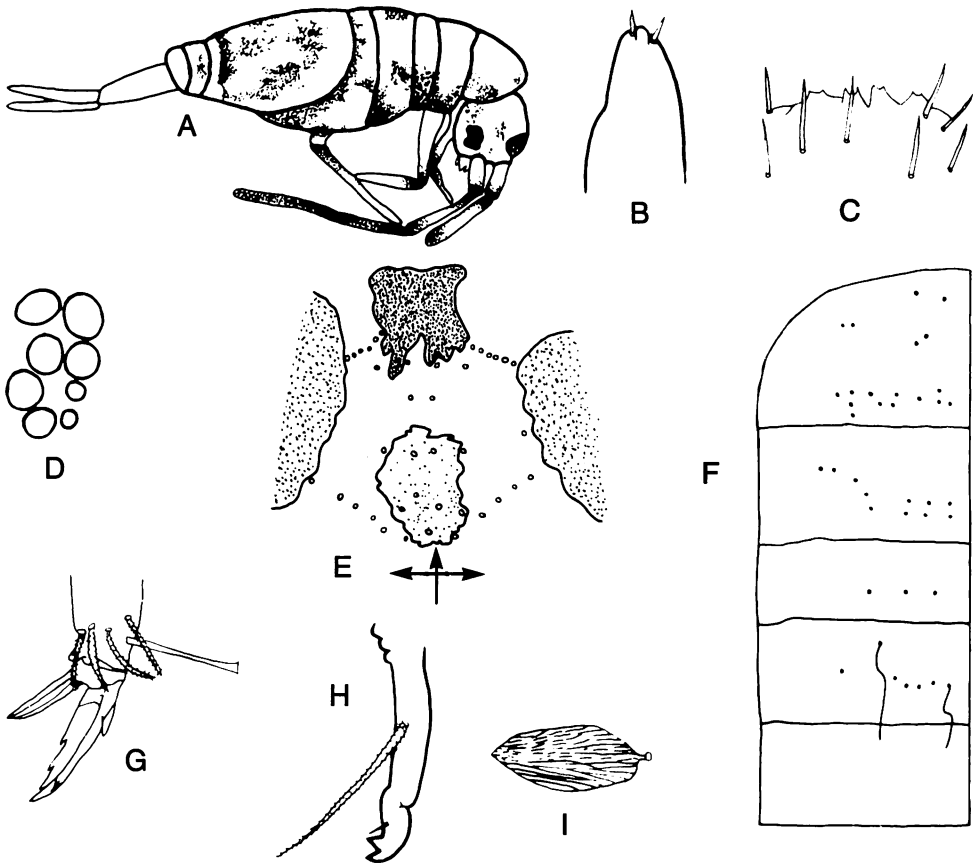


Plate 104—*Willowsia mekila*: A, habitus (holotype); B, apex of antenna (holotype); C, labral papillae (paratype); D, right eyepatch (paratype); E, interoctular macrochaetae (4777, Oahu); F, semidiagrammatic chaetotaxy, left side, second thoracic segment through second abdominal segment, collar setae omitted (composite); G, hind foot complex (4777, Oahu); H, apex of dens and mucro (same); I, scale from abdomen (same).

segments banded; sixth abdominal segment and furcula unpigmented. Scales pointed to weakly rounded apically. Apical antennal bulb simple. Head in dorsal view a rounded hexagon. Labral papillae conical, bisetaceous. Prelabral setae 4-5-5-4 with posterior row ciliate. Labial triangle setae all ciliate, with R much smaller than others. Eyes G and H much smaller than others. Trochanteral organ with about 22 setae in 3 rows. Tenent hair heavy and clavate. Unguis with 4 small inner and 2 small lateral teeth. Uniguiculus acuminate, without external ciliation. All femora and hind tibiotarsi scaled. Mucronal teeth subequal; basal spine reaching or slightly exceeding apex of anteapical tooth. Mesothorax with 2 + 2 median large macrochaetae and a broad posterior band of approximately 13 + 13; metathorax with about 11 + 11 large macrochaetae in an angled band from posterior midline to anterior lateral margin. Maximum length 2.2 mm.

Remarks: The striking pattern of this species as well as the long antennae easily distinguish it from other Hawaiian species, as well as from other described species of *Willowsia*.

Derivatio nominis: Hawaiian, handsome.

Ecology: Known only from litter.

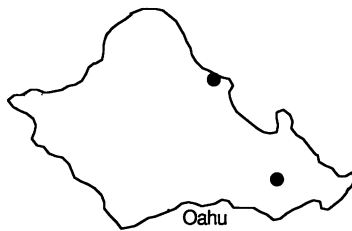
Type locality: Holotype and 1 paratype, Oahu, Tantalus Drive, X-10-1966, open dry woods, PB (4780).

Additional records: Oahu: 4770, 4777.

Willowsia jacobsoni (Börner, 1913) (Plate 105)

Tijdschr. Entomol. 56:44 (*Sira*).—Folsom, 1932.—Mari Mutt, 1981.

Color: background bluish white to yellow, with broad and irregular blue bands across all, or almost all, of the third abdominal segment and the posterior $\frac{2}{3}$ to $\frac{1}{4}$ of the fourth abdominal segment; in our material the posterior margin of the second abdominal segment generally also has a blue band and the second thoracic segment is entirely blue; eyepatches and interantennal band dark; faint, irregular pigment may be scattered over the rest of the body and head. Body scales pointed and heavily striate; scales on manubrium oval to elliptical, with weaker striations. Antenna with a single subapical retractile bulb. Head almost circular in dorsal view. Labral papillae low and broad, each with 3–5 microsetae. Prelabral setae 4-5-5-4, all smooth or with the posterior row sparsely ciliate. Trochanteral organ with about 16 setae in 3 irregular rows. Tenent hair heavy and clavate. Unguis with 4 small inner and 2 small lateral teeth. Unguiculus acuminate; outer edge weakly but clearly serrate. Mucronal teeth subequal; basal spine just reaching apex of anteapical tooth. Large macrochaetae sparse; only 2 + 2 to 3 + 3 on posterior margin of second and third thoracic segments. Maximum length 2.1 mm.



Hawaii 2
Maui 1

Remarks: The banded pattern, multisetaceous labral papillae, and sparse macrochaetae distinguish this from other Hawaiian species. In our specimens there is a greater difference in size between eyes F and G than shown by Folsom (1932), and the striae on the scales are broken rather than continuous as in his figure, but there is little doubt that they belong to the species he calls *W. jacobsoni*. They also agree generally with the redescription by Mari Mutt (1981), except for details of chaetotaxy and the striking sexual dimorphism found in his cultured specimens.

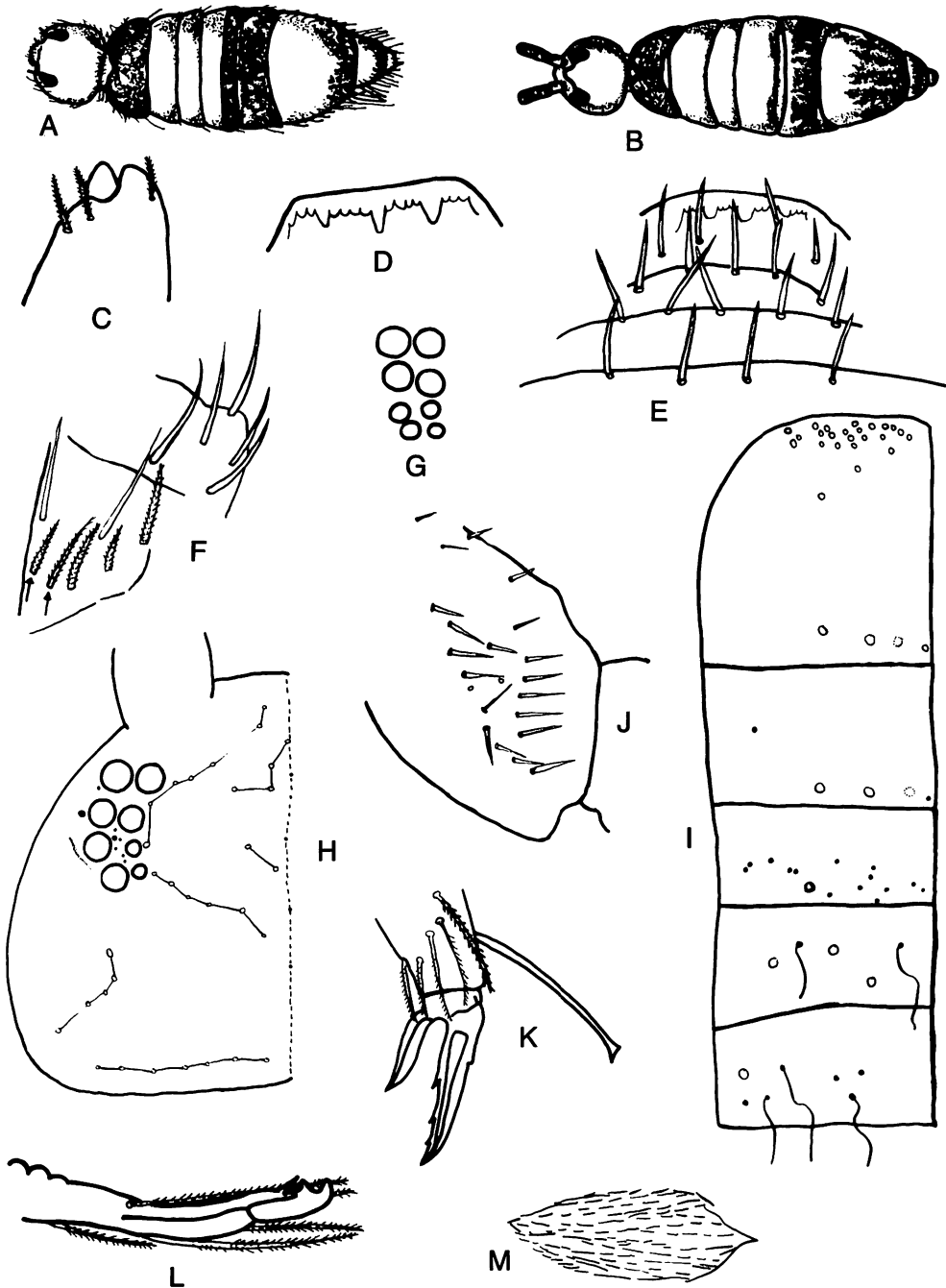


Plate 105—*Willowsia jacobsoni*: A, B, habitus and pattern (after Folsom); C, apex of antenna (4766, Oahu); D, labral papillae (same); E, prelabral setae (4806, Oahu); F, left labial triangle setae (after Mari Mutt); G, left eyepatch (after Folsom); H, cephalic chaetotaxy, left side (after Mari Mutt); I, semidiagrammatic dorsal macrochaetae, left side, second thoracic segment-third abdominal segment (composite); J, trochanteral organ (after Mari Mutt); K, hind foot complex (after Folsom); L, mucro and apex of dens (after Folsom); M, abdominal scale (4786, Oahu).

Our specimens do not show sexual dimorphism, and none have the typical female pattern that he illustrated. The greater number of macrochaetae shown by Mari Mutt on thoracic segments evidently include setae that we call mesochaetae. The male genital plates in our specimens agree perfectly with those drawn by Mari Mutt.

Ecology: Found in litter and less commonly in soil.

Records: Hawaii: 5138, 6847. Maui: 5161. Oahu: 4766, 4786, 4805, 4806.

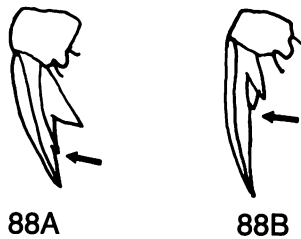
Genus **HAWINELLA** Bellinger and Christiansen, 1974

Type species: *H. lava* Bellinger and Christiansen, 1974

This endemic Hawaiian genus is distinguished from other eyeless entomobryids by the presence of scales on the venter of the manubrium but not on the dens. The scales are narrow and fusiform and most are heavily striate, more like those of *Willowsia* than of *Lepidocyrtus*. The combination of a falcate mucro with absence of scales on the antennae and legs is also distinctive. The genus resembles *Seira* in having many macrochaetae on the head and anterior body segments. The outstanding clavate or truncate ciliate seta of the hind tibiotarsus links it with some *Pseudosinella* species. Finally, there is a strong resemblance to *Sinella* (*Coecobrya*), from which *Hawinella* differs only in having scales, oligochaetotic second and third abdominal segments, and fewer mesochaetae. There are two known species of *Hawinella*: *kuaola* and *lava*.

KEY TO HAWAIIAN SPECIES OF HAWINELLA

1. Apical inner unguual tooth more than halfway to apex of unguis (Fig. 88A) **kuaola**
 Apical inner unguual tooth less than halfway to apex of unguis (Fig. 88B) **lava**



Hawinella kuaola Christiansen and Bellinger, **new species** (Plate 106)

Color white without trace of pigment. Scales pointed, heavily striate, elliptical to fusiform on body and narrowly fusiform on venter of manubrium. Antenna without apical bulb; sense organ of third antennal segment rodlike. Head broadly oval in dorsal view. Labral papillae obscure. Prelabral setae 4-5-5-4, all smooth. Trochanteral organ with 3-4 setae in dorsal and 4-5 in ventral arm. Hind tibiotarsus with 1 outstanding truncate seta on inner margin at $\frac{1}{4}$ of its length from base. Tenent hair slightly shorter than inner edge of unguis, varying from clavate to

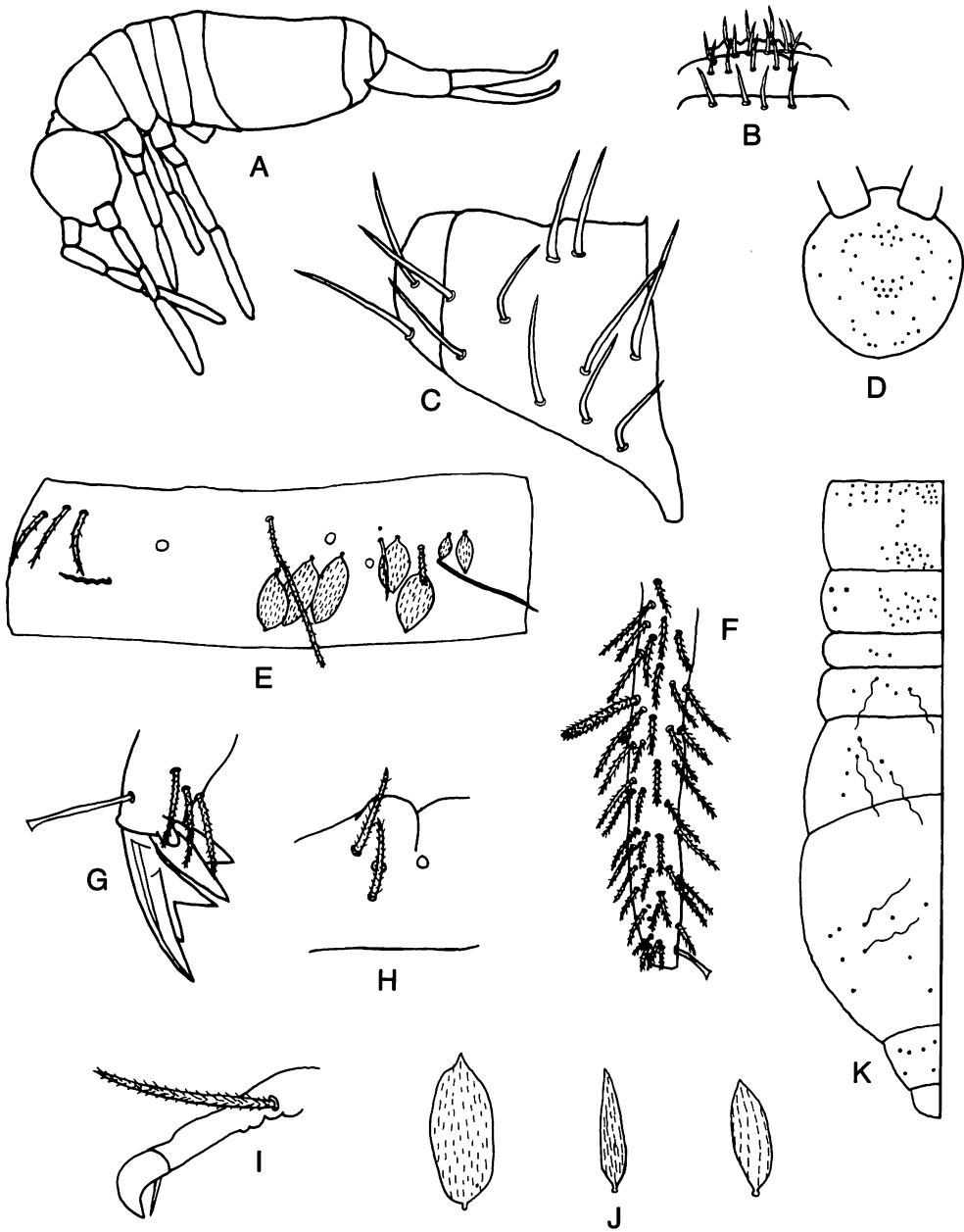


Plate 106—*Hawinella kuaola*: **A**, habitus (paratype); **B**, prelabral setae (holotype); **C**, left labial triangle setae (same); **D**, semidiagrammatic dorsal chaetotaxy (composite); **E**, detail of left side, second abdominal segment chaetotaxy (paratype); **F**, hind tibiotarsus (paratype); **G**, hind foot complex (paratype); **H**, manubrial plaque, left side (paratype); **I**, apex of dens and mucro (paratype); **J**, scales from different parts of body (paratype).

acuminate. Unguis with 3 inner teeth, 1 of basal pair being very large and broad; outer tooth very small. Unguiculus with a strong outer wing tooth. Ventral tube with 2 + 2 posterior setae (1 pair large, 1 small) and 5 + 5 distolateral setae. Mucro with basal spine varying from not quite reaching to just exceeding apex of organ. All labial triangle setae smooth. First abdominal segment dorsally with 3 + 3 macrochaetae; second with 3 + 3. Maximum length 1.5 mm.

Remarks: This species shows much the same relationship to the cave-adapted *H. lava* as other pairs of surface and derived cave Entomobryinae. There appears to be minor variation in the dorsal chaetotaxy.

Derivatio nominis: Hawaiian, verdant mountain.

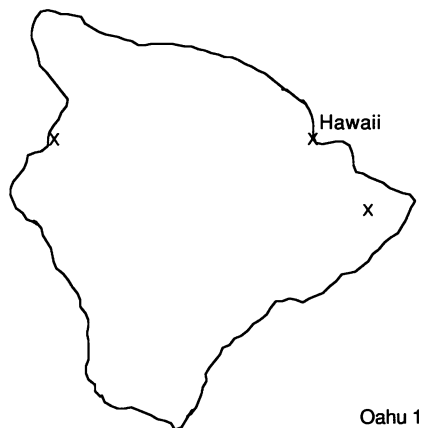
Type locality: Holotype and 2 paratypes, Oahu, N of Palikea, Waianae Mountains, X-20-1966, moss, PB (4796).

Additional record: Oahu: 4794.

Hawinella lava Bellinger and Christiansen, 1974 (Plate 107)

Pac. Insects 16:36.

Color white without trace of pigment. Scales pointed; body scales broadly elliptical with fine striations; manubrial scales narrow and fusiform. Antenna without apical bulb. Apical organ of third antennal segment with elliptical pegs. Head roughly circular in dorsal view. Labral papillae obscure, conical. Prelabral setae 4-5-5-4, all smooth. All labial triangle setae very finely ciliate. Eyes absent. Trochanteral organ with 5 setae in each arm. Hind tibiotarsus with a truncate ciliate seta, slightly larger than others, between $\frac{1}{4}$ and $\frac{1}{3}$ of distance from base to apex, on outer side. Tenent hair short and acuminate. Unguis with 3 inner teeth, 1 basal tooth being slender and elongate and the others small, and a small basal outer tooth. Unguiculus with a large outer wing tooth. Ventral tube with 6-7 distolateral setae per side. Dens without spines. Mucronal spine reaching apex of organ. Head and dorsum of second and third thoracic segments with numerous macrochaetae. First abdominal segment with 4 + 4 macrochaetae; second with 3 + 3. Maximum length 1.3 mm.



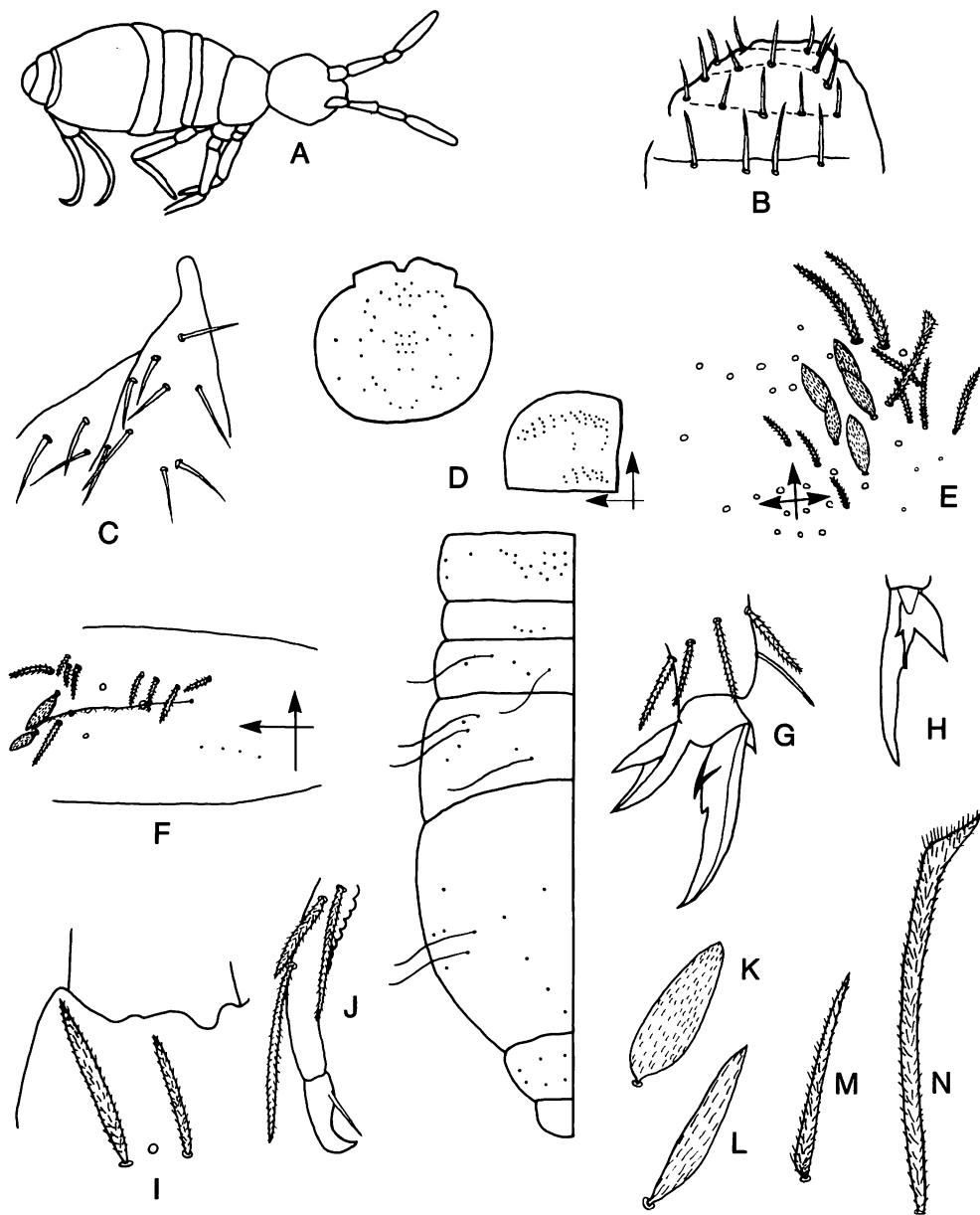


Plate 107—*Hawinella lava*: **A**, habitus (5409, Hawaii); **B**, prelabral setae (same); **C**, labial triangle setae, left side (same specimen); **D**, semidiagrammatic dorsal macrochaetae, head and left side of body (composite); **E**, detail of head chaetotaxy and scales (5409, Hawaii); **F**, detail of left side of second abdominal segment (same). Figures **G**–**N** of types: **G**, lateral view, hind foot complex; **H**, inner view of same; **I**, manubrial plaque setae; **J**, mucro and apex of dens; **K**, typical scale of head and body; **L**, scale of venter of manubrium; **M**, macrochaeta of dorsum of head; **N**, macrochaeta from anterior margin of mesothorax.

Remarks: There appears to be some variation in the dorsal macrochaetae; however, this may be due to the different quality of preparations. The surprising discovery of *H. lava* on Oahu and Hawaii cannot be presently explained in the absence of surface collections.

Ecology: Found only in caves.

Type locality: Oahu, Makua Cave, X-31-1971, FH.

Additional records: Hawaii: 5409, 5431, 5478.

Genus **SEIRA** Lubbock, 1869

Type species: *Degeeria domestica* Nicolet, 1842

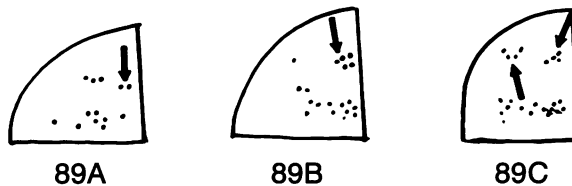
Hawaiian species of this genus are readily recognized by the falcate mucro and thin, brownish scales on the body, furcula, first three antennal segments, and legs (including tibiotarsi). All have paired apical antennal bulbs, eyes G and H smaller than the others, and dentes without spines or knobs; the labral and labial structure is generally similar in all. The body chaetotaxy is usually easy to see and characteristic for each species. There are four Hawaiian species of *Seira*: *gobalezai*, *lelo*, *pihulu*, and *terrestris* (see Table 25).

Table 25. Characteristics of Hawaiian Species of *Seira*

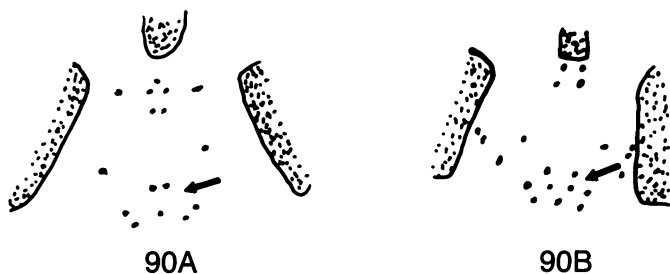
SPECIES	TRUNK COLOR	LABRAL PAPILLAE	DORSAL MACROCHAETAE		
			TH. III	ABD. I	ABD. II
<i>gobalezai</i>	+	?	11	5	3
<i>lelo</i>	-	-	4	12?	3
<i>pihulu</i>	+	2	15	8+	4
<i>terrestris</i>	+, -	4	9	4	3

KEY TO HAWAIIAN SPECIES OF SEIRA

1. First abdominal segment with 2 + 2 macrochaetae; body without pigment. **lelo**
- First abdominal segment with 4 + 4 or 5 + 5 macrochaetae; body usually with some pigment. 2
- 2(1). Median macrochaetae on second thoracic segment 5 on each side, without secondary mediolateral setae (Fig. 89B). **gobalezai**
- Median macrochaetae on second thoracic segment in 2 groups of 4 and 3 setae on each side (Fig. 89C). 3



- 3(2). Median cephalic macrochaetae 7 (Fig. 90A)..... **terrestris**
 Median cephalic macrochaetae 9 (Fig. 90B)..... **pihulu**



Seira gobalezai Christiansen and Bellinger, **new species** (Plate 108)

Color: yellowish background with bluish pigment on antennae, eyepatches, and interantennal spot, and in incomplete transverse bands on second and third abdominal segments and sometimes on third thoracic segment and posterior margin of fourth abdominal segment. Head a rounded hexagon in dorsal view. Labral papillae obscure, conical, and weakly unisetaceous. Prelabral setae 4-5-5-4; posterior row ciliate, others smooth. Labial triangle setae $M_1, M_2, vgEL_1, L_2$. Eyepatches roughly trapezoidal. Eyes G and H elliptical. Trochanteral organ with 15-17 setae. Tenent hair heavy and strongly clavate. Unguis with 4 strong inner teeth and small lateral teeth at about half its length. Unguiculus acuminate, with inner edge smoothly curved and outer edge straight. Ventral tube with 9-10 setae in each distolateral group, all smooth or feebly ciliate. Maximum length 2.3 mm.

Remarks: In most respects this species is very similar to *Seira indra* (Imms, 1912), as redescribed by Yosii and Ashraf (1965); in particular, the chaetotaxy of the first four trunk segments is almost identical. However, *S. indra* appears to lack forms with complete transverse bands and has unguis teeth that are much more basal than in *S. gobalezai*. It also has differentiation of setae of the trochanteral organ and ventral tube that we have not found in *S. gobalezai*. We prefer to keep the two species separate for the present.

Derivatio nominis: Named after Dominador Gobalez, whose work was essential for this project.

Ecology: Known only from litter.

Type locality: Holotype and 2 paratypes, Oahu, Waialua-Haleiwa area, X-28-1966, litter and grass in sugarcane, PB (4810).

Additional records: Oahu: 4753, 4815.

Seira lelo Christiansen and Bellinger, **new species** (Plate 109)

Color yellow, with blue pigment on eyepatches and usually on antennae and interantennal spot. Head roughly circular in dorsal view. Labral papillae conical, usually truncate but sometimes appearing acuminate. Prelabral setae 4-5-5-4, usually all smooth. Labial triangle with r minute or vestigial, M_2 and E ciliate or smooth, and other setae ciliate. Trochanteral organ with 12-15 setae. Tenent hair

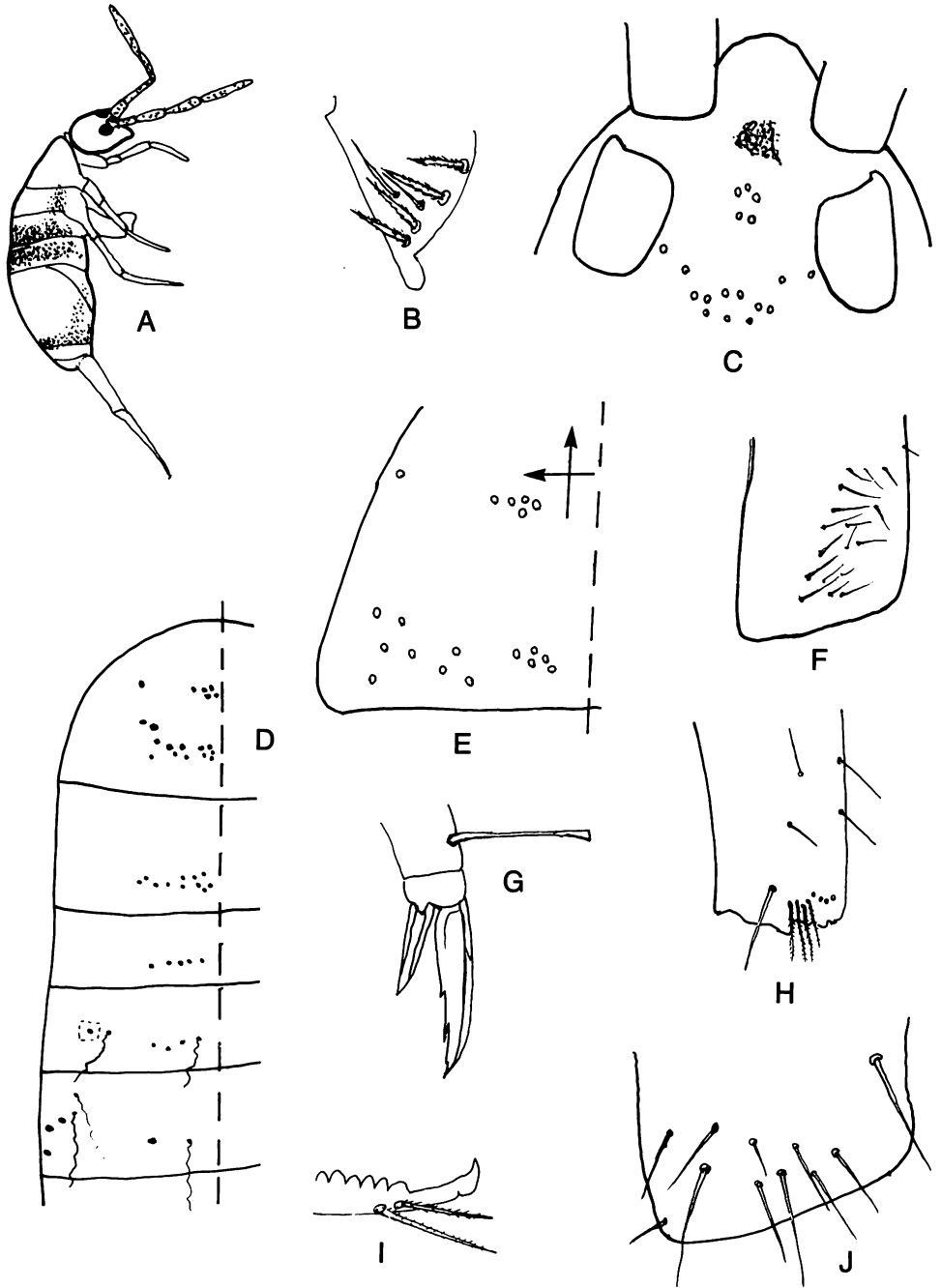


Plate 108—*Seira gobalezai*: A, habitus (paratype); B, left side of labial triangle (4815, Oahu); C, interocular macrochaetae (same); D, semidiagrammatic dorsal median macrochaetae, second thoracic segment through third abdominal segment, collar setae omitted (composite); E, second thoracic macrochaetae, collar setae omitted (4753, Oahu); F, trochanteral organ (paratype); G, hind foot complex (paratype); H, apical $\frac{2}{3}$ of venter of manubrium (holotype); I, mucro (4815, Oahu); J, apex of ventral tube seen from side (holotype).

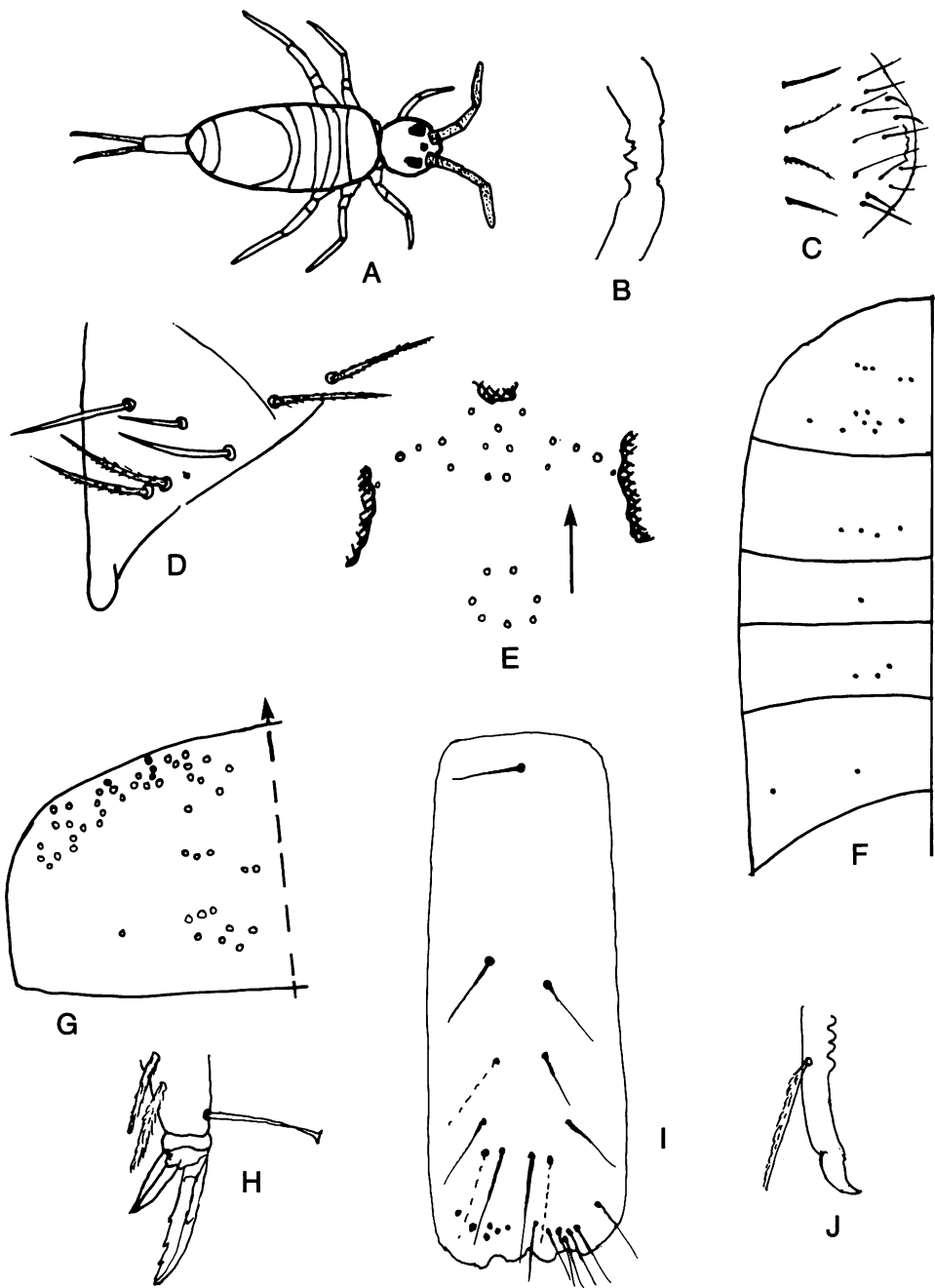
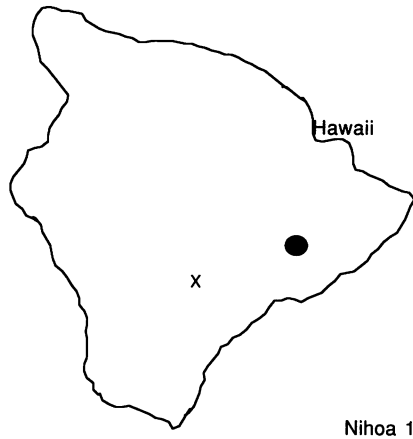


Plate 109—*Seira lelo*: A, habitus (paratype); B, labral papillae (paratype); C, prelabral setae (paratype); D, labial triangle setae, left side (holotype); E, dorsal interocular macrochaetae (paratype); F, semidiagrammatic dorsal median macrochaetae, left side, second thoracic segment through third abdominal segment, collar setae omitted (composite); G, second thoracic macrochaetae (paratype); H, hind foot complex (paratype); I, venter of manubrium, dotted lines represent missing setae present on other specimens (holotype); J, mucro (paratype).



strongly clavate. Unguis with 4 inner teeth, the basal pair prominent and the distal tooth minute; lateral teeth small, at about half length of unguis. Unguiculus with inner edge more curved than serrate outer edge. Ventral tube with 9–11 setae on each distolateral patch. Maximum length 2.4 mm.

Remarks: There is some minor variation, sometimes unilateral, in the number of macrochaetae. Some specimens have two or all of the posterior prelabral setae weakly ciliate. The specimens from Nihoa differ in a number of minor respects and may be a different species. The chaetotaxy of this species distinguishes it from all others; it may be closest to *S. americana* Jacquemart, 1980 from Peru.

Derivatio nominis: Hawaiian, yellowish.

Ecology: Almost all collections of this species come from fumaroles in Hawaii Volcanoes National Park, with site temperatures ranging from 33 °C to 51 °C; the other three collections are also from somewhat extreme conditions.

Type locality: Holotype and 20 paratypes, Hawaii, V.N.P., 1971, Steaming Bluffs Trail, vents 1 and 2, Goff (4955, 4977, 4997).

Additional records: Hawaii: 4905, 4977, 4997, 5003, 5006, 5010, 5017, 5018, 5027, 5033, 5037, 5038, 5040, 5046, 5047, 5050, 5051, 5054, 5062, 5063, 5661. Nihoa: 6195.

***Seira pihulu* Christiansen and Bellinger, new species (Plate 110)**

Color blue, varying from solidly distributed over abdomen and thorax up to the posterior margin of second thoracic segment, to being limited to bands across posterior margins of second and fourth abdominal segments, antennae, and interantennal band. Head roughly circular in dorsal view. Labral papillae with inner pair conical and strongly unisetaceous; outer pair low and conical. Labial triangle with $M_1M_2RE_1L_1L_2$; with R seta much smaller than others. Trochanteral organ with 13–15 setae in arms and 1 inner and 2 external setae. Tenent hair strongly clavate. Unguis with 4 inner teeth all prominent. Lateral and external teeth small but clear. Unguiculus with inner edge more curved than serrate outer edge. Ventral tube with 9–10 setae on each distolateral patch. Scales heavily striate and brownish. Maximum length 2.2 mm.

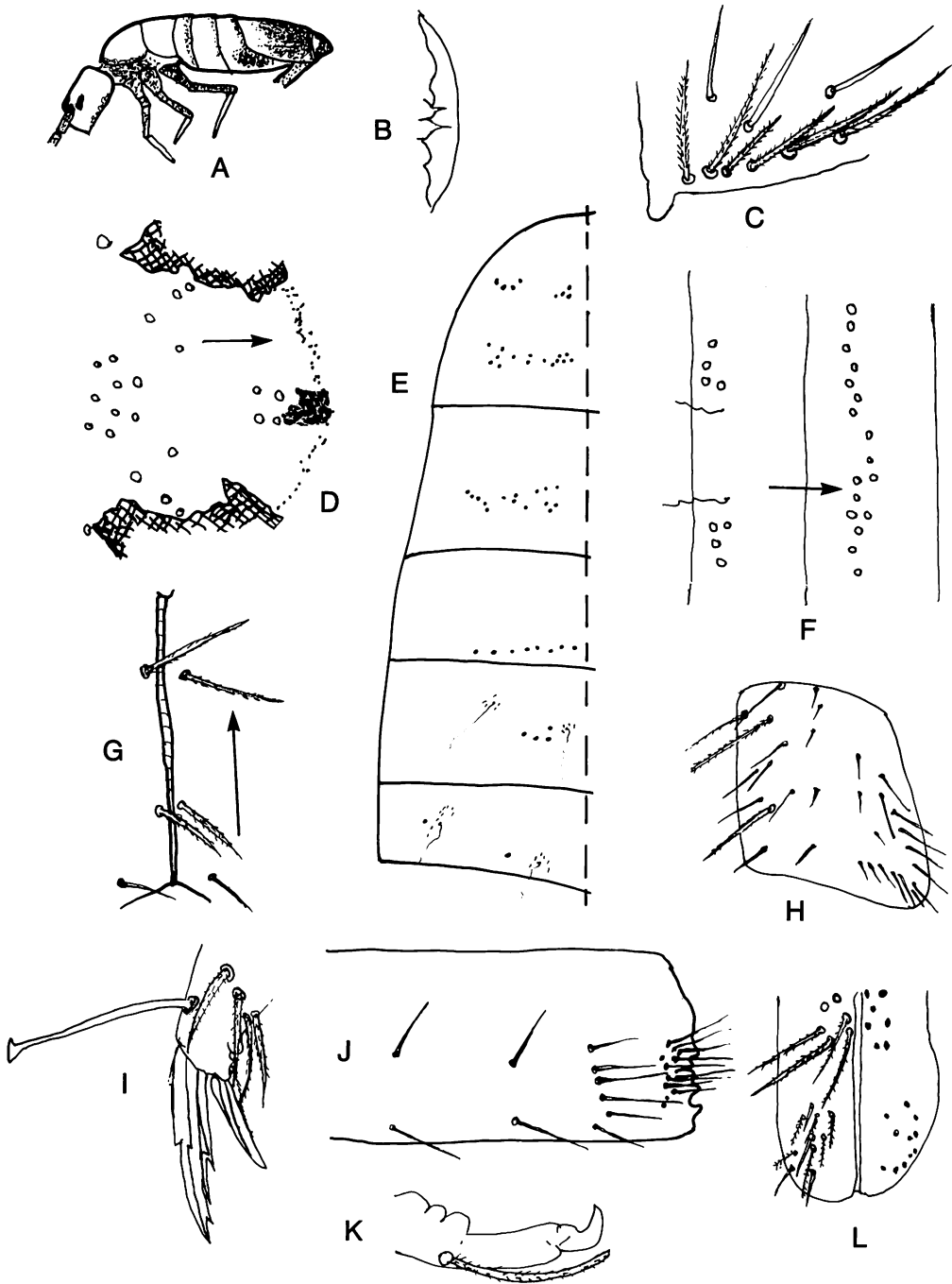


Plate 110—*Seira pihulu*. **A**, schematic pattern (holotype); **B**, labral papillae (holotype); **C**, labial triangle setae, left side (paratype); **D**, interochlear macrochaetae (5668, Hawaii); **E**, semidiagrammatic dorsal macrochaetae, second thoracic segment through third abdominal segment (composite); **F**, dorsal macrochaetae, second and third abdominal segments (5668, Hawaii); **G**, ventral setae along midline of head (paratype); **H**, trochanteral organ and associated setae (holotype); **I**, hind foot complex (paratype); **J**, distal $\frac{2}{3}$ of venter of manubrium (holotype); **K**, mucro (paratype); **L**, anterior surface, ventral tube (paratype).

Remarks: The dorsal chaetotaxy sharply distinguishes this species from other Hawaiian species. The 3 + 3 median distal ventral manubrial setae also distinguish this from most other Hawaiian species. The R seta of the labial triangle is sometimes absent. The specimens from the type locality are all pale, whereas the single specimen from Hawaii is very dark and may represent a different taxon.

Derivatio nominis: Hawaiian, hairy.

Ecology: The two known collections are both from *Casuarina* litter.

Type locality: Holotype and 5 paratypes, Midway Atoll, Sand I., I-17-1983, in *Casuarina* litter adjacent to beach, Gagne (6841).

Additional record: Hawaii: 5668.

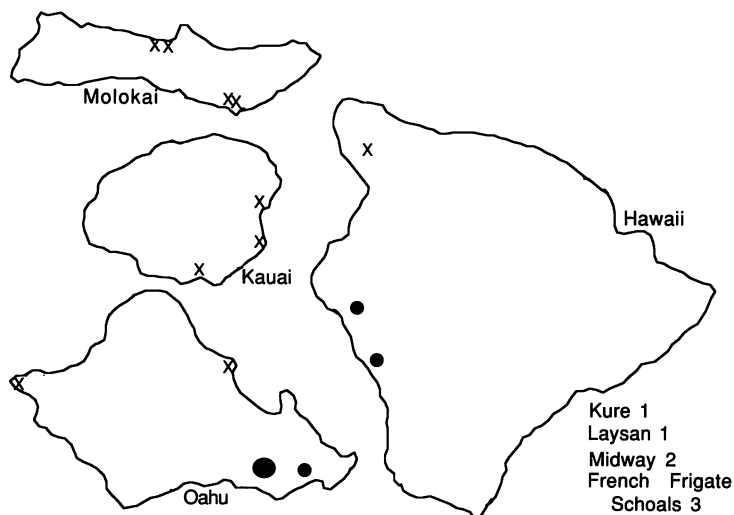
Seira terrestris (Folsom, 1932) (Plate 111)

Proc. Hawaii. Entomol. Soc. 8:69 (*Drepanocyrtus*).—Gapud, 1971.

Entomobrya lactea Folsom, 1932, Proc. Hawaii. Entomol. Soc. 8:65. **New synonym.**

Color yellowish, with blue pigment on antennae and body, nearly uniform in distribution, or only on lateral margin of segments, or confined to eyes, interantennal spot, and antennae. Head a rounded square in dorsal view. Labral papillae minute, conical. Posterior prelabral setae always ciliate. Labial triangle setae ciliate, with r vestigial. Trochanteral organ with 17–28 setae in triangular field. Tenent hair about as long as unguis and clavate. Unguis with 4 strong inner teeth and 2 small lateral teeth at about $\frac{1}{3}$ of its length from base. Unguiculus symmetrically tapering. Ventral tube with 10–13 setae in each distolateral patch. Maximum length 2.2 mm.

Remarks: The thoracic and anterior abdominal chaetotaxy, fortunately visible on a type specimen, verify our application of this name. There is some variation in chaetotaxy, which does not appear significant except for the first abdominal seg-



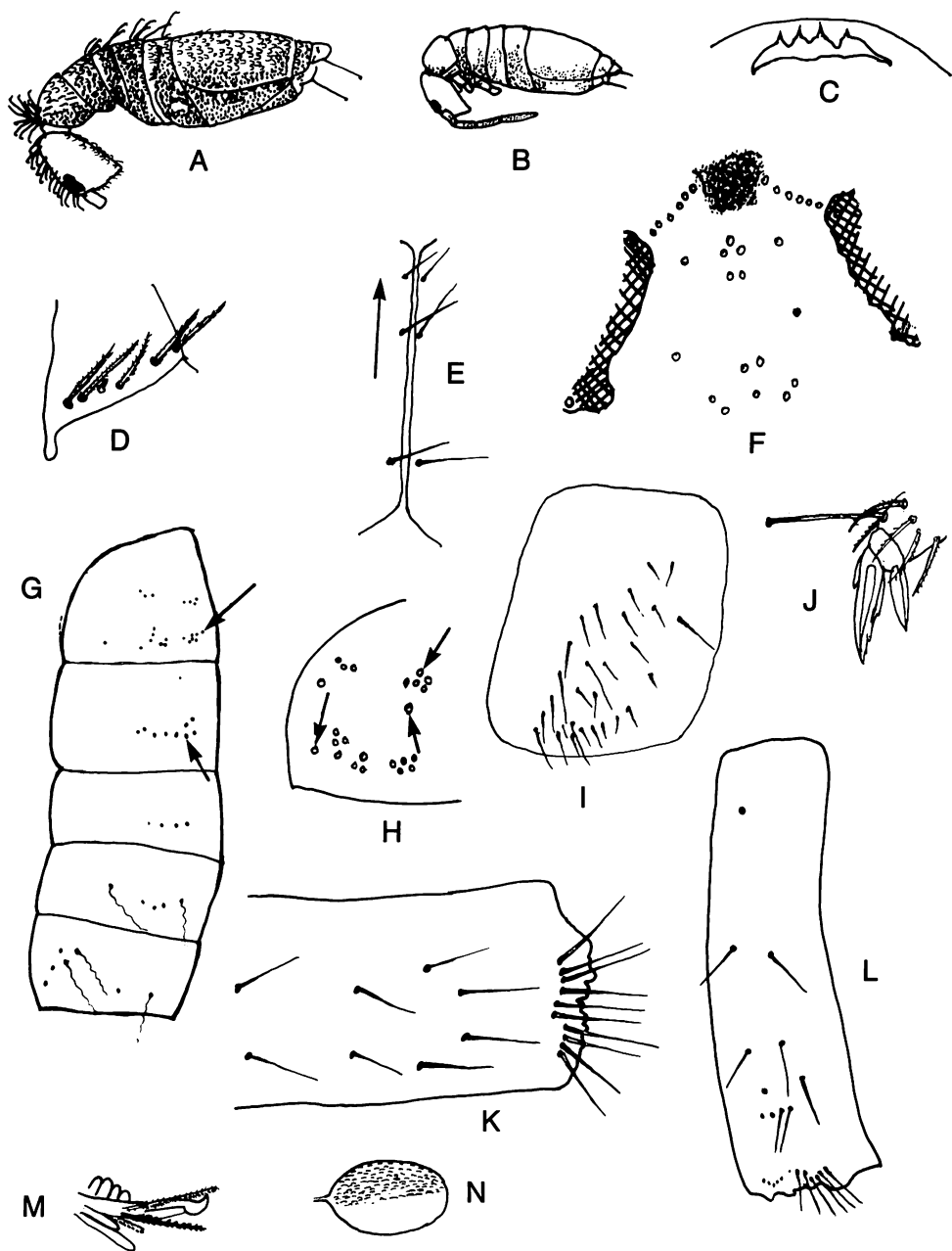


Plate 111—*Seira terrestris*: **A**, head and trunk with scales (after Folsom); **B**, head, trunk, and antennae, without scales (after Folsom); **C**, labral papillae (5497, Molokai); **D**, basal setae, right side of labial triangle (4823, Oahu); **E**, chaetotaxy of ventral groove of head (5497, Molokai); **F**, interantennal macrochaetae (same specimen); **G**, semi-diagrammatic dorsal macrochaetae, left side, collar setae omitted, second thoracic segment through third abdominal segment, arrows indicate setae often absent (composite); **H**, second thoracic segment chaetotaxy, collar setae omitted, arrows indicate setae often absent (5296, Laysan Island); **I**, trochanteral organ (same); **J**, hind foot complex (after Folsom); **K**, ventral chaetotaxy, distal $\frac{2}{3}$ of manubrium, form A (5497, Molokai); **L**, ventral chaetotaxy, distal $\frac{2}{3}$ of manubrium, form B (4823, Oahu); **M**, mucro and end of dens (after Folsom); **N**, scale (after Folsom).

ment; this has 2 + 2 macrochaetae in type specimens and those from Kauai, Oahu (most), Molokai, and Midway Atoll, and 4 + 4 in specimens from Hawaii and one from Oahu.

There is also some variation in the ventral manubrial chaetotaxy. Form A has 5 + 5 distal setae and 1 + 1 mid-distal setae; form B has 6 + 6 distal and 2 + 2 mid-distal setae. Form A is seen in all Molokai specimens and those from Midway Atoll and Kure Island. Form B is seen in all Laysan Island and Hawaii specimens. Specimens from Oahu and Kauai are of both types. It may be that a species complex is involved.

The species has also been recorded from the Philippines and may be the same as *S. iricolor* Yosii and Ashraf, 1964 from Pakistan and *S. caheni* Jacquemart, 1976 from the Galápagos Is. Mari Mutt's (1987) redescription of *S. oceanica* Yosii, 1960 makes it look likely that this is a synonym also. There are some minor differences in chaetotaxy, and settling the relationship between the two taxa will require more extensive comparison of collections.

Ecology: This is the most widespread Hawaiian *Seira* and is found in disturbed areas, beach sites, under stones, in grass, dead animal carcasses, and in debris.

Type locality: Oahu-Honolulu.

Additional records: Hawaii: 5141, 5142, 5143, 5259, 5660, 5668. Molokai: 5497, 5503, 5714, 5735. Oahu: 4752, 4811, 4823, 5239, 5641, 6785, 6786, 6787, 6789, 6790, 6791, 6792. Kauai: 5190, 5193, 6710. French Frigate Shoals: 6835, 6838, 6849. Laysan: 5296. Midway Atoll: 5306, 6818. Kure: 5297.

Genus **LEPIDOCYRTUS** Bourlet, 1839

Type species: *L. curvicolis* Bourlet, 1839

Acrocyrtus Yosii, 1959 [type species: *Lepidocyrtus* (*A.*) *malayanus* Yosii, 1959].

Ascocyrtus Yosii, 1963 (type species: *Lepidocyrtus suborientalis* Denis, 1948).

The genus is unusually well developed in the Islands. We have definitely identified 14 species and suspect the existence of several others that are represented in our material by single specimens. Because some species seem to be local, and because we still lack collections from many areas, it is probable that other species remain to be discovered.

The Hawaiian species all have rounded, thin scales with fine surface sculpture; only in *L. immaculatus* and *L. heterophthalmus* are these found on the antennae or femora. The labral papillae are rounded and lack visible spines; the prelabral setae are 4-5-5-4 in number, although poorly mounted specimens may appear to lack a fourth row and have 4-5-5 setae. The femora and tibiotarsi lack outstanding or strongly differentiated setae, except for the tenent hairs, which are always clavate. The dorsal cephalic macrochaetae S and T are usually absent, and no species has both. The thorax and first abdominal segment lack macrochaetae except for the "collar" on the second thoracic segment.

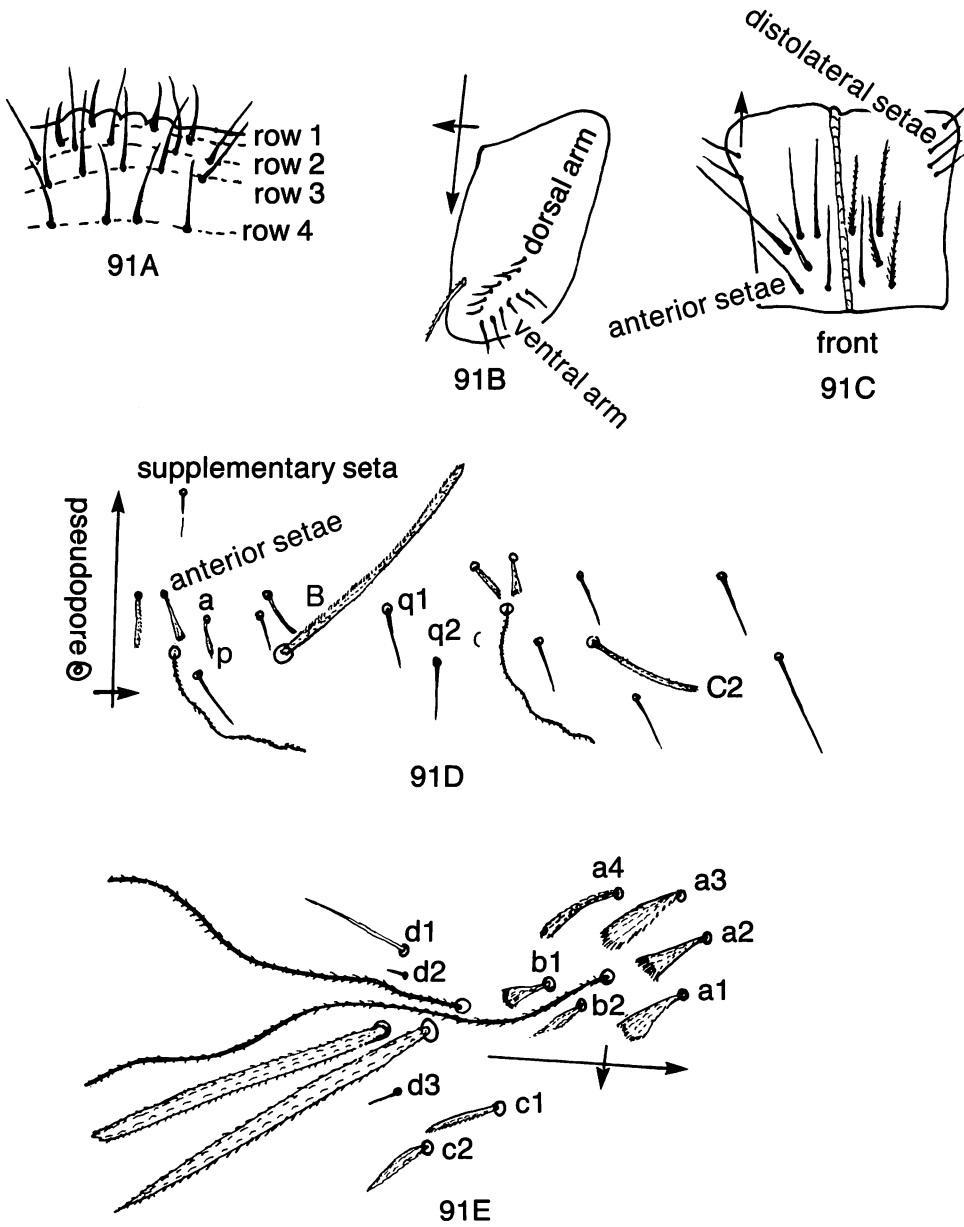


Figure 91—Characters of *Lepidocyrtus*: A, labral setae; B, trochanteral organ; C, ventral tube; D, second abdominal dorsal chaetotaxy; E, outer third abdominal segment setae complex.

Table 26. Characteristics of Hawaiian Species of *Lepidocyrtus*

SPECIES	COLOR	APICAL ANTENNAL BULB	CEPHALIC DIAGONAL/ ANTENNA	EYE G/F	UNGUI- CULUS*	DENTAL TUBERCLE**
<i>aho</i>	blue	-	1.25-1.40	≈	ac	-
<i>apo</i>	blue	bilobed	10/13-4/6	≈	ac	small
<i>eeu</i>	blue	+	8/11	≈	ac	-
<i>hakea</i>	blue	+	5/8	<≈	ac	+
<i>hukulii</i>	blue	-	8/11	<<	tr	+
<i>kuakea</i>	yellow blue	-	5/7	<≈	ac weakly tr	+
<i>heterophthalmus</i>	yellow	+	1.00	<<	ac	++
<i>immaculatus</i>	yellow blue	-	13/24	<≈	tr	++
<i>inornatus</i>	blue-yellow	+	4/5	≈	ac	small
<i>mele</i>	blue yellow	-	12/15-8/14	<<	tr	+
<i>pallidus</i>	blue	-	5/7	<	ac	-
<i>olena</i>	yellow	-	7/9-7/11	<	tr	-
sp. S	blue	-	7/11-7/12	<<	ac	-
<i>poko</i>	blue	bilobed	7/10	≈	ac	+
<i>uku</i>	blue	+	7.5/10	<	ac	-
<i>violaceus</i>	blue	-	20/23	<	ac	-
sp. Y	blue	-	7/8	<	ac	small
sp. Z	yellow	bilobed	4.5/6.5	<	tr	++

*ac = acuminate; tr = truncate.

**Dental tubercle may be confused with dental clasp.

***Capitalized symbols stand for large setae, lower-case symbols for small setae; italic symbols stand for ciliate setae (others are smooth); vg = vestigial, o or - = absent.

†The large posterior setae on the fourth abdominal segment may be hard to make out, and this character should be relied on only if the specimen has relatively complete vestiture. In *L. heterophthalmus* ciliate microchaetae are found here.

CHAETOTAXY***																								
LABIUM					DORSUM OF HEAD				ABD. II						ABD. III			ABD. IV						
					R ₂	S	T	P ₀	SAS	AS	B	a	q ₁	c ₂	p	c ₁	d ₂	d ₃	P ₁	M	s	POST.†		
M	M	R	E	L	-	-	-	+	+	2	M	M	+	M	+	+	+	+	-	-	2	+	0	
M	M	vg	E	L	-	-	-	+	+	2	M	M	+	M	+	+	+	+	-	-	2	+	0	
M	M	vg	E	L	-	-	-	-	+	2	-	m	-	M	+	-	+	+	-	-	2	-	0	
-	M	vg	E	L	+	-	-	+	-	3	M	m	-	M	-	-	-	+	-	-	2	+	0	
-	M	vg	E	L	-	-	-	-	+	2	-	m	+	M	-	+	-	+	-	-	2	+	0	
M	M	vg	E	L	±	±	-	+	+	2	m	m	-	m	+	+	+	-	-	-	3	-	10	
M	M	r	E	L	+	-	-	-	+	2	m	m	+	m	-	+	+	+	-	-	3	-	0	
M	M	R	E	L	?	?	?	?	?	?	?	?	?	?	?	?	?	?	-	-	3	?	?	
m	M	M	vg	E	L	-	-	-	-	-	3	M	-	-	M	-	-	+	+	+	+	3	+	16-22
-	M	vg	E	L	+	-	-	-	+	2	-	m	-	M	+	-	-	+	-	-	2	-	10	
M	M	R	E	L	+	+	-	-	+	2	m	m	+	m	-	-	+	+	-	-	3	-	0	
M	M	o	E	L	-	-	+	-	-	3	M	-	+	M	+	-	+	+	-	+	2	+	8	
M	M	R	E	L	-	-	-	-	-	2	M	m	-	M	+	+	+	+	-	+	3	+	16-22	
M	M	r	E	L	-	-	-	-	+	2	-	m	+	M	+	-	+	+	-	+	2	+	0	
-	M	vg	E	L	-	-	-	-	+	2	-	m	+	M	-	+	+	+	-	-	3	-	0	
-	M	vg	E	L	+	-	-	-	-	2	M	-	+	M	-	-	-	-	-	-	3	+	0	
M	M	R	E	L	-	-	-	-	+	3	M	m	+	M	-	+	-	+	-	+	3	+	10	
-	M	O	E	L	-	-	-	?	?	?	M	?	?	?	?	?	?	?	-	-	2	?	0	
M	M	vg	E	L	-	-	-	-	+	1	-	m	-	M	-	+	+	+	?	-	2	-	22	

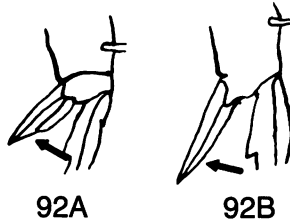
The characters used here are mainly those found useful for the nearctic fauna in *The Collembola of North America*. We have also described the form of the last row of prelabral setae (Fig. 91A), the trochanteral organ (Fig. 91B), the setae of the ventral tube (Fig. 91C), and the manubrial plaque and the presence or absence of some additional setae of the second abdominal segment (Fig. 91D shows our revised interpretation of this segment). Useful features of the chaetotaxy, including the lateral setae of the third abdominal segment shown in Figure 91E and some other important characters, are listed in Table 26. We also use the labral papillae and maxillary palp structures where these are visible. Mari Mutt (1986b) has recently shown that these features are of considerable taxonomic value.

Yosii's genera *Acrocyrthus* and *Ascocyrthus*, defined on the basis of the presence and form of the basal dental tubercle, are not used here because in nearctic and Hawaiian species this useful character does not seem to be correlated with any other, and because of the presence of a dental tubercle in nearctic specimens of *L. curvicollis*. Subdivision of this very large genus must wait, we believe, until many more of the tropical species have been adequately described.

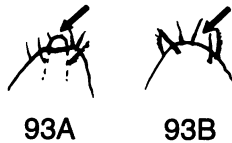
The definitely identified species of *Lepidocyrtus* are *aho*, *apo*, *eeu*, *hakea*, *hukulii*, *kuakea*, *heterophthalmus*, *immaculatus*, *inornatus*, *mele*, *pallidus*, *olena*, *poko*, *violaceus*, and *uku*. In addition, three other species (sp. S, Y, and Z) are keyed but not described.

KEY TO HAWAIIAN SPECIES OF LEPIDOCYRTUS

- 1. Unguiculus in plan view truncate, sharply angled on inner edge (Fig. 92A)..... 2
- Unguiculus in plan view smoothly tapered on both edges (Fig. 92B)..... 6

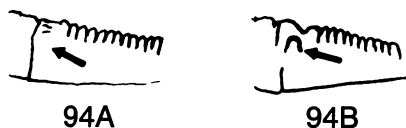


- 2(1). Fourth antennal segment with apical bulb (Fig. 93A)..... **sp. Z**
- Fourth antennal segment without apical bulb (Fig. 93B)..... 3



- 3(2). First antennal segment and hind femur scaled..... **immaculatus**
- First antennal segment and hind femur unscaled..... 4

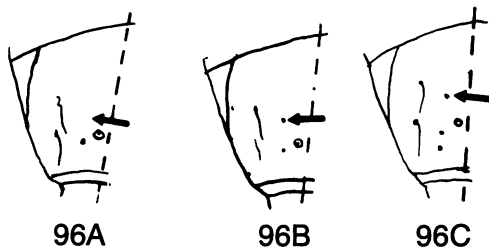
- 4(3). Dental tubercle absent (Fig. 94A)..... **olena**
 Dental tubercle present (Fig. 94B)..... 5



- 5(4). Labial seta r well developed (Fig. 95A)..... **mele**
 Labial seta r vestigial (Fig. 95B)..... **hukulii**



- 6(1). First and second antennal segments and hind femur with scales..... 7
 First and second antennal segments without scales..... 8
 7(6). Blue..... **violaceus**
 Yellow..... **heterophthalmus**
 8(6). Fourth antennal segment with apical bulb (Fig. 93A)..... 9
 Fourth antennal segment without apical bulb (Fig. 93B)..... 14
 9(8). Dental tubercle absent (Fig. 94A)..... 10
 Dental tubercle present (Fig. 94B)..... 11
 10(9). Fourth abdominal segment with 1 M seta (Fig. 96A)..... **uku**
 Fourth abdominal segment with 2 M setae (Fig. 96B)..... **eeu**



- 11(9). Labial triangle with 2 M setae (Fig. 97A)..... **apo**
 Labial triangle with 1 M seta (Fig. 97B)..... 12



- 12(11). Labial setae M and E smooth. **inornatus**
 Labial setae M and E ciliate. 13
 13(12). Fourth abdominal segment with 3 M setae (Fig. 96C). **poko**
 Fourth abdominal segment with 2 M setae (Fig. 96B). **hakea**
 14(8). Dental tubercle present. 15
 Dental tubercle absent. 16
 15(14). Body yellow. **kuakea**
 Body black. **sp. Y**
 16(14). Eye G much smaller than eye F. **sp. S**
 Eye G subequal to or slightly smaller than eye F. 17
 17(16). Inner labral papillae pointed (Fig. 98A). **aho**
 Inner labral papillae blunt (Fig. 98B). **pallidus**



98A



98B

Lepidocyrtus aho Christiansen and Bellinger, **new species** (Plate 112)

Color mottled blue except for unpigmented legs and furcula. Intersegmental membranes and posterior median part of head paler. Antenna without apical bulb. Head rounded in dorsal view. Prelabral setae all smooth with the exception of the posterior row, which is sometimes sparsely ciliate. Outer labral papillae low and broad. Inner papillae narrow, pointed inward, and unisetaceous. Eyepatches irregular, general form trapezoidal. Maxillary palp with basal and apical setae subequal. Mesothorax not projecting forward. Ventral groove with 4 + 4 marginal ciliate setae. Trochanteral organ with 3-4 setae in each arm. Tenent hair strongly clavate, slightly longer than inner unguis. Four inner ungual teeth, distalmost minute and others strong; outer and lateral teeth minute. Unguiculus acuminate, with outer margin very minutely serrate. Fourth abdominal segment 2.7-3.2 times as long as third. Ventral tube with 6 + 6 distolateral setae. Manubrial plaque with 2 inner and 2 outer ciliate setae. Dens without basal tubercle. Mucronal teeth subequal, with basal spine just exceeding apex of basal tooth. Anterior macrochaetae of second thoracic segment truncate, 1.7-3.3 times as long as inner unguis. Maximum length 1 mm.

Remarks: This species is very similar to *L. pallidus*; however, the inner labial papillae, cephalic chaetotaxy, and male genital plate are all quite different. Unfortunately, all these features are difficult to distinguish, so separation of the two forms is difficult. The labial triangle generally has only a single m seta, but occasionally a second smaller one is present on one side. It is known from only one locality.

Derivatio nominis: Hawaiian, thatch.

Type locality: Holotype and 5 paratypes, Oahu, Manoa, V-9-1984, soil under remains of cat carcass, Goff (6787).

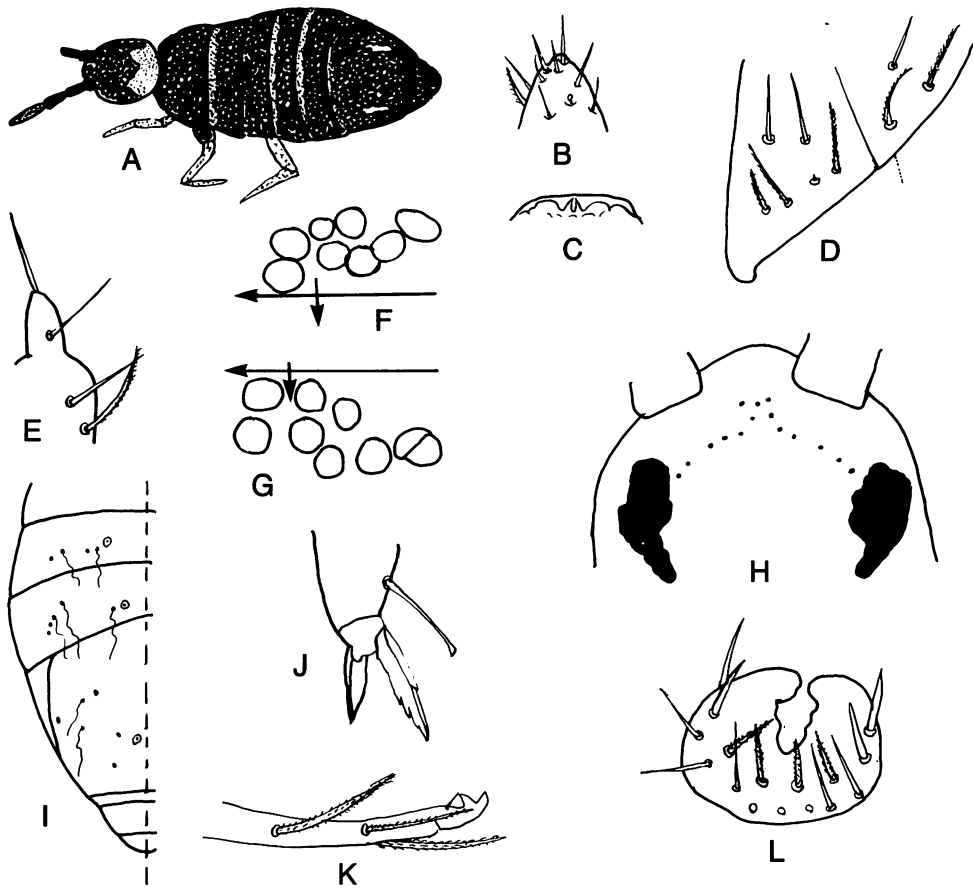


Plate 112—*Lepidocyrtus aho* (all figures of type specimens): A, habitus; B, apex of antenna; C, labral papillae; D, labial triangle, left side; E, apex of maxillary palp; F, G, two different eyepatch forms; H, interocular macrochaetae; I, pseudopores, macrochaetae, and bothriotricha, left side, second through fourth abdominal segments; J, mid foot complex; K, apex of dens and mucro; L, male genital plate.

Lepidocyrtus apo Christiansen and Bellinger, new species (Plate 113)

Color mottled blue with dark antennae, eyepatches, and sometimes an interantennal band; pigment pale to moderately dark and patchy or giving a clear impression of transverse bands; legs beyond femora, and dentes, unpigmented. Scales grayish to brownish, absent from antennae and femora. Apical antennal bulb clearly bilobed. Head nearly circular in dorsal view. Labral papillae small, setaceous, with inner pair much smaller than outer pair. Posterior row of prelabral setae ciliate. Maxillary palp with basal seta clearly longer than apical. Eyepatch elliptical. Eye G subequal to or slightly larger than eye F; eyes G and H sometimes elliptical. Ventral cephalic groove with 5 + 5 setae. Mesothorax projecting slightly

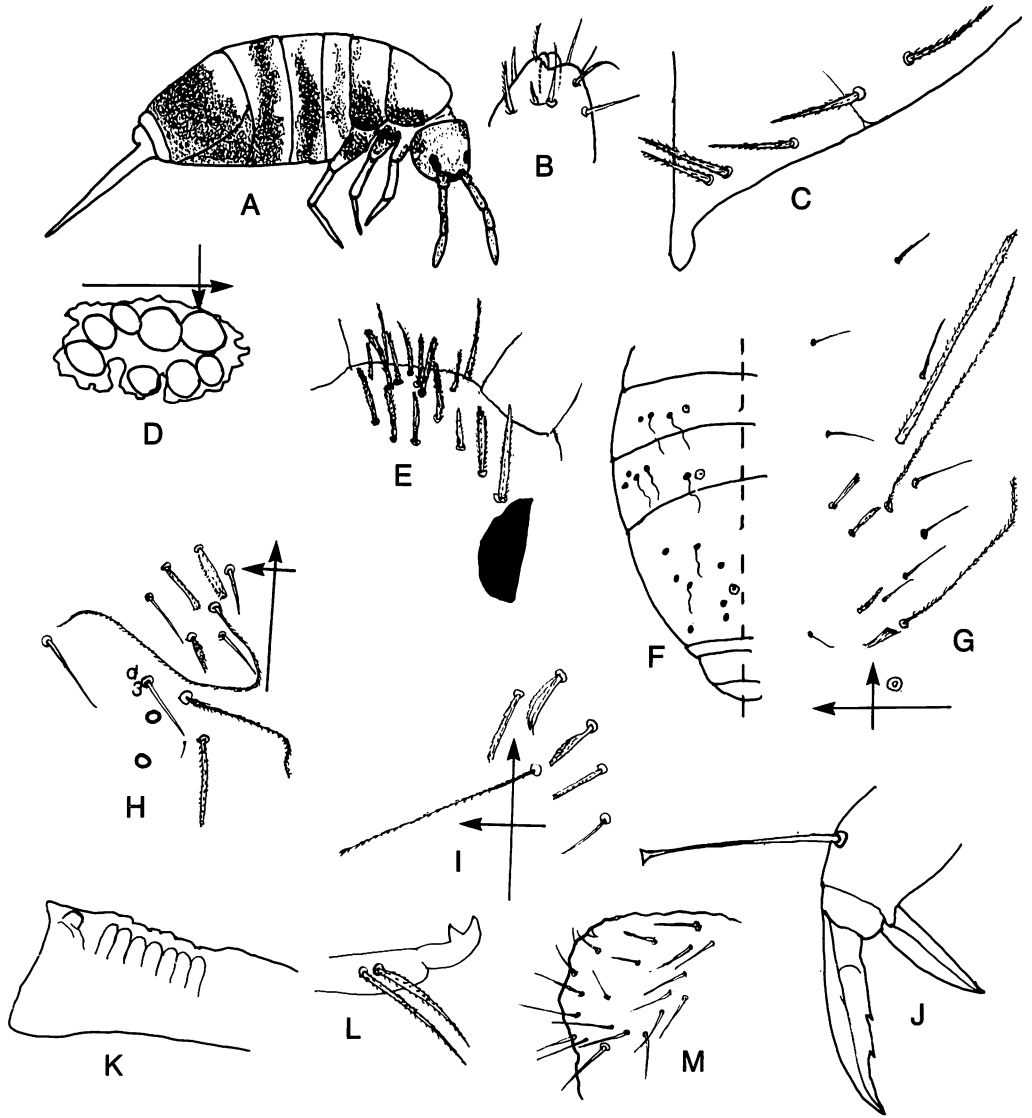
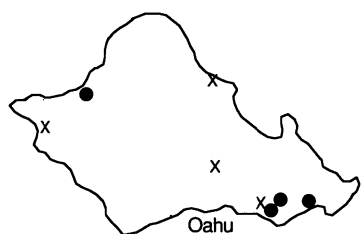


Plate 113—*Lepidocyrtus apo*: A, habitus (4812, Oahu); B, apex of antenna (4823, Oahu); C, basal setae, left labial triangle (same specimen); D, left eyepatch (same); E, interocular and anterior dorsal cephalic macrochaetae (type specimen); F, semidiagrammatic setae, left side, second through fourth abdominal segments (composite); G, detail, right side, second abdominal segment setae (4812, Oahu); H, detail, left side, third abdominal segment chaetotaxy (5219, Oahu); I, anterior bothriotrichal complex, left side, fourth abdominal segment (4812, Oahu); J, hind foot complex (same); K, base of dens showing dental papilla (same); L, mucro (5219, Oahu); M, male genital plate, seen from side (same).

over head. Trochanteral organ with 4-5 setae in each arm and sometimes with a supplementary seta between the arms. Tenent hair strongly clavate and slightly longer than inner edge of unguis. Unguis with 4 inner teeth, the median being the most prominent, and 2 lateral teeth at about $\frac{1}{3}$ of its length from base. Unguiculus acuminate and ciliate externally. Fourth abdominal segment $2\frac{1}{2}$ -4 times as long as third. Ventral tube with 7-10 large, mostly ciliate setae on each distolateral patch. Manubrial plaque with 2-3 inner and 2 outer setae, all ciliate. Dens with very small rounded basal tubercle. Mucronal teeth subequal or anteapical tooth slightly the larger; basal spine slightly exceeding apex of anteapical tooth. Anterior macrochaetae of second thoracic segment subcylindrical, acuminate to truncate, and up to $\frac{1}{3}$ as long as width of segment. Maximum length 1.3 mm.



Hawaii 2
Kauai 2
Molokai 3

Remarks: Originally we split this species into two, with two or three M setae on the fourth abdominal segment; however, it is clear that the difference is only the result of slight enlargement of a third seta, resulting in a change from mesochaeta to macrochaeta. Some specimens of the first form also have labial m_1 small. Although further material may show these to be separable, we now prefer to treat them as belonging to one variable taxon.

Derivatio nominis: Hawaiian, band.

Ecology: The animal is a litter and soil form found primarily in lowland areas.

Type locality: Holotype and 2 paratypes, Oahu, Honolulu, University of Hawaii campus, XII-6-1966, PB (4825).

Additional records: Hawaii: 5643, 5668, 5700. Molokai: 5504, 5734. Oahu: 4785, 4786, 4803, 4804, 4806, 4810, 4812, 4823, 4839, 4849, 5219, 5641, 6746. Kauai: 5193, 6721.

Lepidocyrtus eeu Christiansen and Bellinger, **new species** (Plate 114)

Color from yellow with bluish antennae and dark eyepatches to generally pale blue with broken transverse bands on third and fourth abdominal segments. Scales hyaline to very pale brown, absent from femora and antennae. Antenna with single low, broad apical bulb. Head in dorsal view a rounded pentagon. Labral papillae with inner lobes broad and nonsetaceous; outer lobes unclear; medial intrusion obvious, ridged. Eyepatch irregularly trapezoidal. Eye G equal to or slightly smaller than eye F. Maxillary palp with basal seta subequal to or slightly longer than apical. Ventral cephalic groove with 3 + 3 marginal setae plus 1 + 1 setae lateral to the anterior pair. Mesothorax hardly projecting. Trochanteral organ with

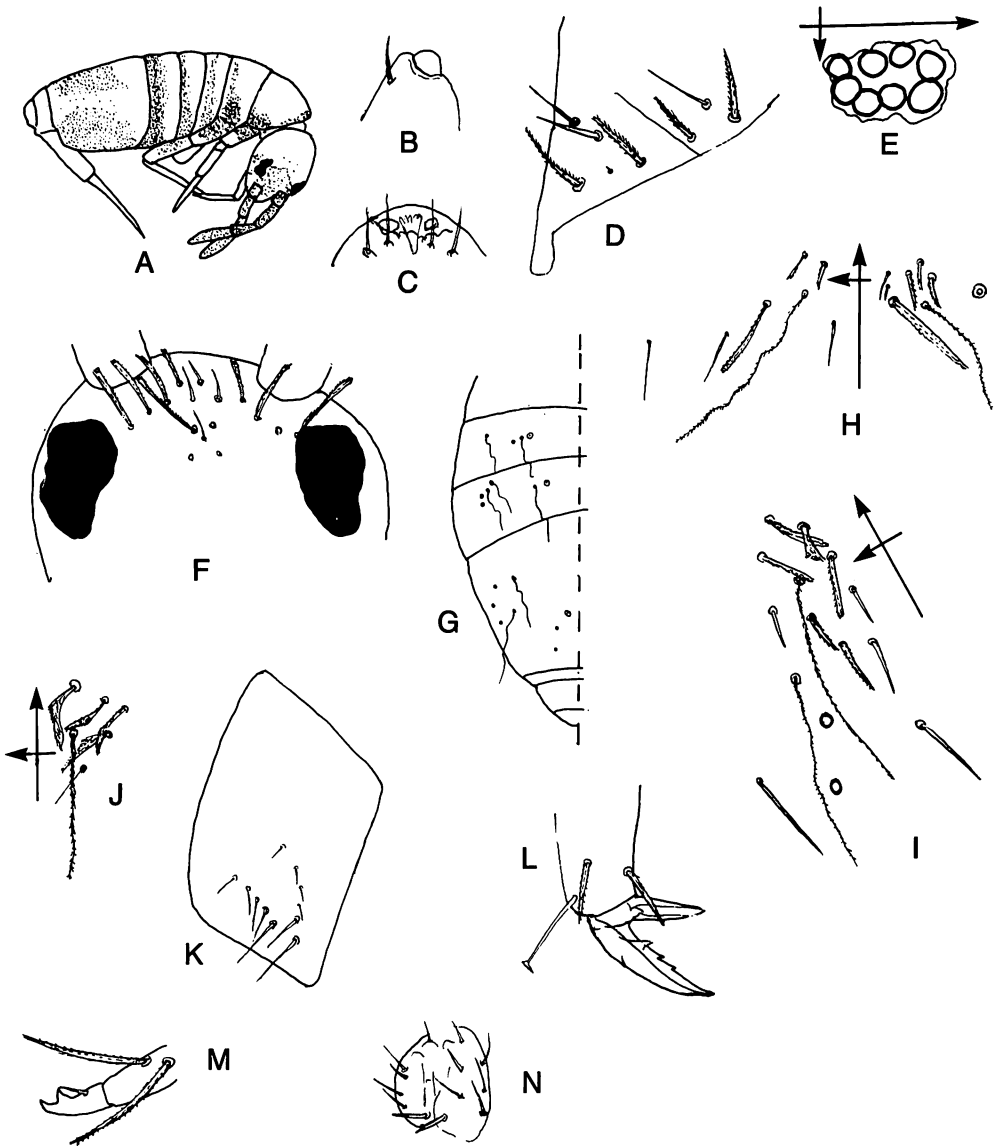
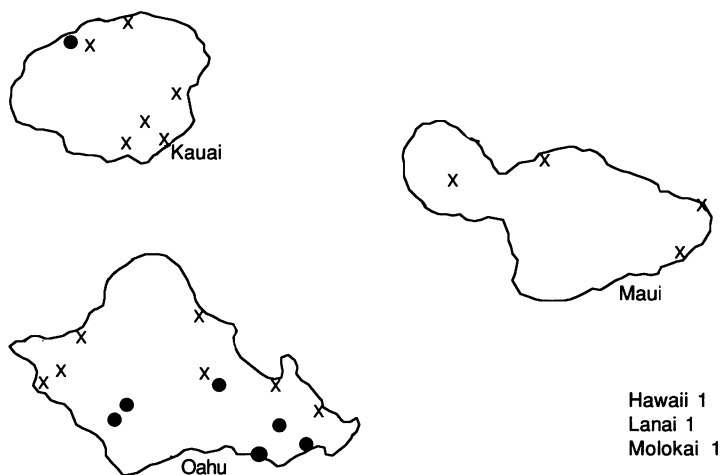


Plate 114—*Lepidocyrtus eeu*: **A**, habitus (4800, Oahu); **B**, apex of antenna (same); **C**, labrum (4748, Kauai); **D**, left labial triangle (4800, Oahu); **E**, right eyepatch (same); **F**, anterior cephalic macrochaetae (type specimen); **G**, large setae and pseudopores, left side, second through fourth abdominal segments (composite); **H**, chaetotaxy, second abdominal segment, left side (5294, Oahu); **I**, lateral bothriotrichal complex, left side, third abdominal segment (5180, Maui); **J**, anterior bothriotrichal complex, fourth abdominal segment, right side (5294, Oahu); **K**, trochanteral organ (same); **L**, mid foot complex (4800, Oahu); **M**, mucro (type); **N**, male genital plate, seen from below (5288, Kauai).

4–6 setae in each arm and 1–2 extra setae. Tenent hair stout and strongly clavate, slightly shorter than inner edge of unguis. Unguis with 4 inner and 2 lateral teeth; median and inner basal teeth larger than outer or apical tooth. Unguiculus acuminate. Fourth abdominal segment 3–4 times as long as third. Ventral tube with 7–8 setae, mostly smooth, on each distolateral patch. Manubrial plaque with 2 + 2 ciliate setae. Basal dental tubercle completely absent. Mucro with anteapical tooth slightly larger than, or subequal to, apical tooth; basal spine just attaining apex of anteapical tooth. Anterior macrochaetae of second thoracic segment clavate, up to $\frac{1}{4}$ as long as width of segment. Maximum length 1 mm.



Remarks: There is considerable minor variation in the chaetotaxy in our samples. The posterior M macrochaete on the fourth abdominal segment is narrower than the anterior one; if it is missing the socket may not be recognizable, and there may appear to be only one M seta. The species differs from *L. apo* in lacking the apical antennal bulb and dental tubercle.

Derivatio nominis: Hawaiian, crawling.

Ecology: This species is found generally in litter and under bark, frequently with *L. mele* or *L. immaculatus* and usually away from cities; it is not found in grassland. It is found on Oahu, Maui, and Kauai; there is an uncertain record from a bird nest on Hawaii, but these specimens do not show the chaetotaxy and may not belong here.

Type locality: Holotype, Oahu, Ulumawao, east slope, VII-19-1966, 150 ft. (5268).

Additional records: Hawaii: 5111. Maui: 5161, 5163, 5180, 6674, 6794. Molokai: 6381. Lanai: 6690. Oahu: 4759, 4766, 4784, 4794, 4797, 4798, 4800, 4814, 4817, 4821, 4824, 4841, 5233, 5234, 5242, 5268, 5294, 5526, 6733, 6746, 6785, 6786, 6787. Kauai: 4748, 5191, 5282, 5288, 6711, 6714, 6717, 6723, 6725, 6728.

Lepidocyrtus hakea Christian and Bellinger, **new species** (Plate 115)

Color white with scattered blue pigment, generally distributed over body or particularly well developed on the antennae, dorsum of head, anterior part of second thoracic segment, and posterior parts of second and fourth abdominal segments. Scales hyaline to pale gray, absent from antennae and femora. Apical antennal bulb unlobed. Labral papillae small, with inner lobes much smaller than outer ones; medial intrusion long and narrow. Maxillary palp with basal seta longer than apical. Head almost circular in dorsal view. Prelabral setae 4-5-5-4, the posterior row ciliate. Eyepatch irregularly trapezoidal. Eyes G and H strikingly oval to elliptical. Ventral cephalic groove with 5 + 5 ciliate bordering setae. Mesothorax not projecting. Trochanteral organ with 4 setae in each arm. Tenent hair clearly clavate, slightly shorter than inner edge of unguis. Unguis with 4 inner teeth, the distal tooth being minute, and small lateral teeth at about $\frac{1}{4}$ its length from base. Unguiculus acuminate. Fourth abdominal segment 3-4 times as long as third. Ventral tube with 11-12 small setae in each distolateral patch and many ciliate anterior setae of various lengths. Manubrial plaque with 2 inner and 3 outer setae, all ciliate. Dens with a very small oval basal tubercle. Mucro with teeth subequal; basal spine just attaining to slightly exceeding apex of subapical tooth. Anterior macrochaetae of second thoracic segment cylindrical, mostly apically truncate, and up to $\frac{1}{3}$ as long as width of segment. Maximum length 1.2 mm.

Remarks: This species resembles *L. apo* and *L. inornatus* in having both apical antennal bulbs and dental tubercles. It differs from them in the chaetotaxy of the labium and second abdominal segment. The cephalic mesochaetae are unusually large and their bases may be mistaken for macrochaetae. The Midway Atoll population, with a slightly different chaetotaxy on the fourth abdominal segment, may be distinct.

Derivatio nominis: Hawaiian, pale.

Ecology: Found in litter, a bird nest, and under bark.

Type locality: Holotype and 3 paratypes, Maui, between Waianapanapa State Park and Hana, coastal trail, I-30-1982, under bark of *Casuarina*, KC (5161).

Additional records: Lanai: 6693. Oahu: 4807. Midway Atoll: 5306.

Lepidocyrtus hukulii Christiansen and Bellinger, **new species** (Plate 116)

Color yellow, with medium-blue pigment forming an interocular band and in erratic transverse bands over the thoracic and anterior abdominal segments; frequently absent from all or part of the posterior half of the third abdominal segment; pigment weak or absent on anterior parts of the fourth and, to a lesser extent, the second abdominal segments, and absent from the fifth and sixth abdominal segments; antennae, coxae, and femora pale blue; furcula and tibiotarsi yellowish; head sometimes with a pink cast. Antenna without apical bulb. Head in dorsal view broadly oval. Posterior row of prelabral setae ciliate. Labral papillae blunt, low, and setaceous. Maxillary palp with apical and subapical setae subequal. Eyepatch elliptical, paler at posterior end. Diameter of eye F 5-6 times that

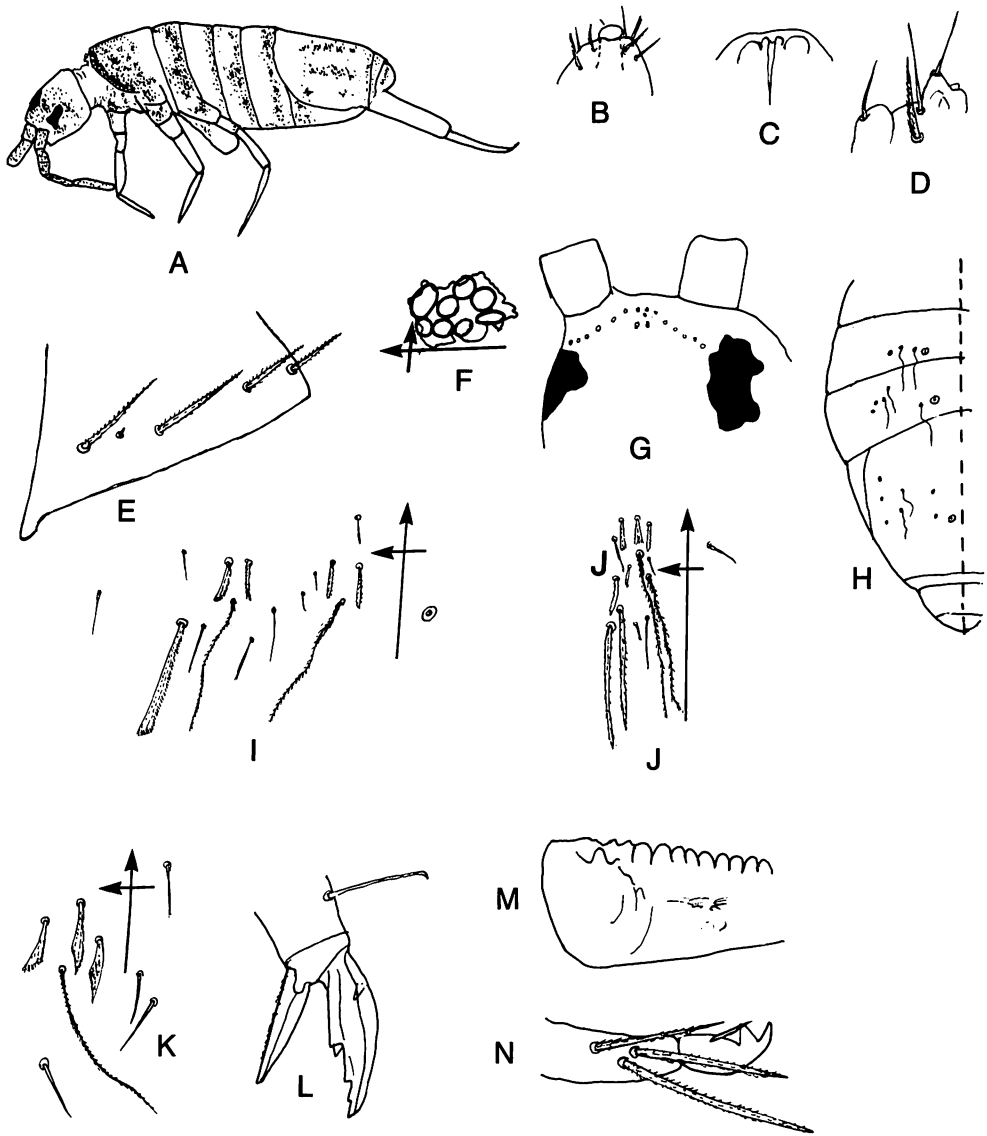


Plate 115—*Lepidocyrtus hakea* (all figures of types unless otherwise noted): **A**, habitus; **B**, apex of antenna; **C**, labral papillae; **D**, maxillary palp; **E**, basal setae of left labial triangle; **F**, right eyepatch; **G**, anterior cephalic macrochaetae; **H**, large setae and pseudopores of left side, second through fourth abdominal segments (composite); **I**, chaetotaxy, left side, second abdominal segment; **J**, outer bothriotrichal complex, left side, third abdominal segment; **K**, anterior bothriotrichal complex, left side, fourth abdominal segment; **L**, mid foot complex; **M**, base of dens; **N**, mucro.

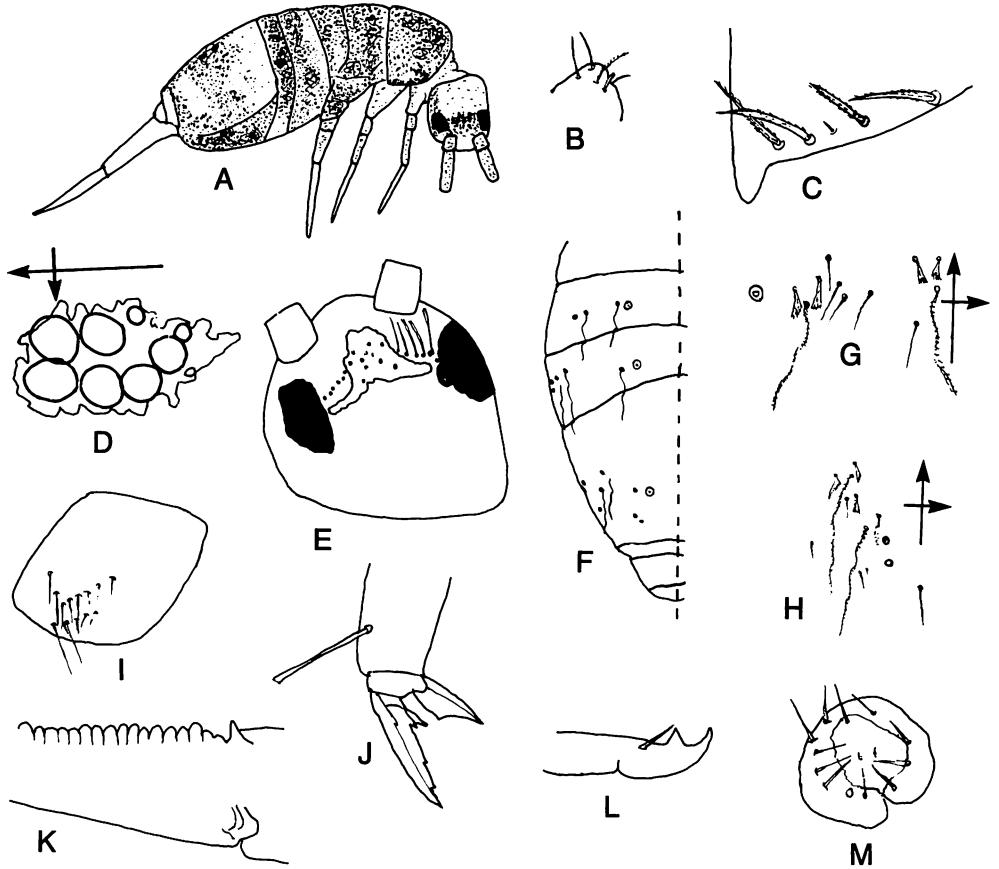
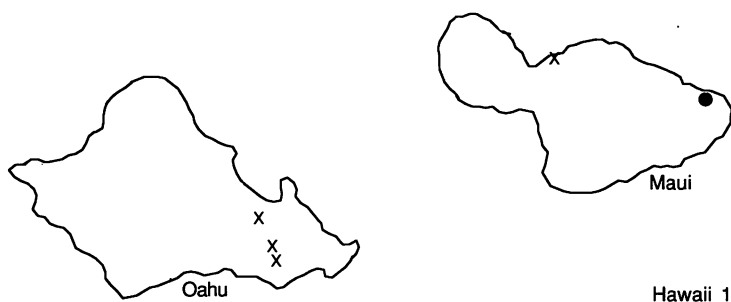


Plate 116—*Lepidocyrtus hukulii*: A, habitus (type); B, apex of antenna (4815, Oahu); C, basal setae, left labial triangle (type); D, left eyepatch (4815, Oahu); E, anterior cephalic macrochaetae (same specimen); F, large setae and pseudopores, left side, second through fourth abdominal segments (composite); G, detail, left side chaetotaxy, second abdominal segment (type); H, same, third abdominal segment (6707, Maui); I, trochanteral organ (type); J, hind foot complex (4815, Oahu); K, base of dens (type); L, mucro (type); M, male genital plate (type).

of G. Ventral cephalic group with 3 + 3 ciliate marginal setae. Mesothorax not strongly projecting. Trochanteral organ with 4–6 setae in each row and 2–3 additional setae near its apex. Tenent hair slender, clavate, and about as long as inner edge of unguis. Basal inner unguis teeth moderately large, median and distal inner teeth minute, lateral teeth strong and projecting. Unguiculus truncate. Fourth abdominal segment 4–5 times as long as third. Ventral tube with 5–6 distal lateral setae on either side and 3 large ciliate setae on anterior face. Manubrial plaque with 2 inner and 2–3 outer setae, all ciliate. Dens with a clear, small, pointed basal tubercle. Mucronal teeth subequal; basal spine just reaching apex of antepical tooth. Anterior macrochaetae of second thoracic segment subcylindrical, acuminate, and $\frac{1}{10}$ – $\frac{1}{5}$ as long as segment width. Maximum length 1.1 mm.



Remarks: This species is similar to *L. mele* in many respects, but is easily distinguished by the color and pattern, the unguinal structure, and the labial chaetotaxy. The chaetotaxy of the second abdominal segment is obscure in our specimens, and the data in Table 26 are uncertain.

Derivatio nominis: Hawaiian, small bump.

Ecology: Collections from litter in well-traveled areas.

Type locality: Holotype and 3 paratypes, Maui, Waianapanapa Cave State Park, I-30-1982, pandanus litter, KC (5160).

Additional records: Hawaii: 6394. Maui: 5162, 6676, 6707. Oahu: 4815, 6764, 6771. Kauai: 6709.

Lepidocyrtus kuakea Christiansen and Bellinger, **new species** (Plate 117)

Color yellow to mottled with blue, with pale blue eyepatches and dark eyes and interantennal spot. Scales hyaline to very pale grayish, absent from antennae and femora. Antenna without apical bulb. Head almost circular in dorsal view. Labral papillae blunt, obscure, inner pair smaller than outer, possibly minutely spined. Medial intrusion narrow, ridged. Posterior row of prelabral setae ciliate. Maxillary palp with subapical seta clearly larger than apical. Eye G clearly elliptical, subequal in maximum length to eye F or slightly smaller. Ventral cephalic groove with 3 + 3 marginal setae. Mesothorax not projecting. Trochanteral organ with 6 setae in each arm and generally with 1 additional seta of variable position. Tenent hair slender, acuminate or weakly clavate, subequal to or slightly longer than inner edge of unguis. Inner unguinal teeth 4, subequal; basal lateral teeth well developed. Unguiculus acuminate but sometimes almost truncate. Fourth abdominal segment $3\frac{1}{2}$ –5 times as long as third. Ventral tube with 7–9 mostly smooth setae on distolateral patches. Manubrial plaque with 2 + 2 ciliate setae. Dens with a clear, low, blunt basal tubercle. Anteapical mucronal tooth subequal to or slightly longer than apical tooth, with basal spine just reaching its apex. Anterior macrochaetae of second thoracic segment cylindrical, acuminate, and up to $\frac{1}{2}$ as long as width of segment. Maximum length 1.4 mm.

Derivatio nominis: Hawaiian, pale.

Remarks: This species is distinguished from other Hawaiian species by the combination of dental tubercle, acuminate unguiculus, and absence of the apical

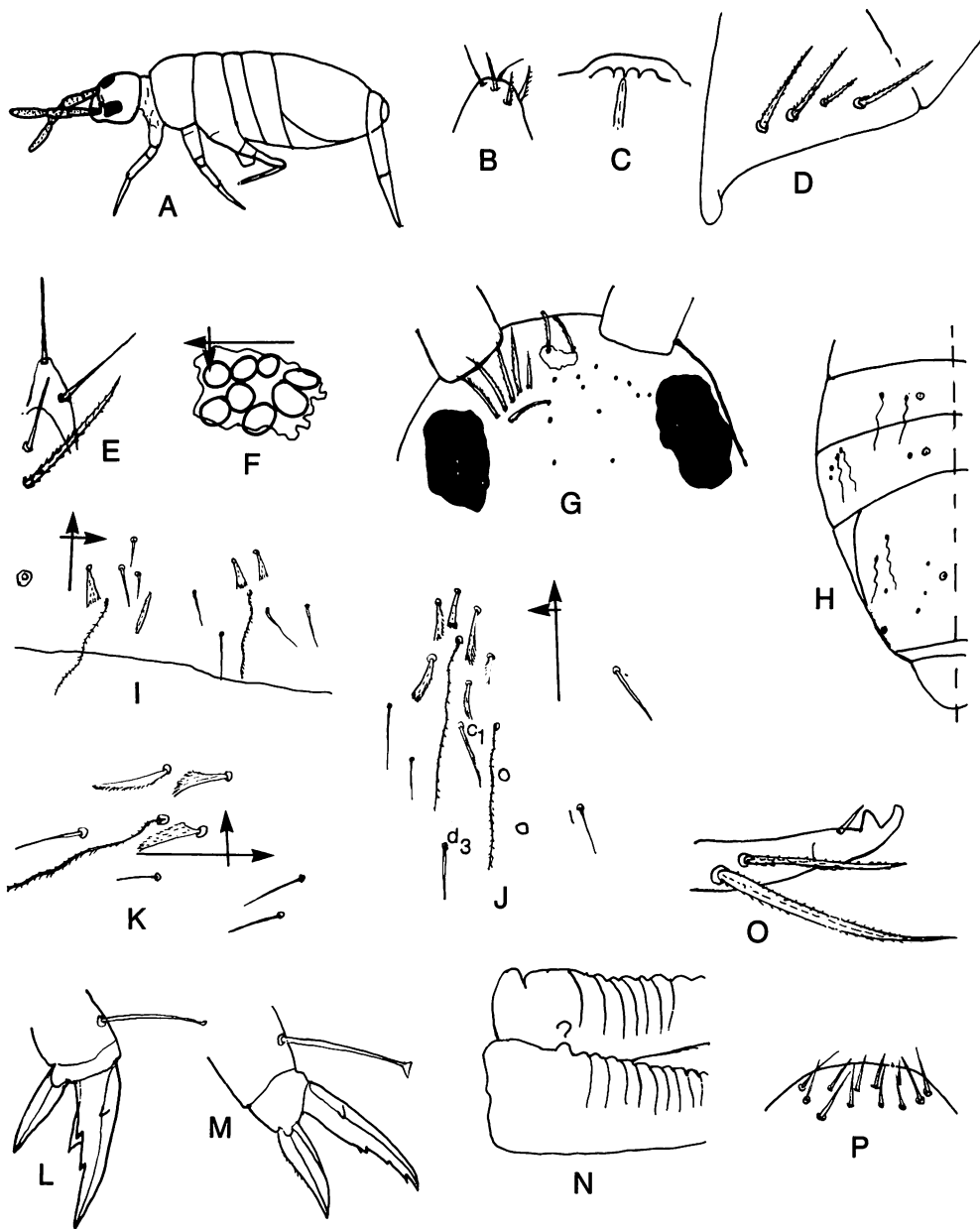
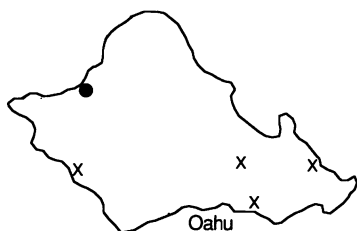


Plate 117—*Lepidocyrtus kuakea*: A, habitus (4839, Oahu); B, apex of antenna (4813, Oahu); C, labral papillae (6783, Oahu); D, basal setae, left labial triangle (4839, Oahu); E, left maxillary palp (6783, Oahu); F, left eyepatch (4839, Oahu); G, anterior cephalic macrochaetae (4813, Oahu); H, large setae and pseudopores, second through fourth abdominal segments (composite); I, chaetotaxy, right side, second abdominal segment (4839, Oahu); J, outer bothriotrichal complex, third abdominal segment (6783, Oahu); K, anterior bothriotrichal complex, fourth abdominal segment (4839, Oahu); L, hind foot complex (5667, Hawaii); M, same (6783, Oahu); N, bases of dentes showing tubercle (4813, Oahu); O, mucro (4839, Oahu); P, male genital plate, seen from front (6783, Oahu).



Hawaii 2
Maui 2

antennal bulb. It is close to *L. mele* and there is considerable overlap in most features, but the typical forms are quite distinct in the structure of eye G (oval in *L. kuakea*, small and rounded in *L. mele*) and the unguiculus (acuminate in *L. kuakea*, truncate in *L. mele*). Specimens from Hawaii are irregularly banded; others are plain yellow.

Ecology: The species has been found in litter in or near cultivated areas on Oahu, Maui, and Hawaii.

Type locality: Holotype and 3 paratypes, Oahu, Weed Circle, X-28-1966, soil under sugarcane, PB (4813).

Additional records: Hawaii: 4882, 5667. Maui: 5181, 6793. Oahu: 4784, 4810, 4813, 4839, 6748, 6783.

Lepidocyrtus heterophthalmus Carpenter, 1904 (Plate 118)

Fauna Hawaiiensis 3:300.

Color yellow except for eyepatches, narrow interantennal band, and scattered mottled patches in cheek area and along lateral margin of thorax and abdomen. Antennae blue, except for basal portion of first segment. Scales on first (and second) antennal segment, all femora, and mid and hind tibiotarsi. Antennae difficult to see but probably with antennal bulb. Posterior row of prelabral setae smooth. Labral papillae rounded. Eyes G and H much smaller than others. Maxillary palp with basal seta slightly longer than apical. Mesothorax projecting sharply, thrusting head downward. Ventral cephalic groove with 4 + 4 setae, anterior smooth, others ciliate. Trochanteral organ with 8 setae in dorsal and 6 in ventral arm; internal and external setae also present. Unguis with 3 small inner teeth and prominent outer small lateral teeth. Unguiculus acuminate and with outer edge serrate. Tenent hairs not intact on any examined specimens but apparently relatively small. Fourth abdominal segment $3\frac{1}{2}$ - $4\frac{1}{2}$ times as long as third. Laterodistal patch of ventral tube with 15-16 setae, mostly ciliate. Manubrial plaque with 3 inner and 10-12 outer setae. Dens with very large prominent basal tubercle. Anteapical mucronal tooth much smaller than apical; basal spine reaching or slightly exceeding apex of basal tooth. Maximum length 2.5 mm.

Remarks: This species has not been recovered since the type collection. The peculiar set of features (large dental tubercle, yellow color, scaled legs and antennae, and acuminate unguiculus, as well as the peculiar labial triangle) should make it very easy to recognize if ever found again.

Type locality: Lectotype, Hawaii, Mauna Loa, IV-1905, 4000 ft., Perkins.

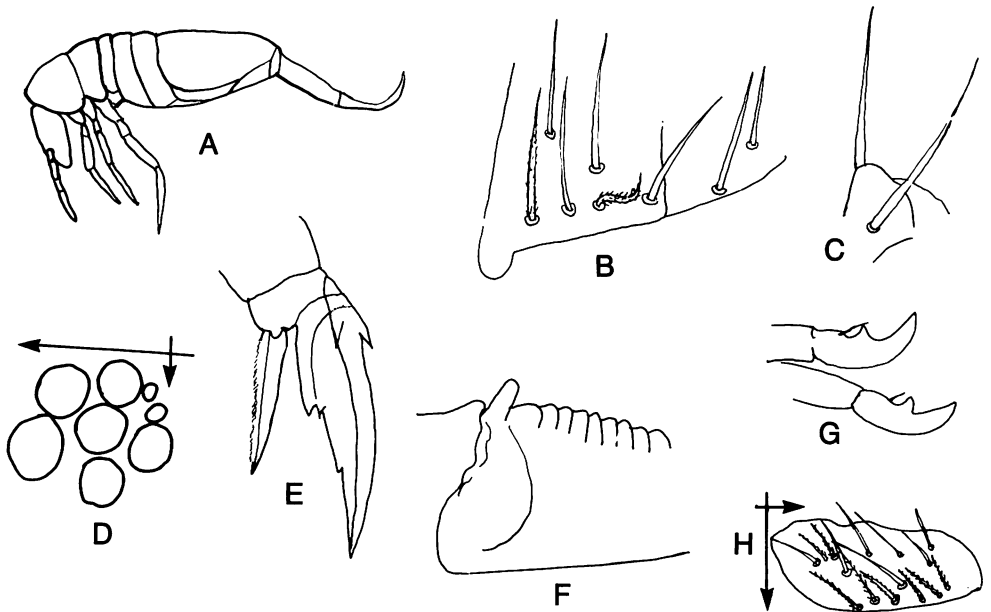


Plate 118—*Lepidocyrtus heterophthalmus* (all figures of types): A, habitus (after Carpenter, scale marks omitted); B, left labial triangle; C, maxillary palp; D, left eyepatch; E, hind foot complex; F, base of dens; G, two mucrones; H, distolateral patch of ventral tube.

***Lepidocyrtus immaculatus* Folsom, 1932 (Plate 119)**
 Proc. Hawaii. Entomol. Soc. 8:68.

Color yellow except for blue antennae, dark eyepatches and interocular spot, and occasional scattered blue pigment on the venter of the abdomen. Scales pigmented, giving fully clothed large specimens a brown or gray color, sometimes appearing banded because of denser scaling on the middle of the abdominal tergites; first antennal segment, hind femur, and all coxae scaled. Antenna without apical bulb. Head in dorsal view parallel-sided and rectangular, with length only slightly greater than width. All prelabral setae smooth. Maxillary palp with subapical seta clearly longer than apical. Eyepatch rectangular, about $1\frac{1}{2}$ times as long as wide. Labral papillae broad, rounded, without setae, inner pair slightly smaller than outer; medial intrusion narrow. Ventral cephalic groove with $4 + 4$ marginal setae. Eyes G and H varying from subequal to F to only half as large; eyes circular except for G, which is occasionally oval. Mesothorax projecting and head hypognathous in adult specimens. Trochanteral organ with 24–36 small smooth setae in a roughly triangular patch. Tenent hair clavate, sometimes shorter than inner edge of unguis. Unguis with 3–4 small inner teeth and strong paired basal lateral teeth. Unguiculus in plan view strongly truncate. Fourth abdominal segment $3\frac{1}{2}$ –6 times as long as third at midline. Ventral tube with about $14 + 14$ to $16 + 16$ mostly smooth distal lateral setae, $2 + 2$ large and about $15 + 15$ shorter

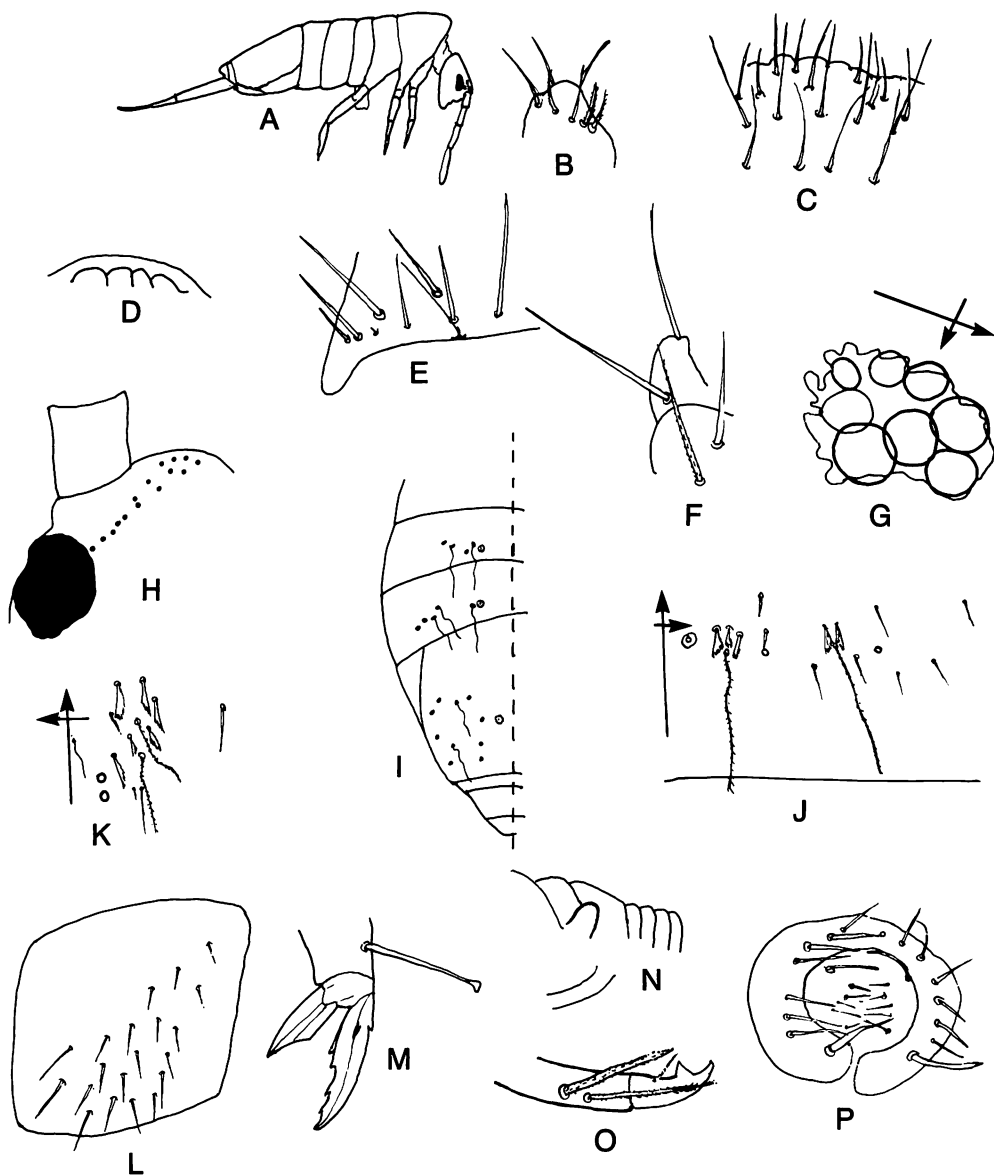
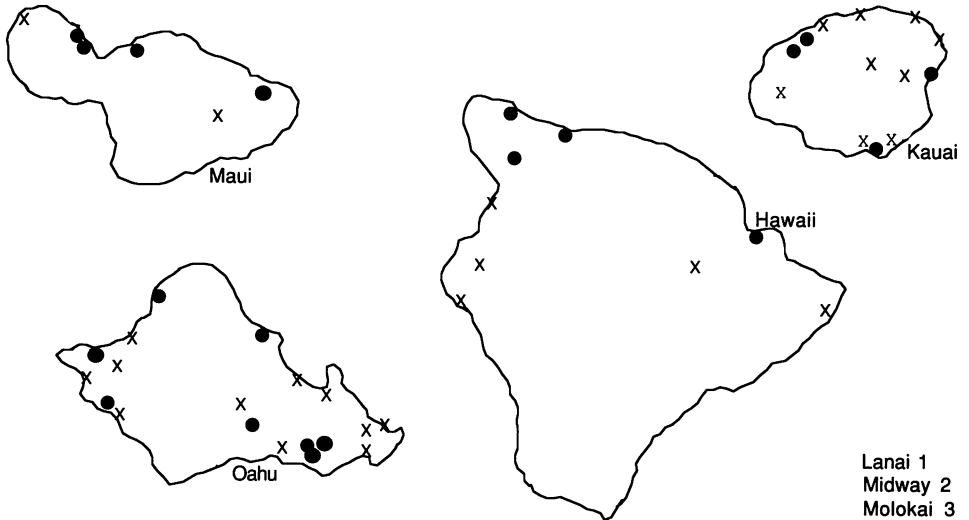


Plate 119—*Lepidocyrtus immaculatus*: A, habitus (5302, Oahu); B, apex of antenna (6772, Oahu); C, prelabral setae (4822, Oahu); D, labrum (6795, Maui); E, basal setae, left labial triangle (5132, Hawaii); F, maxillary palp (6795, Maui); G, right eyepatch (5132, Hawaii); H, interocular macrochaetae, left side (6795, Maui); I, bothriotricha, macrochaetae, and pseudopores, left side, second through fourth abdominal segments (composite); J, chaetotaxy, right side, second abdominal segment (5223, Oahu); K, left bothriotrichal complex, fourth abdominal segment (4747, Kauai); L, trochanteral organ (4785, Oahu); M, hind foot complex (4842, Oahu); N, base of dens, showing tubercle (same); O, mucro (4747, Kauai); P, male genital plate (6794, Maui).



anterior setae, all ciliate, and many ciliate setae of various lengths on posterior face. Manubrial plaque with 2-3 inner and 5-8 outer setae, all ciliate. Dens with strong, apically rounded basal tubercle. Anteapical mucronal tooth shorter than apical tooth and exceeded by basal spine. Anterior macrochaetae of second thoracic segment stout, acuminate, and about $\frac{1}{10}$ as long as width of segment. Maximum length 3.0 mm.

Remarks: This is the most common and widespread species of the genus in the Islands and makes up about half the collections of *Lepidocyrtus* we have seen; it is particularly dominant on Oahu. In spite of considerable variation in eye structure and ratios, it is well marked, being the only Hawaiian species with a truncate unguiculus and scales on the antennae or femora. Its identity has been confirmed by examination of Folsom's types, although Folsom (1932) showed the unguiculus as acuminate. It is possible that this is a synonym of *L. scaber* Ritter, 1911.

Ecology: This is primarily an inhabitant of grass and other low vegetation in open areas, or of leaf litter, although it is also occasionally found under stones or bark. It is common in the Honolulu area on Oahu, but apparently not in wilder areas except on Kauai, where it has been found in Kokee State Park. It was not collected on Hawaii before 1982 and has only been found there in the north and at Hilo.

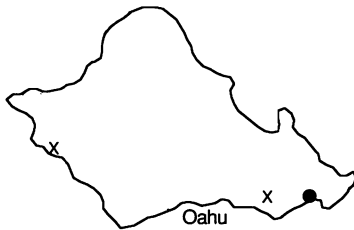
Type locality: Oahu, Honolulu, pineapple roots, Zwaluwenburg.

Additional records: Hawaii: 4856, 4859, 5111, 5132, 5136, 5137, 5138, 5139, 5140, 5158, 5271, 5272, 5466, 5643, 5660, 5668, 6395, 6850. Maui: 4751, 5160, 5161, 5162, 5170, 6665, 6668, 6675, 6683, 6684, 6685, 6686, 6707, 6794, 6795. Molokai: 5495, 5499, 5501. Lanai: 6690. Oahu: 4752, 4753, 4755, 4758, 4759, 4769, 4775, 4777, 4783, 4785, 4804, 4805, 4806, 4810, 4814, 4815, 4818, 4819, 4820, 4822, 4825, 4827, 4828, 4832, 4837, 4839, 4842, 4844, 5112, 5124, 5223,

5228, 5229, 5268, 5294, 5302, 5526, 6386, 6746, 6747, 6748, 6767, 6772, 6781, 6786, 6789, 6790, 6792. Kauai: 4734, 4739, 4747, 5193, 5196, 5198, 5205, 5280, 5285, 5288, 6710, 6714, 6715, 6716, 6718, 6722, 6723, 6727, 6728, 6729. Midway Atoll: 5306, 6818.

Lepidocyrtus inornatus Folsom, 1932 (Plate 120)
Proc. Hawaii. Entomol. Soc. 8:68.

Color yellow, or with scattered blue pigment giving a faint blue shade; antennae blue. Scales pigmented, giving intact specimens a brownish tinge; absent from antennae and femora. Antenna with large single apical bulb. Head nearly circular in dorsal view. With large blunt outer labral papillae and narrow curled inner papillae. Posterior row of prelabral setae ciliate. Maxillary palp with basal seta slightly longer than apical. Eyepatch trapezoidal. Eyes subequal; H elliptical, F slightly so. Ventral groove with 4 + 4 marginal ciliate setae. Mesothorax not projecting. Trochanteral organ with 2 arms, each with 5 setae. Tenent hair slender, weakly clavate, and clearly shorter than inner edge of unguis. Unguis with 4 subequal inner teeth and 2 small lateral teeth at about $\frac{1}{4}$ its length from base. Unguiculus acuminate, but appearing slightly angulate internally in plan view. Fourth abdominal segment 3–4 times as long as third. Ventral tube with 11–14 distal lateral setae per side, mostly smooth, and many anterior ciliate setae of gradually varying sizes, mostly 35–40 μm in length. Manubrial plaque with 2 + 2 ciliate setae. Basal dental tubercle small and generally obscure, below level of dental crenulations. Antepical mucronal tooth shorter than or subequal to apical tooth and exceeded by basal spine. Anterior macrochaetae of second thoracic segment mostly truncate, up to $\frac{1}{6}$ as long as width of segment. Maximum length 1.5 mm.



Remarks: This description is based on specimens collected near Honolulu in 1966, which resemble the single type we have seen more closely than do any other forms in our collections. The posterior M seta on the fourth abdominal segment is quite narrow and may be considered a mesochaeta. E setae of the labial triangle may have a few extremely minute ciliations.

Type locality: Oahu, Honolulu, in pineapple soil, Thomas.

Additional records: Oahu: 4808, 4823, 4824.

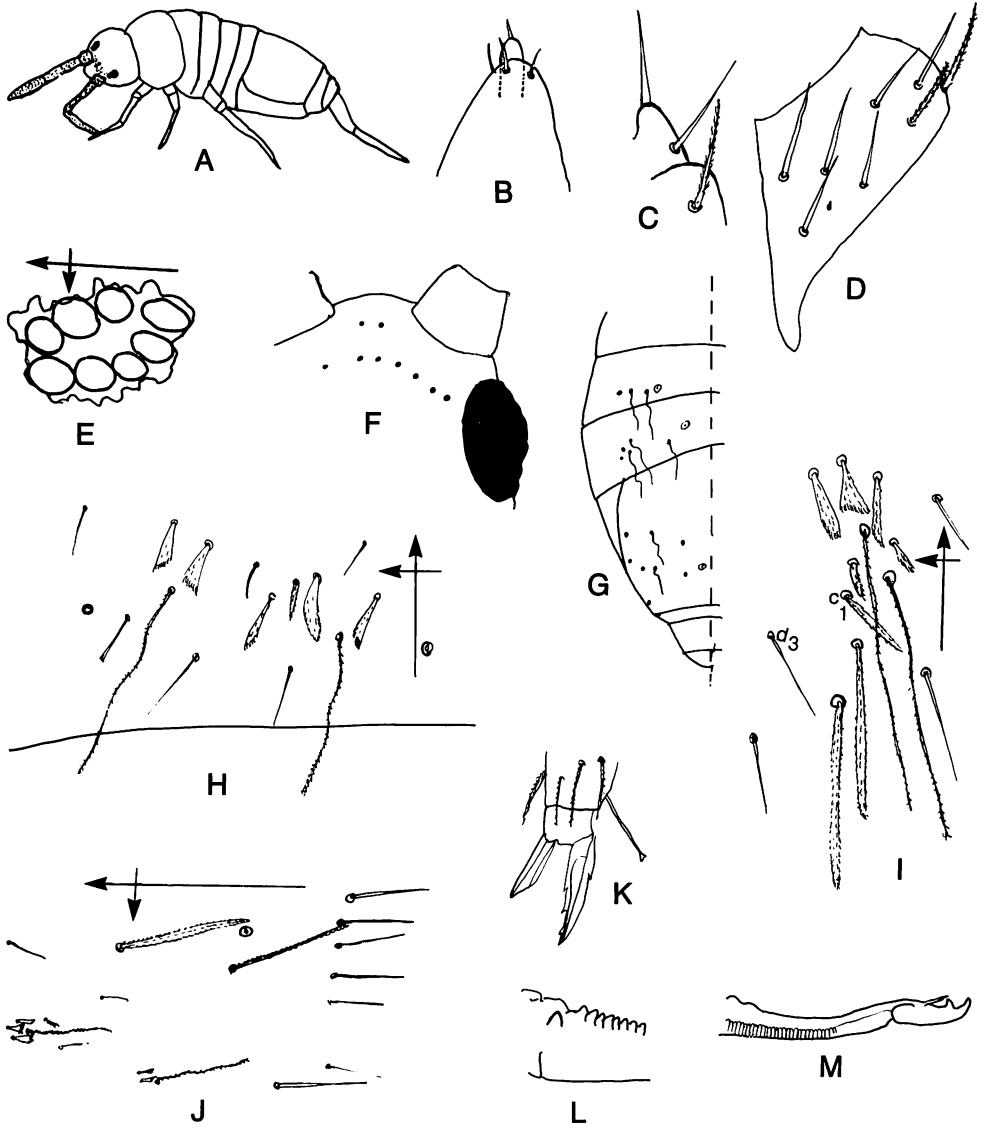
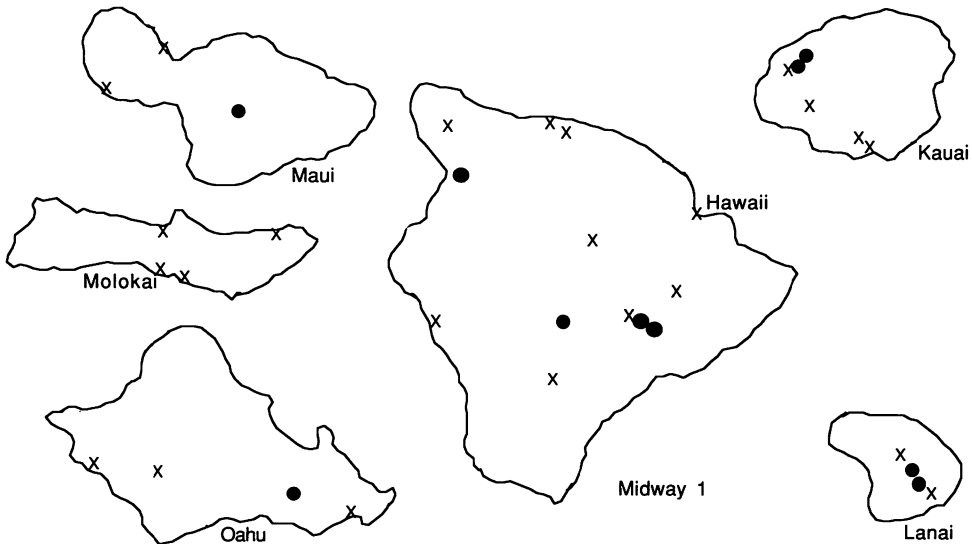


Plate 120—*Lepidocyrtus inornatus* (all figures of specimens from Oahu): **A**, habitus (4824); **B**, apex of antenna (same); **C**, maxillary palp (4823); **D**, left labial triangle (same); **E**, left eyepatch (4824); **F**, interocular setae, right side (4823); **G**, pseudopores, bothriotricha, and large setae, left side, second through fourth abdominal segments (composite); **H**, chaetotaxy, left side, second abdominal segment; **I**, chaetotaxy, left side, outer bothriotrichal complex, third abdominal segment (4808); **J**, median chaetotaxy, left side, fourth abdominal segment (4824); **K**, hind foot complex (after Folsom); **L**, base of dens (4824); **M**, apex of dens and mucro (same).

Lepidocyrtus mele Christiansen and Bellinger, **new species** (Plate 121)

Color yellow except for dark eyepatches and interocular band; antennae pale to medium blue; sometimes with scattered blue pigment grains, particularly on head. Scales giving fully scaled animals a brownish tinge; absent from antennae and femora. Antenna without apical bulb. Head rounded in dorsal view. Posterior row of prelabral setae ciliate. Labral papillae low, broad, with inner pair smaller; labral intrusion as a ridge. Eyepatch trapezoidal. Eyes G and H much smaller than others. Maxillary palp with basal and apical setae subequal. Mesothorax projecting slightly, thrusting head downward. Ventral groove with 3 + 3 marginal setae. Trochanteral organ V-shaped, with (6) 7–8 setae in each arm. Tenent hair clavate, subequal in length to inner edge of unguis. Unguis with 4 small inner teeth and a pair of small lateral teeth. Inner edge of unguiculus strongly angled in plan view, usually with a minute corner tooth. Fourth abdominal segment $3\frac{1}{2}$ –5 times as long as third. Ventral tube with 7 + 7 to 9 + 9 small distal lateral setae. Manubrial plaque generally with 2 outer and 2 inner setae, all ciliate; occasionally with 3 on either side, or no inner setae. Dens with a clear, small, rounded basal tubercle. Anteapical mucronal tooth subequal to or slightly shorter than apical tooth, with basal spine varying from not reaching to slightly exceeding its apex. Anterior macrochaetae of second thoracic segment acuminate and $\frac{1}{10}$ to $\frac{1}{5}$ as long as width of segment. Maximum length 1.2 mm.

Remarks: The species is well marked, although there is great variation in eye size and shape and in degree of projection of the mesothorax, and some minor variation in the chaetotaxy of the third and fourth abdominal segments. Originally we had split these forms into several species, but intergradation between these make it seem better to assign all to a single taxon. The most marked difference occurs in two Lanai specimens, which have only one ciliate M seta in the labial triangle.



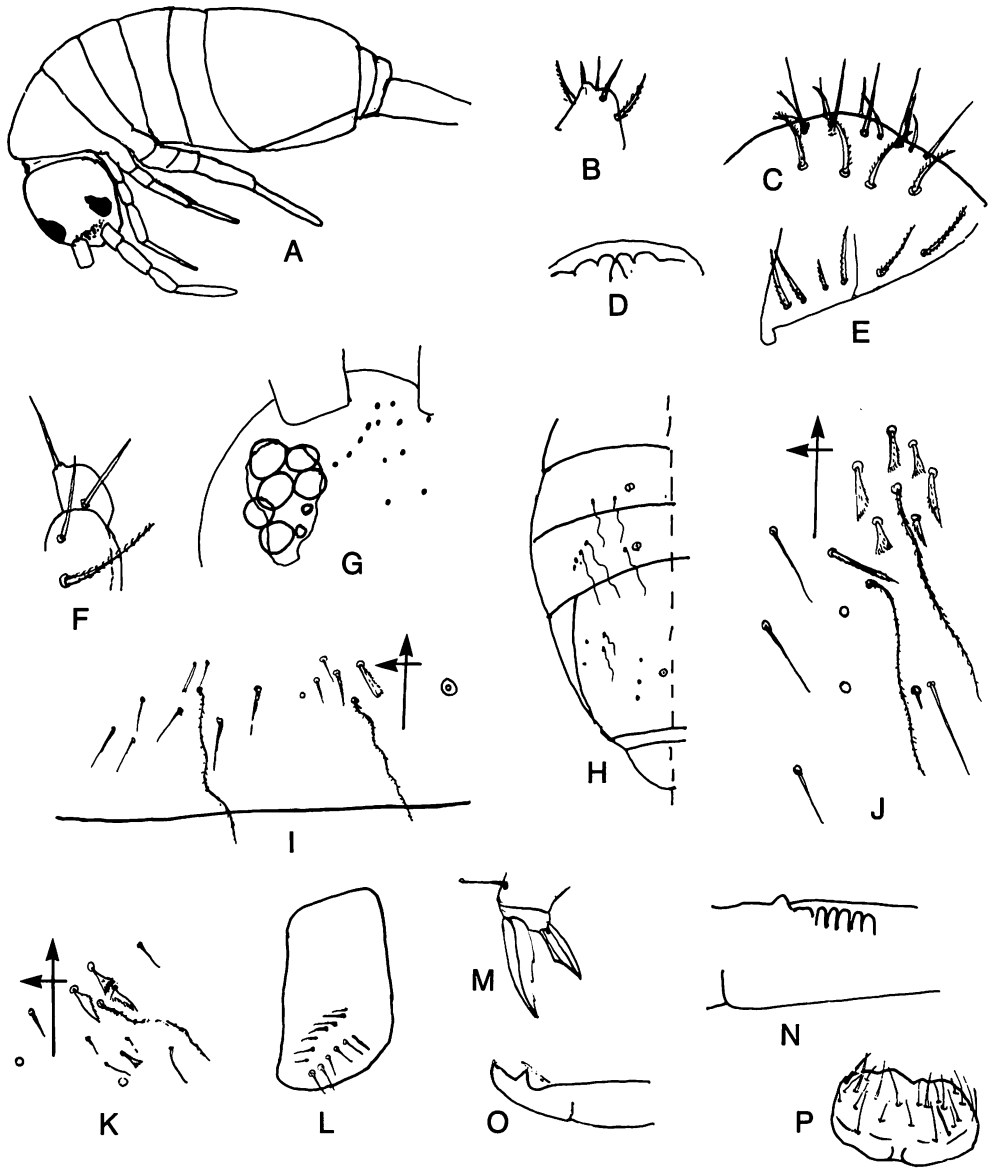


Plate 121—*Lepidocyrtus mele*: A, habitus (4727, Hawaii); B, apex of antenna (5659, Hawaii); C, prelabral setae (4727, Hawaii); D, labral papillae (5659, Hawaii); E, basal setae, left labial triangle (5200, Kauai); F, maxillary palp (5659, Hawaii); G, eyepatch and large setal bases, left side, anterior part of head (5152, Hawaii); H, bothriotricha, large setae, and pseudopores, left side, second through fourth abdominal segments (composite); I, chaetotaxy, left side, second abdominal segment (5276, Hawaii); J, left bothriotrichal complex, third abdominal segment (5198, Kauai); K, anterior bothriotrichal complex, fourth abdominal segment (5276, Hawaii); L, trochanteral organ (5152, Hawaii); M, hind foot complex (5200, Kauai); N, base of dens (same); O, mucro (4740, Kauai); P, male genital plate, seen from back (6698, Lanai).

Derivatio nominis: Hawaiian, yellow.

Ecology: This seems to be primarily a species of forest litter, although it is also found in grass and occasionally in other habitats. We have collections from seven islands, but the distribution appears highly localized on each island, and with the exception of collections from Mahaka on Oahu and Midway Atoll all records are from above 1000 ft.

Type locality: Holotype and 3 paratypes, Hawaii, Volcanoes National Park, east slope of Mauna Loa, Kipuka Ki Weather Station, III-13-1972, 1220 m, beneath koa, Jacobi (6901).

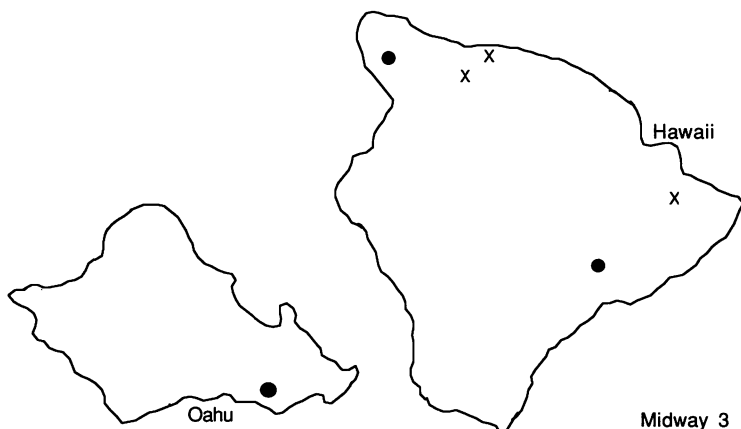
Additional records: Hawaii: 4725, 4727, 4856, 4859, 4869, 4870, 5147, 5152, 5156, 5276, 5292, 5307, 5336, 5345, 5489, 5647, 5649, 5651, 5652, 5659, 5680, 5681, 5685, 5694, 5699, 6822, 6845, 6854, 6898, 6901. Maui: 4751, 5174, 5181, 6664. Molokai: 5494, 5501, 5710, 5716. Lanai: 6689, 6693, 6694, 6695, 6698, 6700. Oahu: 4838, 5219, 5233, 6526, 6536, 6540, 6748, 6761, 6766, 6769, 6770, 6771, 6772, 6779. Kauai: 4740, 4741, 5190, 5198, 5200, 5201, 5202, 5216, 5262, 5277, 5285, 5288, 5308, 6527, 6714, 6715. Midway Atoll: 6390.

Lepidocyrtus pallidus Reuter, 1892 (Plate 122)

Medd. Soc. Fauna Flora Fenn. 17:24.—Christiansen and Bellinger, 1980.

Lepidocyrtus cyaneus Tullberg: Folsom, 1932:68.

Color more or less uniform pale gray-blue to blue with inconspicuous pale inter-segmental bands. Eyepatch elongate, triangular to trapezoidal, with eye G definitely posterior to F; eyes G and H rounded to oval. Palp with 2 apical and basal setae subequal. Outer labral papillae large and blunt; inner papillae narrow and curved. Medial intrusion triangular. Head roughly circular in dorsal view. Ventral cephalic groove with 4 + 4 ciliate marginal setae. Mesothorax not projecting markedly forward. Trochanteral organ with 5–7 setae in each arm and 1–3 erratically placed setae; basal 2 setae in ventral arm much larger than others. Unguis with 3 strong inner teeth and obvious lateral and external teeth. Unguiculus clearly



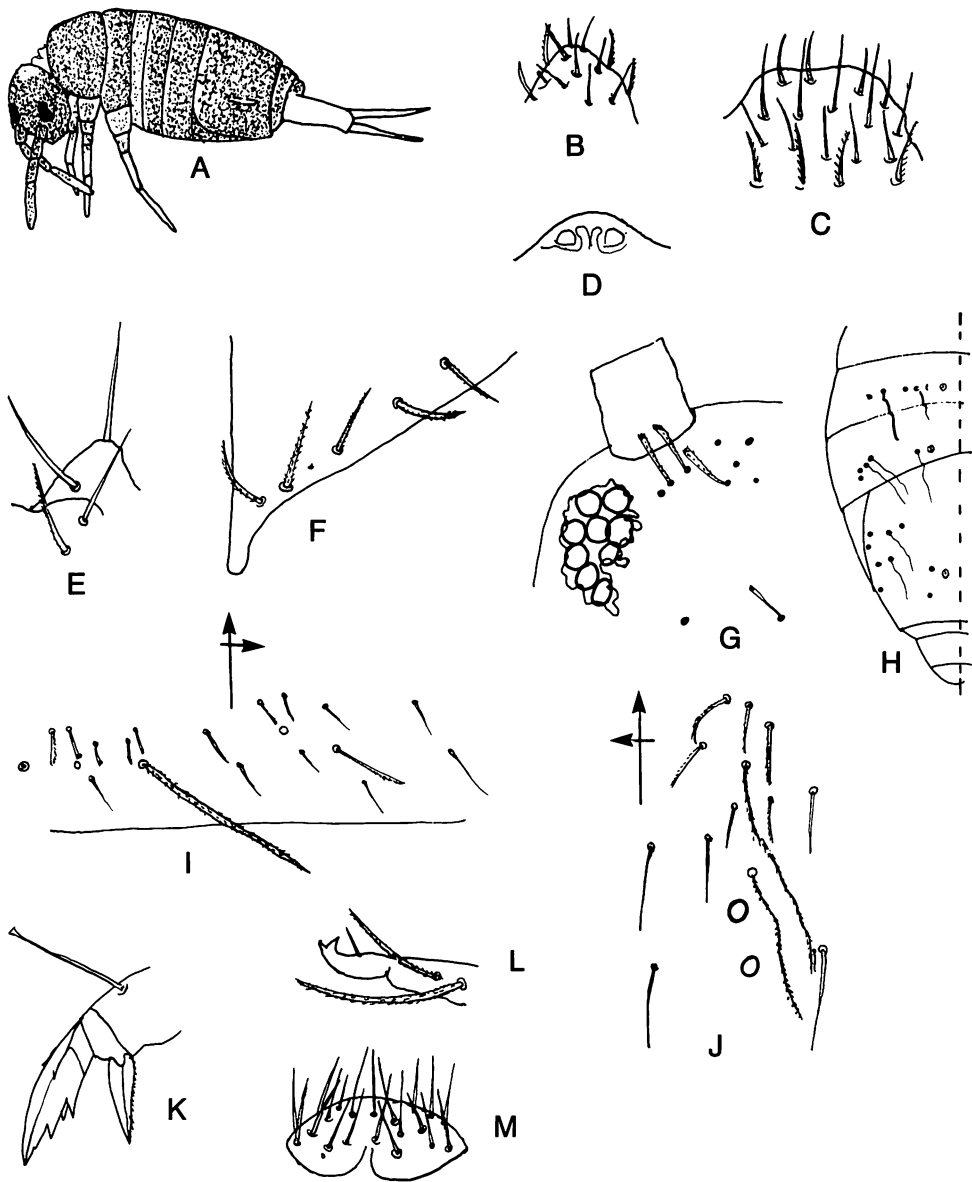


Plate 122—*Lepidocyrtus pallidus*: A, habitus (6787, Oahu); B, apex of antenna (5276, Hawaii); C, prelabral setae (same); D, labral papillae (same); E, maxillary palp (5306, Midway Atoll); F, basal setae, left labial triangle (5043, Hawaii); G, interocular macrochaetae and eyes of left side (same); H, pseudopores, macrochaetae, and bothriotricha, left side, second through fourth abdominal segments (composite); I, chaetotaxy, right side, second abdominal segment (5043, Hawaii); J, left outer bothriotrichal complex, third abdominal segment (5306, Midway Atoll); K, hind foot complex (5043, Hawaii); L, apex of dens and mucro (5306, Midway Atoll); M, male genital plate (5276, Hawaii).

serrate externally. Ventral tube with 8 + 8 to 11 + 11 distal lateral setae, mostly ciliate. Manubrial plaque with 2 + 2 ciliate setae. Maximum length 1.6 mm.

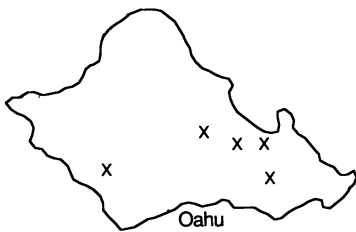
Remarks: The Hawaiian specimens are indistinguishable from North American material except for generally smaller size. Dark specimens are more common in Hawaii than on the U.S. mainland. Midway Atoll specimens are unusually dark and show some variations in chaetotaxy not seen elsewhere.

Ecology: It is found under stones and in debris and animal carcasses; one collection is from a cave.

Records: Hawaii: 4905, 4937, 4980, 5043, 5051, 5274, 5276, 5667, 5668. Oahu: 6785, 6786, 6787, 6789. Midway Atoll: 4942, 5306, 6818.

Lepidocyrtus olena Christiansen and Bellinger, **new species** (Plate 123)

Color yellow except for pale blue antennae, dark eyepatches, and sometimes a dark interocular spot. Scales pigmented, giving intact animals a pale brownish color; absent from antennae and femora. Antenna without apical bulb. Head broadly oval in dorsal view. All prelabral setae smooth. Labrum with papillae small and subequal. Median intrusion ridgelike. Maxillary palp with basal and apical setae subequal. Eyepatch trapezoidal. Eye G $\frac{1}{2}$ to $\frac{1}{3}$ of width of eye F. Mesothorax projecting slightly. Ventral cephalic groove with 5 + 5 (rarely 4 + 4) setae; apicalmost of these is smooth and the others ciliate. Trochanteral organ with 2 arms of 8–10 setae and a few scattered setae between these. Tenent hair clavate, slightly shorter than inner edge of unguis. Unguis with 4 very small inner teeth and a pair of large basal lateral teeth. Unguiculus strongly truncate. Fourth abdominal segment $3\frac{1}{2}$ times as long as third. Ventral tube with 8–10 distal lateral setae per side and many long, ciliate anterior setae. Manubrial plaque with 2–3 inner and 4–5 outer setae, all ciliate. Dens without basal tubercle. Anteapical mucronal tooth shorter than apical tooth and exceeded by basal spine. Anterior macrochaetae of second thoracic segment cylindrical and truncate, up to $\frac{1}{3}$ as long as width of segment. Maximum length 1.5 mm.



Hawaii 1
Midway 1
Kauai 2
Maui 2

Remarks: This species is very similar to *L. immaculatus*, but differs in labial chaetotaxy, ventral cephalic groove chaetotaxy, scale distribution, and absence of the dental tubercle. The sympatric occurrence of smaller specimens of *L. immaculatus* makes it unlikely that this is a variant of that species.

Derivatio nominis: Hawaiian, yellow.

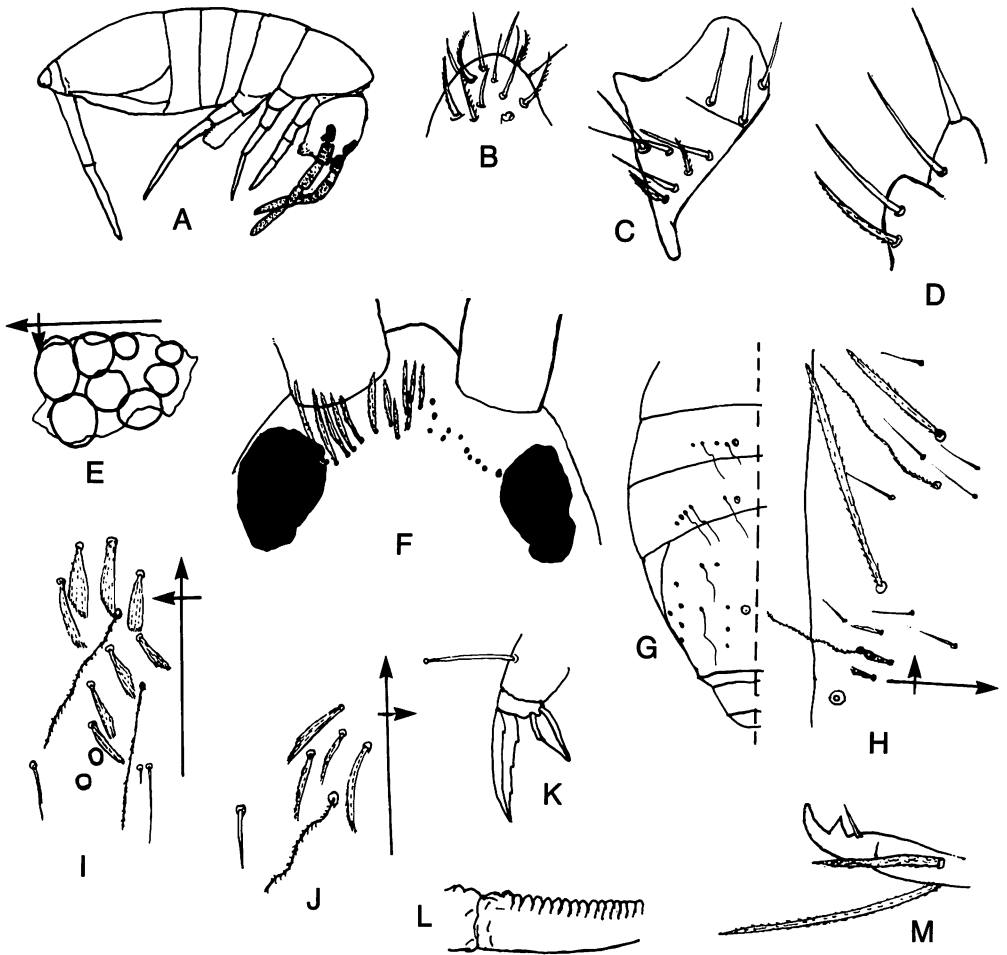


Plate 123—*Lepidocyrtus olena*: A, habitus (4762, Oahu); B, apex of antenna (6751, Oahu); C, left labial triangle (type); D, maxillary palp (4761, Oahu); E, left eyepatch (type); F, interocular macro-mesochaetae (type); G, pseudopores, macrochaetae, and bothriotricha, left side, second through fourth abdominal segments (composite); H, chaetotaxy, left side, second abdominal segment (type); I, chaetotaxy, outer bothriotrichal complex, third abdominal segment (type); J, anterior bothriotrichal complex, fourth abdominal segment (type); K, fore foot complex (type); L, base of dens (type); M, mucro (4762, Oahu).

Ecology: Found generally in wooded areas in litter, under bark, in rotten wood, or on low vegetation in lowland areas. None of the collections are from urban areas or high altitudes.

Type locality: Holotype and 5 paratypes, Oahu, Mt. Tantalus, IX-16-1966, under bamboo, litter, and soil, PB (4761).

Additional records: Hawaii: 4980. Maui: 5170, 6686. Oahu: 4762, 4796, 6746, 6751, 6754, 6760. Kauai: 5194, 5288. Midway Atoll: 4942.

Lepidocyrtus poko Christiansen and Bellinger, new species (Plate 124)

Color white, with scattered blue granules on antennae, head, and body, denser toward lateral margins of segments and on coxal bases; sixth abdominal segment, legs, and furcula unpigmented. Scales pale yellow, varying from broadly elliptical to narrowly fusiform. Apical antennal bulb clearly bilobed. Head nearly circular in dorsal view. Posterior row of prelabral setae ciliate. Labral papillae with outer pair broad, low; inner small, conical, unisetaceous. Eyepatch roughly elliptical. Ventral groove with 4 + 4 marginal setae. Trochanteral organ not seen clearly, but apparently with only 3 setae in each arm. Tenent hair about 1.2 times as long as unguis, strongly clavate. Unguis with 2 lateral and 4 very small inner teeth. Unguiculus gradually and smoothly tapered. Fourth abdominal segment 3.3–3.7 times as long as third. Ventral tube with 6 + 6 large ciliate anterior setae and 4 ciliate and smooth setae on distolateral patches. Manubrial plaque with 2 inner and 2 outer setae, all ciliate. Dens with a small, rounded inner basal tubercle. Mucronal teeth

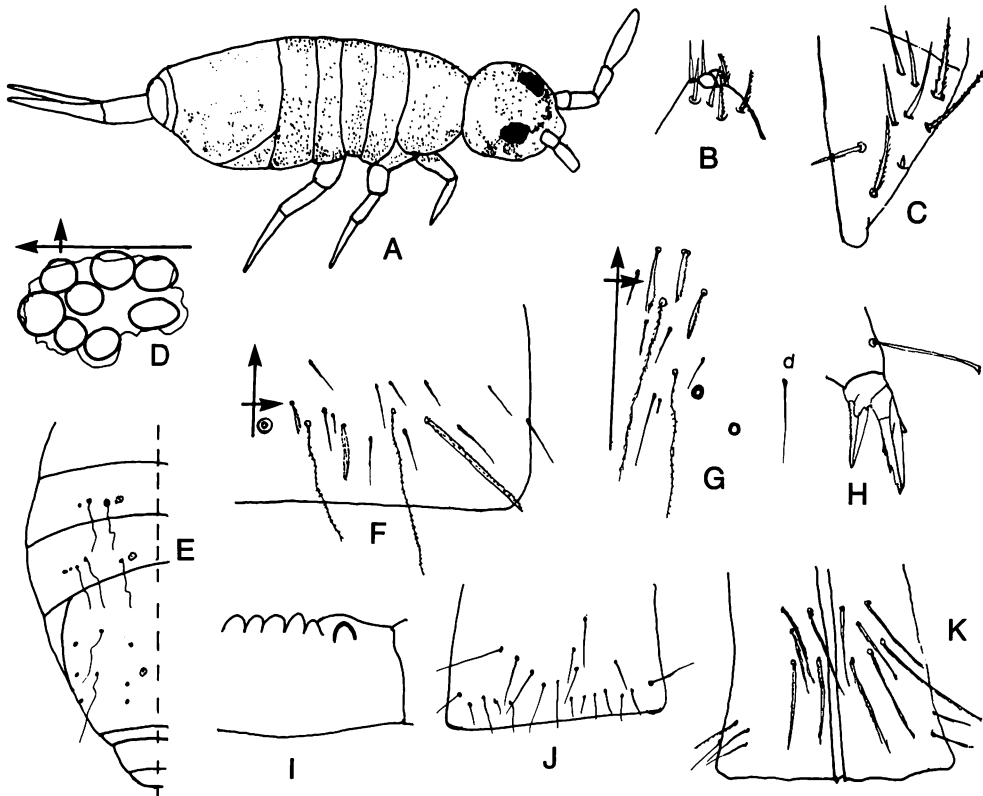


Plate 124—*Lepidocyrtus poko* (all figures of type specimens): A, habitus; B, apex of antenna; C, left labial triangle; D, left eyepatch; E, pseudopores, macrochaetae, and bothriotricha, left side, second through fourth abdominal segments; F, chaetotaxy, second abdominal segment, right side; G, outer bothriotrichal complex, right side, third abdominal segment; H, hind foot complex; I, base of dens; J, posterior face of ventral tube; K, anterior face of ventral tube.

subequal; basal spine not quite attaining apex of antepical tooth. Anterior macrochaetae of second thoracic segment cylindrical; medial setae truncate, lateral acuminate; setae up to $\frac{1}{6}$ as long as width of segment. Maximum length 0.75 mm.

Remarks: *Lepidocyrtus poko* resembles *L. hakea* but differs from that species in chaetotaxy of the second and fourth abdominal segments and ventral tube, and has eye H much less elliptical. The combination of a bilobed apical antennal bulb and a dental tubercle appears to distinguish this species from all known members of the genus; however, the bilobed antennal bulb was seen on only one specimen, on one antenna.

Derivatio nominis: Hawaiian, small cloud.

Type locality: Holotype and 2 paratypes, Oahu, Makua, I-25-1969, roadside bush, Lee (4841).

Lepidocyrtus violaceus (Fourcroy, 1785) (Plate 125)

Entomologia Parisiensis: 525 (*Podura*).—Christiansen and Bellinger, 1980:956–957.

Color blue with pale intersegmental membranes, legs, furcula, and sixth abdominal segment. Head with very dark interantennal band and paler pigmented interocular patch and lateral posterior cheek patches. Antennae relatively uniformly pigmented. Scales present on first two antennal segments and on all femora and hind tibiotarsi. Antennae lacking apical bulbs. Head rounded in dorsal view. Posterior row of prelabral setae ciliate. Labral papillae unisetaceous and small. Eyepatch trapezoidal. Eyes G and H smaller than others. Maxillary palp with apical and basal setae subequal. Mesothorax projecting slightly, thrusting head downward. Ventral groove with 4 + 4 marginal ciliate setae. Trochanteral organ with 4 + 4 arm setae. Tenent hair clavate, slightly longer than inner unguis. Unguis with 4 small inner and 2 strong lateral teeth. Unguiculus smoothly tapered, outer edge smooth or possibly extremely finely ciliate. Fourth abdominal segment 2.0–2.75 times as long as third. Ventral tube with 6 + 6 to 7 + 7 distolateral setae. Manubrial plaque with 2 + 2 inner and 3 + 3 outer ciliate setae. Dens without basal tubercle. Mucro with basal spine slightly exceeding apex of basal tooth, which is distinctly shorter than apical tooth. Anterior mesochaetae of second thoracic segment truncate and short. Maximum length 1.5 mm.

Remarks: The description, except for maximum length, is based on Hawaiian specimens; however, the data in Table 26 were from mainland U.S. specimens because the chaetotaxy was only poorly visible on Hawaiian material. The features seen in the Hawaiian specimens agreed well with those on mainland U.S. specimens; however, all Hawaiian material consisted of subadult specimens, and those were only poorly cleared. Only four specimens from one locality were seen, taken in 1986. This may represent a very recent introduction. The combination of scaled legs and antennae and acuminate unguiculus makes it very easy to separate from other Hawaiian species.

Records: Maui: 6795.

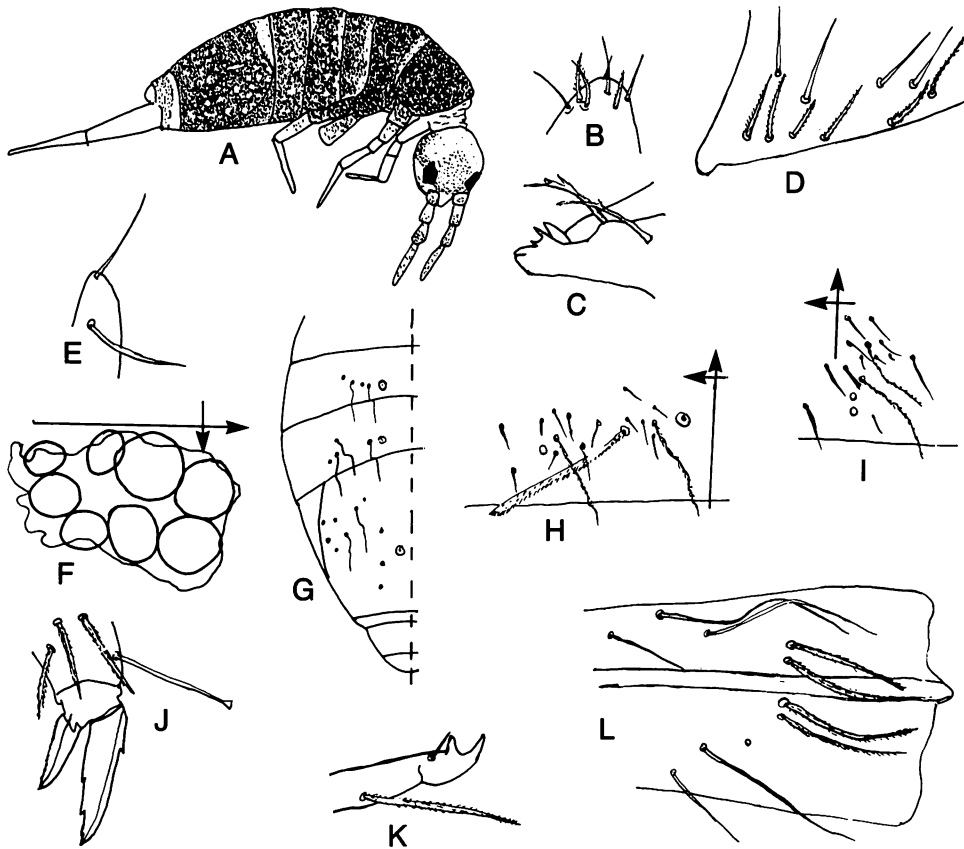


Plate 125—*Lepidocyrtus violaceus*: A, habitus (6795, Maui); B, apex of antenna (after Christiansen and Bellinger); C, labral papillae, from side (after Christiansen and Bellinger); D, left labial triangle (6795, Maui); E, apex of maxillary palp (same); F, right eyepatch (same); G, pseudopores, macrochaetae, and bothriotricha, left side, second through fourth abdominal segments (based on Utah specimens); H, chaetotaxy, second abdominal segment, left side (after Christiansen and Bellinger); I, outer bothriotrichal complex, left side, third abdominal segment (same); J, hind foot complex (same); K, mucro and apex of dens (6795, Maui); L, anterior face of ventral tube (same).

***Lepidocyrtus uku* Christiansen and Bellinger, new species (Plate 126)**

Background color pale yellow, with mottled pale blue pigment over dorsum of body and central and lateral areas of head. Antennae moderately pigmented and legs and furcula pale. Antenna with strong, obvious, single apical bulb. Head rounded in dorsal view. Posterior row of prelabral setae ciliate. Labral papillae with outer papillae broad and low, inner papillae narrow and curved outward. Median intrusion narrow. Maxillary palp with apical and basal setae subequal and finely ciliate. Eyepatches trapezoidal. Eyes G and H slightly smaller than others, with eye G varying from ovoid to round. Mesothorax not projecting forward. Ventral groove with 3 + 3 ciliate marginal setae. Trochanteral organ with 7 setae in arms and 1 internal seta. Unguis with 4 inner teeth, apical one extremely minute

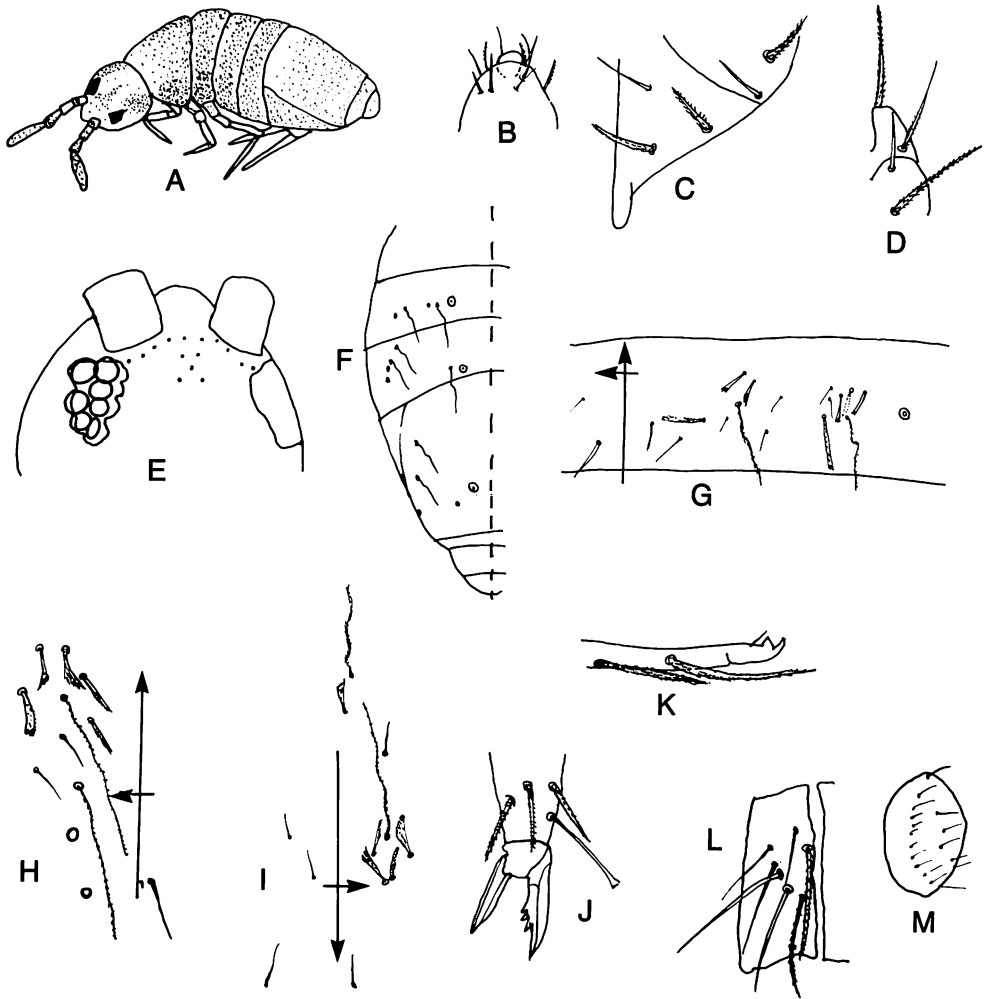


Plate 126—*Lepidocyrtus uku* (all figures of type specimens): A, habitus; B, apex of antenna; C, left labial triangle; D, maxillary palp apex; E, cephalic interocular macrochaetae and left eyepatch; F, pseudopores, macrochaetae, and bothriotricha, left side, second through fourth abdominal segments; G, chaetotaxy, left side, second abdominal segment; H, chaetotaxy, left outer bothriotrichal complex, third abdominal segment; I, chaetotaxy, region of left bothriotrichal complex, fourth abdominal segment; J, hind foot complex; K, apex of dens and mucro; L, right side, anterior face of ventral tube; M, male genital plate, seen from front.

and possibly absent in some. Median tooth usually larger than basal teeth. Unguiculus acuminate and very minutely externally ciliate. Fourth abdominal segment 3.3–3.6 times as long as third. Ventral tube with 6 + 6 to 7 + 7 distolateral setae. Manubrial plaque with 2 + 2 inner and 2 + 2 outer ciliate setae. Dens without basal tubercle. Mucro with apical and subapical teeth subequal. Basal spine just attaining apex of subapical tooth. Anterior macrochaetae of second thoracic segment truncate, curved and 2–2 ½ times as long as inner unguis. Maximum length 1.1 mm.

Remarks: This is the only Hawaiian species having a single m seta on the fourth abdominal segment. The labial triangle is quite variable. Some specimens have a very minute knob at the site of the dental tubercle, usually on one side only. The ciliate nature of the maxillary palp setae can only be seen in large specimens, and even there is very faint.

Known only from the type locality.

Derivatio nominis: Hawaiian, tiny.

Type locality: Holotype and 5 paratypes, Kauai, Hanalei Valley State Conservation Area, 1 mile up side road, XII-25-1986, dry forest, under bark, KC (6728).

Genus **PSEUDOSINELLA** Schäffer, 1897

Type species: *Tullbergia immaculata* Lie-Pettersen, 1897

This genus is well developed in the Islands. We have seen five species and others probably remain to be discovered. *Pseudosinella fujiokai*, the most common species, and *P. octopunctata* are probably introduced; they differ from the others, and from Hawaiian *Lepidocyrtus*, in the presence of an outstanding, truncate macrochaeta on the hind tibiotarsus. Of the remaining three, one is a marine littoral species with adaptations to this habitat that are unique in *Pseudosinella*. The fourth species is represented by three specimens from Kauai and a single incomplete specimen from Lanai. The last species (sp. YY) is represented by a single specimen from Oahu from the University of Hawaii campus; it is included in the key and Table 27 but is not formally described. It is remarkable that in spite of the relative abundance of the genus in Hawaii only a single cave collection has been made.

The four Hawaiian species of *Pseudosinella* discussed here are *fujiokai*, *kalalauensis*, *lahainaensis*, and *octopunctata*.

In Table 27 species are grouped according to some of their taxonomic features. The characters chosen are either structural features that are recorded in almost all descriptions or elements of chaetotaxy that are given in most modern descriptions; the latter are illustrated in Figure 99. For a discussion of the characters used, see *The Collembola of North America* and our treatment of Hawaiian *Entomobrya* and *Lepidocyrtus* in this volume. The "species formula" given in each description is a code introduced by Christiansen, Gama, and Bellinger (1983). The meaning of the numerical code is given in Table 28.

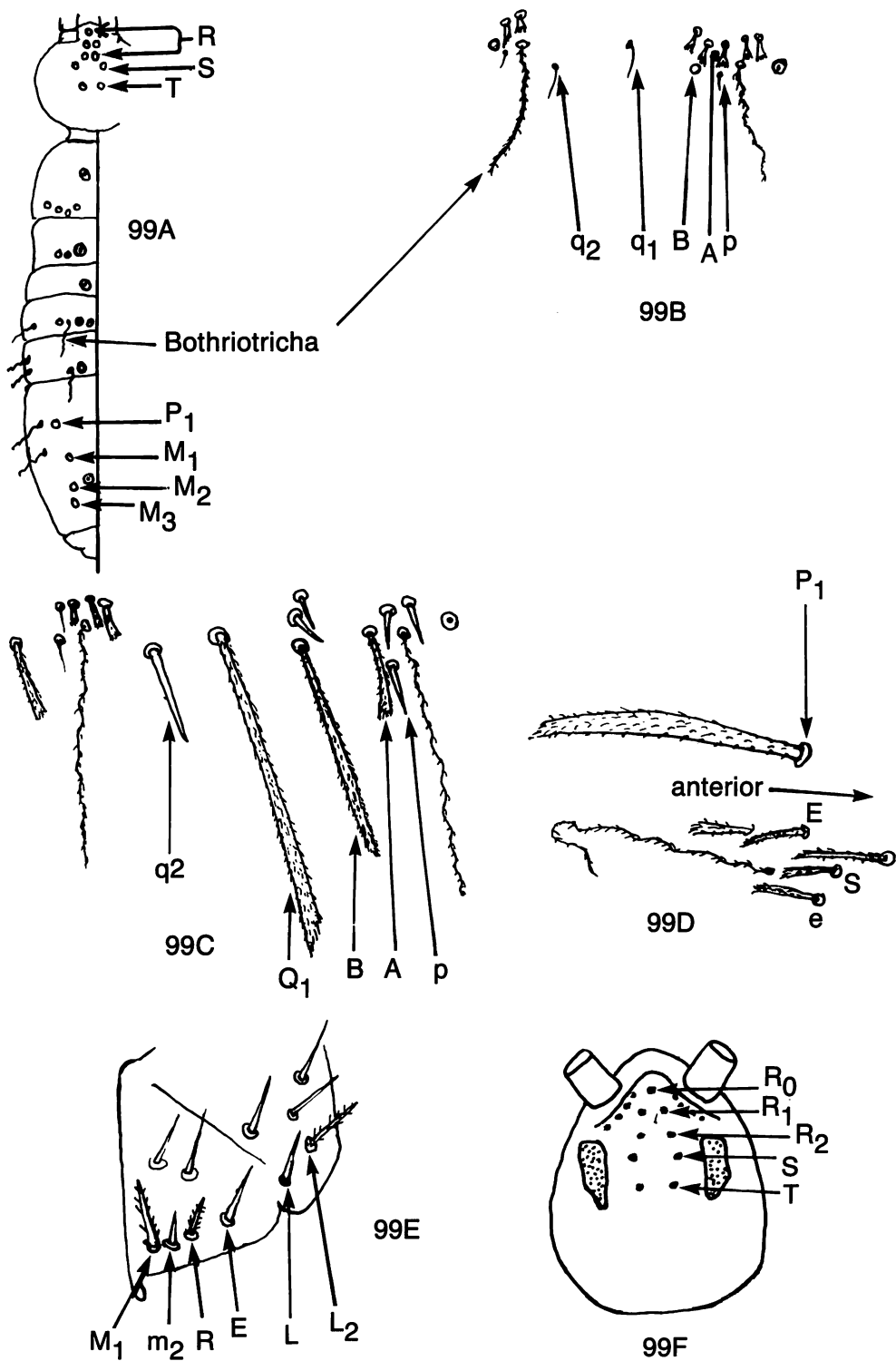


Figure 99—Characters of *Pseudosinella*: A, dorsal macrochaetae, bothriotricha, and pseudopores (circles with center dots); B and C, typical second abdominal segment chaetotaxy conditions; D, typical anterior lateral fourth abdominal segment seta complex; E, labial triangle; F, detail of cephalic dorsal chaetotaxy.

Table 27. Characters of Hawaiian Species of *Pseudosinella*

SPECIES	CHAETOTAXY*																								
	EYES PER SIDE	TENENT HAIR	UNIGUI- CULAR TOOTH	MANUBRIAL PLAQUE		MIDCEPHALIC MACROCHAETAE					SETAE OF LABIAL TRIANGLE					THORACIC MACRO- CHAETAE**			ABD. II				ABD. IV		
				INNER	OUTER	R ₀	R ₁	R ₂	S	T	M ₁	M ₂	r	E	L ₁	L ₂	II	III	p	a	b	q ₁	q ₂	P	M
<i>fujiokai</i>	0	acuminate	+	2	1	+	+	+	-	-	-	<i>M</i>	vg	<i>E</i>	<i>L</i>	<i>L</i>	-	-	-	A	B	q	q	1	1-(2)
<i>kalalauensis</i>	4	clavate	-	2	2-3	+	-	-	+	+	<i>M</i>	<i>M</i>	<i>r</i>	<i>E</i>	<i>L</i>	<i>L</i>	-	-	-	a	b	q	q	0	3
<i>lahainaensis</i>	4-(5)	acuminate	+	2	2	+	+	-	-	-	-	<i>M</i>	vg	<i>E</i>	<i>L</i>	<i>L</i>	-	-	-	a	B	q	q	0	1
<i>octopunctata</i>	4	clavate	-	2	1	+	+	+	+	+	-	<i>M</i>	-	<i>E</i>	<i>L</i>	<i>L</i>	1	-	+	A	B	Q	q	1	2
sp. YY	0	clavate	-	2	1	+	+	+	-	-	<i>M</i>	<i>M</i>	o	<i>E</i>	<i>L</i>	<i>L</i>	-	-	-	a	b?	Q?	q	0	2

*Capitalized symbols stand for large setae, lower-case symbols for small setae; italic symbols stand for ciliate setae (others are smooth); vg = vestigial, o or - = absent.

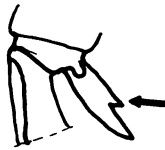
**Exclusive of collar setae of second thoracic segment.

Table 28. Explanation of Numerical Code Used in Descriptions of *Pseudosinella*

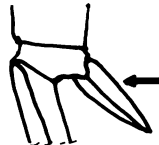
CODE DIGIT	CODE
First:	Eye number (eyes per side)
Second:	Large outer (wing) tooth on unguiculus: present = 1; absent = 2
Third:	Dorsal cephalic macrochaetae S and/or T present = 1; S and T absent = 2
Fourth:	q_1 seta on dorsum of second abdominal segment: present and minute, unciliated = 1; developed as macrochaeta (Q), ciliated = 2; absent = 3
Fifth:	Tenant hair: acuminate = 1; truncate or clavate = 2
Sixth:	Labial triangle setae M_1 , M_2 , E, L_1 , L_2 : all present and ciliated = 1; one or more absent or smooth = 2
Seventh:	Dorsal macrochaetae of fourth abdominal segment: P_1 absent, 2 M macrochaetae ($0 + 2$) = 1; P_1 present, 2 M macrochaetae ($1 + 2$) = 2; P_1 present, 3 M macrochaetae ($1 + 3$) = 3; P_1 absent, 3-4 M macrochaetae ($0 + 3$ or $0 + 4$) = 4; P_1 present, 1 M macrochaetae ($1 + 1$) = 5

KEY TO HAWAIIAN SPECIES OF PSEUDOSINELLA

1. Without eyes or pigment. 2
 Eyes and pigment present. 3
 2(1). Unguiculus with conspicuous tooth on outer margin (Fig. 100A). **fujiokai**
 Unguiculus without conspicuous tooth on outer margin (Fig. 100B). **sp. YY**
 3(1). Unguiculus with conspicuous tooth on outer margin (Fig. 100A). **lahainaensis**
 Outer margin of unguiculus smoothly tapering (Fig. 100B). 4



100A



100B

- 4(3). Inner margin of unguiculus sharply angled (Fig. 101). **kalalauensis**
 Inner margin of unguiculus smoothly tapering. **octopunctata**

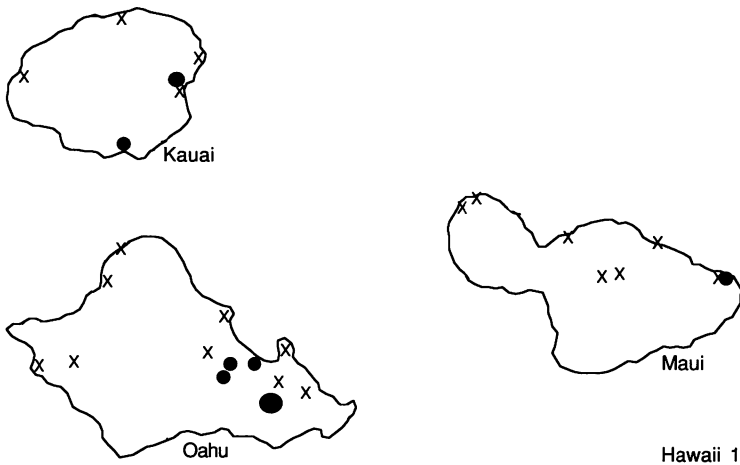


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***Pseudosinella fujiokai* Yosii, 1964 (Plate 127)**

Kontyu 32:13.

Color white without trace of pigment. Scales hyaline, absent from antennae and legs. Antenna usually with only a trace of apical bulb in the form of a knob. Head in dorsal view almost circular. Labral papillae not clear; prelabral setae 4-5-5-4, with only posterior row ciliate. Eyes absent. Trochanteral organ with 3-6 setae in arms. Hind tibiotarsus with 2 stout, clavate, outstanding setae on basal $\frac{1}{2}$ of the organ; the basal seta is on the anterior leg face and the distal on the inner face. Tenent hair short and usually acuminate, rarely weakly clavate. Unguis with 2 basal teeth, one prominent and winglike, and 1 small median tooth. Unguiculus with inner edge apically angled in plan view and with prominent outer wing tooth. Ventral tube with 4 + 4 or 5 + 5 distolateral smooth setae. Manubrial plaque with 2 inner and 1 outer setae, all ciliate. Dens without basal tubercle. Mucronal teeth subequal; basal spine just reaching or (usually) slightly surpassing apex of anteapical tooth. Collar setae of anterior margin of second thoracic segment in several rows, strongly clavate and up to $\frac{1}{5}$ - $\frac{1}{4}$ as long as width of segment. Species formula 0121125 or 0121122. Maximum length 1.1 mm.



Remarks: This form agrees very well with Yosii's (1964) description and figures, except that the trochanteral organ of the Hawaiian specimens has longer setae than those figured by Yosii; however, some question as to its identity will remain until the chaetotaxy of Tonga Islands specimens has been fully described.

The presence of only a single macrochaete of the M series on the fourth abdominal segment is a character not previously described in this genus; the "5" in position 7 of the species formula stands for this condition. In three-fourths of our samples, specimens had only one M seta, but single specimens in two samples and all individuals in a few others had two. The second M seta is in the posterior row and is a microseta or (rarely) a mesochaete in other samples.

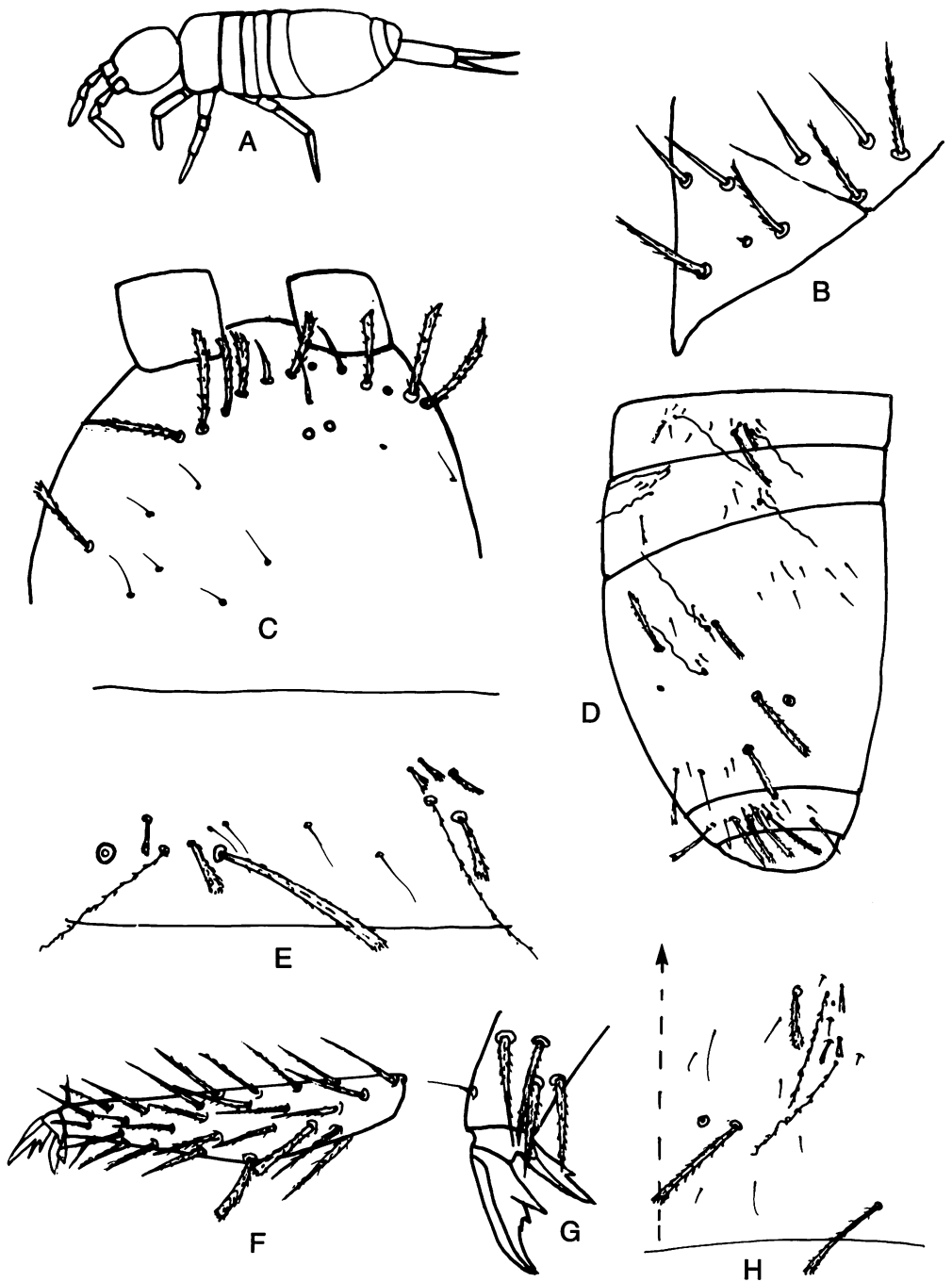


Plate 127—*Pseudosinella fujiokai*: A, habitus (4786, Oahu); B, left labial triangle (same); C, dorsal anterior cephalic chaetotaxy (same); D, left posterior dorsal abdominal chaetotaxy (same specimen); E, enlargement of second abdominal segment dorsal chaetotaxy (4790, Oahu); F, hind tibiotarsus (4786, Oahu); G, hind foot complex (4790, Oahu); H, fourth abdominal segment dorsal chaetotaxy, right side (5205, Kauai).

A single specimen from Waahila Ridge, Oahu, has an obvious apical antennal bulb.

Ecology: Found mainly in soil or litter in grassland or disturbed areas, but also in moss and occasionally in grass or debris under bark and rocks; in lowland and a few well-traveled upland areas.

Records: Hawaii: 4724. Maui: 5159, 5162, 6667, 6670, 6676, 6680, 6705, 6707, 6794. Oahu: 4769, 4773, 4777, 4778, 4782, 4786, 4787, 4790, 4806, 4814, 4816, 4847, 5222, 6731, 6734, 6735, 6736, 6746, 6747, 6753, 6755, 6756, 6766, 6768, 6769, 6770. Kauai: 4746, 4749, 5191, 5192, 5202, 5203, 5205, 5285, 6728.

Pseudosinella kalalauensis Christiansen and Luther, 1986 (Plate 128)
Proc. Hawaii. Entomol. Soc. 26:49-51.

Color white except for antennae, eyepatches, spot between eyes, and a faint scattering of blue pigment granules, much darker on the head than elsewhere. Scales hyaline, absent from femora and antennae. Head in dorsal view roughly pentagonal. Prelabral setae 4-5-5-4; only the last row ciliate. Eyepatch diffuse and irregular; eyes 4 + 4. Trochanteral organ with 6-8 setae in each arm. Tibiotarsi with unclearly differentiated ciliate acuminate setae about $\frac{1}{6}$ way from base to apex of segment. Tenent hair clavate, subequal in length to inner edge of unguis. Three inner ungual teeth, median and 1 basal tooth being minute; basal lateral and outer teeth small but distinct. Inner edge of unguiculus sharply angled in plan view. Ventral tube with 7-12 smooth and ciliate setae on each distolateral patch. Manubrial plaque with 2 inner and 3 (rarely 2) outer ciliate setae. Dens with a small, distinct basal tubercle. Mucronal teeth subequal or basal slightly larger; basal spine reaching or slightly surpassing apex of antepical tooth. Anterior macrochaetae on second thoracic segment acuminate, slender, and comparatively short. Species formula 4211214. Maximum length 1.1 mm.

Remarks: Some specimens have a bulge in the position of, and approaching the form of, the apical antennal bulb. This species is very similar to *Lepidocyrtus mele*, and at first we regarded it as a variant of that species; but in addition to the difference in eye number, *P. kalalauensis* lacks the setae anterior to the outer bothriotracha of the second abdominal segment. The species formula distinguishes it from all described species of *Pseudosinella*. The S and T macrochaetae of the head are more anterior than normal and might be considered as R₂ and S. The thoracic collar setae are easily lost in handling.

Single specimens were taken from Lanai and Oahu in the summer of 1986; each is missing its head but they appear to belong to related species.

Ecology: All known collections are from wet broadleaved forests.

Type locality: Kauai, Waikanaloa Trail, II-10-1982, wet broadleaved forest, beating understory vegetation, KC (5194).

Additional records: Lanai: 6692. Oahu: 6748.

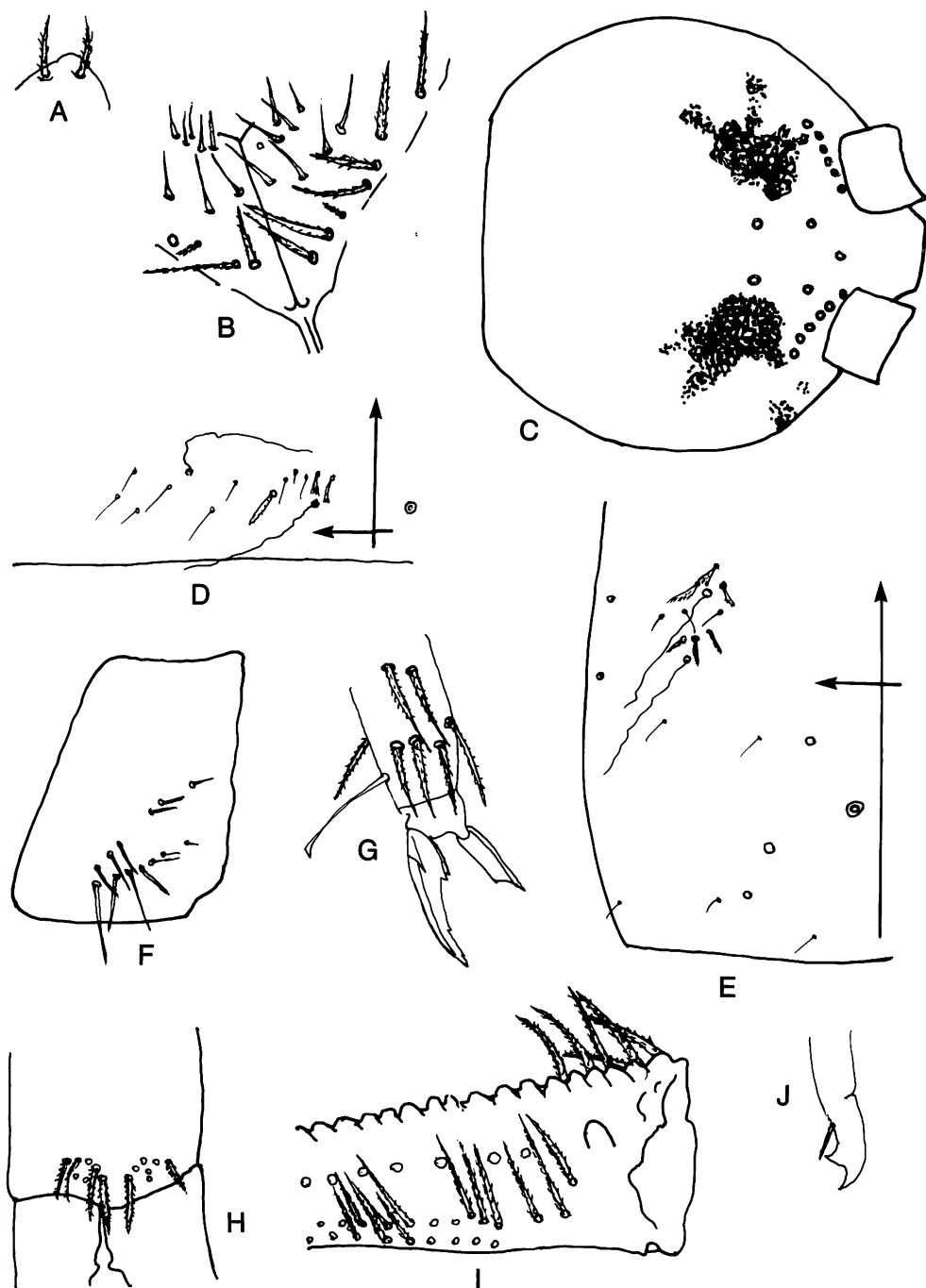


Plate 128—*Pseudosinella kalalauensis* (all figures of type specimens): A, apex of antenna; B, labial triangle; C, head seen from top; D, second abdominal segment chaetotaxy, left side; E, fourth abdominal segment chaetotaxy, left side; F, trochanteral organ; G, hind foot complex; H, manubrial plaque; I, base of dens seen from inner surface; J, mucro.

Pseudosinella lahainaensis Christiansen and Luther, 1986 (Plate 129)

Proc. Hawaii. Entomol. Soc. 26:46-49.

Color mottled blue, including appendages except dens, manubrium, and tibiotarsi. Scales hyaline to faintly brownish, absent from antennae and legs. Apex of antenna bulging and with thinner cuticle than rest of segment, but no obvious apical bulb. Head in dorsal view a rounded hexagon. Prelabral setae 4-5-5-4, with posterior row ciliate. Eyepatch a rounded square, only slightly darker than rest of head. Eyes 4 + 4 (rarely 5 + 5); inner posterior eye sometimes smaller than others. Trochanteral organ with 4-6 setae in each arm. Tibiotarsus without clearly differentiated macrochaete. Tenent hair acuminate, shorter than inner edge of unguis. Basal unguis teeth large and equal; median inner tooth reduced or absent, apical tooth absent. Unguiculus with excavate inner margin and moderate to small outer wing tooth. Ventral tube with 7-9 setae, mostly smooth, in each distolateral patch. Manubrial plaque with 2 inner and 2 outer ciliate setae. Anteapical mucronal tooth shorter than apical tooth and slightly surpassed by basal spine. Anterior macrochaetae of second thoracic segment all short and acuminate. Species formula 4(5)121125. Maximum length 1.3 mm.

Remarks: This distinctive species shows the typical marine littoral adaptation of the unguis and unguiculus; the foot structure distinguishes it from all other members of the genus. Small dental papillae were seen on one specimen, but were apparently absent in all others. The distribution of the species is remarkable; it has also been found in the littoral zone of northern Sonora, Mexico. This species shares with *P. fujiokai* the peculiarity of a single M seta on the fourth abdominal segment.

Ecology: So far the species has been found under rocks and in lava in regularly inundated marine littoral localities on Hawaii and Maui.

Type locality: Maui, Lahaina city seashore, II-5-1982, near high-tide mark on and under porous rocks, KC (5177).

Additional records: Hawaii: 5130, 5139.

Pseudosinella octopunctata Börner, 1901 (Plate 130)

Zool. Anz. 24:705.—Christiansen and Bellinger, 1980.

Color white except for dusting of blue pigment granules on body and especially on head and antennae. Scales hyaline, absent from antennae and legs beyond coxae. Antenna with a weakly developed apical bulb. Head in dorsal view elongate oval. Labral papillae not clear. Prelabral setae 4-5-5-4, with only posterior row ciliate. Eyepatches broadly oval and dark; eyes subequal in size. Trochanteral organ with only 3 setae in each arm. Hind tibiotarsus with an outstanding weakly truncate seta on inner margin at about $\frac{1}{4}$ its length from base. Tenent hair clavate, slightly longer than inner edge of unguis. Unguis with 3 inner teeth, subequal in size or basal pair slightly larger than apical tooth. Unguiculus evenly tapering. Ventral tube with 5 + 5 ciliate distolateral setae. Manubrial plaque with 1 outer and 2 inner ciliate setae. Dens without basal tubercle. Subapical mucronal tooth slightly smaller than apical tooth, with basal spine just attaining its apex. Anterior

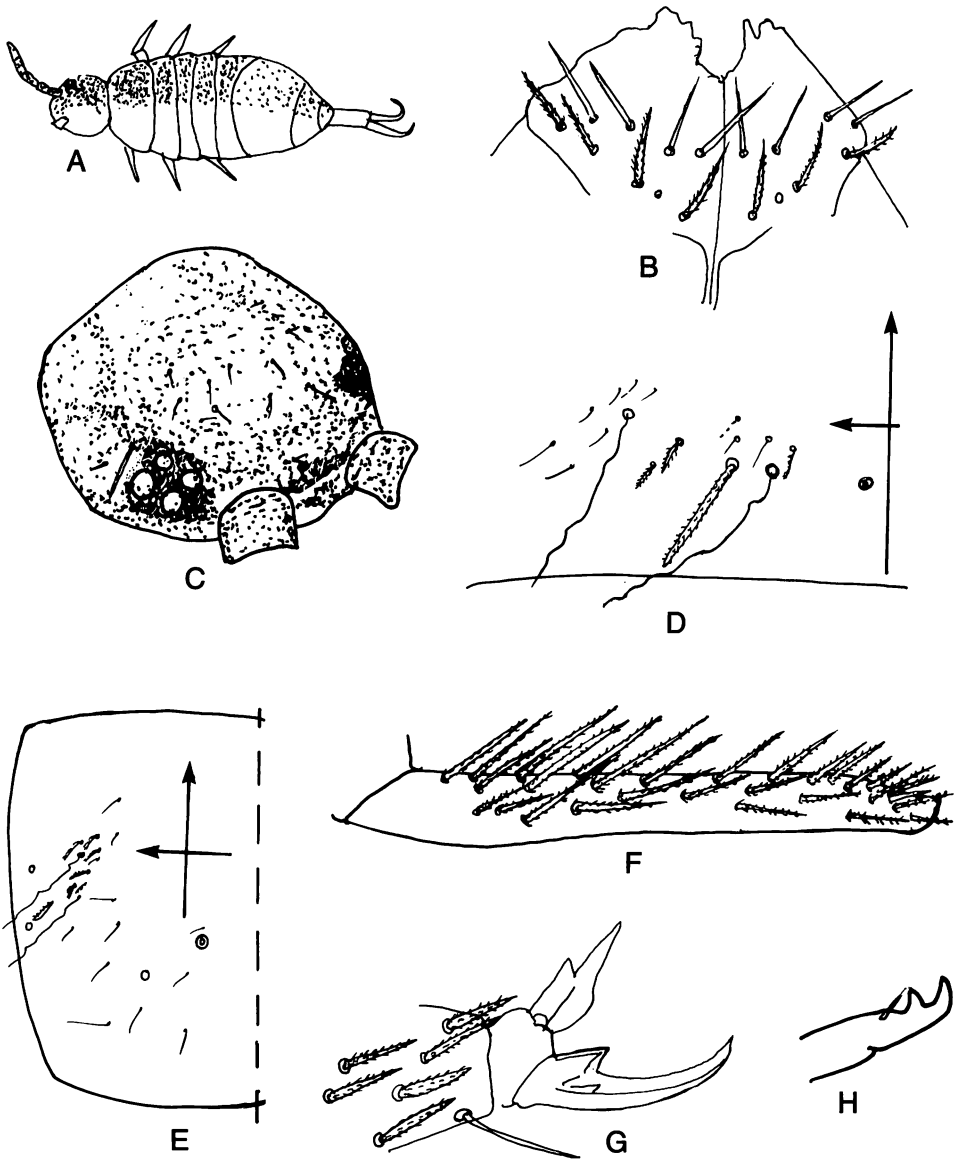


Plate 129—*Pseudosinella lahainaensis*: A, habitus (type specimen); B, labial triangle (5130, Hawaii); C, head seen from above and one side (type specimen); D, chaetotaxy, left side, second abdominal segment (type specimen); E, chaetotaxy, fourth abdominal segment, left side (same specimen); F, setae of inner side of hind tibiotarsus (type specimen); G, hind foot complex (type specimen); H, mucro (type specimen).

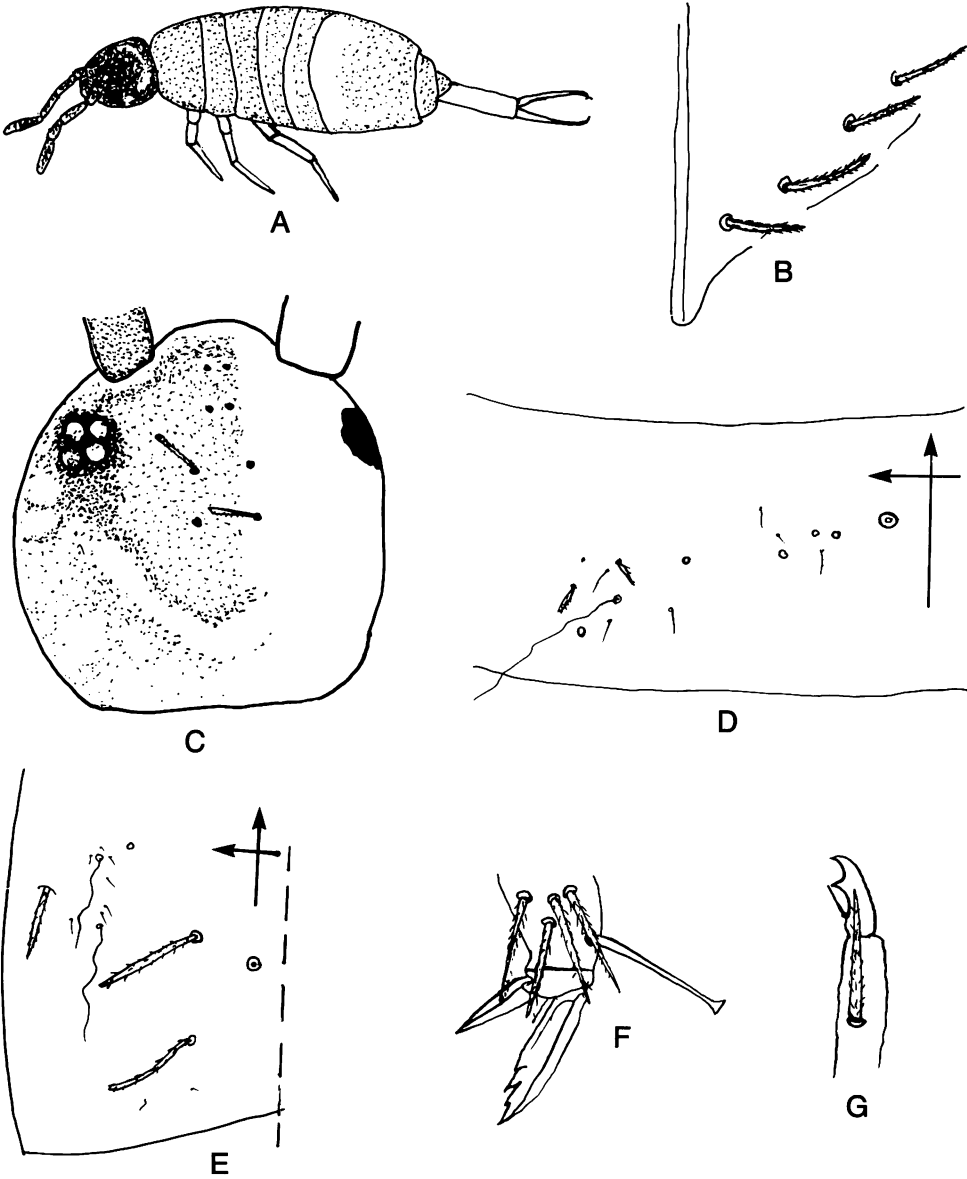


Plate 130—*Pseudosinella octopunctata*: A, habitus (5486, Molokai); B, left side, labial triangle (same specimen); C, head seen from above and slightly to one side (4865, Hawaii); D, second abdominal segment chaetotaxy, left side (same specimen); E, fourth abdominal segment chaetotaxy, left side (same specimen); F, hind foot complex (same specimen as A); G, mucro (same specimen).

margin of second thoracic segment with several rows of clavate setae up to $\frac{1}{6}$ as long as width of segment. Species formula 4212222. Maximum length of Hawaiian specimens 1 mm.

Remarks: There are some minor differences between Hawaiian specimens and those from the mainland United States: Hawaiian specimens have 2 + 1 rather than 2 + 2 manubrial plaque setae and a less prominent apical antennal bulb. However, we do not believe that these differences justify their separation.

Ecology: Found in litter and rotten wood.

Records: Hawaii: 4863, 4865, 4867, 4930. Maui: 6795. Molokai: 5486.

Subfamily CYPHODERINAE

Members of this subfamily may be distinguished from other entomobyrids by the combined absence of ocelli, dental crenulations, and dental spines. Only one genus has been found in Hawaii.

Genus **CYPHODERUS** Nicolet, 1842

Type species: *C. albinus* Nicolet, 1842

This genus is represented in collections we have seen only by the species *C. similis*; however, Adachi (1956) recorded *C. squamidives* Silvestri, 1917, with four mucronal teeth. *Cyphoderus* is easily distinguished from other white, scaled Collembola by the greatly elongate mucro. For a general review of the genus and its relatives, see Delamare (1948b).

Cyphoderus similis Folsom, 1927 (Plate 131)

Proc. U.S. Natl. Mus. 72:12.—Christiansen and Bellinger, 1980.

Cyphoderus assimilis Börner: Folsom, 1932:71.—Bellinger and Christiansen, 1974.

Color white without trace of pigment. Antennae subequal to head length in small specimens, up to 1.6 times as long in large specimens; segments of very different lengths, with fourth the longest, second next, and first the shortest. Head ovoid in dorsal view. Eyes absent. Tenent hair varying from strongly clavate to (rarely) acuminate. Unguis normally with 4 inner teeth, 1 of the basal pair being elongate and projecting; distal unpaired teeth often very small and occasionally absent. Unguiculus with large outer wing tooth. Ventral tube with 5 large ciliate setae on base of posterior face; 2 other large and 4 minute setae on posterior face, 2 + 2 on anterior face, and 2 + 2 on distolateral patches, all smooth. Dens with 2 dorsal rows of heavy, ciliate scales; largest distal scale from 0.75 to 1.6 times as long as mucro. Mucro long, with 2 apical teeth and occasionally a minute lamella ending just before the antepical tooth. Mesothoracic "collar" setae short, stout, and acuminate, striate or finely ciliate, slightly larger laterally. Maximum length 2 mm.

Remarks: The chaetotaxy of the body and ventral tube agree very well with those seen in nearctic specimens. The mucro of the "inermis" type is occasionally

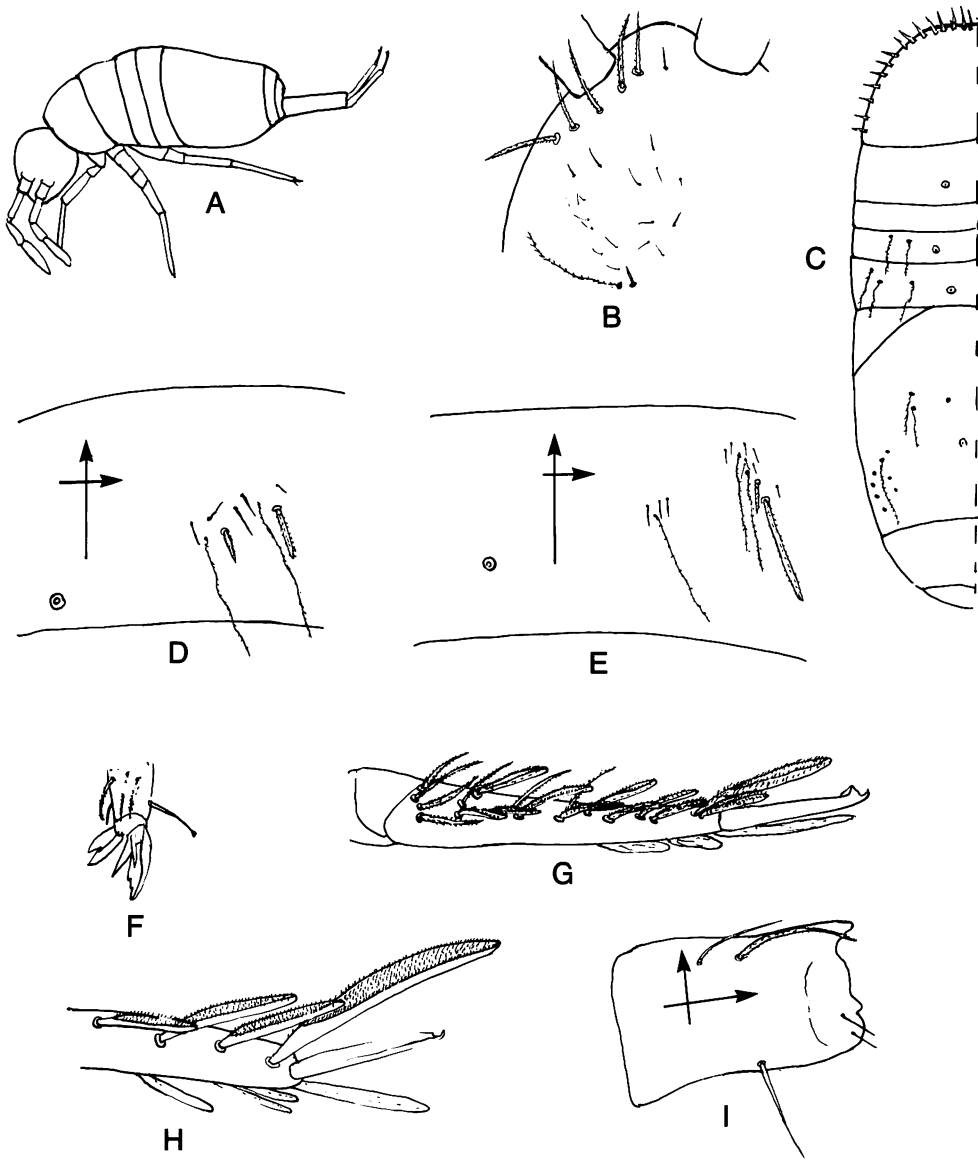


Plate 131—*Cyphoderus similis*: **A**, habitus (5667, Hawaii); **B**, cephalic chaetotaxy, left side (5272, Hawaii); **C**, body pseudopores, bothriotricha, and macrochaetae, left side (composite); **D**, detail of chaetotaxy, right side, second abdominal segment (5158, Hawaii); **E**, detail, chaetotaxy, right side, third abdominal segment (5125, Hawaii); **F**, hind foot complex (after Folsom); **G**, mucro and dens (after Folsom); **H**, apex of dens and mucro, unusual form (5439, Oahu); **I**, ventral tube, seen from right side, posterior basal and minute setae omitted (5125, Hawaii).

found in Hawaiian specimens. As in *The Collembola of North America*, we follow Casagnau (1963) in keeping this species separate from the very similar *C. assimilis* Börner, 1906.

Ecology: Found in disturbed lowland areas, associated with ants or in litter and debris, under stones, in caves, or occasionally in grass or old manure.

Records: Hawaii: 5125, 5140, 5141, 5143, 5150, 5158, 5272, 5667. Maui: 6667, 6673, 6707, 6793, 6794. Molokai: 5498, 5503, 5714, 5734, 6383. Lanai: 6692. Oahu: 4769, 4775, 4782, 4786, 4808, 4821, 4839, 4843, 5219, 5224, 5229, 5242, 5439, 5487, 6730, 6734, 6736, 6746, 6771, 6791, 6792. Kauai: 4734, 5284, 5288, 6714, 6717, 6723, 6725. Laysan: 6191. Pearl and Hermes Reef: 6836, 6837.

Subfamily PARONELLINAE

Members of this subfamily may be distinguished from other entomobryids by the straight unringed dentes, without spines but with a terminal bladderlike projection. The mucro is short and blunt and quite different from that of other entomobryids. There is a single Hawaiian genus and species.

Genus **SALINA** MacGillivray, 1894

Type species: *S. banksi* MacGillivray, 1894

This genus is the only representative of the Paronellinae found in the Islands. It is easily distinguished from all other Hawaiian forms by the greatly elongate antennae (longer than the head and body in adults), the dens (which is straight and without subsegments or crenulations), and the peculiar tridentate mucro with an adjacent apical dental bulb. There is a single Hawaiian species, *S. celebensis*.

Salina celebensis (Schäffer, 1898) (Plate 132)

Arch. Naturgesch. 64:407 (*Cremastocephalus*).—Yosii, 1981.

Salina maculata Folsom, 1932, Proc. Hawaii. Entomol. Soc. 8:71. **New synonym.**

Color white, with blue to bluish purple pigment on eyepatches and in a ventral longitudinal band (sometimes broken) on the posterior thorax and abdomen; typically also with a series of 14 spots of various sizes on the posterior half of the body, and marginal darkenings on the first 3 body segments; darker specimens with more complicated patterns of varying intensity on all segments posterior to the mesothorax; head with weakly or strongly developed cheek patches and sometimes with an interantennal band. Antennae 1.2–1.8 times as long as head and body together. Ratio of antennal segments about 11:18:14:15. Fourth antennal segment with a prominent unlobed apical bulb; setae usually distinctly whorled. Eyes 8 + 8, varying in size but with some anterior eyes; F, and sometimes A and E, much larger than others. Labial triangle setae M, E, L₁, and L₂ all ciliate and subequal. Trochanteral organ with 30–40 setae in a triangular patch. Tenent hair heavy, finely striate, and clavate. Unguis with 4 inner and 2 lateral teeth; apical inner

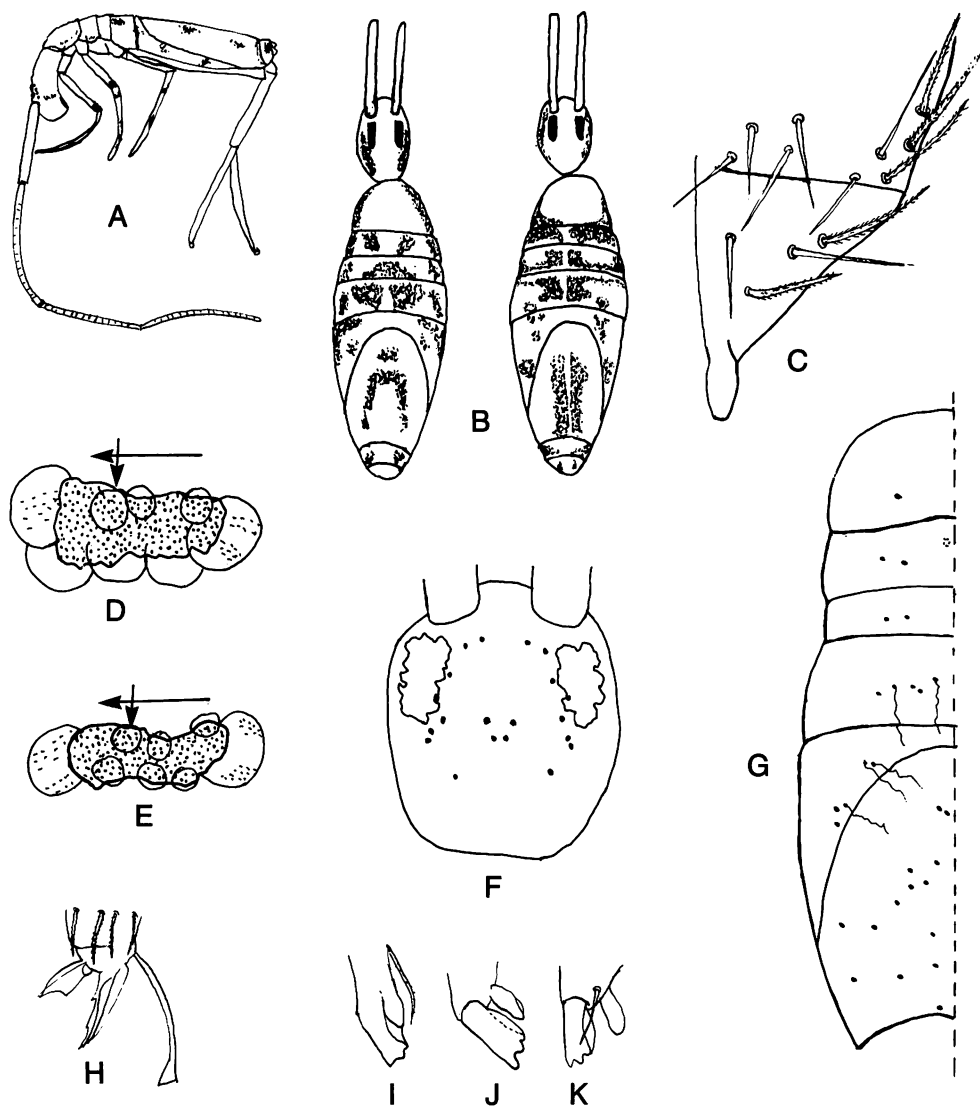
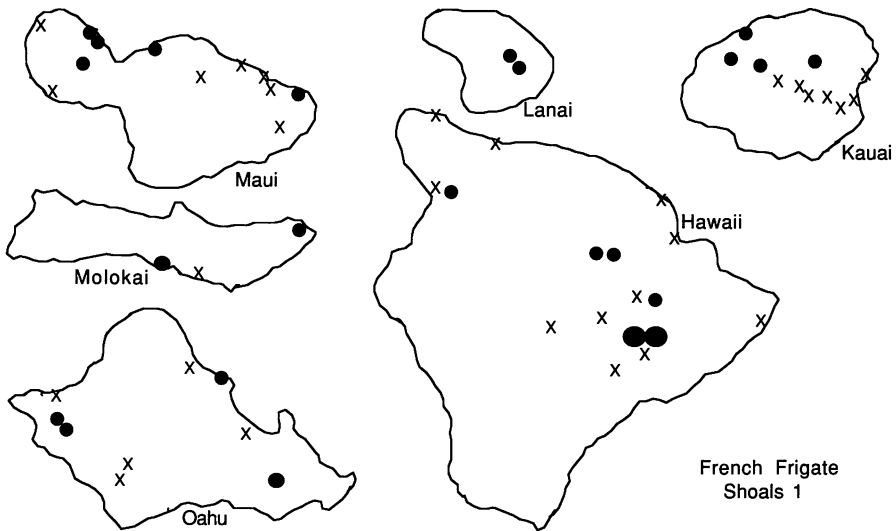


Plate 132—*Salina celebensis*: **A**, habitus (after Folsom); **B**, common pattern variants; **C**, left labial triangle (6684, Maui); **D**, left eyepatch (4800, Oahu); **E**, left eyepatch (5271, Hawaii); **F**, cephalic macrochaetae (4728, Kauai); **G**, dorsal macrochaetae, left side (4726, Hawaii); **H**, hind foot complex (after Folsom); **I-K**, variants of mucrones (after Folsom).



tooth minute, others small and subequal. Unguiculus with prominent inner tooth and distally excavate. Mucro with 3 apical teeth; ventral tooth often pointed, others rounded. Maximum length 3 mm.

Remarks: This species has constant chaetotaxy on the mesothorax and first three abdominal segments, moderately variable chaetotaxy on the fourth abdominal segment, and highly variable chaetotaxy on the metathorax. The apical ungual tooth is sometimes absent. The pattern is extremely variable, sometimes within a single population.

Salina celebensis differs from most species of *Salina* whose chaetotaxy has been described in the relatively small number of dorsal macrochaetae. Our Hawaiian material agrees well with the redescription of this species by Yosii in 1981 except for the anterior macrochaeta on the third abdominal segment shown in Yosii's figure, which is never present in Hawaiian material. An earlier illustration by Yosii (1959) failed to show this, so its existence remains problematic. Some of the Hawaiian specimens are darker than any described forms of *S. celebensis*; however, many Hawaiian specimens have the typical pale coloration. Other species with unknown chaetotaxy differ in either mucronal structure or pattern.

Ecology: This is an inhabitant of vegetation, primarily of the moist understory in wood areas. In this habitat it is ubiquitous and can be found on almost every leaf. It is probably the most abundant animal in Hawaii. It is also common in grass and is found under loose bark, debris, or rocks; it is underrepresented in collections because it is so easily recognized that we avoided collecting it. *Salina celebensis* is primarily an inhabitant of lowland areas, but occasionally has been found as high as 7000 ft.

Records: Hawaii: 4725, 4726, 4939, 5018, 5068, 5129, 5131, 5132, 5139, 5148, 5149, 5154, 5155, 5271, 5362, 5363, 5470, 5489, 5491, 5493, 5643, 5645, 5648, 5664, 5665, 5673, 5675, 5676, 5677, 5682, 5683, 5684, 5685, 5686, 5687, 5689,

5692, 5693, 5694, 5695, 5696, 5697, 5699, 5702, 6834. Maui: 4750, 5164, 5165, 5168, 5170, 5171, 5176, 5178, 5179, 6664, 6666, 6668, 6672, 6673, 6674, 6676, 6683, 6684, 6685, 6686, 6705, 6707, 6862. Molokai: 5501, 5502, 5704, 5707, 5708, 5710, 5711, 5727. Lanai: 6691, 6693, 6694, 6695, 6699, 6700, 6857. Oahu: 4716, 4756, 4759, 4760, 4800, 4817, 4829, 4830, 5225, 5231, 5239, 5525, 5526, 5527, 5528, 5531, 5532, 6614, 6759. Kauai: 4728, 4731, 4736, 4739, 4740, 4741, 4743, 4744, 4745, 5109, 5194, 5195, 5198, 5206, 5214, 6720, 6721. French Frigate Shoals: 6835.

Subfamily ONCOPODURINAE

Only the one non-cave-adapted genus of this subfamily has been found in Hawaii. The peculiar large dental setae and postantennal organ easily separate this from other entomobryids.

Genus **HARLOMILLSIA** Bonet, 1944

Type species: *Oncopodura oculata* Mills, 1937

This monotypic genus is the only member of the subfamily Oncopodurinae recorded from the Hawaiian Islands.

Harlomillsia oculata (Mills, 1937) (Plate 133)

Can. Entomol. 69:67 (*Oncopodura*).—Bonet, 1943.—Szeptycki, 1977.—Christiansen and Bellinger, 1980.

Color gray to blue-gray with pigment in uniform granules in irregular clusters of various sizes and shapes; young specimens white except for eyes. Fourth antennal segment with peculiar hooked, spatulate apical seta and 2 blunt setae. Apical sense rods of third antennal segment hidden by an integumentary fold that forms as apical "shelf" on the segment. Postantennal organ with elongate lobes that are free



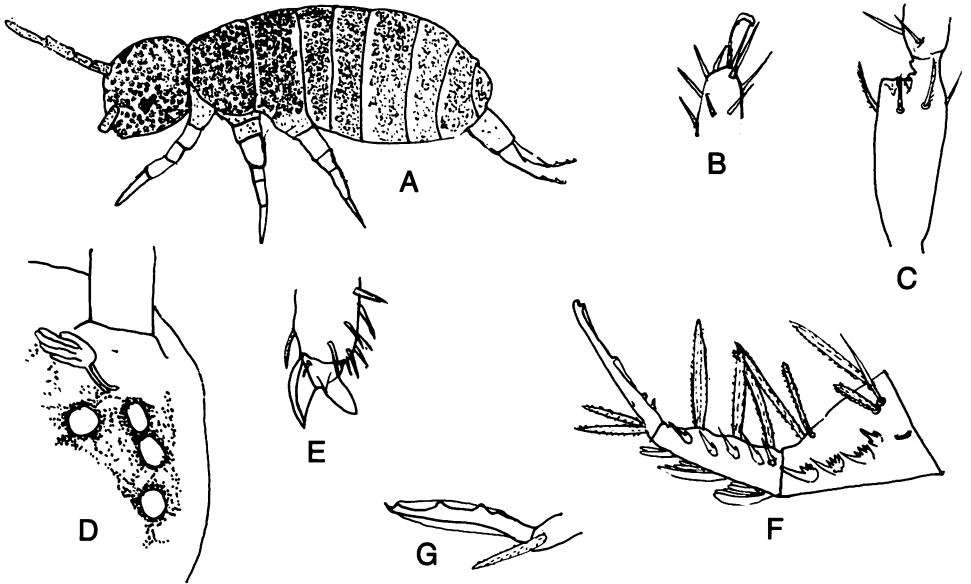


Plate 133—*Harlomillsia oculata*: A, habitus (5068, Hawaii); B, apex, antenna (after Mills); C, apex, third antennal segment (5015, Hawaii); D, eyepatch and right postantennal organ (after Bonet); E, hind foot complex (after Mills); F, mucro and dens (after Bonet); G, mucro (after Mills).

apically but often difficult to see. Eyes 4 + 4; anterior lateral and posterior eyes removed from the other two. Tibiotarsi without spatulate setae or clavate tenent hairs. Unguis and unguiculus without teeth. Basal dental subsegment with an inner row of 4 dentate spines, all clearly larger than the 4 outer and 5 inner spines of the distal subsegment. Mucro elongate and quinque-dentate. Maximum length 0.6 mm.

Remarks: Hawaiian specimens of this strange species appear identical to those found on the U.S. mainland. Scales and several types of macrochaetae are present, but are difficult to see and easily lost; they are well described by Szeptycki (1977).

Ecology: Taken from litter, soil, rotten wood, and grass clumps.

Records: Hawaii: 4870, 4936, 5015, 5068. Maui: 6795. Molokai: 5709, 5715. Oahu: 6738, 6758, 6759.

Subfamily TOMOCERINAE

The peculiar feature of a fourth antennal segment shorter than the third easily separates this subfamily from all other entomobryids. There is a single Hawaiian genus and species.

Genus **TOMOCERUS** Nicolet, 1842

Type species: *Macrotoma minor* Lubbock, 1862

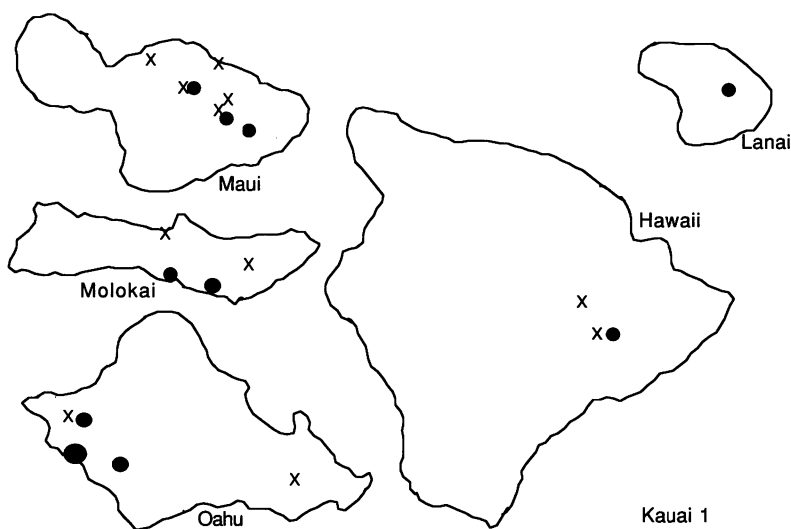
This genus is represented in the Islands by a single species, probably introduced. The antennae, with the last two joints ringed and the fourth much shorter than the third, are distinctive but often atypical because of damage and regenerations; the hairy mucro is unique among Collembola.

Tomocerus minor (Lubbock, 1862) (Plate 134)

Trans. Linn. Soc. London 23:598 (*Macrotoma*).—Christiansen, 1965.

Color: blue to yellow background, commonly blue anteriorly and yellow posteriorly; usually gray-brown to lead-colored in life. First 2 antennal segments scaled; third and fourth annulate, with fourth less than $\frac{1}{3}$ length of third in intact adults. Head broadly elliptical to nearly circular in dorsal view. Eyes 6 + 6, subequal. Trochanteral organ with 1 seta. Inner surface of tibiotarsus with 2 rows of large heavily striate or ciliate setae, 3–4 in anterior and 3 in posterior row. Tenent hair heavy and clavate. Unguis with 6 small inner teeth and 2 very large lateral basal teeth. Unguiculus with strong inner corner tooth. Mature individuals with 3–4 setae on corpus of tenaculum. Inner base of dens with variably differentiated scale. Dental spine formula 1-4,1-3/-2-5,1,1,1 (/ marks end of basal dental subsegment; boldfaced numbers indicate spines are larger than others); spines tridentate. Maximum length (in Hawaiian material) 4 mm.

Remarks: Careful examination of European, nearctic, and Hawaiian material failed to uncover any consistent differences among them. Sometimes the living Hawaiian forms appear to be banded, a pattern not found in other collections, but



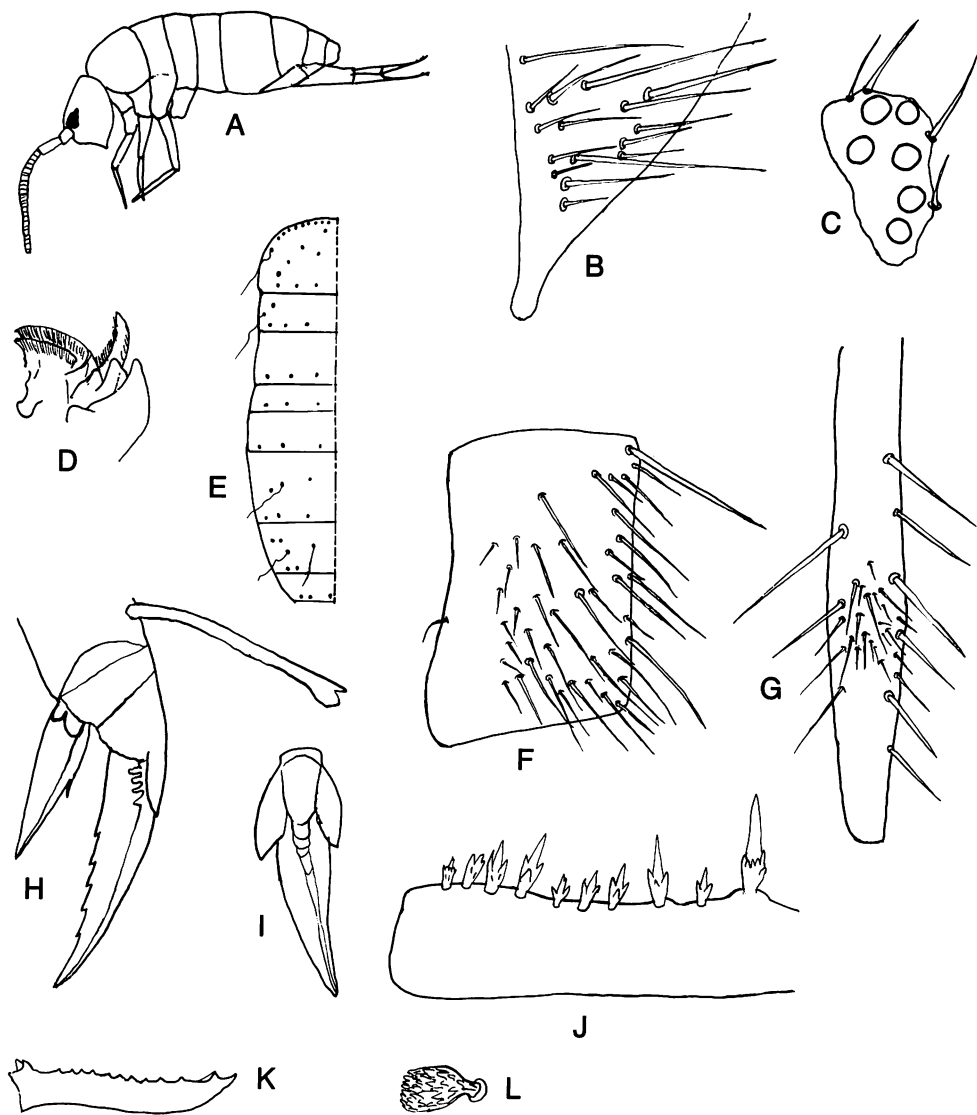


Plate 134—*Tomocerus minor*: A, habitus (5355, Hawaii); B, left labial triangle (6689, Lanai); C, eyepatch (after Maynard); D, maxilla (after Christiansen); E, macrochaetae and bothriotricha, left side of body (composite); F, hind trochanter (5215, Kauai); G, hind tibiotarsus showing some of the large setae (same); H, hind foot complex (6677, Maui); I, hind unguis seen from inside (5159, Maui); J, base of dens showing spines (5355, Hawaii); K, mucro (after Christiansen); L, differentiated basal seta of dens (5355, Hawaii).

this feature is not common. In a number of respects earlier figures were in error; in particular, the unguiculus, dental scale, inner tibiotarsal setae, and macrochaetae were figured or described incorrectly in *The Collembola of North America*.

Although described from England, *T. minor* is immediately distinguishable from all other European species, which have simple dental spines. In this respect *T. minor* approaches a number of Oriental species such as *T. cuspidatus* Börner, 1909, in which these spines are multidentate.

The actual distribution of this species is far greater than the listed records indicate. The fact that the species is easily identified in the field meant that we frequently avoided collecting it.

Ecology: Found in litter, debris, under stones, and sometimes in low vegetation, mostly in wild forested regions above 2000 ft. Although the occurrence of the species in the Islands has been known for more than 20 years, few collections made before 1982 have been seen.

Records: Hawaii: 5275, 5355, 5369, 5698, 5701. Maui: 5159, 5183, 5189, 5263, 5366, 5373, 5481, 5492, 6677, 6678, 6680, 6795. Molokai: 5495, 5706, 5709, 5715, 5723, 5724, 5728, 5729, 5731, 6863. Lanai: 6689, 6693, 6694. Oahu: 4815, 5230, 5232, 5233, 5236, 5237, 5238, 5293, 5526, 5528, 5532, 5533, 5534, 5535, 6774, 6776, 6777, 6778, 6779, 6780, 6781, 6783, 6829. Kauai: 5215.

Suborder SYMPHYPLEONA

Globular Collembola, without clear indication of trunk segmentation at least between the thorax and last two abdominal segments; furcula always well developed. Probably a composite group, including two families that are not closely related.

Family NEELIDAE

Members of this family have the thorax and abdomen fused into a spherical or ovoid mass with the thoracic and abdominal portions subequal (unlike Sminthuridae); they lack eyes and have antennae shorter than the head and a dens subdivided into two parts. There is a single Hawaiian genus, with three species in two subgenera: *N. piloli*, *N. poki*, and *N. minutus*.

Genus NEELUS Folsom, 1896a

Type species: *Neelus murinus* Folsom, 1896a

With the characters of the family. See Table 29 for comparative characters.

Table 29. Characteristics of Hawaiian Species of *Neelus* s.l.

SPECIES	MUCRONAL SERRATIONS	FUSION OF ANTENNAL SEGMENTS III AND IV	FRINGE ON LABRUM	FORK ON LABRAL R SETAE	PROJECTING UNGUICULAR LOBE	POSTERIOR POSTERIOR LOBE OF VENTRAL TUBE
<i>piloli</i>	-, +	+	-	+	+	±
<i>poki</i>	-	+	-	±	+	-
<i>minutus</i>	+	-	+	-	-	+

KEY TO HAWAIIAN SPECIES OF NEELUS S.L.

1. Third and fourth antennal segments separate (Fig. 102A). . . . **N. (Neelides) minutus**
 Third and fourth antennal segments fused (Fig. 102B). 2



102A



102B

- 2(1). Inner labral R setae strongly forked (Fig. 103A). **N. (Megalothorax) piloli**
 Inner labral R setae smooth or weakly toothed (Fig. 103B).
 **N. (Megalothorax) poki**



103A



103B

Subgenus **NEELIDES** Caroli, 1912

Type species: *Neelides folsomi* Caroli, 1912

Neelus (Neelides) minutus Folsom, 1901 (Plate 135)

Psyche 9:220.—Bonet, 1948.—Christiansen and Bellinger, 1981.

Color white without trace of pigment or with scattered blue-black pigment over trunk and head. All antennal segments distinct. Fourth antennal segment clearly narrower than third, with an apical knob, a minute, spherical subapical organ, and 4 thick setae, 1 of which is blunt. Apical organ of third antennal segment of 2 oval pegs projecting from separate shallow pits, and a dorsal, thickened, curved seta projecting to the level of the basal 1/5 of the fourth antennal segment. Labrum with a well-developed distal fringe and 3 narrow projecting rods, apically branched and dorsally curved; the median rod is slightly longer and narrower than the others and

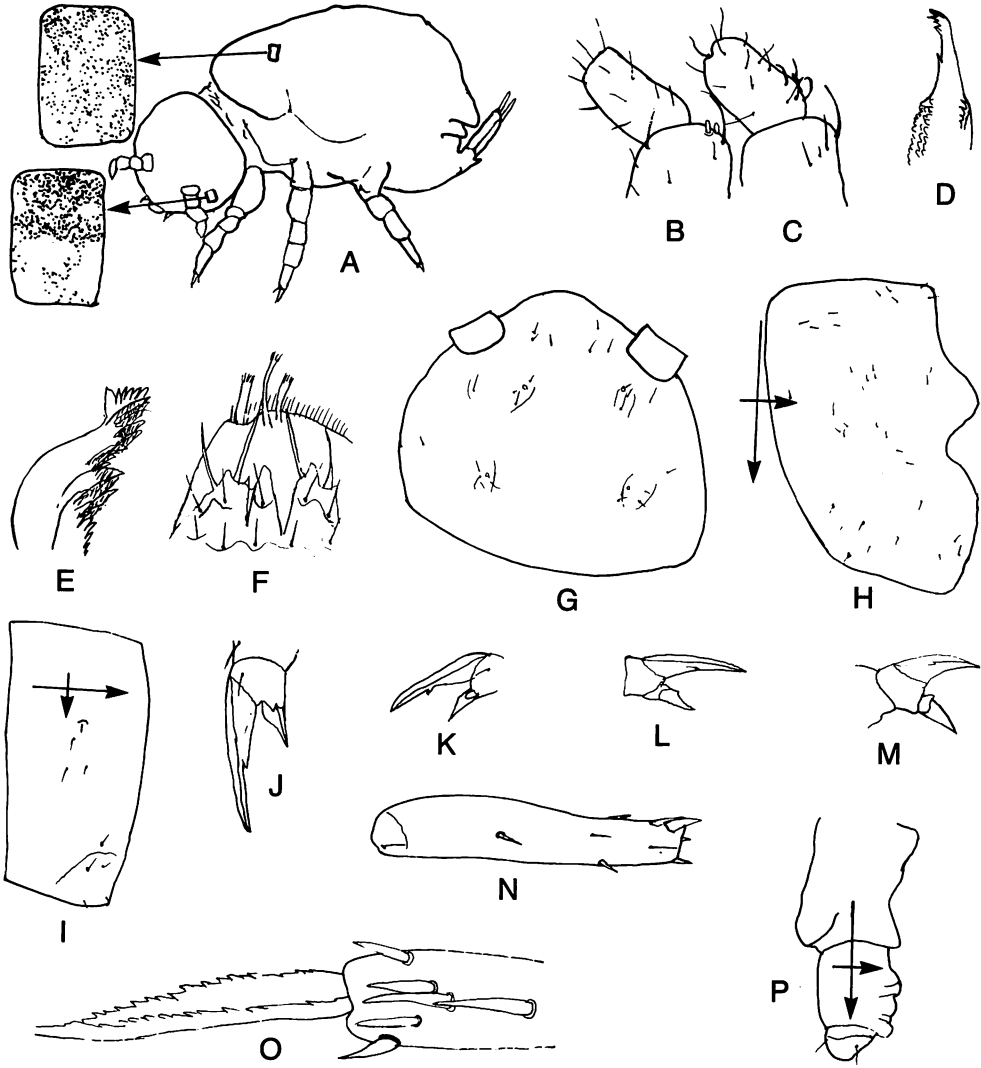
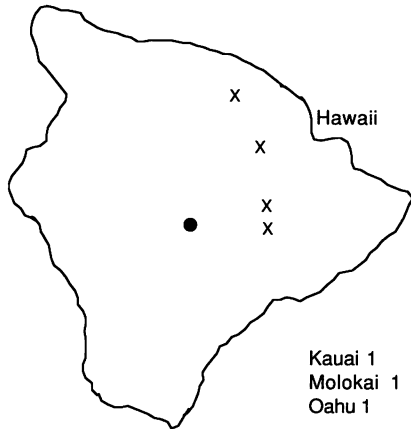


Plate 135—*Neelus (Neelides) minutus*: A, habitus (6723, Kauai); B, fourth and apex of third antennal segments, dorsum (6776, Oahu); C, same, ventral surface (same); D, mandible (4904, Hawaii); E, maxilla (same); F, labrum (5347, Hawaii); G, cephalic chaetotaxy (5671, Hawaii); H, trunk chaetotaxy, right side (6776, Oahu); I, detail, second thoracic segment chaetotaxy (5715, Molokai); J, fore foot complex (5325, Hawaii); K, mid foot complex (4904, Hawaii); L, mid foot complex (6723, Kauai); M, hind foot complex (same); N, dorsal surface, dens (4904, Hawaii); O, ventral surface, dens and mucro (5347, Hawaii); P, ventral tube, seen from side (5715, Molokai).



has fewer apical branches. Labral R and r setae simple and arising from a single straight papilla on each side; m seta arising from the dorsal surface of a conical papilla. Maxillae with fringed or striate lamellae projecting beyond toothed lamellae. Cephalic sensory fields well developed but difficult to make out; each with 3 minute setae, 1 well separated from others; spherical bodies present or absent. Thorax and abdomen with extremely minute setae, some with minute basal projection, and without clearly demarcated sensory fields. Fore and mid unguis with small to moderate inner and lateral teeth. Hind unguis sometimes lacking tooth. Unguiculi on first 2 feet slightly concave internally; unguiculus of third foot obliquely sharply truncate to acuminate. Ventral tube with a clear posterior lobe and 2 + 2 distal setae. Tenaculum with 2 + 2 teeth and no setae. Manubrial articular process prominent. Dens with 5 small dorsal setae, 1 in basal subsegment, 2 large distolateral, and 4 distal ventral setae. Both margins of mucro strongly serrate. Maximum length 0.6 mm.

Remarks: Originally we thought that the Hawaiian specimens of this species represented a new taxon; however, more extensive collections show variation that makes it indistinguishable from nearctic material we have identified as *N. minutus*. Thorough examination with scanning electron microscopy may show that two species are involved.

Ecology: From litter, soil, and under bark; all except one collection above 1000 ft.

Records: Hawaii: 4904, 5325, 5347, 5671, 6821, 6907, 6909. Molokai: 5715. Oahu: 6776. Kauai: 6723.

Subgenus **MEGALOTHORAX** Willem, 1900

Type species: *M. minimus* Willem, 1900

Neelus (Megalothorax) piloli Christiansen and Bellinger, **new species** (Plate 136)

Color white without trace of pigment. Fourth antennal segment fused to third ventrally but weakly separate dorsally; without apical knob but with a small oval to

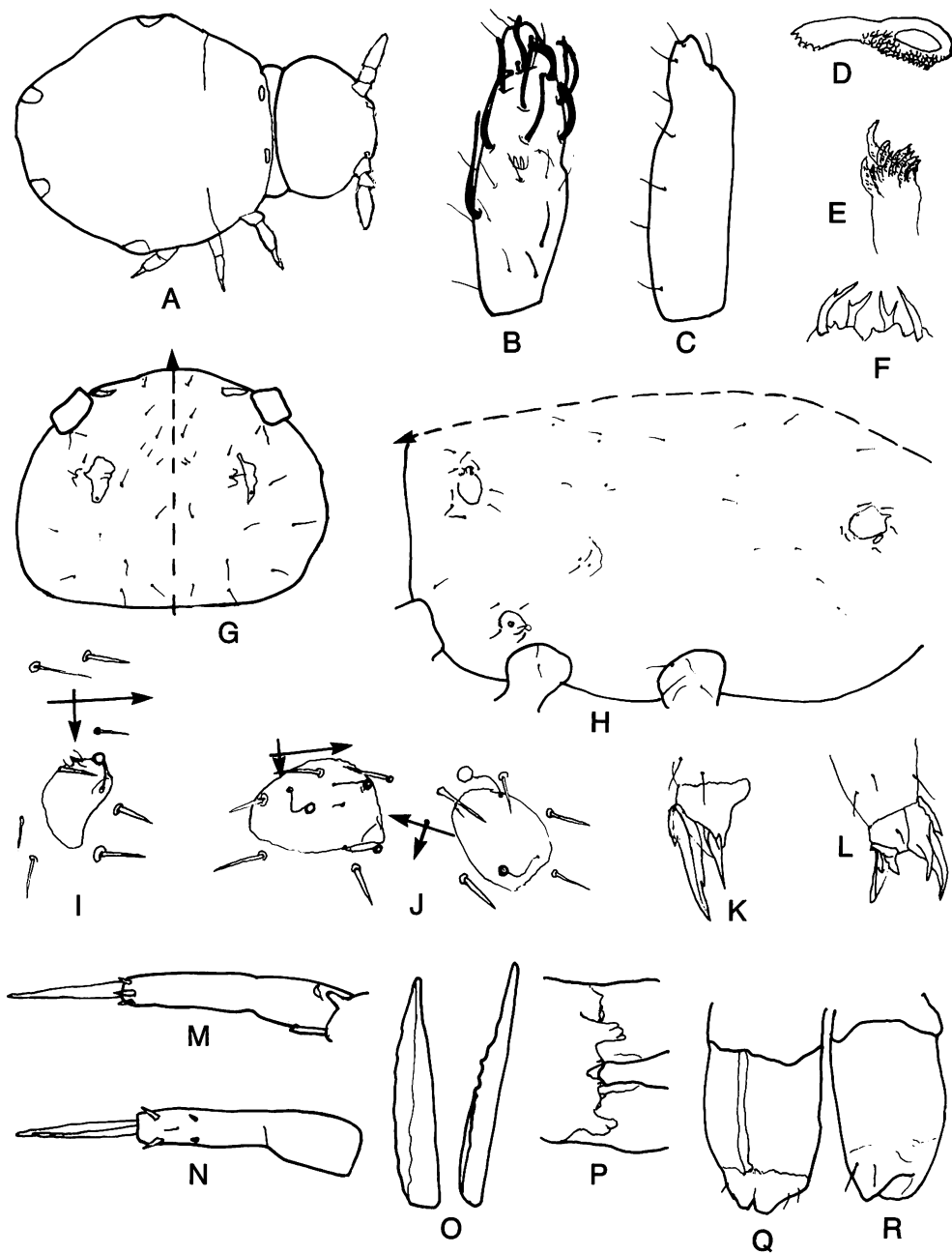
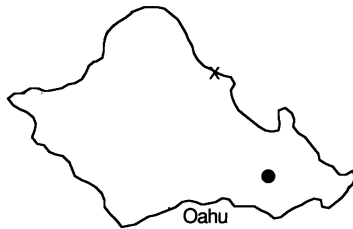


Plate 136—*Neelus (Megalothorax) piloli*: A, habitus (4766, Oahu); B, dorsal surface, third and fourth antennal segments (paratype); C, ventral surface, same; D, mandible (4762, Oahu); E, maxilla (same); F, labral setae (holotype); G, cephalic chaetotaxy (same); H, trunk chaetotaxy, left side (paratype); I, sensory field, second thoracic segment (paratype); J, abdominal sensory fields (same); K, mid foot complex (same); L, hind foot complex (same); M, ventral surface of mucro and dens (4762, Oahu); N, dorsal surface, same; O, mucrones (holotype); P, articular processes of manubrium (paratype); Q, posterior surface, ventral tube (same); R, anterior surface, same.

spherical subapical sense peg, and with 8(9) long, slender, curved blunt setae, 1 of which is clearly thicker than the others. Apical organ of third antennal segment of double small ovoid sensillae in a deep pit. Labral r setae curved and simple; R setae curved, inner pair forked, outer pair simple. Maxilla with toothed lamellae extending beyond striate lamellae. Sensory fields of head with 2 guard setae, those of trunk with 5-6. Each sensory field with a slender hair in a pit at the apex of a cone or knob at the inner edge of the field; each hair is very slender and may be bent or twisted and has at the apex a globule from 0.003 to less than 0.001 mm in diameter. Most or all fields also bear a smaller globule on the anterior margin. Posterior pits deeper than others. Unguis with a strong inner spine and small lateral teeth. Unguiculus with a strong basal projection. Ventral tube with 2 + 2 lateral setae and a very weakly developed posterior lobe. Tenaculum with 4 + 4 teeth. Dental manubrial processes prominent; 6 dorsal and 3 ventral dental setae. Mucronal lamellae smooth or faintly serrate. Maximum length 0.4 mm.



Hawaii 1
Maui 1

Remarks: This is a problematic species. The spherical bodies associated with the sensory fields are possibly secreted matter and are sometimes absent. The sensory fields and cephalic chaetotaxy are similar to those seen in nearctic specimens of *N. incertus* Börner, 1903, but the foot complex and manubrial structure are more like those of *N. minimus*. The abdominal and thoracic sensory fields are clearly visible only on the specimen from Maui. It is possible that the material from Hawaii represents another species. The R setae of the labrum are not like those we have seen in other species. The apical sense pegs of the third antennal segment are much smaller than in *N. minimus* or *N. poki*.

Derivatio nominis: Hawaiian, small.

Ecology: Found in soil and litter in coastal regions.

Type locality: Holotype and 1 paratype, Maui, near Haleakala Park, I-30-1982, rain forest, leaf litter, KC (5163).

Additional records: Hawaii: 4724. Oahu: 4762, 4766, 4805.

***Neelus (Megalothorax) poki* Christiansen and Bellinger, new species (Plate 137)**

Color white to yellow. Fourth antennal segment fused with third, lacking apical knob but with a small, stalked, spherical subapical sense peg, 7 slender blunt setae, and 1 thick, strongly curved blunt seta. Labral r and m setae straight and simple; R setae curved and weakly toothed or simple, all similar. Maxilla with toothed lamella extending beyond fringed lamellae. 3 + 3 setae between sensory fields of

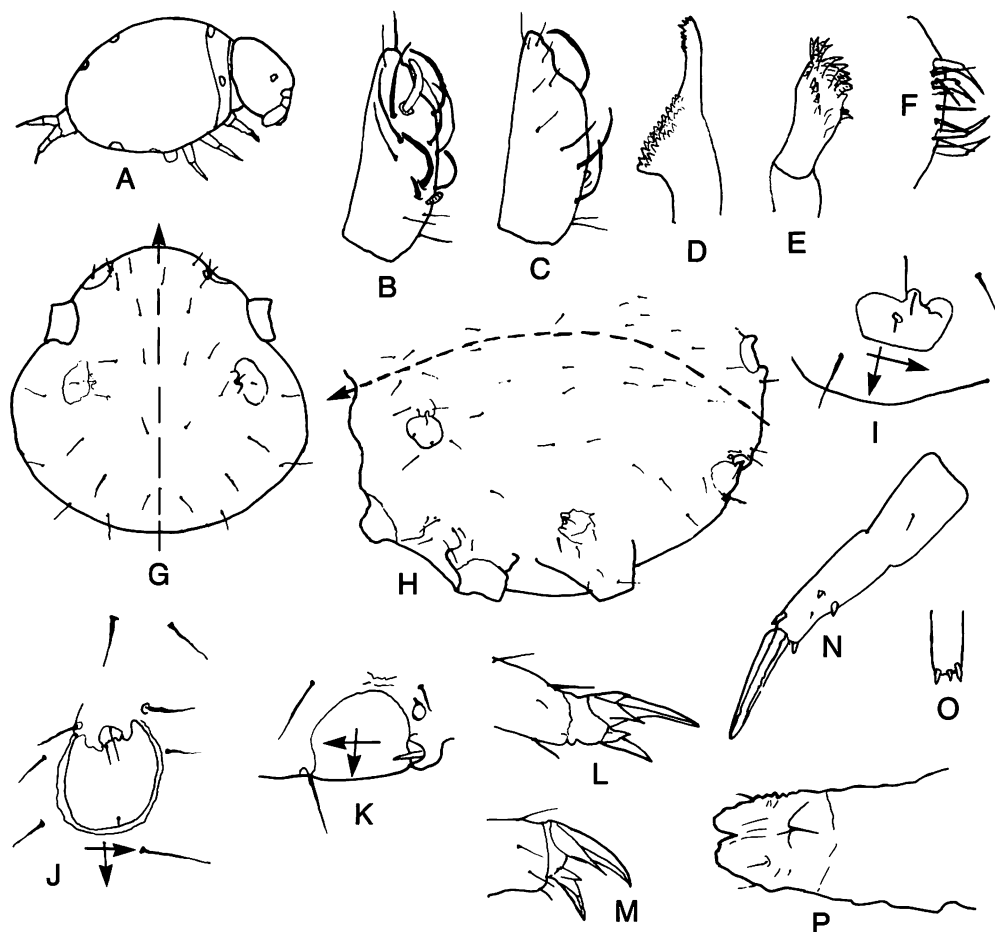
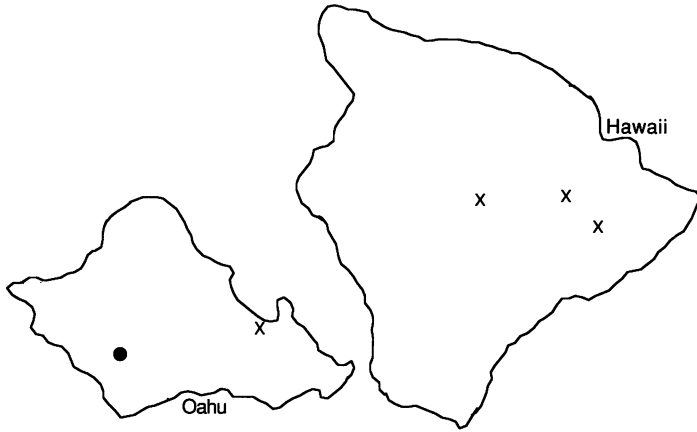


Plate 137—*Neelus (Megalothorax) poki*: A, habitus (composite, holotype and paratype); B, dorsal surface, third and fourth antennal segments (paratype); C, ventral surface, same; D, mandible (paratype); E, maxilla (same); F, labral setae (4795, Oahu); G, cephalic chaetotaxy (paratype); H, trunk chaetotaxy, left side (paratype); I, posterior cephalic sensory pit (paratype); J, thoracic sensory pit (same); K, abdominal sensory pit (same); L, fore foot complex (paratype); M, hind foot complex (paratype); N, dorsal dental chaetotaxy and mucro (5327, Hawaii); O, apex, ventral dental surface, same; P, ventral tube, seen from rear (paratype).

head. Sensory fields of body with 5-6 guard setae. Unguis with a strong inner spine and lateral teeth. Basal lobe of unguiculus with strong projection. Ventral tube with 2 + 2 distal setae and no basal lobe. Tenaculum with 3 + 3 teeth. Dens with 5 dorsal and dorsolateral and 3 small distal ventral setae. Manubrial articular processes well developed. Mucro with smooth edges. Maximum length 0.4 mm.

Remarks: Originally we thought this species was identical with *N. (Megalothorax) minimus*. Most features are identical with our earlier description and with those shown by Massoud and Delamare (1969) and Lawrence and Massoud (1973); however, there is one major and consistent difference. The large basal striated



macrochaeta on the fused third and fourth antennal dorsum is absent in *N. poki*. Reexamination of nearctic material indicates that this species may also occur there; however, fresh material is necessary to determine this.

Derivatio nominis: Hawaiian, small.

Ecology: Found in soil and litter.

Type locality: Holotype and 4 paratypes, Hawaii, Mauna Loa, IX-20-1973, pit-fall trap, Jacobi? (6826).

Additional records: Hawaii: 4870, 5327. Oahu: 4794, 4795, 4796, 6762.

Family SMINTHURIDAE

This family includes all the Hawaiian Symphypleona with eyes. All Hawaiian members have the antennae longer than the head, which is hypognathous. A post-antennal organ is absent and the first four abdominal segments are fused; the limits of the thoracic segments may be visible dorsally or not; the fifth abdominal segment may be distinct or fused to the fourth or sixth segment. The coxae and trochanters have characteristic shapes and bear setae and other organs of taxonomic value (Fig. 104I, J). The mucro is always elongate and commonly serrate along one or both margins. Sexual dimorphism occurs in many genera and may involve foot structure, supraanal structure, setal form, special organs of the head and body, coloration, and size. The animals are usually brightly and strongly pigmented, and many have striking patterns.

The trunk of the sminthurids bears bothriotricha (usually four pairs) whose position is characteristic in each genus or subgenus. The principal patterns are shown in Figure 104B-H. Individual bothriotricha except C are absent in certain cases.

The circumanal setae and dorsal setae of the fifth and sixth abdominal segments are of considerable taxonomic importance, as is the dental chaetotaxy. We follow the system used in Christiansen and Bellinger (1981) for circumanal setal designation (Fig. 104K).

We follow Richards (1968) in recognizing four subfamilies, which can be separated using the following key.

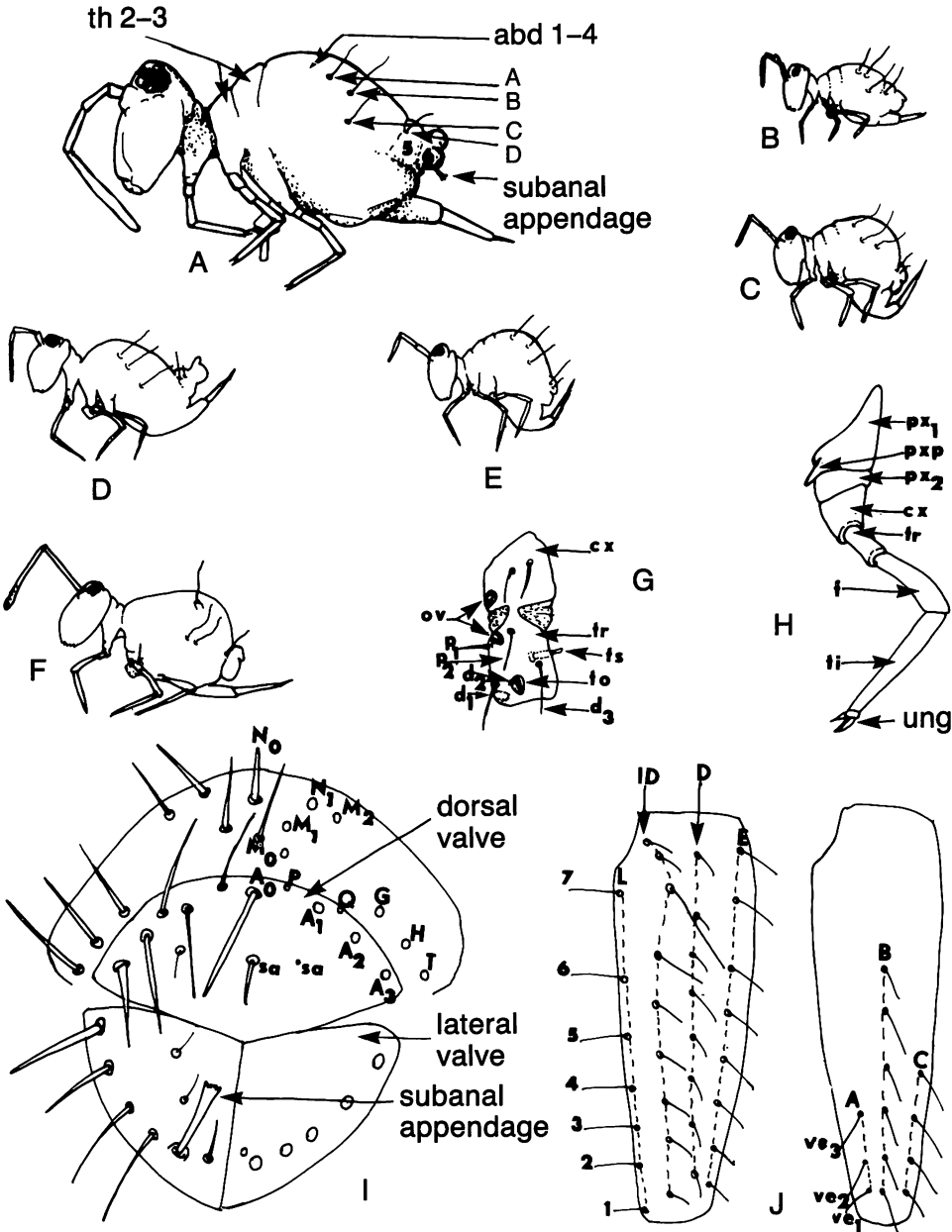


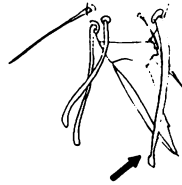
Figure 104—Characters of Sminthuridae: A, habitus of typical sminthurid showing distribution of bothriotricha A-D (after Richards); B-F, sketch outlines of different genera showing bothriotrichal patterns (after Richards); B, *Sminthurinus*, triangular; C, *Sminthurides* (*Sphaeridia*), inverted; D, *Bourletiella*, linear; E, *Sminthurides* (*Sminthurides*), triangular; F, dicyrtomid pattern; G, coxal and trochanteral organs: cx=coxa, d=distal trochanteral seta, ov=oval organ, p=proximal trochanteral seta, to=trochanteral organ, tr=trochanter, ts=trochanteral spine (after Richards); H, structure of leg: cx=coxa, f=femur, px₁, px₂=subcoxal rings, pxp=subcoxal process, ti=tibia, tr=trochanter, ung=unguis (after Richards); I, schematic representation of circumanal setae in posterior view; J, schematic representation of dental setae of dorsal (left) and ventral (right) surfaces of right dens, seen from above: dashed lines connect setae belonging to the same row, L=lateral row, ID=inner dorsal row, D=dorsal row, E=external row, Ve=ventral setae, with rows A (medial), B, C.

KEY TO SUBFAMILIES OF HAWAIIAN SMINTHURIDAE

1. Fourth antennal segment less than half as long as third. Dicyrtominae
 Fourth antennal segment at least as long as third. 2
 2(1). Female without subanal appendages; male with antennal clasping organ.
 Sminthuridinae
 Female with subanal appendages; male without clasping organ. 3
 3(2). Metathoracic trochanters with trochanteral organ (Fig. 104J). Katianninae
 Metathoracic trochanters without trochanteral organ. Sminthurinae

KEY TO HAWAIIAN GENERA OF SMINTHURIDAE

1. Fourth antennal segment less than half as long as third. **Dicyrtoma**
 Fourth antennal segment more than half as long as third. 2
 2(1). With 2 or more clavate tenent hairs. 3
 Without clavate tenent hairs. 4
 3(2). Tenent hairs 2 to 3, parallel to long axis of tibiotarsus, very strongly clavate (Fig.
 105A). **Bourletiella**
 Tenent hairs often more than 3, outstanding and not strongly clavate (Fig. 105B)
 **Sminthurinus**



105A



105B

- 4(2). Eyes 2 + 2 or fewer. **Arrhopalites**
 Eyes 4 + 4 or more. 5
 5(4). Fourth antennal segment with 8 or more subsegments. **Sphyrotheca**
 Fourth antennal segment with at most 6 subsegments. **Sminthurides**

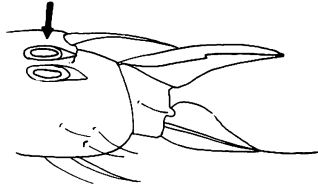
Genus **SMINTHURIDES** Börner, 1900

Type species: *Smynthurus aquaticus* Bourlet, 1843

This genus includes the Hawaiian sminthurids with male antennae modified to form a clasping organ and without subanal appendages in adult females. The species have six normal and two reduced eyes on each side, lack tenent hairs, and have 3 + 3 teeth in addition to a pair of basal fingerlike projections on the tenaculum. The tenacular structure and absence of subanal appendages are also found in juveniles of other sminthurids, so caution should be used in identifying specimens as *Sminthurides* on the basis of these characters alone. The Hawaiian fauna includes representatives of three subgenera.

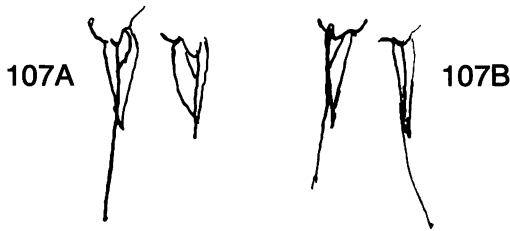
KEY TO HAWAIIAN SPECIES OF SMINTHURIDES S.L.

1. Hind tibiotarsus with lateral organ of 2 pegs and 1 highly differentiated seta (Fig. 106). **Sminthurides (Sminthurides) lolaelua**
 Tibiotarsal organ absent. 2



106

- 2(1). Apical filament much shorter on third than on first unguiculus (Fig. 107A).
 **Sminthurides (Sphaeridia) biniserratus**
 Apical filament of all unguiculi similar, exceeding apex of unguis (Fig. 107B).
 **Sminthurides (Denisiella) ramosus**

Subgenus **DENISIELLA** Folsom and Mills, 1938

Type species: *Sminthurides seurati* Denis, 1925

Members of this subgenus have a mucronal seta but no tibiotarsal organ. There is a single Hawaiian species.

Sminthurides (Denisiella) ramosus Folsom, 1932 (Plate 138)
 Proc. Hawaii. Entomol. Soc. 8:72.—Folsom and Mills, 1938.

Female: body and head uniformly bluish purple, with venter and dens slightly paler. Fourth antennal segment simple, with apical knob and a minute, obscure, truncate subapical knob; no differentiated sensory setae. Apical organ of third antennal segment of 2 rods deeply withdrawn into separate pits; guard setae long and acuminate. Setae of first 3 antennal segments mostly heavy and spinelike. 6 + 6 large, clear eyes; 2 + 2 small inner eyes present at least as corneas. Fore tibiotarsus with 1 distal inner heavy seta, slightly serrate. Hind tibiotarsi with 5 blunt serrate setae on inner surface, the distal setae more strongly serrate than the others.

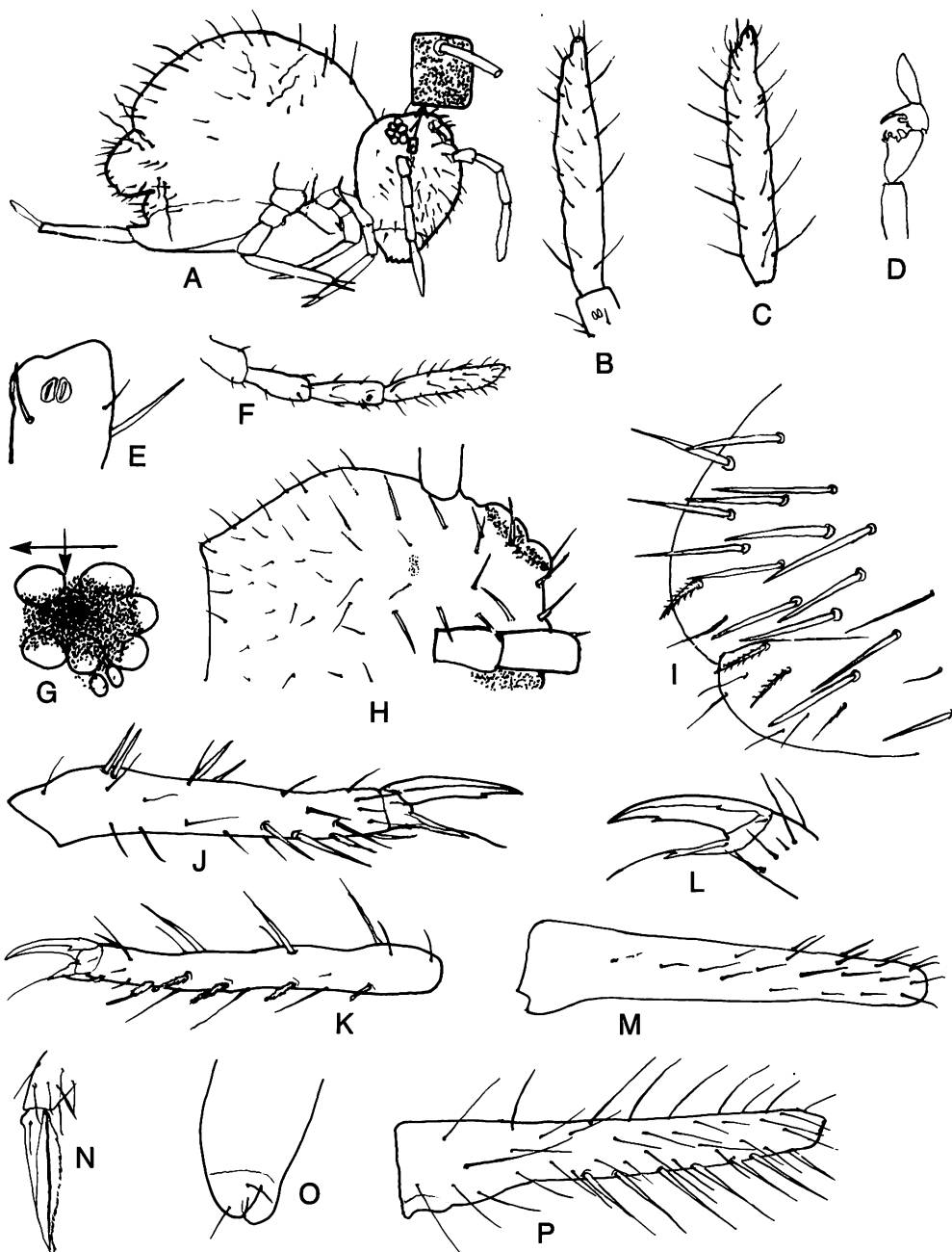


Plate 138—*Sminthurides (Denisiella) ramosus* (all figures of specimens from Oahu): **A**, habitus (showing chaetotaxy) (4825); **B**, outer face, fourth antennal segment (same); **C**, inner face, same; **D**, male antenna (after Folsom); **E**, apical organ of third antennal segment (same); **F**, antenna of female (same); **G**, left eyepatch (4825); **H**, facial chaetotaxy, right side (same); **I**, posterior chaetotaxy, female, right side (same); **J**, fore leg (same); **K**, hind leg (same); **L**, fore foot complex (after Folsom); **M**, ventral surface, dens (4825); **N**, mucro (after Folsom); **O**, ventral tube (4825); **P**, dorsal surface dens (same).

Ungues similar in size and shape on all legs, with clear lateral teeth; an obvious inner tooth on the first and second; the third unguis has a much smaller tooth. Unguiculi with long, slightly clavate subapical filaments on all legs. Ventral tube without basal lobe, with 1 + 1 distal setae. Tenaculum with 3 + 3 teeth and 1 + 1 fingerlike projections, basal appendage, and 2-3 setae. Dens with multisetaceous chaetotaxy (type B, Christiansen and Bellinger 1981) but with 20-22 Ve setae in 4 rows; dorsal setae variable but typically 6-9 E, 7-9 L, 7-11 ID, 9-12 D, and 8 supplementary setae. Mucro with apex blunt and upturned; outer margin smooth and inner serrate; seta on outer base. Dorsal head and body setae heavy, spinelike, and with minute appressed scalelike serrations. Maximum length 1.2 mm.

Male (not seen): "Body and antennae purple. Legs tinged with purple. Furcula unpigmented. Antennae remarkably stout, a third longer than the head, with segments as 10:9:4:8. Middle antennal segments forming a clasping organ. Apical antennal segments simple, elliptical. Each tibiotarsus of the front legs bears basally on the outer side 4 sense organs, suboblong, thick-walled, and slightly elevated. Claws and mucrones similar to those of the female, although the mucrones are more slender. Length 0.6 mm." (from Folsom and Mills 1938).

Remarks: This well-marked species is quite distinct from other Hawaiian *Sminthurides*. The fact that the only Hawaiian records are from disturbed lowland areas and the records of this species or a related form from Africa (Murphy 1960, Greenslade 1981) strongly suggest that it is not native to the Islands. This may be synonymous with *S. seppinnatus* of Denis (1931); however, we feel it best to keep them separate until chaetotaxy of Costa Rican specimens can be compared.

Ecology: The type collection was in a cane field; the only later collection is from a lawn.

Type locality: Oahu, Honolulu, XII, XI-1925, cane fields, soil, Van Zwaluwenburg.

Additional record: Oahu: 4825.

Subgenus **SPHAERIDIA** Linnaniemi, 1912

Type species: *Sminthurus pumilis* Krausbauer, 1898

Members of this subgenus have no mucronal seta or tibiotarsal organ. There is a single Hawaiian species.

Sminthurides (Sphaeridia) biniserratus (Salmon, 1951) (Plate 139)

Proc. R. Entomol. Soc. London B 20:138 (*Sphyrotheca*).—Massoud and Delamare, 1964.

Head and body pale uniform blue to (rarely) yellow; antennae medium blue; eyepatches dark. Fourth antennal segment with apical knob but without clearly differentiated blunt setae; subapical sense peg minute and rodlike. Apical organ of third antennal segment of 2 blunt rods in separate pockets. Male clasping organ on second and third antennal segments without highly modified setae. Eyes 6 + 6, or

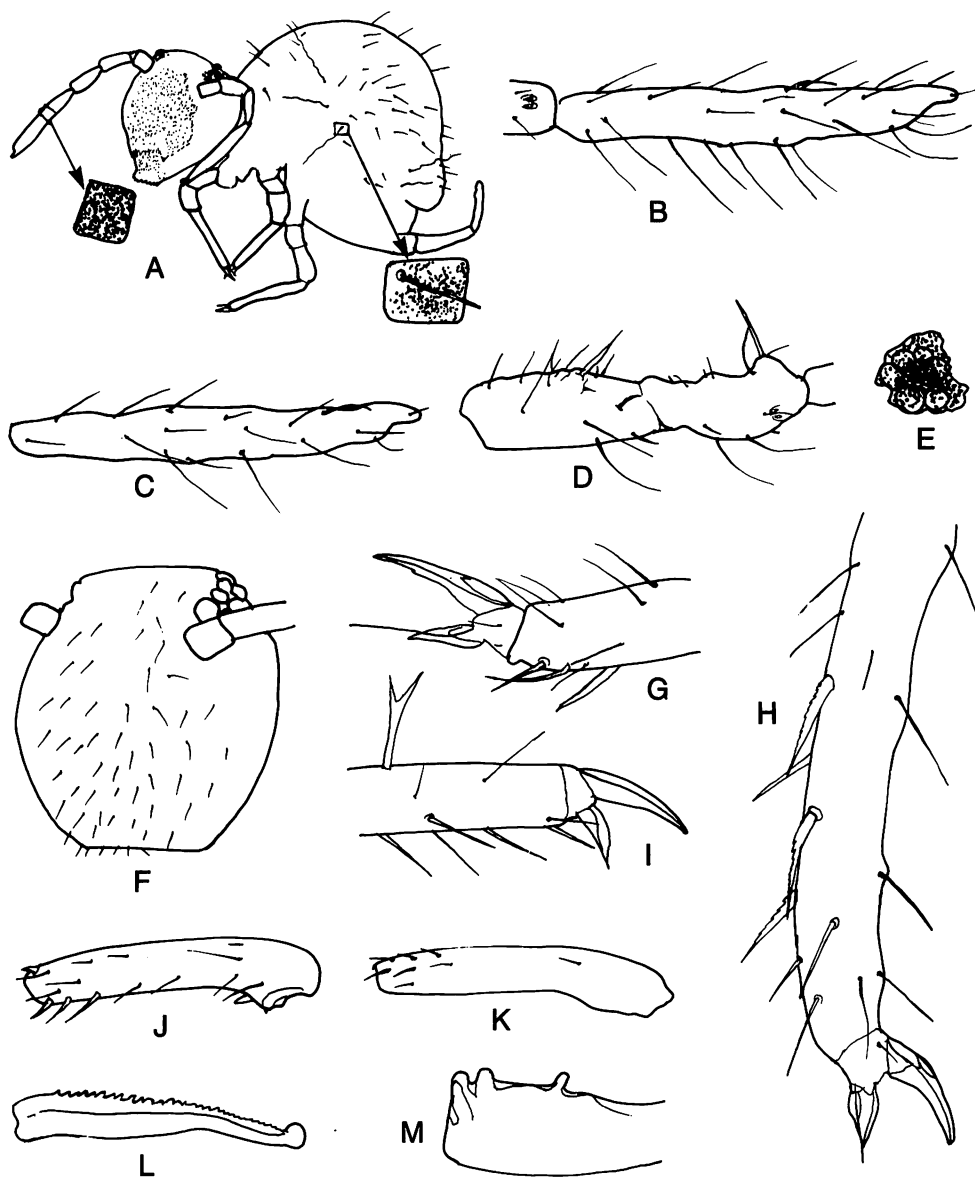
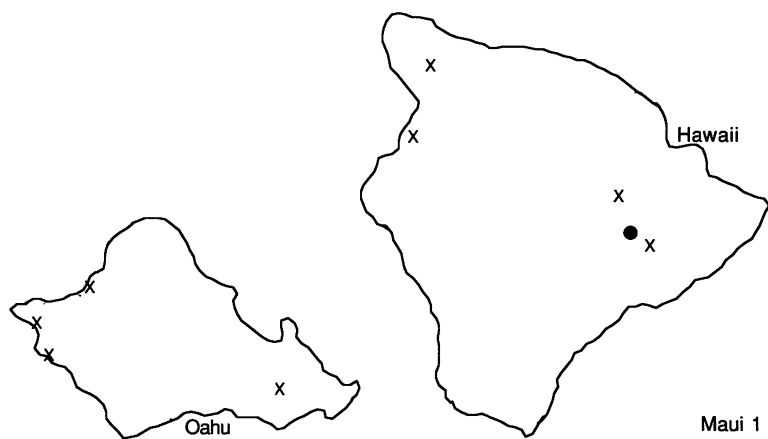


Plate 139—*Sminthurides (Sphaeridia) biniserratus*: A, habitus (showing trunk chaetotaxy) (5181, Maui); B, outer face, fourth antennal segment and apical organ of third, female (same); C, inner surface, fourth antennal segment (same); D, second and third antennal segments, male (same); E, left eyepatch (same); F, facial chaetotaxy, female (same); G, fore foot complex and end of tibiotarsus, female (4828, Oahu); H, hind leg (same); I, hind foot complex and end of tibiotarsus, male (same); J, dorsal surface of dens (5181, Maui); K, ventral surface, same; L, mucro (same); M, detail of inner dental base (same).

8 + 8, in the latter case with 2 + 2 deformed. Hind tibiotarsus of females with 2 differentiated setae having 1-2 large branches or 2-8 smaller serrations. Hind tarsus of male with a large, normally bifurcate seta on dorsal surface at about $\frac{1}{3}$ of its length from apex. Ungues with strong lateral teeth; fore and mid ungues with small inner teeth. Fore unguiculi narrower and longer than others; acuminate apical filaments longer on fore and mid unguiculi than on third pair. Ventral tube with 1 + 1 distal setae and without posterior projections. Tenaculum with 3 + 3 teeth and 1 + 1 fingerlike basal projections and 2 setae. Dens with 8 Ve setae and 14 large and 2 minute dorsal setae; E_1 and L_1-L_3 are heavier than other setae and spinelike in large specimens. Dens with a dorsal tubercle near the base and another at $\frac{1}{4}$ of its length from base. Mucro with serrate inner and smooth outer margin and small apical swelling. All head and trunk setae slender and acuminate. Maximum length 0.4 mm.



Remarks: Specimens match the redescription by Delamare and Massoud (1964) quite well; the two dental tubercles and the tibiotarsal setae of both sexes are distinctive. Minor differences, notably the presence of only 6 + 6 eyes in some specimens, probably represent local variation. Males have been seen from Oahu and Maui; the latter differ in smaller size and absence of the forked tibiotarsal setae, but are so similar in other respects as to be best placed in the same taxon. This species resembles *S. asiatica* Rusek, 1971, but differs in having the apical third antennal rods clearly separate and having more dental setae, as well as a number of more minor differences.

Ecology: Found in soil and low vegetation, mostly in lowland disturbed areas; occasionally at higher altitudes.

Records: Hawaii: 4987, 5068, 5115, 5136, 5303, 6816. Maui: 5181. Oahu: 4812, 4828, 4838, 4841.

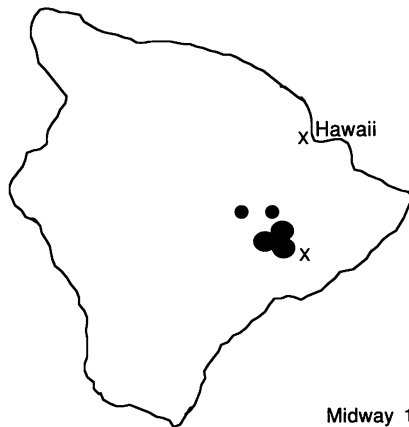
Subgenus **SMINTHURIDES** s.str.

Members of the typical subgenus have both a mucronal seta and a tibiotarsal organ. There is a single Hawaiian species.

Sminthurides (Sminthurides) lollelua Christiansen and Bellinger, **new species** (Plate 140)

Background color white; antennae pale violet-blue to purple-gray; dorsum of head, and sometimes sides and lower front, deep violet-blue. Trunk pigment extremely variable, ranging in color from pale purple-gray to dark blue-violet and extremely variable in pattern. Venter, legs, and furcula pale. Fourth antennal segment in female with 4 to 5 subsegments, the second and third more or less rectangular and a fourth often indistinctly separated from the fifth. Six subequal round peripheral eyes and 2 inner eyes that are smaller and narrowly oval to circular. Unguis with distinct outer and lateral teeth, without or with distinct inner teeth; first unguis narrower than others. Unguiculus narrowly tapering and inwardly concave; apical filament reaching to exceeding apex of unguis on first foot and exceeding it on other feet. Ventral tube with 1 + 1 setae, with or without clear lobes. Tenaculum with 3 + 3 setae. Dens with 3-4(2-5) L, 8-9 (6-7) ID, 6-8 (5) D, 7-8 (6-9) E, 3-4 (5) VeC, 7-8 (6) VeB, and 2-3 (4) VeA setae, plus 6 posterior dorsal setae on basal subsegment; and a blunt tubercle at inner apex. Inner mucronal lamella serrate, with 8-11 teeth; outer lamella smooth or irregularly wavy, ending in a rounded expansion separated by a notch from the apical mucronal tooth; outer basal seta present. Dorsal head and anterior trunk setae somewhat thicker than setae of front or posterior trunk. Sixth abdominal segment with 8-14 (17) dorsal setae in rows; median posterior seta thicker than others and recumbent. Maximum length of females, 0.55 mm; of males, 0.4 mm.

Male fourth antennal segment (with 1 exception) without capitate subapical sensilla. Two forms of segment: one with 12 blunt setae and a second with only 6-7. Third antennal segment with c_1 varying from nearly cylindrical to basally swollen to medially constricted, distal c_2 ovate and apically acuminate or forked. Second



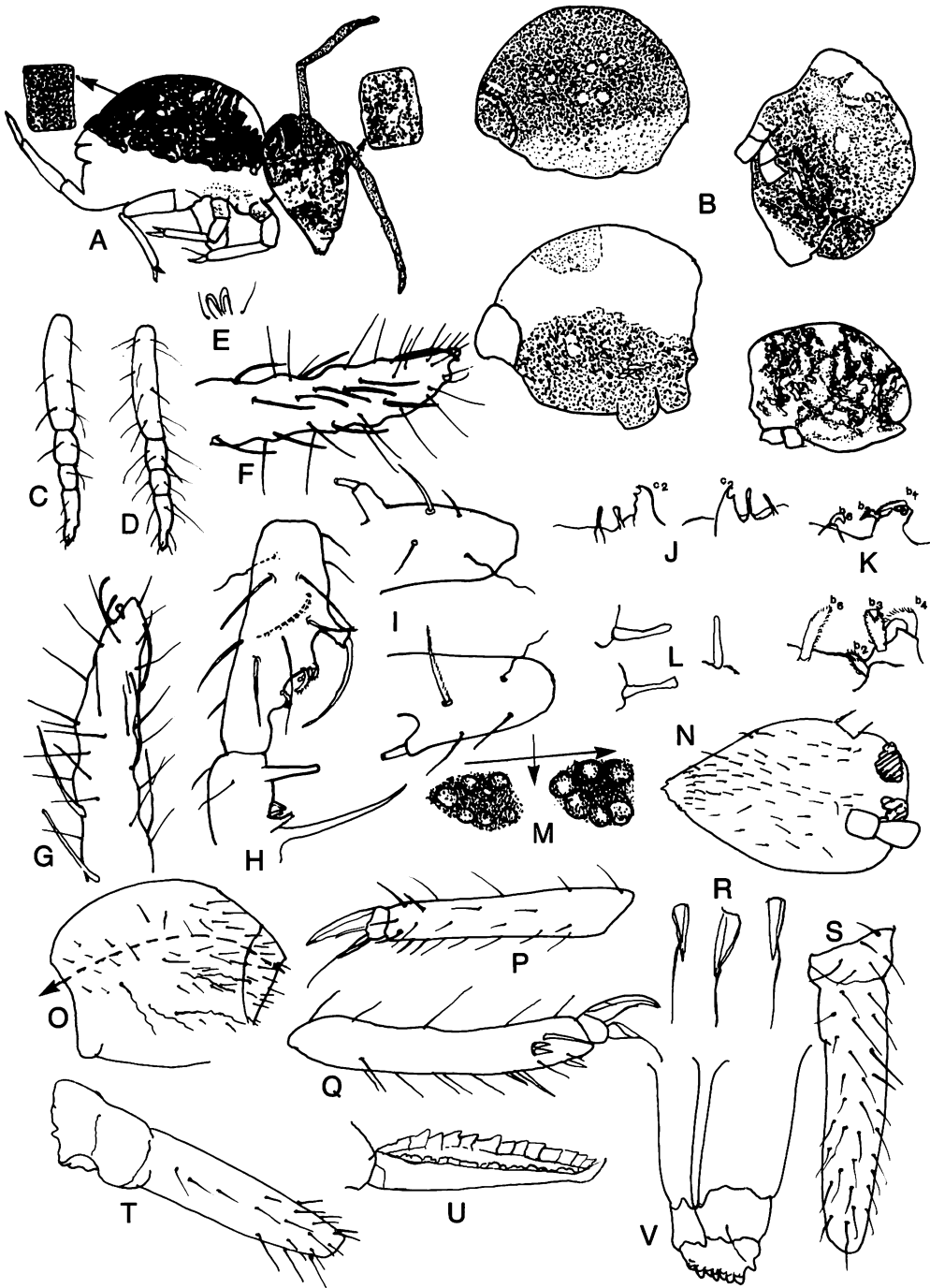


Plate 140—*Sminthurides (Sminthurides) lolleua* (all figures of specimens from Hawaii): A, habitus (holotype); B, variations in trunk pattern (specimens from Hawaii Volcanoes National Park); C, outer surface, fourth antennal segment, female (paratype); D, inner surface, same; E, apical organ, third antennal segment, female (4999); F, fourth antennal segment, male (4905); G, same (4999); H, second and third antennal segments, male (4960); I, variations in male second antennal segment B₁ complex; J, variations in C₂ seta, male; K, variations in male b₂-b₆ setae; L, variations in C₁ seta, male; M, variations in eyepatch (5000); N, facial chaetotaxy (paratype); O, dorsal trunk chaetotaxy, left side (4960); P, fore leg (paratype); Q, hind leg (same); R, variations in fore unguiculus, female; S, dorsal dental chaetotaxy (5043); T, ventral dental chaetotaxy (same); U, mucro (4960); V, ventral tube (paratype).

antennal segment with b_2 - b_4 (rarely only b_3 and b_4) distinct; long seta lateral to b_1 varying from long and ciliate to short and smooth. Lateral thoracic vesicle variable in length.

Remarks: This species is so remarkably varied in many respects that we were convinced that two or three species are involved. We pursued this view with a detailed analysis involving 55 characteristics and utilizing cluster analysis, exploratory data analysis, and principal components analysis techniques. That study will be published elsewhere. The taxonomic result of that detailed analysis is that no species can be clearly separated from the welter of variable features. It does appear that there are five or six clusters of phenotypes; however, these show so much overlap that taxonomic recognition is not merited. They do not show geographic separation and thus subspecific designation is also unmerited. The variation is so great that this overlaps several described species, including *S. macnamarai* Folsom and Mills, 1938; however, we feel it wisest to consider it a separate taxon. It is quite possible that several semi-species are involved.

Derivatio nominis: Hawaiian, variable.

Ecology: Found primarily on wet vegetation around fumaroles in Hawaii Volcanoes National Park; occasionally in wet litter.

Type locality: Holotype and 64 paratypes, Hawaii, Volcanoes National Park, Crater Rim Road, 0.9 mi from Park Headquarters, X-19-1970, steam vent #2, vegetation, Goff (4882).

Additional records: Hawaii: 4727, 4857, 4868, 4884, 4885, 4886, 4905, 4947, 4959, 4960, 4962, 4980, 4981, 4991, 4999, 5000, 5003, 5005, 5006, 5010, 5014, 5015, 5017, 5018, 5021, 5026, 5038, 5043, 5044, 5045, 5050, 5051, 5053, 5054, 5064, 5150, 5264, 5348, 6811, 6812, 6813, 6814, 6816, 6817. Midway Atoll: 4942.

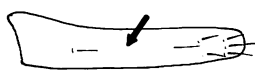
Genus **ARRHOPALITES** Börner, 1906

Type species: *Sminthurus caecus* Tullberg, 1871

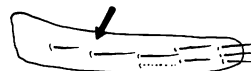
This genus includes the Hawaiian sminthurids with a single eye on each side. Hawaiian species have the fourth antennal segment longer than the third segment, a triangular trochanteral organ on the hind trochanter, no clavate tibiotarsal setae, dentes with basal papillae and some spinelike setae, mucrones straight with both edges serrate, and female subanal appendages. The shape of these appendages and the cephalic and dental chaetotaxy provide the most useful characters. There are two Hawaiian species of *Arrhopalites*: *benitus* and *caecus*.

KEY TO HAWAIIAN SPECIES OF ARRHOPALITES

- 1. With 7 Ve setae (Fig. 108A)..... **benitus**
- With 8 Ve setae (Fig. 108B)..... **caecus**



108A



108B

Arrhopalites benitus (Folsom, 1896*b*) (Plate 141)

Psyche 7:446 (*Smynthurus*).—Christiansen, 1966.—Christiansen and Bellinger, 1981.

Dorsal and lateral surfaces of head and body, and antennae, with mottled purple-blue pigment; eyes dark. Fourth antennal segment with 5 distinct subsegments. All ungues without tunica and with single inner teeth. Unguiculi with single corner teeth and subapical filaments that exceed apices of ungues (clearly on first 2 and barely on third pair of legs). Tenaculum with 2 setae. Base of dental seta Ve_4 at about $\frac{1}{3}$ length of dens from base. Dental setae E_1 , E_3 , and L_1 as heavy spines; L_2 and L_3 weakly spinelike, with projecting filaments. Female subanal appendage palmate and serrate for apical $\frac{1}{3}$. Some dorsal cephalic setae weakly spinelike. Large circumanal setae not flanged or serrate. Length 0.56 mm.

Remarks: A single adult and a single questionable immature specimen of this species were seen. The adult is darker and has a longer hind unguicular filament

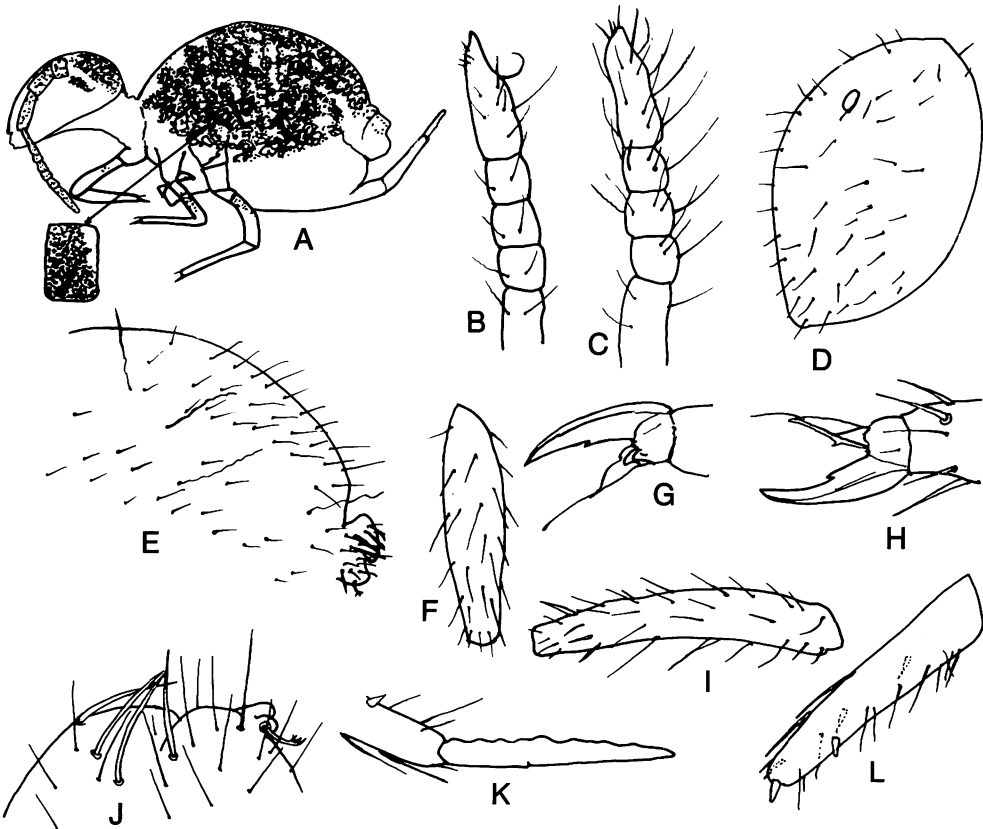


Plate 141—*Arrhopalites benitus* (all figures of 5671, Hawaii): A, habitus; B, outer surface, fourth antennal segment; C, inner surface, same; D, cephalic chaetotaxy of left side, seen from side; E, abdominal chaetotaxy of left side; F, fore tibiotarsus; G, fore foot complex; H, hind foot complex; I, hind tibiotarsus; J, anogenital segment and subanal appendage of female, seen from side; K, end of dens and mucro; L, dens.

than typical nearctic specimens, but both characters are variable, and the range of variation includes the conditions found in this specimen. It is quite possible that there are in fact several nearctic species included in "*benitus*" in our sense.

Ecology: Found in lava rock "soil" and litter at about 4000 ft. elevation.

Records: Hawaii: 5671, 5682.

Arrhopalites caecus (Tullberg, 1871) (Plate 142)

Ofver. K. Vet. Akad. Forh. 28:146 (*Sminthurus*).—Christiansen, 1966.—Christiansen and Bellinger, 1981.

Head, including eyes, and body unpigmented. Fourth antennal segment without subsegments. Unguis without tunica; inner tooth well developed on third, minute on second, and absent on first foot. Subapical filament very short on third foot, reaching apex of unguis on second, and exceeding it on first foot. Tenaculum with a single seta. Base of seta Ve_3 at 0.28 of length of dens from base. Median Ve_1 seta strongly spinelike; L_1 spinelike with a clear apical filament; other dental setae simple. Female subanal appendage straight and cylindrical, with serrate apex. Some dorsal cephalic setae moderately spinelike. Largest circumanal setae basally flanged; 2 are unilaterally serrate. Anal valves in adults with supplementary short spines. Maximum length 0.62 mm.

Remarks: We have seen a single adult specimen and a probable juvenile of this species. The adult differs from nearctic specimens examined only in having one tenacular seta instead of two; because this character does vary in other species we do not feel it desirable to separate the Hawaiian specimen on this basis alone. The immature lacks teeth on unguis and unguiculus, flanges on circumanal setae and supplementary spines, and dental setae E_6 - E_8 and is 0.58 mm long.

Records: Hawaii: 5465.

Genus **SMINTHURINUS** Börner, 1901e

Type species: *Sminthurus niger* Lubbock, 1868

This genus includes the Hawaiian sminthurids with 8 + 8 eyes and a trochanteral organ (see Fig. 104J) on the hind legs. The species have a triangular bothriotrachelal pattern and three or more outstanding tenent hairs on each foot; they lack dental spines and mucronal setae. All belong to *Sminthurinus* s.str. (Christiansen and Bellinger 1981), having the median supraanal seta of the female forked (see Fig. 109). There are three Hawaiian species of *Sminthurinus*: *elegans*, *kaha*, and *quadrimaculatus*. Their characteristics are given in Table 30.

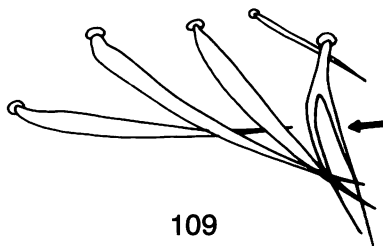


Figure 109—Female posterior chaetotaxy in *Sminthurinus*.

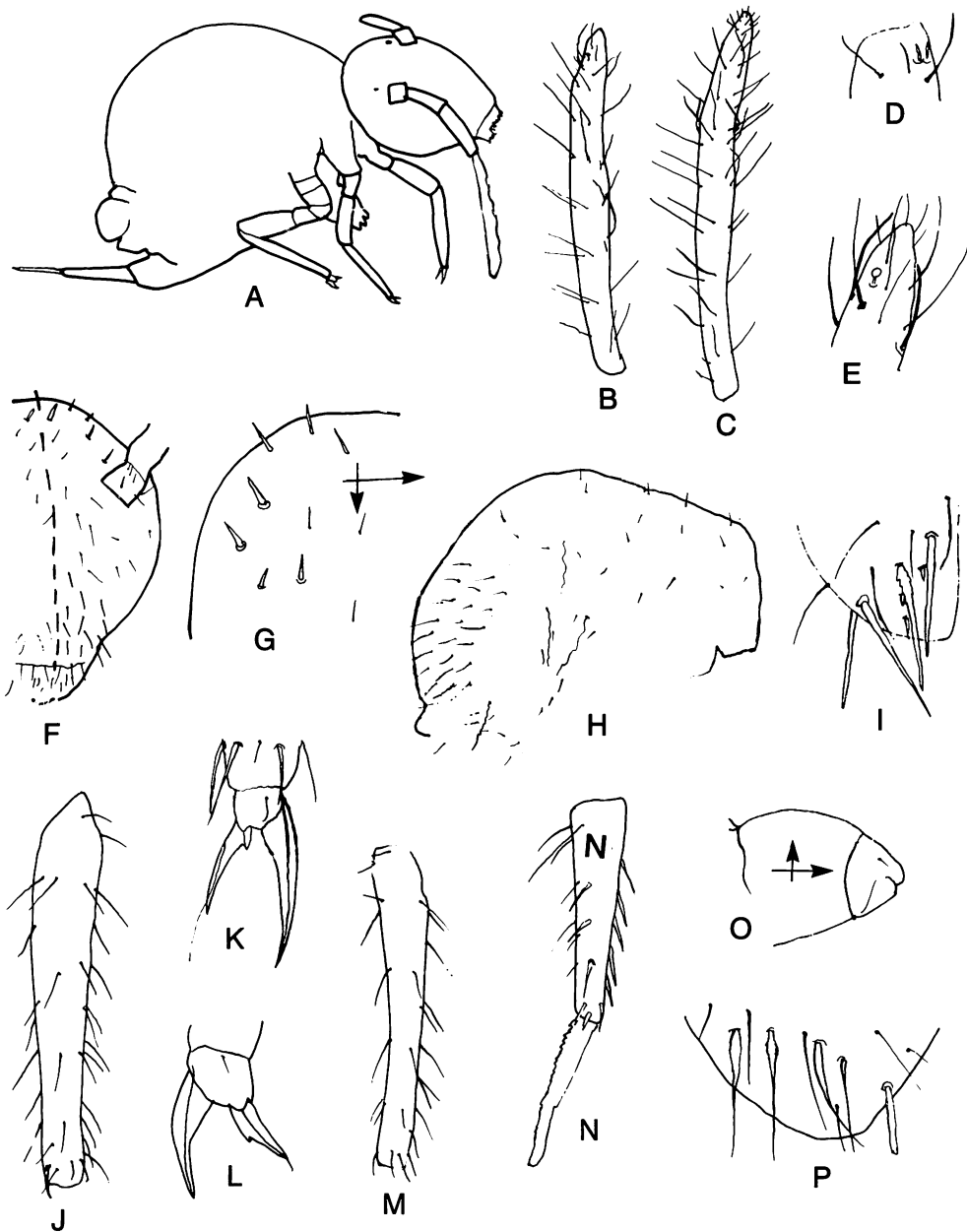


Plate 142—*Arrhopalites caecus* (all figures of 5465, Hawaii): A, habitus; B, outer surface, fourth antennal segment; C, inner surface, same; D, apical organ, third antennal segment; E, detail, apex, fourth antennal segment; F, facial chaetotaxy, left side; G, detail, dorsum of head; H, greater abdomen chaetotaxy, right side; I, dorsal valve of anogenital segment, same; J, fore tibiotarsus; K, fore foot complex; L, hind foot complex; M, hind tibiotarsus; N, mucro and dens; O, ventral tube, seen from side; P, setae of ventral anogenital valve and subanal appendage of female.

Table 30. Characteristics of Hawaiian Species of *Sminthurinus*

SPECIES	APICAL BULB	ANT. III PAPILLA		EYES C/H	TENENT HAIRS	TUNICA	PSEUDO- NYCHIA	INNER UNGUAL TOOTH	TENAC- ULAR SETAE	DENTAL SETAE		SERRATE MUCRONAL EDGES		FEMALE SUBANAL APPEND- AGES
		PRESENT	LOBES							E ₄	SUBAP- ICAL VENTRAL	OUTER (DORSAL)	INNER (VENTRAL)	
<i>kaha</i>	+	+	(3)4	<	3-4	-	-	(1)-2	1	-	-	±	+	-
<i>elegans</i>	(+)-	weak	1-3	<	3-4	±	±	2-3	1	-	-	-	+	+
<i>quadrifasciatus</i>	+	+	1	≈	(3)-5	-	+	3	2(1)	-	2	+	+	+

KEY TO HAWAIIAN SPECIES OF SMINTHURINUS

1. Two subapical setae on venter of each dens (Fig. 110B). **quadrimaculatus**
 No subapical setae on venter of dens (Fig. 110A). 2



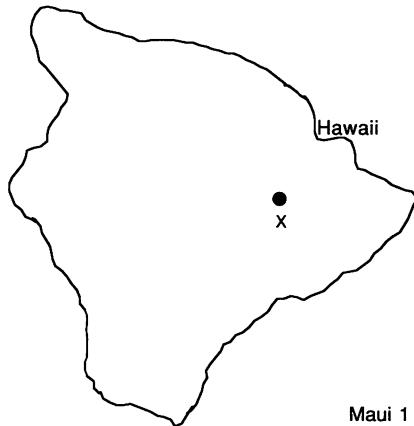
- 2(1). Filament of hind unguiculus more than 1/3 length of organ (Fig. 111A). **elegans**
 Filament of hind unguiculus less than 1/3 length of organ (Fig. 111B). **kaha**



Sminthurinus (S.) elegans (Fitch, 1863) (Plate 143)

Trans. N.Y. State Agric. Soc. 22:657 (*Smynthurus*).—Folsom, 1934.—Christiansen and Bellinger, 1981.

Background yellow; brownish purple or reddish heavy pigment forming an irregular interocular stripe, a band running around the middle 1/3 of the lateral and anterior surfaces of the head, and 4 broad longitudinal stripes and a thinner mid-dorsal stripe on the body. Fourth antennal segment with a deep apical pit but normally without apical bulb and with a short pigmented truncate seta just before the apex and a subapical sense peg, minute and apparently weakly clavate, in a broad pit. Apical organ of third antennal segment of 2 blunt rods in separate shallow pits



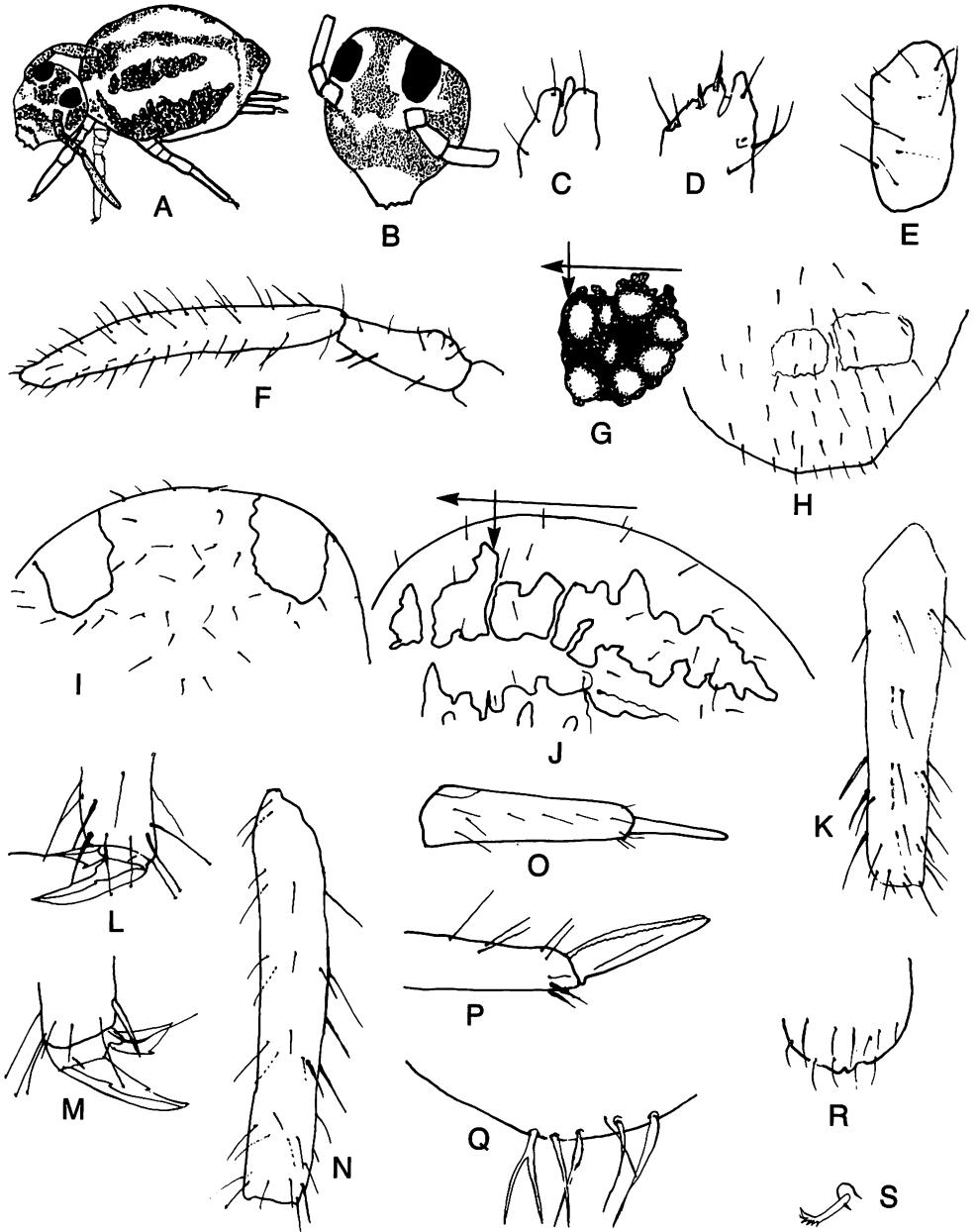


Plate 143—*Sminthurinus elegans*: A, habitus (5070, Hawaii); B, facial pattern (same); C, D, apices, antennae of two specimens (5520, Hawaii); E, second antennal segment, anterior face setae solid, posterior face setae broken lines (6671, Maui); F, anterior faces, third and fourth antennal segments (same); G, left eyepatch (5520, Hawaii); H, ventral and I, dorsal face setae of head (same); J, dorsal greater abdomen and thoracic setae, left side (5070, Hawaii); K, fore tibiotarsus, seen from outside (6671, Maui); L, fore foot complex (same); M, hind foot complex (same); N, hind tibiotarsus (same); O, dens and mucro seen from above (5520, Hawaii); P, apex of dens and mucro from side (same); Q, circumanal setae, right side, seen from above (same); R, male genital plate, seen from side (6671, Maui); S, female subanal appendage right side, seen from below (5520, Hawaii).

or in a common pit; basal papilla low, broad, and simple or weakly trilobed. Eyes C and D strikingly smaller than others. Three or 4 small, weakly clavate tenent hairs per foot. Unguis with 2-3 clear inner teeth (visible only on some), weakly developed pseudonychia, and usually a small distal tunica. Unguiculus with strong inner tooth and acuminate subapical filament, about as long as unguiculus on fore foot and half as long on hind foot. Tenaculum with 3 + 3 teeth, 1 seta, and 1 + 1 fingerlike basal appendages. Dens without subapical ventral setae. Mucro with inner margin weakly serrate and outer smooth (rarely weakly serrate). Female subanal appendages slender, curved, and sparsely but deeply serrate apically. Large circumanal setae with lateral flanges extremely variable. Maximum length 0.95 mm.

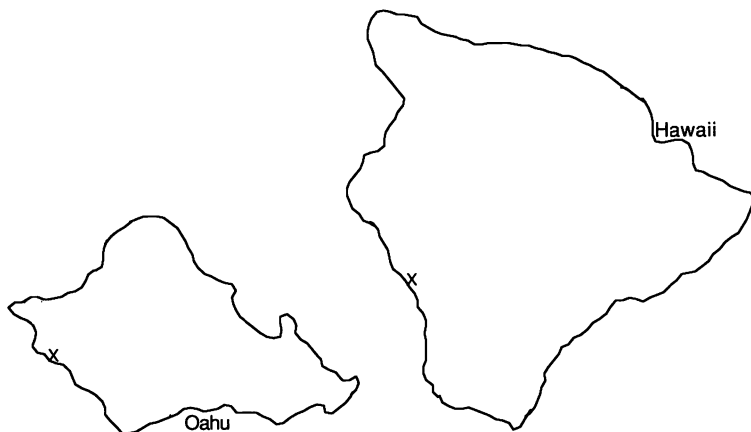
Remarks: The Hawaiian specimens mostly fall well within the range of variation of the nearctic material. Two specimens (see Pl. 143D) appear to have an apical antennal bulb, but this is generally absent. Occasionally the deep apical pit appears to divide the apex into two lobes. The specimens from Maui have broad flanges on the large circumanal setae; however, those from Hawaii have no flanges or very small ones.

Ecology: Found in open forests, in litter and rotten wood.

Records: Hawaii: 5070, 5331, 5520. Maui: 6671.

Sminthurinus (S.) kaha Christiansen and Bellinger, **new species** (Plate 144)

Color medium to pale blue with scattered pale patches and intersegmental lines; furcula and venter of abdomen pale. Fourth antennal segment with well-developed apical bulb; subapical sense peg a simple rod. Third antennal segment with apical organ of 2 elliptical rods in a common deep pit; basal papilla low, broad, and with 3-4 lobes. Eyes 8 + 8 with C and D much smaller than others. Clavate tenent hairs 3-4 per foot. Unguis with 2 minute inner teeth, well-developed lateral teeth, and 1-2 external teeth but without pseudonychia. Unguiculus with strong corner tooth; subapical filament slightly shorter to subequal to unguiculus on fore foot and $\frac{1}{6}$ - $\frac{1}{5}$ as long on hind foot. Tenaculum with 3 + 3 teeth, 1 seta, and 1 + 1 basal



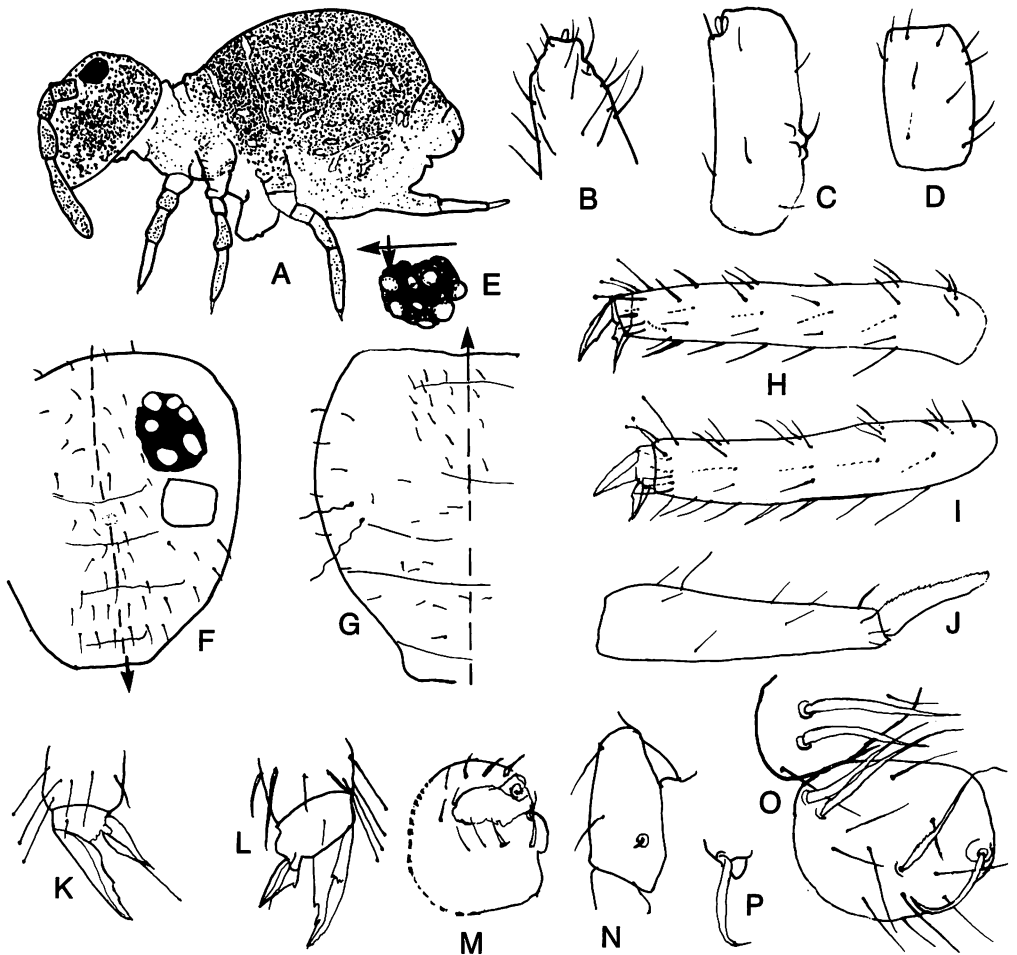


Plate 144—*Sminthurinus kaha*: A, habitus (5142, Hawaii); B, apex of antenna (same); C, third antennal segment (holotype); D, anterior face, second antennal segment (same); E, left eyepatch (same); F, facial setae, left side (same); G, dorsal thoracic and greater abdomen setae, right side (same); H, fore tibiotarsus and foot (same); I, hind tibiotarsus and foot (same); J, mucro and dens from side (5142, Hawaii); K, fore foot complex (same); L, hind foot complex (same); M, male genital plate from below (same); N, trochanteral organ (same); O, circumanal setae and subanal appendage, female (same); P, female subanal appendage (holotype).

fingerlike appendages. Ventral tube with 1 + 1 distal setae. Female subanal appendage strongly curved, acuminate, and not branched or serrate. Large circumanal setae with weak serrate lateral flanges. Dens without subapical ventral setae. Mucro with inner edge strongly serrate and outer edge weakly serrate to smooth. All ordinary body and head setae slender, acuminate, and curved. Maximum length 0.62 mm.

Remarks: Unbranched subanal appendages have apparently not been recorded in *Sminthurinus* s.str.; the new species, which we place here because of the bifid

median supranal seta of females, may be recognized by this character alone. The combination of apical antennal bulb, quadripartite papilla of the third antennal segment, absence of subapical ventral dental setae, and mucro with both edges serrate also seems to distinguish it.

Derivatio nominis: Hawaiian, plump.

Ecology: The three known collections are too disparate to allow generalization.

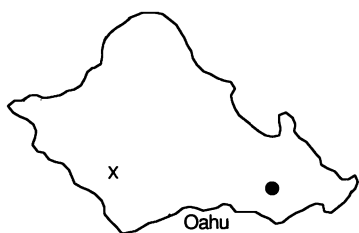
Type locality: Holotype and 1 paratype, Oahu, Makaha, II-7-1969, Lee (4838).

Other records: Hawaii: 5142, 6814.

Sminthurinus (S.) quadrimaculatus (Ryder, 1879) (Plate 145)

Proc. Acad. Nat. Sci. Philadelphia 30:335 (*Smynthurus*).—Folsom, 1934.—Christiansen and Bellinger, 1981.

Color pale blue and irregularly mottled to solid dark blue dorsally and laterally; head, venter, and appendages yellowish to pale blue mottled; furcula unpigmented. Fourth antennal segment with well-developed mottled apical bulb and minute, obscure, apically expanded subapical sense peg in pit. Apical organ of third antennal segment of 2 elliptical pegs separated from each other in a common shallow pit; basal swelling simple and varying from slight to prominent. Eyes C and H subequal. Tenent hairs weakly clavate, 3 to 5 per foot. Unguis with moderately or weakly developed pseudonychia and 3 inner teeth. Unguiculi with strong corner tooth; subapical filament exceeding apex of organ by $\frac{1}{3}$ – $\frac{3}{4}$ of its length on fore foot, but barely exceeding apex on mid and hind foot. Tenaculum with 3 + 3 teeth, 2 setae, and 1 + 1 basal fingerlike appendages. Female subanal appendages broad, slightly curved, apically expanded and deeply serrate. Lateral circumanal setae with broad serrate flanges. Dens with 2 subapical ventral setae. Both edges of mucro serrate. Maximum length 1 mm.



Maui 1

Remarks: The identity of this species is in doubt. The Hawaiian specimens fall within the range of variation of North American *S. quadrimaculatus* in most respects, but never have the characteristic spotted pattern to which the name refers. In addition, the flanges on the circumanal setae are larger and the integumentary granules slightly smaller than in nearctic *S. quadrimaculatus*.

Ecology: Found in litter in disturbed areas.

Records: Maui: 5181. Oahu: 4796, 4809, 4825.

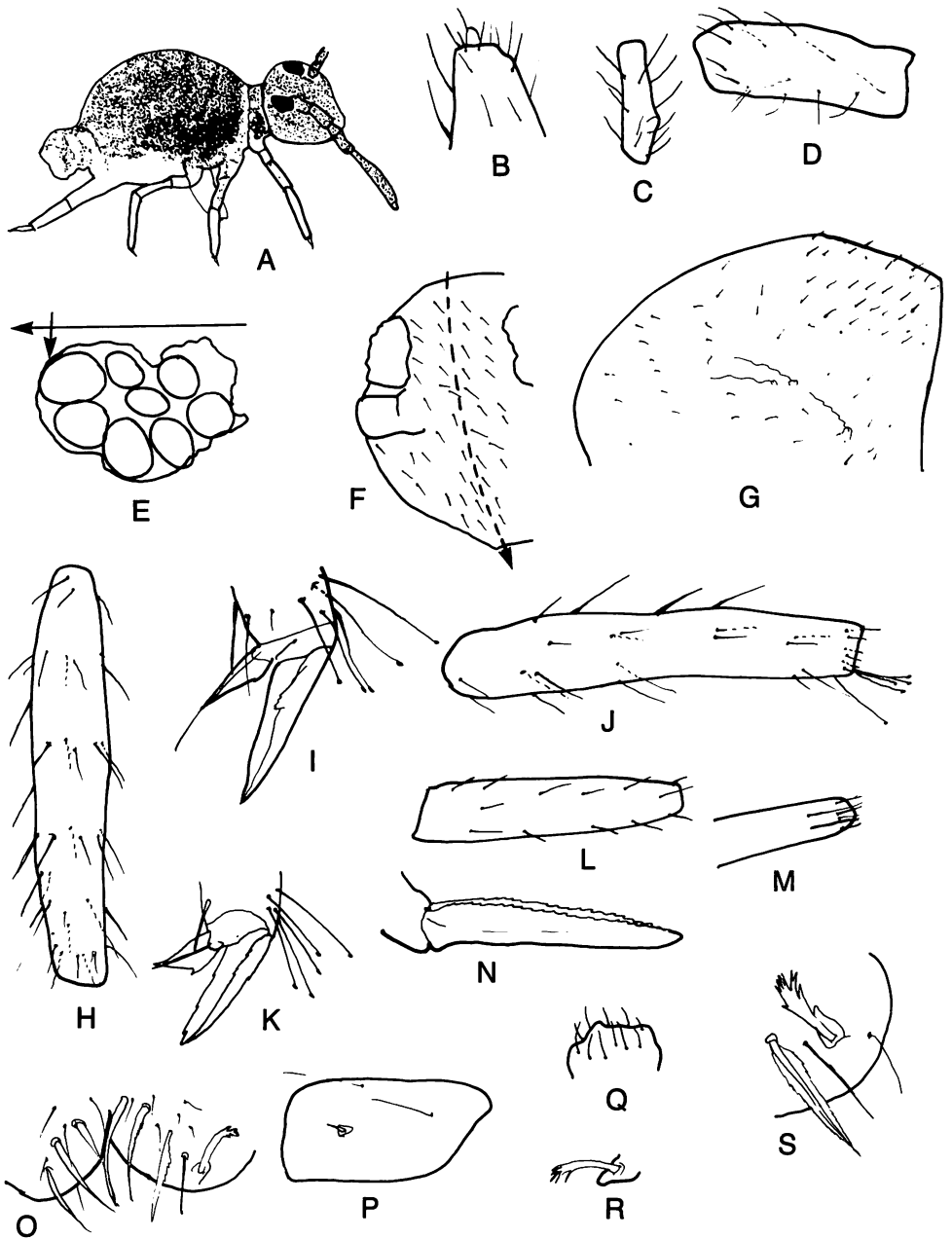


Plate 145—*Sminthurinus quadrimaculatus*: A, habitus (4809, Oahu); B, apex of fourth antennal segment (5181, Maui); C, anterior face, third antennal segment (same); D, anterior (solid lines) and posterior (dotted lines) setae of second antennal segment (4809, Oahu); E, left eyepatch (same); F, facial setae, right side (same); G, thoracic and greater abdominal setae, right side (same); H, fore tibiotarsus seen from outer surface (broken lines represent setae of inner surface) (same); I, fore foot complex (same); J, hind tibiotarsus, broken lines same as H (same); K, hind foot complex (same); L, dorsal surface of dens (same); M, ventral surface, apex of dens (same); N, mucro (same); O, circumanal setae, female (same); P, trochanteral organ (4825, Oahu); Q, male genital plate from side (4809, Oahu); R, female subanal appendage (same); S, enlargement, circumanal flanged seta and subanal appendage (5181, Maui).

Genus **BOURLETIELLA** Banks, 1899

Type species: *Smynturus hortensis* Fitch, 1863

This genus includes the Hawaiian springtails with two or three thick, strongly clavate tenent hairs parallel to the long axis of each tibiotarsus. Species have the fourth antennal segment subdivided, the three bothriotricha of the greater abdomen in a diagonal line, no posterior pretarsal setula, and a mucro without sharp teeth on either margin. The most useful characters for separation of the Hawaiian species are the pattern, the shape of the unguiculus, dental chaetotaxy (see Fig. 112), and, in some species, differentiated groups of setae or cuticular modifications of the front or posterior dorsal greater abdomen in males. The third antennal segment organs also vary strikingly (see Fig. 113). The female circumanal setae also show various forms (see Fig. 114). Members of four subgenera occur in the Islands. The five Hawaiian species are *B. (Bourletiella) hortensis*, *B. (B.) insula*, *B. (Deuterosminthurus) polena*, *B. (Heterosminthurus) ihu*, and *B. (Prorastriones) lipponi*.

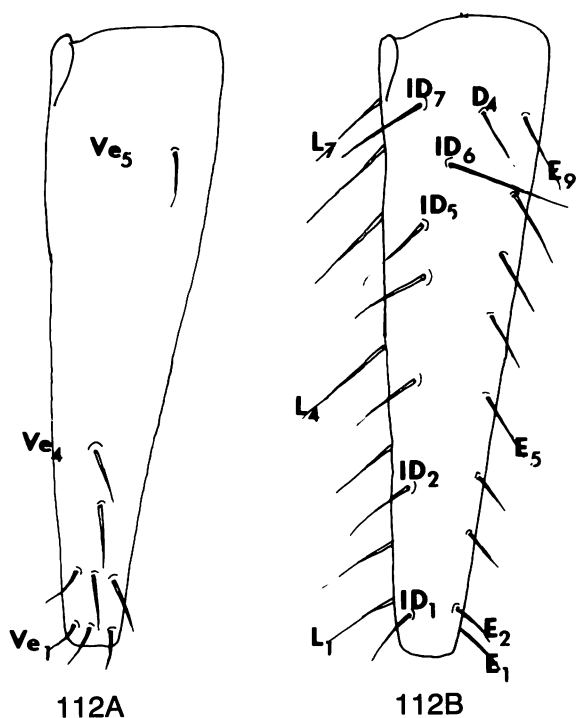


Figure 112—Dental chaetotaxy in *Bourletiella*: A, ventral view; B, dorsal view.

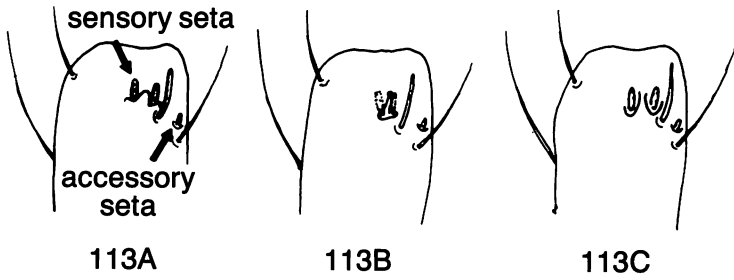


Figure 113—Different forms of the third antennal segment organ in *Bourletiella*.

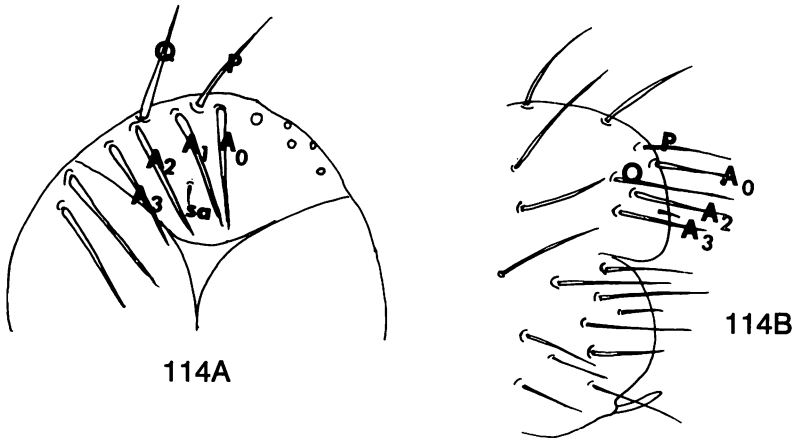
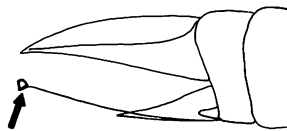


Figure 114—Female circumanal setae in *Bourletiella*: A, posterior view; B, lateral view.

KEY TO HAWAIIAN SPECIES OF *BOURLETIELLA* S.L.

- 1. Filament of unguiculus clavate (Fig. 115)..... **B. (*Prorastriopes*) lipponi**
- Filament of unguiculus acuminate or truncate..... 2



115

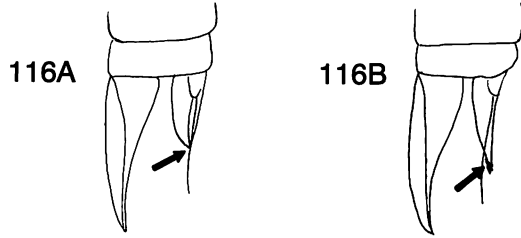
Table 31. Characteristics of Hawaiian Species of the Genus *Bourletiella*

SPECIES	ANT. SEGMENT IV SUBSEGMENTS	TYPE APICAL ORGAN ANT. SEGMENT III*	EYES C/H	DISTAL TENACULAR SETAE	VE ₂ DENTAL SETA	DENTAL SETA L ₂ /MUCRO	CLAVATE UNGUICULAR FILAMENT	SEXUAL DIMORPHISM**
Subgenus <i>Bourletiella</i>								
<i>hortensis</i>	7	A-C	>	3	2	0.38-0.51	-	abdominal dorsal organ
<i>insula</i>	6-7	A	>	3	2	0.25-0.42	-	abdominal dorsal organ
Subgenus <i>Deuterosminthurus</i>								
<i>polena</i>	5-8	A-C	~	2-3	1	0.3-0.4	-	abdominal spines
Subgenus <i>Heterosminthurus</i>								
<i>ihu</i>	(7)8-9	A	~	3	3	0.4-0.85	-	frontal spines; pattern
Subgenus <i>Prorastriope</i>								
<i>lippsoni</i>	6-8	B	~	3	2	0.42-0.61	+	pattern

*See *The Collembola of North America*, pp. 1139-1140.

**In addition to genital opening and subanal appendages.

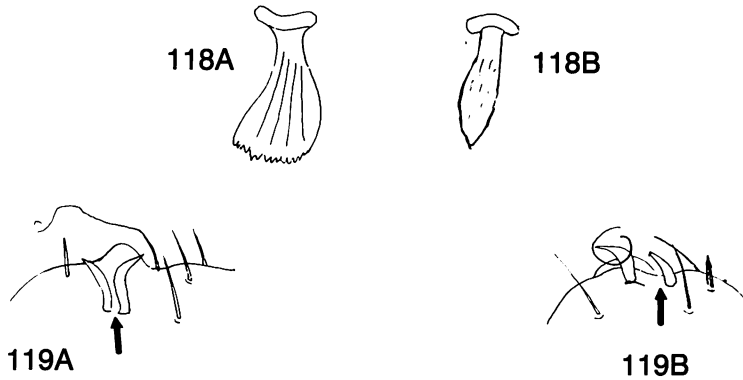
- 2(1). Hind unguiculus abruptly narrowed (Fig. 116A)..... **B. (Heterosminthurus) ihu**
 Hind unguiculus gradually narrowed (Fig. 116B)..... 3



- 3(2). Two Ve_2 dental setae (Fig. 117A); males with dorsal organ on greater abdomen..... 4
 One Ve_2 dental seta (Fig. 117B); males without dorsal organ.....
 **B. (Deuterosminthurus) polena**



- 4(3). Female subanal appendages paddle-shaped (Fig. 118A); male dorsal organ with lateral spines pointing in opposite directions (Fig. 119A)..... **B. (B.) hortensis**
 Female subanal appendages elongate oval (Fig. 118B); male dorsal organ with lateral spines both pointing posteriorly (Fig. 119B)..... **B. (B.) insula**



Subgenus **BOURLETIELLA** s.str.

This subgenus includes species with a characteristic dorsal organ on the greater abdomen of males. Females may be distinguished from the other subgenera by the difference in size of eyes C and H.

Bourletiella (Bourletiella) hortensis (Fitch, 1863) (Plate 146)

Trans. N.Y. State Agric. Soc. 22:668 (*Smythurus*).—Christiansen and Bellinger, 1981.

Color mottled blue to purplish brown; greater abdomen with oval pale spots and diagonal, broken, narrow pale bands; sexes similar in pattern. Fourth antennal segment with well-developed apical bulb and 1–2 slender acuminate sensory setae on distal 5 subsegments. Apical organ of third antennal segment with inner guard seta slightly shorter than outer. Tibiotarsus with some heavy but not clearly spine-like inner setae. Unguis with 2 strong lateral teeth on each side and 1 inner tooth. Unguiculus with acuminate subapical filament not nearly reaching apex of unguis. Tenent hairs 3-2-2. Dental chaetotaxy normal, with 6 L, 7–8 E, and 3 Ve_1 setae. Mucro with both edges weakly crenulate. Male dorsal organ with anterior lateral spine much thicker than posterior and pointing in opposite direction from the other. “Female subanal appendages paddle-shaped and distally curved or finely serrate.” All head and body setae smooth, curved, acuminate, and similar in length; posterior setae of greater abdomen thicker than others. Length 1.3 mm.

Remarks: Only a single (male) specimen of this species was seen. It agrees well with nearctic material except that the caudal spine is more slender and curved (as in European forms), and the third antennal segment apical organ (not clearly visible) appears to be intermediate between types A and C (Richards 1968). The part of the description in quotes is from Christiansen and Bellinger 1980–1981.

Record: Hawaii: 5367.

Bourletiella (Bourletiella) insula Folsom, 1932 (Plate 147)

Proc. Hawaii. Entomol. Soc. 8:73.

Color varying from uniform pale yellow except for eyepatches and slightly bluish antennae to mottled blue extending over dorsal and lateral portions of head and body; males usually paler and more yellow than females but without striking color dimorphism. Fourth antennal segment with strong apical bulb and 1–3 slender acuminate sensory setae on all but the basal subsegment. Apical organ of third antennal segment of type A, with 2 subequal guard setae and minute conical supplementary seta; primary sensilla in a deep pocket. Tenent hairs 3-3-2. Unguis with small lateral and inner teeth. Unguiculus with apical filament acuminate, not reaching apex of unguis. Tibiotarsi each with 4–5 moderately heavy spinelike setae on distal inner face. Dens with 6 L and 7–8 E setae; Ve setae 1, 1, 2, 3, with setae longer than distance between them; none of the setae are heavy or spinelike. Mucro with sparse to regular crenulations on both edges. Female subanal appendages broadly oval and striate in plan view, slightly curved in side view. Male dorsal organ with both lateral spines curved posteriorly, the anterior distinctly thicker than the posterior. Caudal spine long, curved, and setiform; opercular spines absent. All body setae smooth, curved, and acuminate; in the male those on the thorax and greater abdomen are slightly heavier than those on the head. Maximum length 1.5 mm.

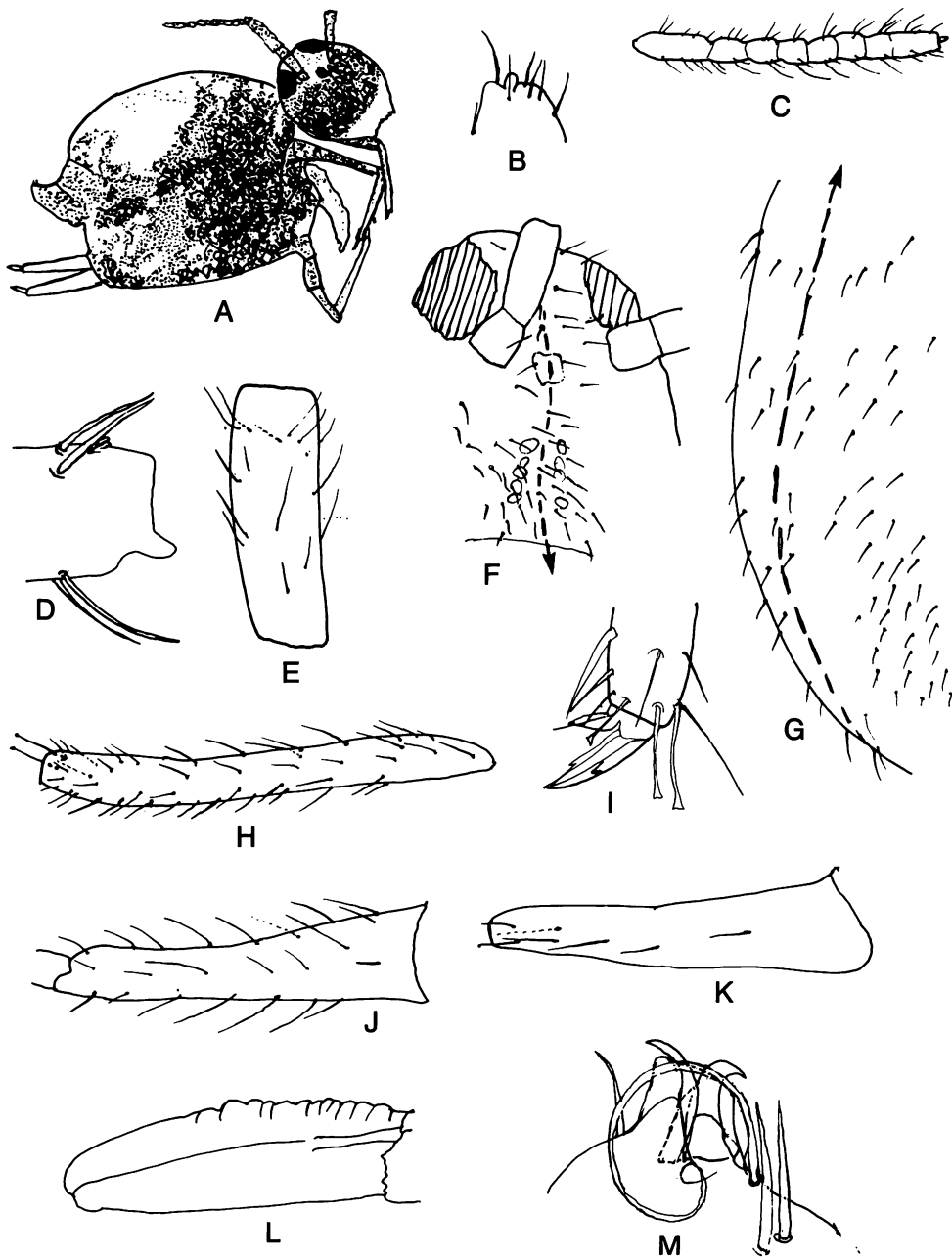
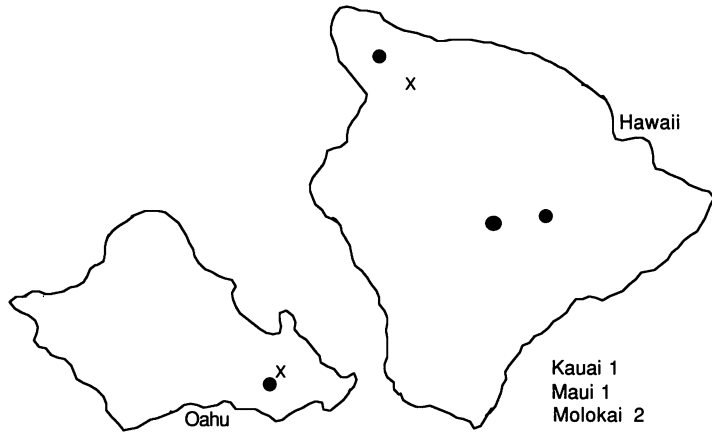


Plate 146—*Bourletiella* (*Bourletiella*) *hortensis* (all figures of male from 5367, Hawaii): A, habitus; B, apex of antenna; C, profile of fourth antennal segment; D, apex of third antennal segment; E, second antennal segment, seen from anterior face; F, visible portions of median chaetotaxy of face; G, median setae, thorax and greater abdomen; H, hind tibiotarsus seen from outer surface; I, fore foot complex; J, dorsal surface of left dens; K, ventral surface, same; L, mucro seen from below; M, dorsal organ.



Plate 147—*Bourletiella (Bourletiella) insula*: A, habitus, male (4825, Oahu); B, apex of antenna (5431, Hawaii); C, fourth antennal segment (after Folsom); D, apex of third antennal segment (5431, Hawaii); E, second antennal segment, seen from anterior face (same); F, eyepatch (after Folsom); G, facial setae, left side, male (5341, Hawaii); H, dorsum of trunk (5335, Hawaii); I, fore foot complex (4825, Oahu); J, hind tibiotarsus (same); K, hind foot complex (same); L, dorsal surface, dens (5341, Hawaii); M, ventral surface, same; N, mucro (5720, Molokai); O, male dorsal organ (4766, Oahu); P, female subanal appendages and neighboring setae (5335, Hawaii).



Remarks: Our specimens differ from Folsom's description in a number of respects, including the number of tenent hairs and the form of the subanal appendages, but in spite of not seeing type specimens there is little doubt that this is his species. The setiform dorsal spine, absence of opercular spines and large lateral spines on the dorsal organ, and the female subanal appendage distinguish it from nearctic forms; the dorsal organ resembles that of *B. pistillum* Gisin, 1946 from Europe, but the subanal appendage is quite different. Most specimens from the island of Hawaii have eight E setae on the dens, whereas those from other islands often have seven.

Ecology: Found in grass and taken in pitfall traps: on Hawaii and Maui between 3500 and 8000 ft., on Kauai and Oahu in lowland disturbed areas.

Type locality: Oahu, Honolulu, 4-25-1925, in cane soil, Van Zwaluwenburg.

Other records: Hawaii: 5135, 5319, 5335, 5341, 5346, 5658, 5666, 6799, 6800, 6802, 6805, 6806. Maui: 5188. Molokai: 5720, 5727. Oahu: 4765, 4766, 4825, 6789. Kauai: 5284.

Subgenus **DEUTEROSMINTHURUS** Börner, 1901e

Type species: *Smynthurus bicinctus* Koch, 1840

This subgenus is used here for a species that lacks the distinctive characters (male dorsal organ, strongly modified tibiotasal setae, or highly differentiated unguiculi) found in the other Hawaiian subgenera. This species and some nearctic forms differ from typical *Deuterosminthurus*, whose species, according to Betsch (1980), lack unguicular filaments and sexual dimorphism.

Bourletiella (Deuterosminthurus) polena Christiansen and Bellinger, **new species** (Plate 148)

Color pale yellow; dark pigment limited to eyepatches. Fourth antennal segment with clear apical bulb and with 1-2 slender acuminate sensory setae sometimes vis-

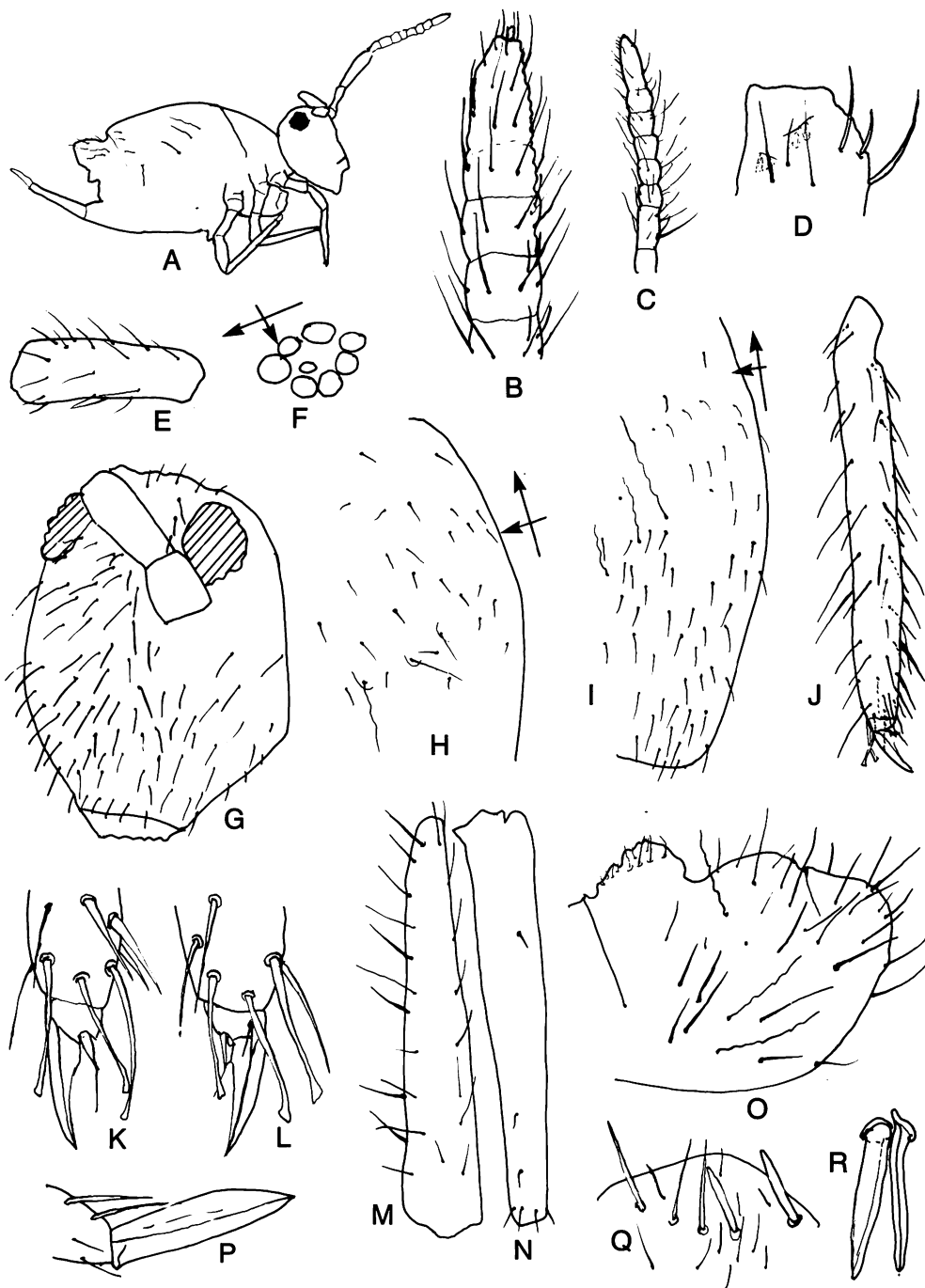
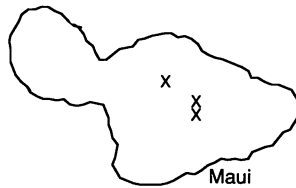


Plate 148—*Bourletiella* (*Deuterominthurus*) *polena*: A, habitus, male (5187, Maui); B, apex of antenna (paratype); C, fourth antennal segment (5184, Maui); D, apex of third antennal segment (paratype); E, second antennal segment (same); F, left eyepatch (5184, Maui); G, facial setae (holotype); H, anterior thoracic and greater abdomen dorsal setae, left side (holotype); I, same, posterior greater abdomen setae (paratype); J, hind tibiotarsus (holotype); K, fore foot complex (5184, Maui); L, hind foot complex (5184, Maui); M, dorsal surface of dens (5187, Maui); N, ventral surface, same; O, lesser abdomen and genital plate from side, male (same, specimen inverted); P, mucro (same); Q, female subanal appendages and neighboring setae (same); R, enlarged subanal appendages (same).

ible at the base of the apical subsegment and always present at the apices of the previous 2-3 subsegments. Apical organ of third antennal segment with a clear pit, inner guard seta about $\frac{1}{2}$ as long as outer, and supplementary seta small and conical and also in a pit. Eyes C and H subequal, but inner eye (D) much smaller than others. Clavate tenent hairs 3-3-2. The distal dorsal tibiotarsal seta is acuminate and very finely tapered, with the threadlike tip often bent or broken off. Unguis either without teeth or with a minute inner tooth. Unguiculi with acuminate apical filaments that do not reach the apex of the unguis; anterior filament longer than unguiculus, posterior shorter. Hind unguiculus slightly larger than others. Dorsal dental setae normal for genus (see Pl. 148M) except that L_7 is missing; Ve setae 4, 1, 1, with proximal 2 setae shorter than distance between setal bases. Circumanal setae of female not basally expanded; a supplementary A_+ seta present; P and Q more lateral than usual, with P smaller than Q. Subanal appendages tapering beyond basal $\frac{1}{4}$ of their length, with a ridge along inner margin. Setae of head and of trunk in female slender and acuminate; lateral and dorsal surfaces of male greater abdomen with many short, basally expanded, curved, acuminate setae. Both sexes with a small fourth bothriothrix near hind margin of greater abdomen, more prominent in males. Maximum length 0.95 mm.



Remarks: The small anterior ventral dental setae of this species distinguish it in the Hawaiian fauna. It resembles the nearctic *B. russata* Maynard, 1951 in many respects, but differs slightly in the shape of the female subanal appendage. The anterior unguicular filament is much smaller in *B. russata* than in *B. polena*; *B. polena* also lacks the saddle-shaped marking often found in male *B. russata*. The clavate tenent hairs are sometimes very minutely clavate.

Derivatio nominis: Hawaiian, yellowish.

Ecology: Under stones, in rotted wood and low vegetation at middle to low elevations.

Type locality: Holotype and 2 paratypes, East Maui, Rt. 377, 1.6 mi. from junction Rt. 37, VII-6-1986, eucalyptus grove, rotten wood, KC (6671).

Other records: Maui: 5184, 5187.

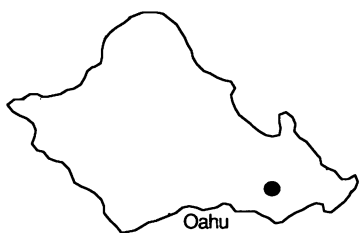
Subgenus **PRORASTRIOPE** Delamare, 1947

Type species: *Prorastriopes pulchra* Delamare, 1947

This subgenus includes species with some tibiotarsal setae heavy and abruptly flattened at the end.

Bourletiella (Prorastriopes) lipponi Snider, 1978, **new combination** (Plate 149) Great Lakes Entomol. 11:224 [*Bourletiella (Deuterostminthurus)*].—Christiansen and Bellinger, 1981.

Background color pale yellow with pigment blue in females and purple to blue in males. Female pattern of large irregular spots usually forming broad irregular bands on lateral and dorsal surfaces of the body and head. Males with pigment solidly covering lateral and dorsal surfaces of the posterior $\frac{1}{2}$ of the greater abdomen. Fourth antennal segment with apical bulb and 2 acuminate sensilla on each of apices of the subapical 2–4 subsegments. Apical organ of third antennal segment with sensilla withdrawn into a pocket with a broadly oval to triangular opening; inner guard seta distinctly shorter than outer; accessory seta peglike and acuminate. Eyes C and H subequal. Inner eye not seen. Ungues with minute inner teeth or none. Unguiculi small and with heavy subapical filaments, strongly clavate and exceeding apices of ungues, slightly smaller on fore feet than on others. Tenent hairs 3-3-2. Dens with 6 L, 7 E, and 4 Ve_1 setae; none of the dental setae strikingly larger or heavier than others. Female circumanal setae A_0 – A_3 , P, and Q all normal. Subanal appendages very narrow, truncate in plan view, acuminate and slightly curved in side view. Mucro with both edges smooth and with a basal flange that projects posteriorly (dorsally). Head and body setae smooth, slender, and acuminate, similar in size in both sexes. Maximum length 0.84 mm.



Kauai 1

Remarks: This is one of a group of species with similar sexually dimorphic patterns. Specimens with a clear lateral stripe on the head have minute unguual teeth. *Bourletiella lipponi* differs from the nearctic *B. coalingaensis* Snider, 1978 in the smaller number of subsegments of the fourth antennal segment. The neotropical species *B. cingula* Bonet, 1934 and *B. procingula* Delamare and Massoud, 1963 both appear to differ in dental setae, having a greater number of E setae. The insufficiently described nearctic species *Deuterostminthurus yumanensis* Wray, 1967 may also belong here. We had originally considered this a new species; however, R. J. Snider examined our material and concluded it was *B. lipponi*.

Ecology: Found in grass in lowland disturbed areas.

Records: Oahu: 4754, 4758, 4765, 4786, 4825. Kauai: 5196.

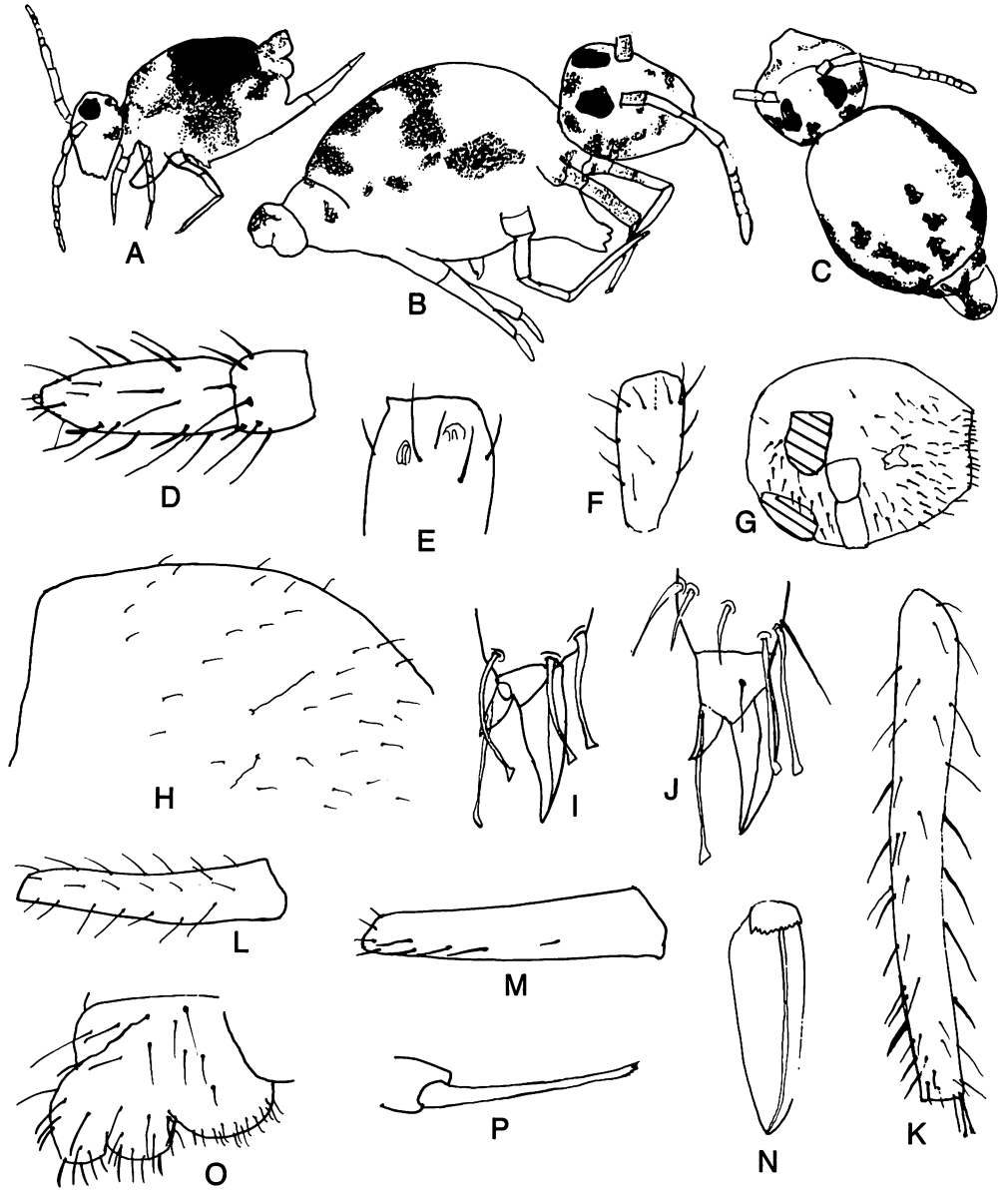


Plate 149—*Bourletiella (Prorastrisopes) lipponi*: A, habitus, male (4754, Oahu); B, habitus, female (4758, Oahu); C, habitus of another female (4754, Oahu); D, apex of antenna (same); E, apex of third antennal segment (5196, Kauai); F, second antennal segment (same); G, facial setae, male (same); H, dorsal thoracic and greater abdomen setae, left side (4758, Oahu); I, fore foot complex (4754, Oahu); J, hind foot complex (same); K, hind tibiotarsus (4758, Oahu); L, dorsal dental setae (4754, Oahu); M, ventral dental setae (same); N, mucro seen from below (same); O, male lesser abdomen and genital plate seen from side (4758, Oahu); P, female subanal appendage (4754, Oahu).

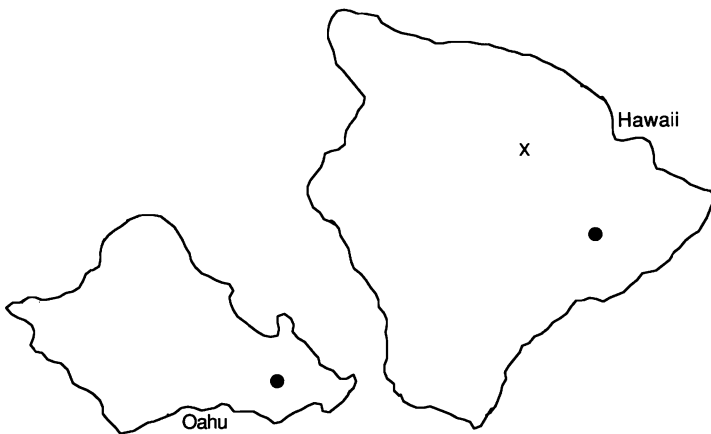
Subgenus **HETEROSMINTHURUS** Stach, 1955

Type species: *Sminthurus insignis* Reuter, 1876

Members of this subgenus have broad lamellae, ending abruptly, on the second and third unguiculi, while the first unguiculus is narrow, evenly tapered, and curved. Males of most species have some cephalic setae enlarged. There is one Hawaiian species: *B. (H.) ihu*.

Bourletiella (Heterosminthurus) ihu Christiansen and Bellinger, **new species**
(Plate 150)

Female mostly yellow with pigment in the form of a broken longitudinal band of lateral spots on the thorax and first 5 abdominal segments, continuing solid bands running through eyes to base of clypeus; antennae lightly pigmented, usually darker on apices of first 3 and all of fourth segment in both sexes. Male with heavy broken dark pigment on the dorsal, frontal, and lateral parts of head and lateral and dorsal parts of thorax, anterior and posterior parts of greater abdomen, and fifth abdominal segment, with middle of greater abdomen pale. Fourth antennal segment with clear apical bulb and minute peglike subapical organ; last 5-6 subapical subsegments each with a slender dorsal sensory seta. Apical organ of third antennal segment with sensilla in a deep common pit; guard setae subequal and supplementary seta minute and peglike. Eyes C and H subequal; inner eye not observed. Tenent hairs 3-3-2. Ungues without or (rarely) with minute inner teeth. Apical filaments of unguiculi acuminate or truncate, curved at tips, and exceeding apices of ungues. Dens with usual setae but L₃-L₆ heavy and spinelike; ventral setae 3-3-1-1-1. Mucronal edges irregularly wavy, sometimes with 1-3 spinelike folds visible in lateral view. Female circumanal setae normal except that A₀ and P are small. Subanal appendages straight and blunt in plan view, slightly curved and acuminate in side view. Body setae and female head setae slender and acuminate.



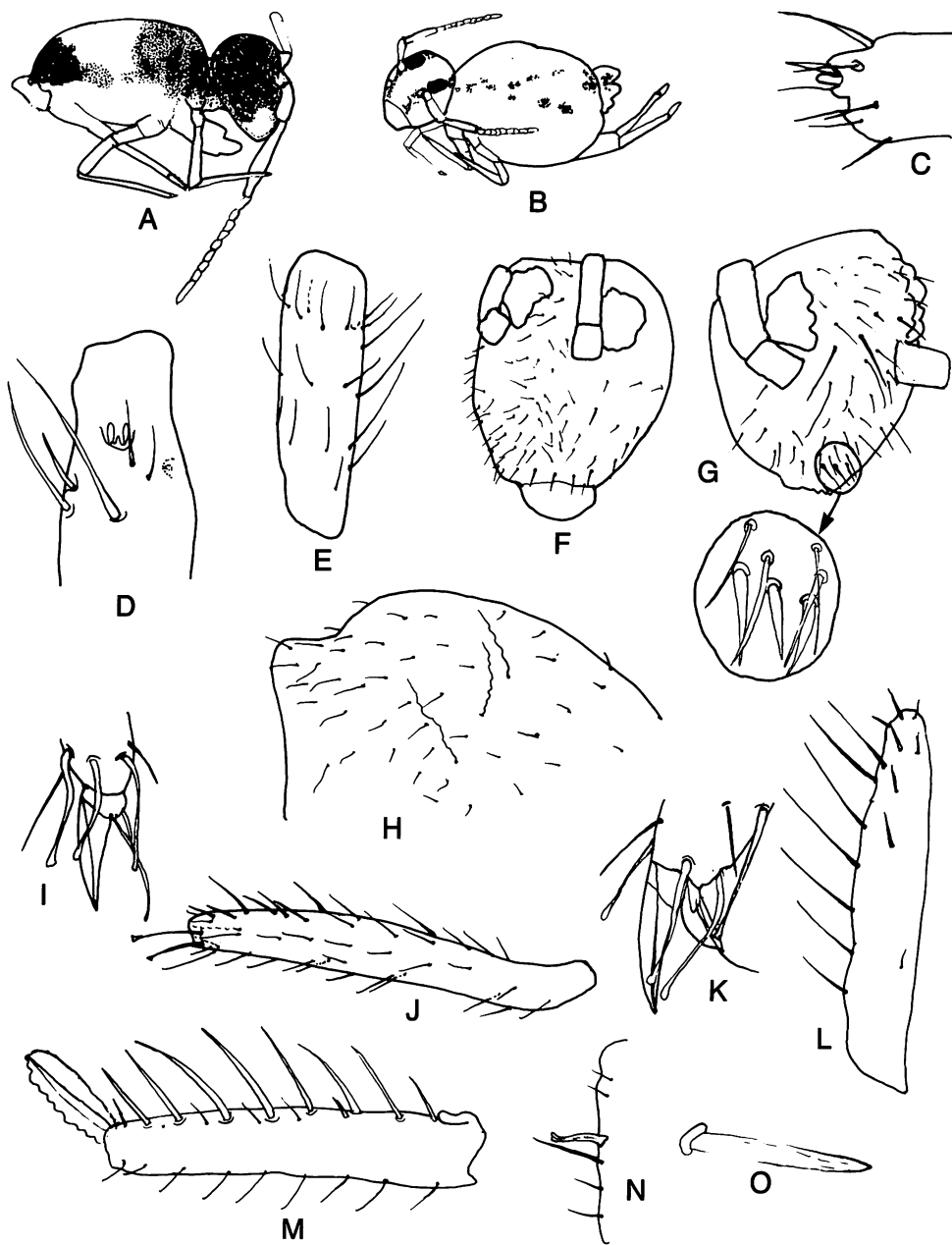


Plate 150—*Bourletiella (Heterosminthurus) ihu*: **A**, habitus, male (4725, Hawaii); **B**, habitus, female (paratype); **C**, apex of antenna (5695, Hawaii); **D**, apex of third antennal segment seen from inner face, supplementary peg on opposite face (same); **E**, second antennal segment (same); **F**, facial setae, female (5683, Hawaii); **G**, facial setae, enlarged distal setae shown (male holotype); **H**, thoracic and greater abdomen setae, right side, female (5695, Hawaii); **I**, fore foot complex (paratype); **J**, hind tibiotarsus (same); **K**, hind foot complex (same); **L**, dorsal surface, dens and mucro (4786, Oahu); **M**, ventral surface of dens (same); **N**, nasal organ, male, seen from side (4725, Hawaii); **O**, female subanal appendage (4786, Oahu).

Males with some cephalic setae much longer and heavier than others and with a clear nasal organ of 2 heavy setae and 3 heavy striate spines below them. Maximum length 1.5 mm.

Remarks: The females vary in color from that described above to almost entirely yellow. One of the four males seen had a pattern like that of the females. In the presence of the male nasal organ and other characters *B. ihu* resembles *Heterosminthurus undulans* Yosii and Lee, 1963. That species has a different pattern and is said to have the sensilla of the third antennal segment apical organ not in a groove, and no modified setae on the fourth antennal segment.

Derivatio nominis: Hawaiian, nose.

Ecology: Found on grass and sticks in open areas at intermediate elevations.

Type locality: Holotype and 3 paratypes, Hawaii, Niaulani cabin, 1 mi. from Volcano House, Volcanoes National Park, I-24-1967, lawn, sweeping, PB (4727).

Other records: Hawaii: 4725, 5683, 5695. Oahu: 4753, 4786.

Genus **SPHYROTHECA** Börner, 1906

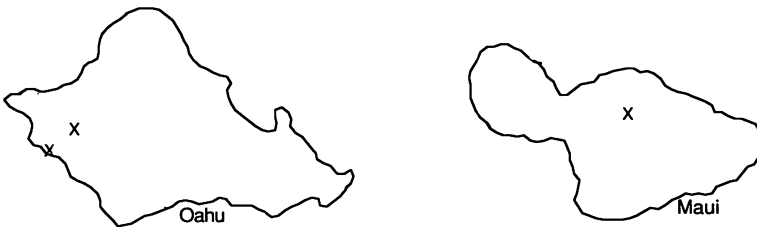
Type species: *Sminthurus multifasciatus* Reuter, 1881

This genus includes Hawaiian sminthurids with the fourth antennal segment longer than the third and subsegmented, 8 + 8 eyes, and dorsal spinelike setae on the head and trunk. The hind trochanter has an inner spine. There is a single Hawaiian species.

Sphyrotheca nani Christiansen and Bellinger, **new species** (Plate 151)

Background color pale yellow; blue (light to dark) or purple pigment confined to eyes and antennae, and forming lightly to darkly mottled patches on sides of body and dorsal surface of head. Fourth antennal segment with 8–9 subsegments. Third antennal segment with apical sense pegs in 2 deep separate pits. Ungues all with heavy tunica and inner tooth, larger on fore unguis than on others. Unguiculus with a minute corner tooth; subapical filament acuminate, medially thickened, and exceeding apex of unguis. Tenent hairs acuminate. Trochanteral spine apically knobbed. Tenaculum with 4 setae. Dens with 10–15 dorsal and 1 basal and 3 apical ventral setae. Inner edge of mucro weakly serrate; outer edge smooth; mucronal seta absent. Female subanal appendages acuminate, curved, and weakly ciliate on apical portion. Dorsal cephalic and trunk spines straight and fusiform. Cephalic spines heavy, straight, and acuminate. Maximum length 1.3 mm.

Molokai 2



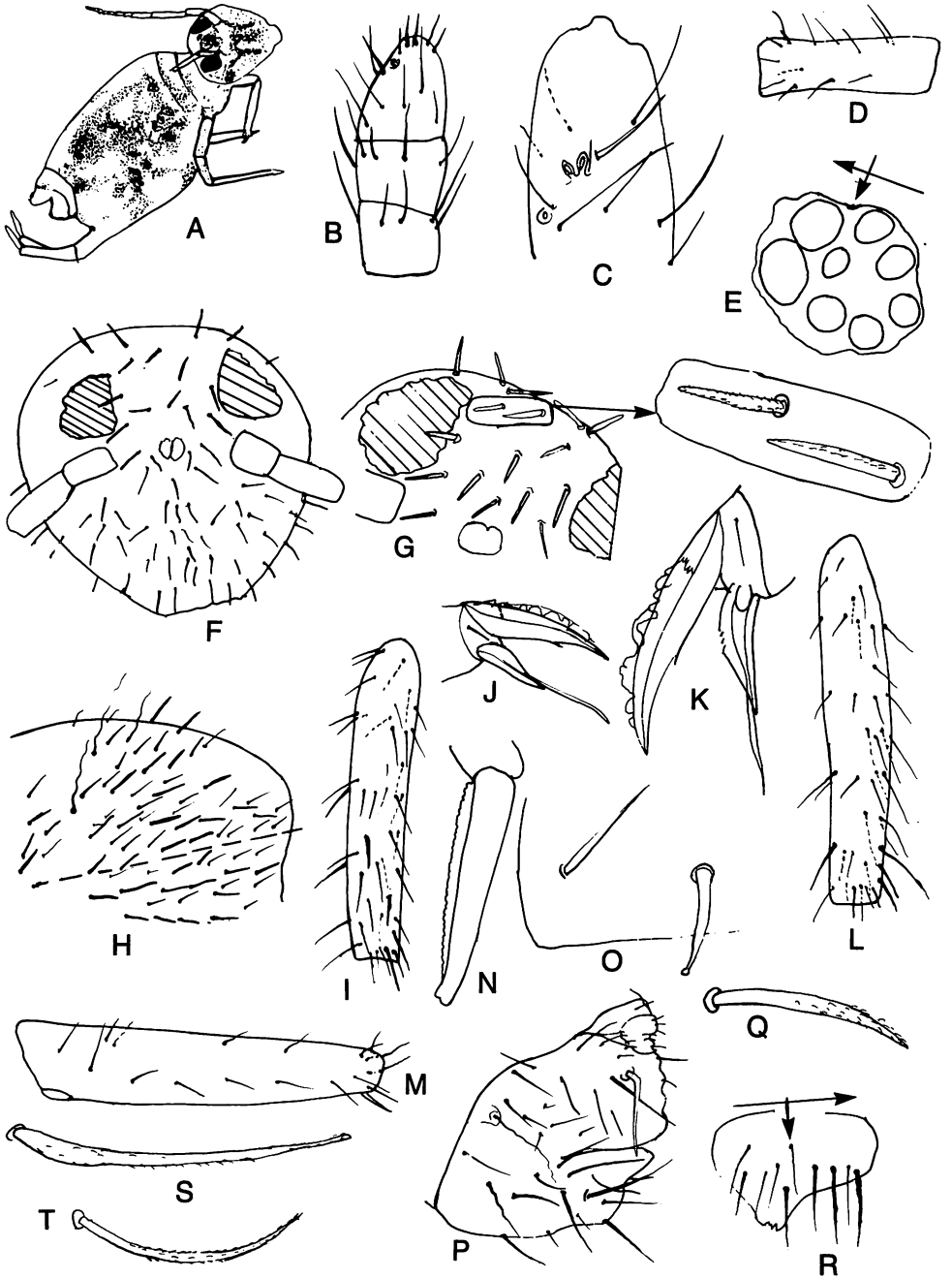


Plate 151—*Sphyrotheca nani* (all figures except E, R, and T of type specimens): A, habitus; B, apex of fourth antennal segment, anterior face; C, apex of third antennal segment, posterior face; D, second antennal segment; E, left eyepatch, margins of eyes obscured by heavy pigment (5113, Molokai); F, facial chaetotaxy; G, enlargements of spines in facial chaetotaxy; H, greater abdomen dorsal chaetotaxy, right side; I, fore tibiotarsus; J, fore foot complex; K, hind foot complex; L, hind tibiotarsus; M, dens seen from above; N, mucro; O, trochanteral spine; P, circumanal setae, right side; Q, female subanal appendage; R, male genital plate (5113, Molokai); S, large abdominal seta; T, same (5291, Oahu).

Remarks: This species resembles *S. multifasciata* (Reuter, 1881) in many respects but differs in having acuminate rather than heavily blunt cephalic spines. It also differs in having a more clearly serrate inner mucronal edge and in details of the chaetotaxy of the anogenital segments. The overall similarity is sufficient that these may represent the same taxon; however, we feel it best to consider them as distinct for the present. *Sphyrotheca nani* may be distinguished from *S. nepalica* Yosii, 1966 by its smooth outer mucronal margin and stouter facial spines. It can be distinguished from *S. implicata* Hüther, 1967 by the much longer unguicular filament on the hind foot as well as details of the circumanal chaetotaxy.

Two single specimens [one immature from Oahu (4838) and one mature from Maui (6672)] have darker patterns and 10 antennal subsegments. They were both taken in lowland disturbed areas and probably represent a separate taxon; however, more material is needed to determine whether they are part of the variation of *S. nani*.

Derivatio nominis: Hawaiian, pretty or beautiful.

Ecology: Found in moss and understory vegetation in rain forest or swamp areas, 3000–4000 ft. elevation.

Type locality: Holotype and 5 paratypes, Molokai, near Nature Conservancy cabin (Cabin Puu Kolekole), leeward side of mountains, I-13-1983, 3000 ft., rain forest understory, beating, KC (5722).

Other records: Maui: 6672. Molokai: 5113. Oahu: 4838, 5291.

Genus **DICYRTOMA** Bourlet, 1842

Type species: *Papirius fuscus* Lubbock, 1873

This genus includes all the Hawaiian sminthurids with the fourth antennal segment shorter than the third. The filaments of the ventral tube are warty; the tenaculum has 3 + 3 teeth and a pair of basal fingerlike projections; the mucronal seta is absent and the bothriothrix A arises from a papilla that also bears a cup sensilla. The chaetotaxy of this genus is quite regular. We show here the designation of the major setae used in *The Collembola of North America*. A number of additional taxonomic features have been used by Deharveng, Snider, and others. One of these, the cup sensilla, is used in this work. These structures (see Fig. 120–126) have distributions that offer valuable species criteria.

There are 11 Hawaiian species, all endemic. Ten of these species were discovered in the course of this work. Given the localization of most species, it is likely that more species remain to be discovered in the Islands. The species may be placed in three subgenera: *Calvatomina*, with a tunica on the unguis; *Papirioides*, with a tubercle on the greater abdomen; and *Ptenothrix*, lacking these two specializations.

R. J. Snider (personal communication) has made a strong case for the separation of *Ptenothrix*, with *Papirioides* as a subgenus, from *Dicyrtoma*, with subgenus *Calvatomina*. We agree that the recognition of two genera accurately reflects apparent phylogeny; however, we prefer not to make the revision here because of practical problems.

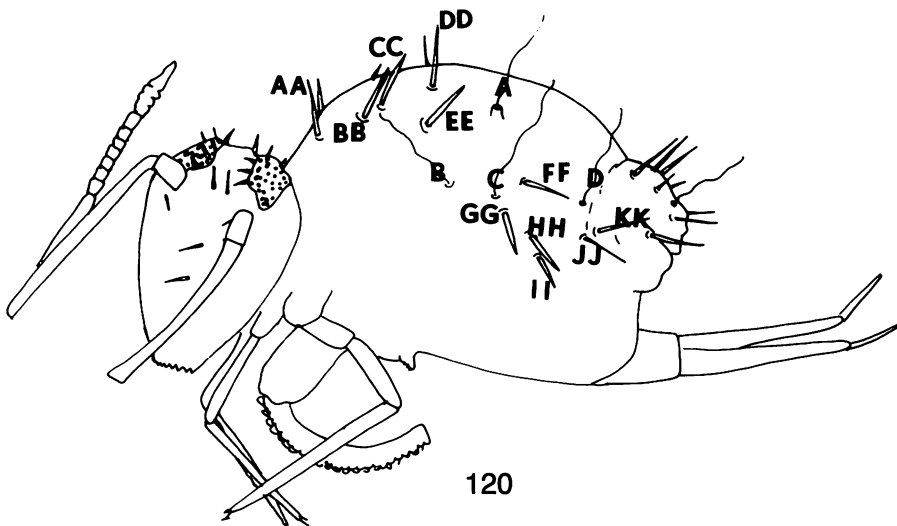


Figure 120—Normal distribution of bothriotricha (single letters A-D) and heavy spinelike setae (double letters) on thorax and greater abdomen of *Dicyrtoma*.

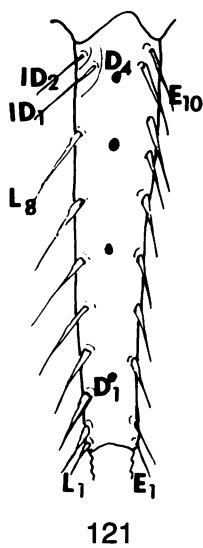
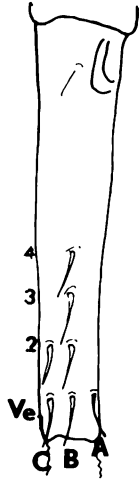
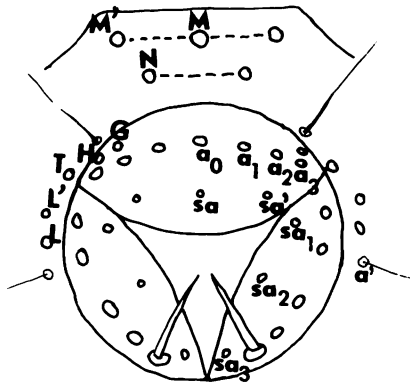


Figure 121—Normal dorsal dental chaetotaxy of *Dicyrtoma*.



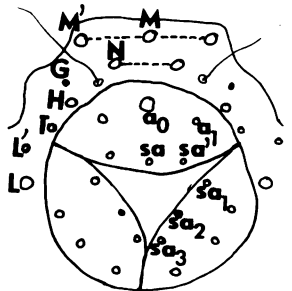
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Figure 122—Normal ventral dental chaetotaxy of *Dicyrtoma*.



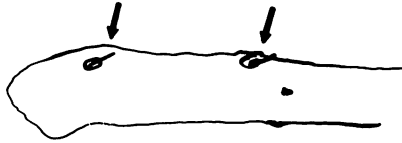
123

Figure 123—Female circumanal chaetotaxy in *Dicyrtoma*.



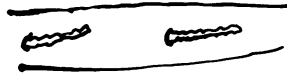
124

Figure 124—Male circumanal chaetotaxy in *Dicyrtoma*.



125

Figure 125—Cup sensilla of *Dicyrtoma*.

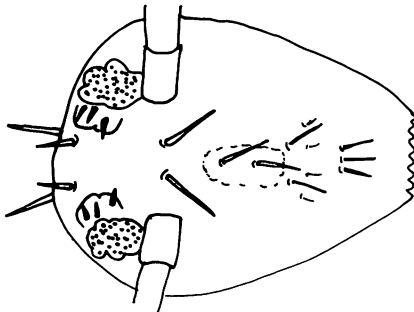


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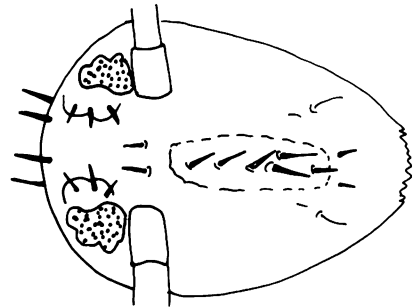
Figure 126—Hind tibiotarsus of *Dicyrtoma* (*Ptenothrix*) with modified setae.

KEY TO HAWAIIAN SPECIES OF DICYRTOMA

- 1. Two median unpaired facial setae, spinelike (Fig. 127A)..... **D. (*Ptenothrix*) hawaiiensis**
- Five to seven median unpaired facial setae (Fig. 127B)..... 2

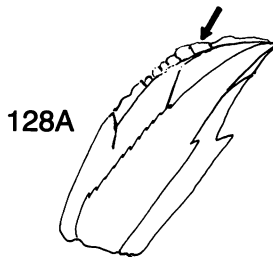


127A

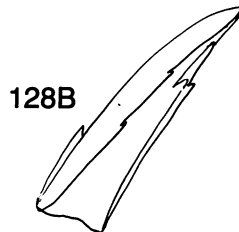


127B

- 2(1). Unguis with tunica (Fig. 128A)(subgenus *Calvatomina*)..... 3
- Unguis without tunica (Fig. 128B)(subgenus *Papirioides*)..... 9

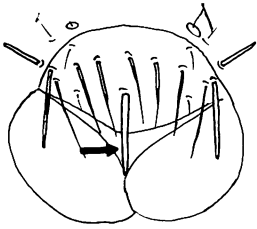


128A

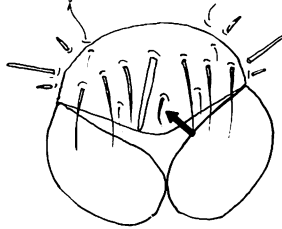


128B

- 3(2). Circumanal seta A_0 spinelike (Fig. 129A)..... 4
 Circumanal seta A_0 not spinelike (Fig. 129B)..... 5

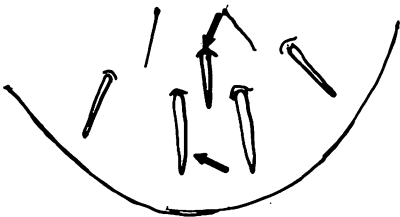


129A

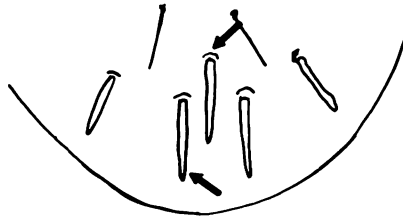


129B

- 4(3). All M setae much smaller than N setae (Fig. 130A).... **D. (*Calvatomina*) madestris**
 Median M seta similar in size to N setae (Fig. 130B).....
 **D. (*Calvatomina*) microdentata**



130A



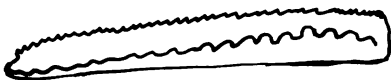
130B

- 5(3). Body uniformly purple except for scattered pale spots (Fig. 131).....
 **D. (*Calvatomina*) longidigita**
 Body with patches or bands of pigment..... 6



131

- 6(5). Outer mucronal edge much more finely serrate than inner (Fig. 132A).....
 **D. (*Calvatomina*) sylvestratilis**
 Serration widths of outer and inner edges of mucro similar (Fig. 132B)..... 7



132A



132B

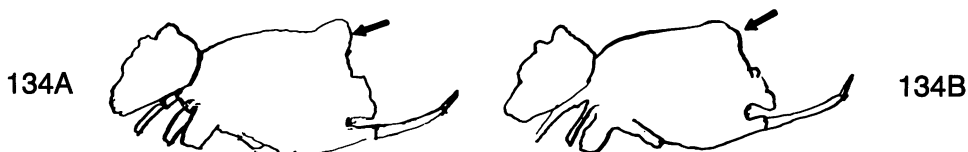
Table 32. Characteristics of Hawaiian Species of *Dicyrtoma* s.l.

SPECIES	ANT. SEG- MENT IV SUBSEG- MENTS	ANT. SEG- MENT III SUBSEG- MENTS	UNPAIRED MEDIAN FACIAL SETAE	HIND	TENA- CULAR SETAE	DENTAL SETAE E ₁ /E ₂
				UNGUICULUS + FILAMENT		
Subgenus <i>Calvatomina</i>						
<i>bellingeri</i>	0	0	6	0.83	4	1.2
<i>brevifibra</i>	0	0	5	0.70-0.73	4	0.81
<i>longidigita</i>	0	0	5	0.48	4	1.0
<i>maderstris</i>	0	0	5	0.85-0.90	4	1.0-1.25
<i>microdentata</i>	0	0	5	0.85	4	1.1
<i>sylvestralis</i>	0	0	5-7	0.83-0.87	4	1.2-1.4
<i>tesselata</i>	0	0	5	0.76-0.83	4	0.95-1.1
Subgenus <i>Papirioides</i>						
<i>dubia</i>	5	7	7	0.52-0.56	6	1.2-1.7
<i>kauaiensis</i>	5	7	4-5	0.58-0.68	4	0.7-0.9
<i>serrata</i>	5	7	5-7	0.51-0.58	5-6	1.5-2.35
Subgenus <i>Ptenothrix</i>						
<i>hawaiiensis</i>	4	8	2	0.51-0.6	4	0.75-0.95

- 7(6). Fore unguiculus with corner tooth (Fig. 133A). 8
 Fore unguiculus without corner tooth (Fig. 133B). **D. (*Calvatomina*) *brevifibra***



- 8(7). M and N spines subequal. **D. (*Calvatomina*) *bellingeri***
 M spines distinctly smaller than N. **D. (*Calvatomina*) *tesselata***
 9(2). Greater abdomen with strong dorsal projection (Fig. 134A).
 **D. (*Papirioides*) *dubia***
 Greater abdomen with weak arcuate dorsal projection (Fig. 134B). 10



DENTAL SETAE E_3/E_2	ANTERIOR SETAE OF GREATER ABDOMEN MODIFIED AS SPINES	LENGTH OF POSTERIOR DORSAL SPINES OF GREATER ABDOMEN	LENGTH OF M SETAE	CIRCUMANAL SETAE MODIFIED AS SPINES, BLUNT, OR SHORT CONICAL SETAE					
			LENGTH OF N SETAE OF LESSER ABDOMEN	M	A ₀	T	L	H	G
1.25	-	0.022-0.036	0.93-0.95	3	-	-	+	+	small
1.6	-	0.033	0.75-0.83	3	-	-	+	+	+
1.1	-	0.026-0.029	0.70	3	-	-	+	+	-
0.9-1.0	-	0.017-0.025	0.30-0.39	0	+	-	+	+	-
1.2	-	0.022	1.0	1	+	-	+	+	-
1.3	-	0.022-0.028	0.91-0.95	3	-	-	+	+	-
1.1-1.3	-	0.028-0.033	0.74-0.81	3	-	-	+	+	+
2.2-3.0	DD(EE)	0.028-0.039	0.95-1.1	3	+	+	-	+	-
2.0-2.80	BB,DD,EE	0.22-0.33	1.0-1.4	3	-	+	-	+	-
2.6-3.4	(AA),DD	0.029-0.038	0.90-1.2	3	+	-	+	+	-
1.80-1.85	AA-FF	0.020	1.14-1.29	3	+	+	-	+	+

- 10(9). Circumanal seta A₀ not spinelike (Fig. 129B) **D. (Papirioides) kauaiensis**
 Circumanal seta A₀ spinelike (Fig. 129A) **D. (Papirioides) serrata**

Subgenus **PAPIRIOIDES** Folsom, 1924

Type species: *Papirioides jacobsoni* Folsom, 1924

This subgenus includes species with a spine-bearing protuberance on the posterior dorsum of the greater abdomen. They also have facial and dorsal cephalic spines and spines on the anterior part of the greater abdomen and all four bothriotracha. The unguis lack a tunica, and the posterior tibiotarsus has two serrate blunt setae. They resemble the subgenus *Ptenothrix* in all these features save the abdominal protuberance. There are three Hawaiian species of *Dicyrtoma (Papirioides)*: *dubia*, *kauaiensis*, and *serrata*.

Dicyrtoma (Papirioides) dubia (Folsom, 1932) (Plate 152)

Proc. Hawaii. Entomol. Soc. 8:74 (*Ptenothrix*).

Background color yellow; mottled blue pigment mostly on lateral and ventral surfaces of body and head below level of eyes; antennae and furcula dark; legs dark from base to middle of tibiotarsus. Fore tibiotarsus with 4 and mid with 5 cup sensillae. Hind tibiotarsus with 6 cup sensillae and 2 large blunt serrate setae. Foot complex similar on all feet. Unguis with 2 strong inner and 2 + 2 strong lateral

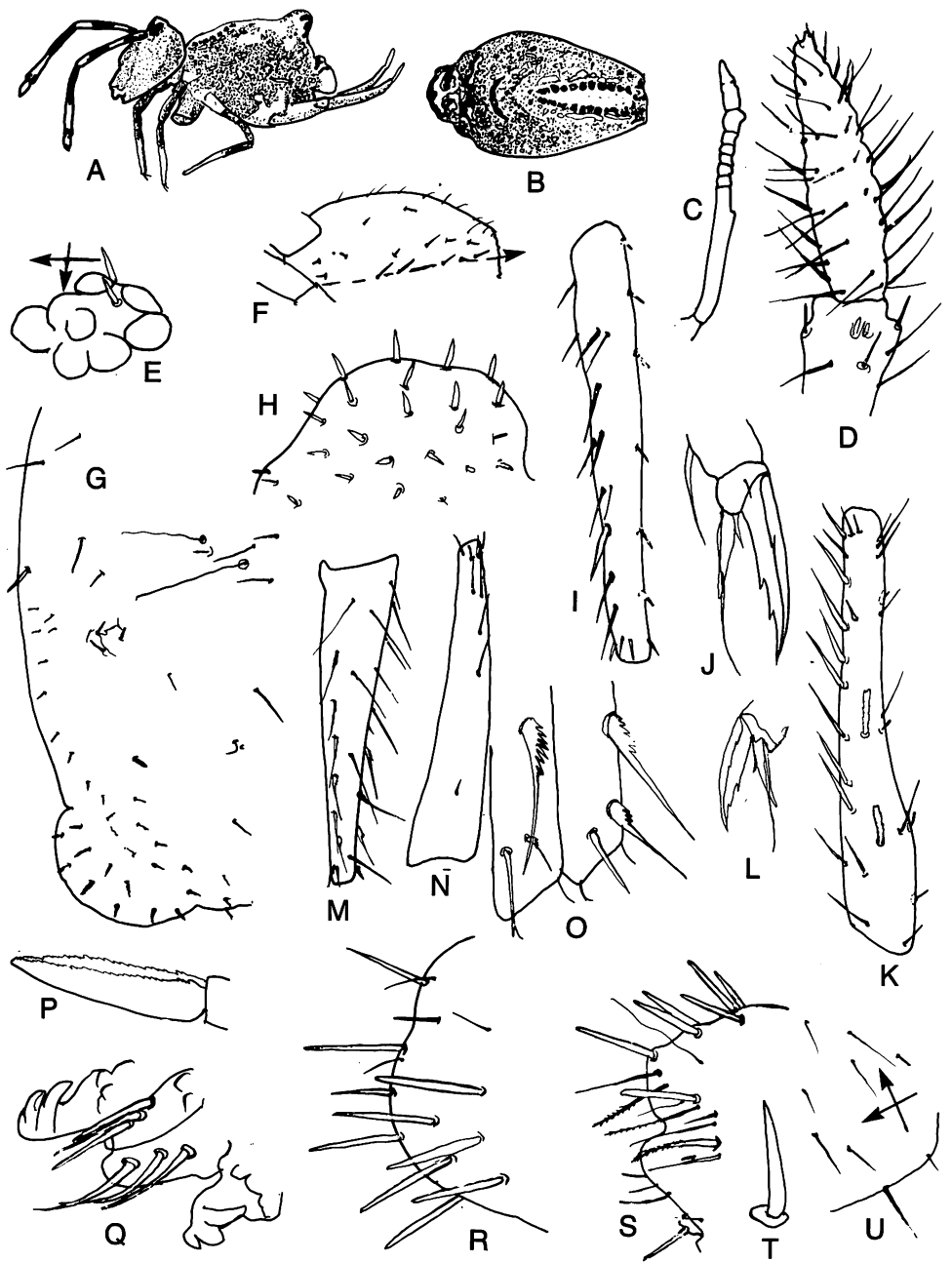
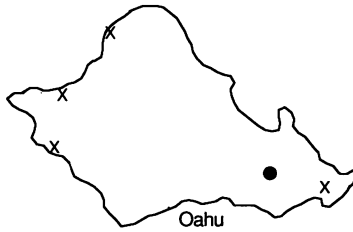


Plate 152—*Dicyrtoma (Papirioides) dubia* (all specimens from Oahu): A, habitus (after Folsom); B, pattern of dorsum (same); C, third and fourth antennal segments (4779); D, fourth antennal segment and apex of third, dorsal view (4827); E, left eyepatch (same); F, facial chaetotaxy, left side (same); G, dorsal thorax and greater abdomen chaetotaxy, left side, female (4779); H, enlargement, chaetotaxy of hump (same); I, posterior face, fore tibiotarsus (same); J, fore foot complex (same); K, posterior face, hind tibiotarsus (same); L, hind foot complex (same); M, dorsal surface, dens (4829); N, ventral surface (same); O, enlargement of inner and outer surfaces, apex, dorsal surface of dens (4779); P, mucro (same); Q, tenaculum (4827); R, lesser abdomen chaetotaxy, male, seen from above and slightly to one side (4779); S, same chaetotaxy, female specimen (same locality); T, female subanal appendage (4827); U, left parafurcular lobe (4832).

teeth, the basal lateral teeth serrate basally. Unguiculus with a single strong corner tooth and a subapical filament about as long as the unguiculus. Dental setae L_1 - L_7 and E_1 - L_9 serrate; L_2 to L_4 or L_5 and E_2 to E_3 or E_4 with many coarse serrations, others with only 1-4 small teeth. Female subanal appendage straight, smooth, and acuminate. Mucro with outer lamella slightly more finely serrate than inner and with a distinctly larger tooth about $\frac{1}{3}$ of its length from the base. Dorsal abdominal projection large and sharply set off. Setae AA, BB, EE, and II are large and acuminate, but only DD and sometimes EE are large and weakly spinelike. Heavy posterior short spines on the greater abdomen are limited to the hump area. Bothriothrix D present but short. Maximum length 2.3 mm.



Remarks: Bothriothrix D has a shorter similar seta directly above it. We did not see the double-striped pattern illustrated by Folsom in our samples. Specimens we have seen are readily separated from other Hawaiian species by the large and prominent hump and the oddly marked legs with only the basal half of the tibiotarsus pale.

Ecology: Found in open woods at middle elevations.

Type locality: Oahu, Honolulu, Tantalus, Hering Valley, VII-31-1929, on damp boulder, Williams.

Additional records: Oahu: 4779, 4817, 4827, 4828, 4829, 4832, 4838, 5222, 5225.

Dicyrtoma (Papiroides) kauaiensis (Snider, 1990), **new combination** (Plate 153)

Zool. Scr. 19:75 [*Ptenothrix (Papiroides)*].

Color yellow with purple pigment limited to a broken middorsal line on the posterior portion of the greater abdomen and small scattered patches elsewhere on the head and body; antennae purplish; legs banded with purple. Fore tibiotarsus with 4, and mid and hind with 5 cup sensillae. Foot complex similar on all legs. Unguis with 2 inner teeth, the basal one smaller than the apical, and 2 + 2 complex lateral teeth. Unguiculus with a strong inner tooth and a knobbed subapical filament, slightly longer than the unguiculus on the first 2 feet and slightly shorter and less heavily knobbed on the hind foot. Dental setae E_2 - E_3 and L_1 - L_6 strongly serrate; E_1 , E_7 - E_8 , and L_7 - L_8 weakly serrate, E_6 weakly to strongly serrate. Inner mucronal lamella with serrations blunter and more numerous than those on outer lamella. Female subanal appendage curved and acuminate. Dorsal abdominal projection

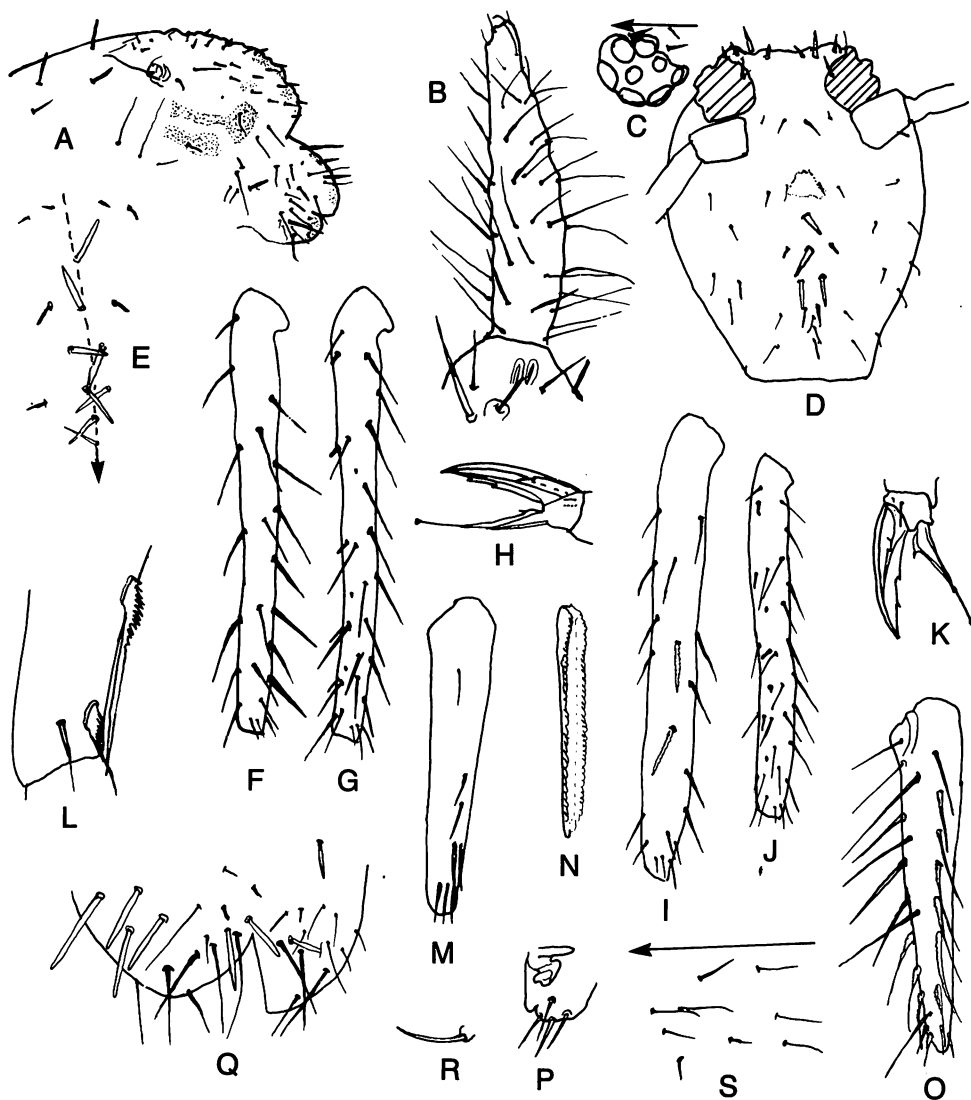


Plate 153—*Dicyrtoma (Papirioides) kauaiensis*: A, posterior habitus (after Snider); B, dorsum of fourth antennal segment and apex of third (holotype); C, eyepatch (after Snider); D, facial chaetotaxy (paratype); E, inner facial setae (after Snider); F, posterior face, midtibiotalarsus (same); G, anterior face, same (same); H, anterior foot complex (same); I, posterior face, hind tibiotalarsus (same); J, anterior face, same (same); K, hind foot complex (same); L, details of distal dorsal dental setae (paratype); M, ventral surface of dens (same); N, mucro (after Snider); O, dorsal surface of dens (same); P, tenaculum (same); Q, lesser abdomen seen from side (same); R, female subanal appendage (same); S, parafurcular lobe setae (same).

low and arcuate, with many short spines. Dorsum of greater abdomen with setae BB, EE, and usually DD large and spinelike. In addition to this the posterior dorsum has 2-4 rows of short spinelike setae. Maximum length 1.1 mm.

Remarks: This species is readily distinguished from other Hawaiian *Dicyrtoma* by the large number of spinelike setae and the knobbed unguicular filaments.

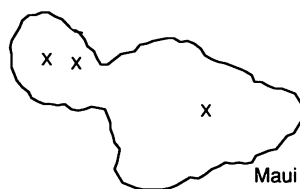
Ecology: Known only from the type locality.

Type locality: Kauai, Wailua River crossing on paved road, inland from experiment station, I-18-1967, PB (4745).

***Dicyrtoma (Papiroides) serrata* (Snider, 1990), new combination (Plate 154)**

Zool. Scr. 19:79 [*Ptenothrix (Papiroides)*].

Antenna purple-blue except distal and basal portions of second antennal segment, which are light; band of purple on lower frons, with irregular mosaics concentrated on gena; macula of blue between eyepatches, head otherwise light. Body irregularly mottled, with faint wash of blue, middorsal line on anterior $\frac{1}{2}$, lower anal valves bluish, upper valve distally blue. Legs banded. Manubrium-dens purple-blue, becoming darker distally; mucro blue. Fore tibiotarsus with 4 and mid tibiotarsus with 6 cup sensillae. Hind tibiotarsus with 5 cup sensillae and 2 large heavily serrate blunt setae. Foot complex similar on all legs. Unguis with 2 inner teeth and 2 + 2 complex lateral teeth. Unguiculus with a strong inner tooth and slightly longer than the truncate apical filament. Dental setae E_3 - E_6 and L_2 - L_5 moderately serrate basally; E_2 , E_7 , L_1 , and L_6 weakly serrate. Mucro with serrations similar on inner and outer margins. Female subanal appendage thick, straight to slightly curved apically, and with apical $\frac{1}{3}$ more sharply tapered than base. Dorsal abdominal projection low and blunt. Bothriothrix D short and with a similar shorter seta directly above it. Dorsal setae all small. The anterior setae DD and sometimes EE slightly spinelike, but the only clearly spinelike setae are in the posterior inner 2 to 4 rows of setae. Maximum length 2.2 mm.



Oahu 2

Remarks: The very low hump is replaced on some specimens by an area that does not project but is outlined by lines, suggesting that the organ has collapsed. This difference in the dorsal hump distinguishes it from the similar *D. dubia*, from which it also differs in pattern and in the different sizes of the M and N setae.

Ecology: Found in forests, on vegetation, in litter, and on rocks.

Type locality: Oahu, Honolulu, Mt. Tantalus, XI-1966, 1000 ft., pan trap, Vockeroth (4827).

Additional records: Maui: 5173, 5174, 5265. Oahu: 5222.

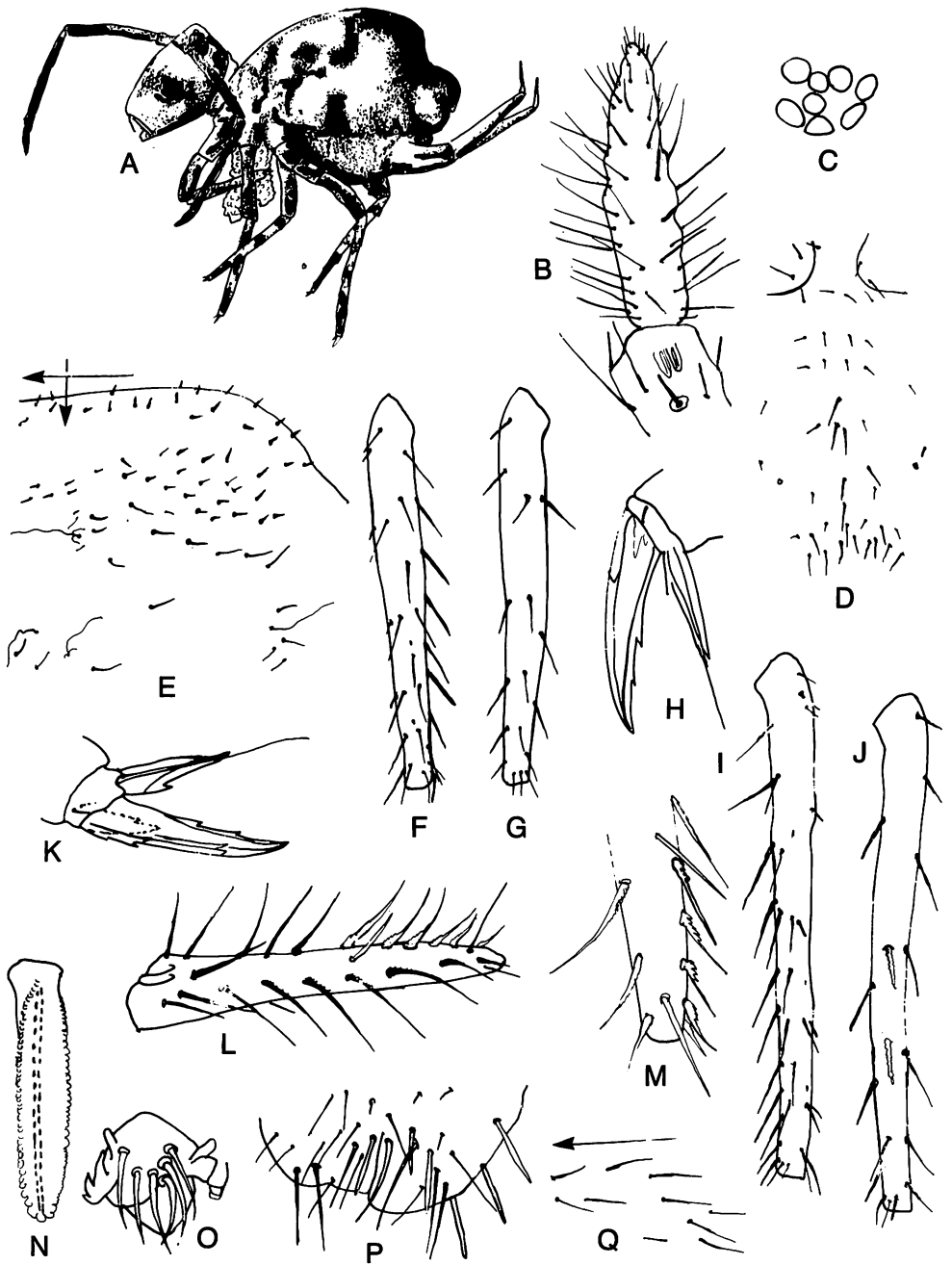


Plate 154—*Dicyrtoma (Papirioides) serrata*: A, habitus (after Snider); B, dorsum of fourth antennal segment and apex of third (paratype); C, eyepatch (after Snider); D, facial chaetotaxy, left side (same); E, chaetotaxy of thorax and greater abdomen, left side (same); F, anterior face, fore tibia (same); G, posterior face, same (same); H, anterior face, hind tibia (same); I, anterior face, hind tibia (same); J, posterior face, same (same); K, hind foot complex (same); L, dens (same); M, detail of dorsal apex of dens (paratype); N, mucro (after Snider); O, tenaculum (same); P, lesser abdomen, seen from side (same); Q, parafurcular lobe setae (same).

Subgenus **PTENOTHRIX** Börner, 1906

Type species: *Podura atra* Linnaeus, 1758

This subgenus includes species of *Dicyrtoma* that resemble *Papirioides* except for the absence of the abdominal hump. There is a single Hawaiian species, *D. (P.) hawaiiensis*, which differs from typical *Ptenothrix* in having many small spines at the location of the hump, as in subgenus *Papirioides*; its placement here is somewhat arbitrary.

Dicyrtoma (Ptenothrix) hawaiiensis (Snider, 1990), **new combination** (Plate 155)

Zool. Scr. 19:74 [*Ptenothrix (Ptenothrix)*].

Background dull white; blue pigment distributed in following patterns. Antenna uniformly blue. Vertex of head with blue maculae, dark blue-black patch between ocelli; frons and gena with irregular blue mosaics. Great abdomen with blue mosaics forming irregular lateral patterns. Legs with blue banding at intervals. Furcula light blue. Lesser abdomen blue with flecks of blue-black. Ocular and cephalic spines well developed; posterior ocular spines much larger than others. Fore and mid tibiotarsi with 4 cup setae. Hind tibiotarsus with 5 cup setae and 2 heavily serrate, truncate setae on inner surface. Foot complex similar on all legs. Unguis without tunica, with 2 strong inner teeth and 2 + 2 complex lateral teeth. Unguiculus with a strong corner tooth and a weakly knobbed apical filament about as long as the unguiculus; knob of filament weaker on hind foot. Dental setae normal in number and position; all L setae and E₁-E₈ serrate, with serrations coarsest on L₂ and E₂ and becoming progressively finer on more anterior setae. Mucro with inner and outer lamellae similarly serrate. Female subanal appendage curved, gradually tapered, and acuminate. Dorsal abdominal projection absent, but a differentiated patch bearing many short spines in the corresponding location. Trunk setae AA through FF all large and spinelike. Maximum length 2.0 mm.

Remarks: This striking species resembles *D. (Papirioides) kauaiensis* in some respects, but is easily distinguished by the pattern, facial spines, absence of a dorsal hump, and spinelike A₀ seta.

Type locality: Hawaii, Lava Tree State Park, I-20-1982, beating vegetation, KC (5131).

Additional record: Maui: 5265.

Subgenus **CALVATOMINA** Yosii, 1966

Type species: *Dicyrtomina (Calvatomina) cruciata* Yosii, 1966

This subgenus includes species of *Dicyrtoma* with a well-developed unguis and complex lateral pseudonychia, and lacking bothriothrix D. The Hawaiian species share the following characters as well: antennae without subsegments, five to six unpaired median facial setae, no spines on the head or anterior part of the

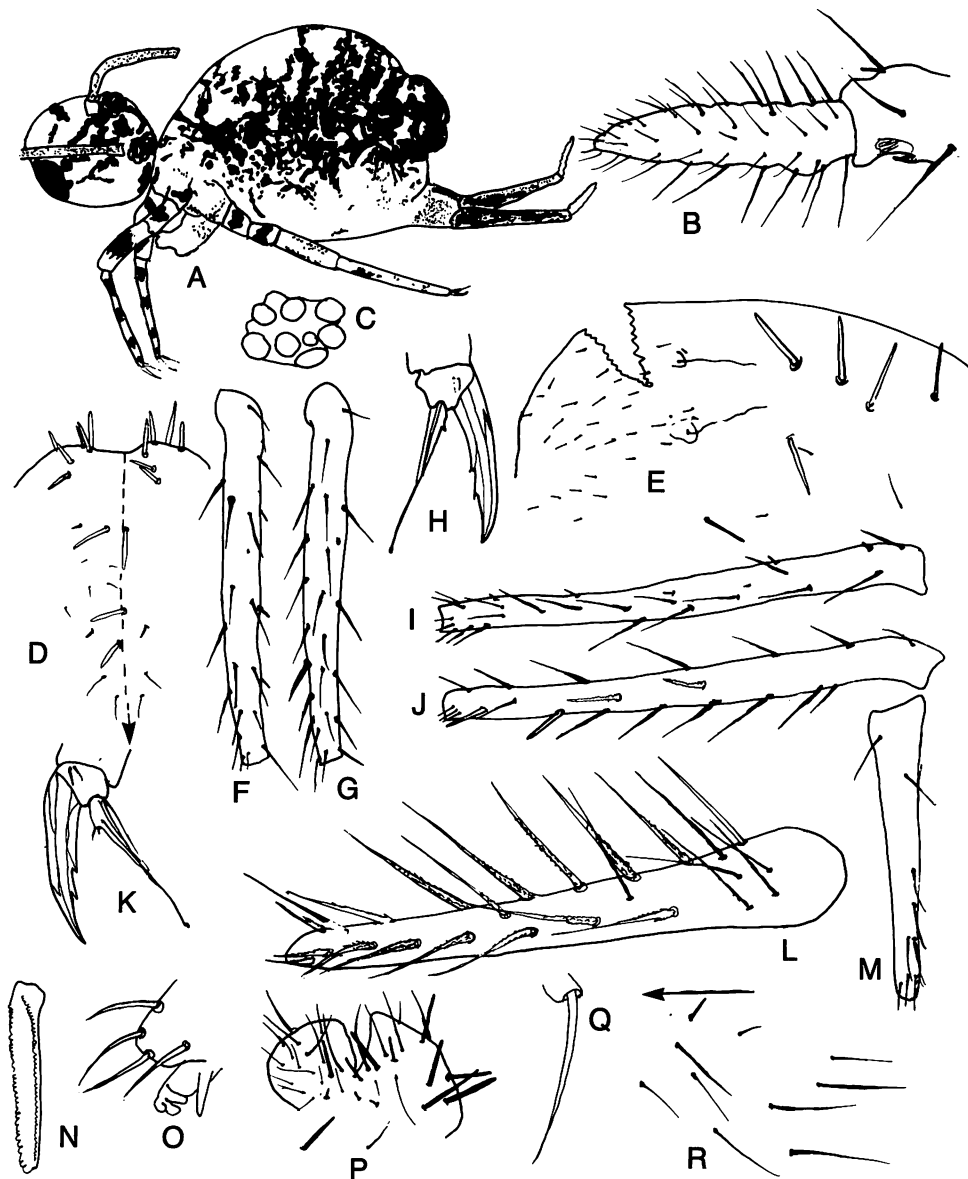


Plate 155—*Dicyrtoma (Plenothrix) hawaiiensis*: A, habitus (after Snider); B, fourth antennal segment and apex of third (holotype); C, eyepatch (after Snider); D, median facial setae (same); E, dorsal chaetotaxy of thorax and greater abdomen, right side (paratype); F, anterior face, fore tibia (after Snider); G, posterior face, same (same); H, fore foot complex (same); I, anterior face, hind tibia, (same); J, posterior face, same (same); K, hind foot complex (same); L, dorsal surface of dens (same); M, ventral surface, dens (same); N, mucro (same); O, tenaculum (same); P, lesser abdomen from side (same); Q, subanal appendage of female (paratype); R, parafurcular lobe setae (after Snider).

greater abdomen, many small spines on the posterior half of the greater abdomen, acuminate unguicular filaments, no serrate spines on the hind tibiotarsus but with short differentiated setae, all dental setae smooth. There are seven Hawaiian species of *Dicyrtoma* (*Calvatomina*): *bellingeri*, *brevifibra*, *longidigita*, *maestrus*, *microdentata*, *sylvestratilis*, and *tesselata*.

***Dicyrtoma* (*Calvatomina*) *bellingeri* Snider, 1990 (Plate 156)**

Zool. Scr. 19:90.

Background white with brown-purple pigment laid down in irregular polygons. Antenna distally dark purple-blue, becoming lighter basally. Vertex of head with light purple macula between eyepatches and flanked by smaller, darker maculae. Frons with purple mosaics forming an irregular band extending to postgenal area. Lower frons with medial macula, frontal oral area bordered with purple mosaics. Body with purple lateral band becoming darker posteriorly; a large purple V posterodorsally and pair of light purple rectangular patches. Upper and lower valves of anal papilla with ventral purple spots. Legs from lower femur distally with purple-blue, colophore and furcula with light purple dusting. Fore tibiotarsus with 4 and mid and hind with 5 cup sensillae. All unguis with pseudonychia, outer tooth, and 2 inner teeth. Fore unguiculus with subapical filament exceeding apex of unguis and with 1 sharp corner tooth. Mid and hind unguiculi with 2 corner teeth and with subapical filament just reaching apex of unguis. Mid unguiculus with a small subapical tooth. Dens with 10 E setae, with setae 2 and 3 displaced toward a median position. Mucro with both margins coarsely serrate. Female subanal appendage heavy, sharply tapered, and curved at apex. Bothriothrix A short, on a large papilla bearing a cup sensilla. No large anterior spinelike setae present; however, there are 4–6 rows of short to moderate dorsal and lateral spines starting from slightly anterior to the A bothriothrix. Maximum length 0.85 mm.

Remarks: This species is one of a series of Hawaiian species related to *D. formosana* Yosii, 1965. Among these it is most closely related to *D. tessellata*. It can be distinguished from this species by the unguis dentition, dental E setae, pattern, and the relative lengths of the M and N spines. It is known only from the type locality.

Type locality: Kauai, Na Pali wilderness area, near Hanakoa camp site, VII-22-1986, 400 ft., near stream bed, litter, sifting, KC (6722).

***Dicyrtoma* (*Calvatomina*) *brevifibra* Snider, 1990 (Plate 157)**

Zool. Scr. 19:85.

Background color white with dark blue pattern. First antennal segment with distal blue ring; second antennal segment light blue, becoming dark blue distally; third antennal segment light blue on basal $\frac{1}{4}$, dark blue distally; fourth antennal segment dark blue. Vertex of head light blue with interocular macula dark blue, extending just below antennal bases; upper frons with light blue macula, lower frons to labrum blue, surrounding area white; gena with dark blue forming a stripe that extends to occiput, with a stripe of blue extending from antennal bases to



Plate 156—*Dicyrtoma (Calvatomina) bellingeri*: A, lateral habitus (after Snider); B, fourth antennal segment and apex of third (paratype); C, detail of apex of fourth antennal segment (paratype); D, dorsal facial setae (after Snider); E, ventral facial setae (same); F, dorsal median trunk setae, right side (paratype); G, fore foot complex (after Snider); H, hind foot complex (same); I, anterior face, fore tibia-tarsus (same); J, posterior face, same (same); K, anterior face, hind tibia-tarsus (same); L, posterior face, same (same); M, dorsal chaetotaxy, dens (same); N, ventral chaetotaxy, dens (same); O, detail of apical dorsal dental chaetotaxy (same); P, mucro (same); Q, female lesser abdomen, seen from side (same); R, parafurcular lobe setae (same).

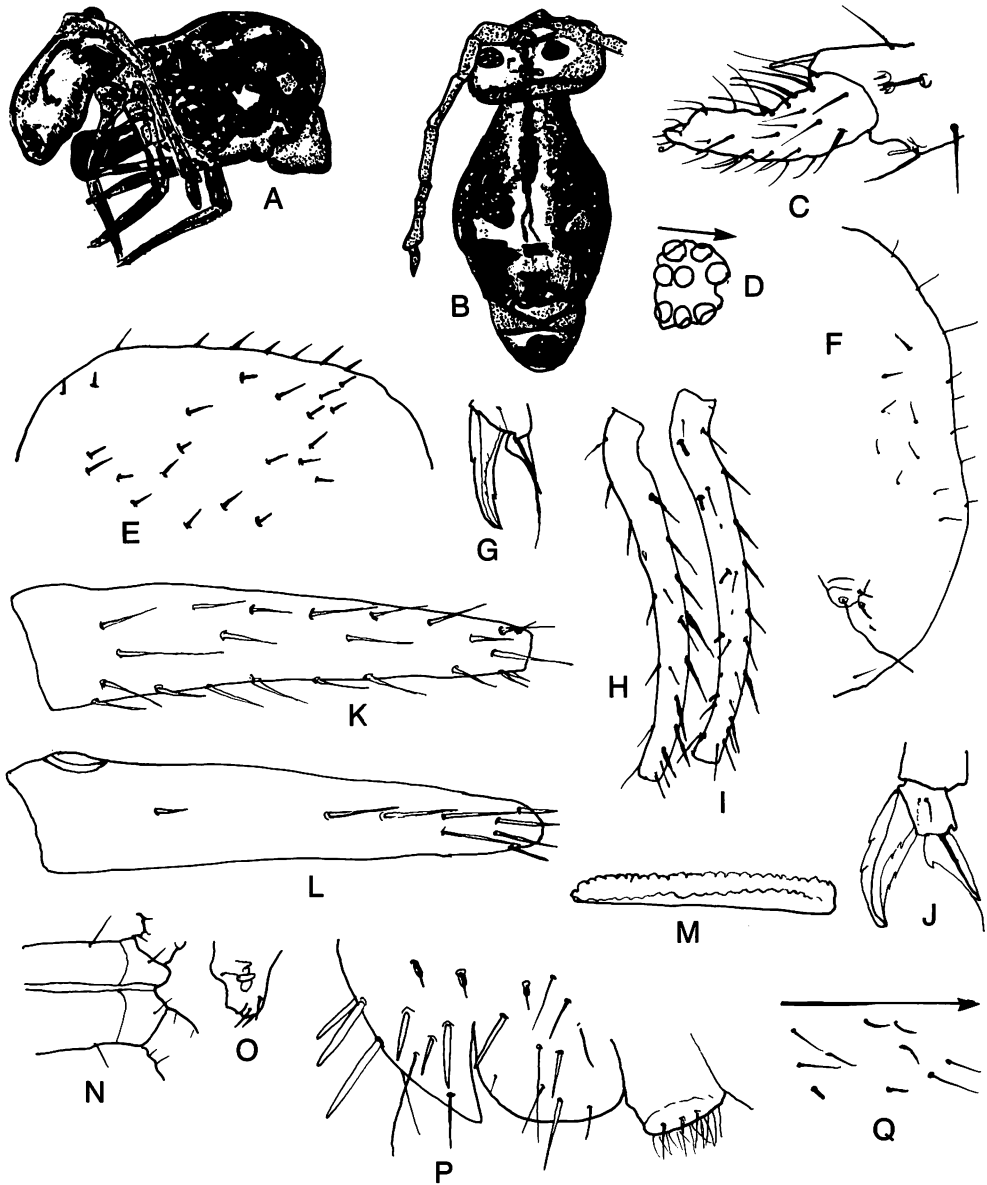
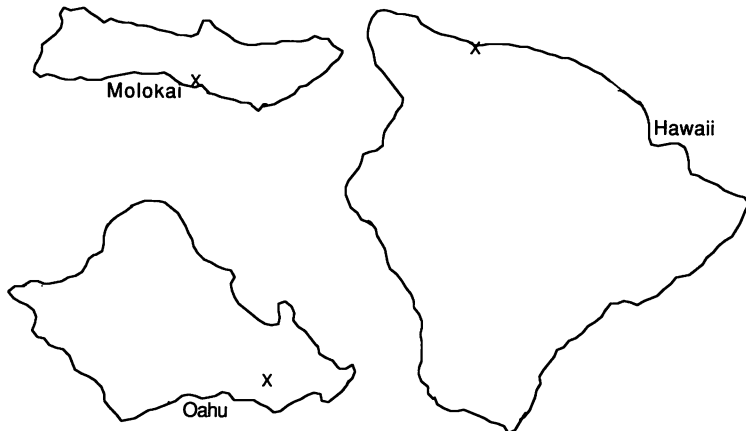


Plate 157—*Dicyrtoma (Calvatomina) brevisfibra*: A, habitus (after Snider); B, dorsal view (same); C, dorsum, fourth antennal segment and apex of third (holotype); D, eyepatch (after Snider); E, cephalic chaetotaxy, right side (holotype); F, visible (partly obscured) dorsal chaetotaxy of greater abdomen, right side (holotype); G, fore foot complex (after Snider); H, anterior surface, hind tibiotarsus (same); I, posterior surface, same (same); J, hind foot complex (same); K, dorsal surface of dens (same); L, ventral surface of dens (same); M, mucro (same); N, anterior face of ventral tube (same); O, tenaculum (same); P, lesser abdomen (same); Q, parafurcular lobe setae (same).

mouthparts. Thoracic segments with blue laterally, forming horizontal stripes dorsally, segments lined with white and scattered white maculae. Abdomen dark blue with dark blue stripe originating at thorax and terminating at apex before anal valves, this stripe is bordered with white; laterally with scattered white maculae roughly forming a square; anal valves dorsally light with dark apical macula. Manubrium light blue, dens white. Collophore light blue. Legs with coxa and trochanter dark blue, femur dark blue distally, otherwise white, tibiotarsus light blue on distal $\frac{3}{4}$. Fore and mid tibiotarsi with 4 and hind with 5 cup sensillae. All unguis with 2 inner teeth, outer teeth, pseudonychia, and tunica. First unguiculus without and mid and hind with a corner tooth. Apical filaments about as long as unguiculus on first 2 legs and slightly less than $\frac{1}{2}$ as long on hind leg. Dens with 9 E setae. Mucro with edges equally coarsely serrate, but serrations deeper on inner edge. Female subanal appendage acuminate and slightly curved. Bothriothrix C normal and B absent. Spinelike setae on greater abdomen limited to posterior $\frac{1}{2}$, and up to 0.03 mm in length. Maximum length 1.0 mm.



Remarks: This species is allied to the *formosana* group of Yosii (1969b). The presence of dorsal cup sensillae on the manubrium separates it from other species of this group.

Type locality: Molokai, vicinity of Kalahuapueo Lookout, I-12-1983, approximately 4000 ft., scrub forest, litter, sifting, KC (5709).

Additional records: Hawaii: 5111. Oahu: 4766.

Dicyrtoma (Calvatomina) longidigita Snider, 1990 (Plate 158)
Zool. Scr. 19:90.

Body, legs, furcula, antennae, and dorsal $\frac{2}{3}$ of head purple with small scattered pale spots. Fore tibiotarsus with 4 and mid and hind with 5 cup sensillae. Unguis with 2 small inner teeth, an outer tooth, pseudonychia, and tunica. Unguiculi all with 1 large and 1-3 minute corner teeth and acuminate subapical filaments that are longer than the unguiculus on the fore and mid foot and about as long as

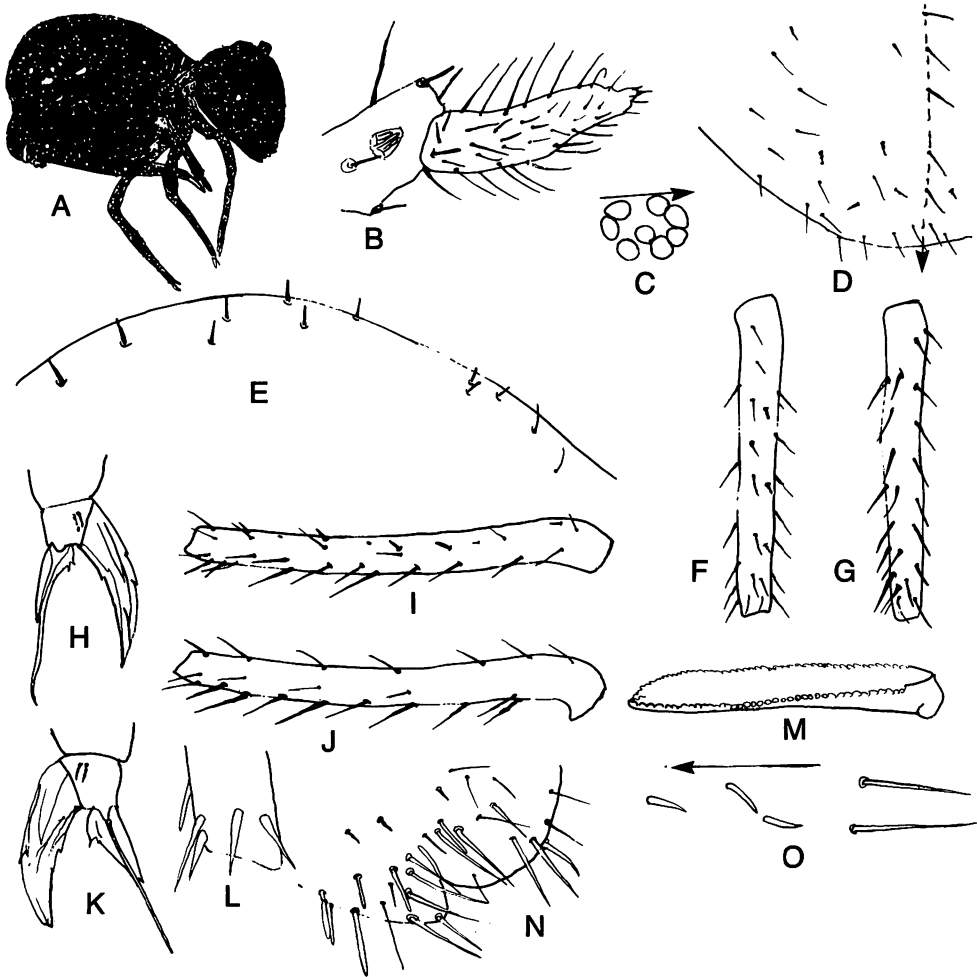


Plate 158—*Dicyrtoma (Calvatomina) longidigita*: A, habitus (after Snider); B, dorsum of fourth and apex of third antennal segment (holotype); C, right eyepatch (after Snider); D, lower facial chaetotaxy, right side (same); E, dorsal greater abdomen and thoracic chaetotaxy (same); F, anterior face, fore tibiotarsus (same); G, posterior face, same (same); H, fore foot complex (same); I, anterior face, hind tibiotarsus (same); J, posterior face, same (same); K, hind foot complex (same); L, distal end, dorsum of dens (holotype); M, mucro (after Snider); N, lesser abdomen from side (same); O, parafurcular lobe setae (same).

unguiculus on hind foot. Dens with only 9 E setae. Mucro with outer edge slightly more finely serrate than inner. Female subanal appendage gradually tapered from base; in lateral view straight for basal $\frac{1}{2}$ and sharply upturned apically. Trunk with no anterior spinelike setae, but 2–4 rows of small posterior setae are spinelike. Bothriotricha A–C normal, D missing. Maximum length 1.6 mm.

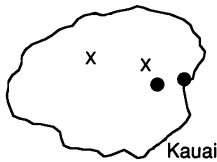
Remarks: This species is generally similar to three other Hawaiian species of *Dicyrtoma (Calvatomina)*: *brevifibra*, *sylvestratilis*, and *tesselata*. The four species can be

separated as follows. In *D. (C.) longidigitata* and *D. (C.) sylvestratilis*, the circumanal T seta is present and setaceous; in *D. (C.) brevifibra* and *D. (C.) tessellata* it is absent. In *D. (C.) longidigitata*, *D. (C.) brevifibra*, and *D. (C.) tessellata*, there are three parafurcular spinelike setae; in *D. (C.) sylvestratilis*, there are five.

Type locality: Hawaii, Kohala Mts., Puu Pili, VII-6-1964, 4500 ft., forest floor, litter, Haas (5244).

Dicyrtoma (Calvatomina) madestris Snider, 1990 (Plate 159)
Zool. Scr. 19:80.

Background cream to light yellow with purple pigment dusting and irregular polygons. Head with interocular macula of light purple; light polygons on frons with macula between antennal bases and slightly below; purple increases on gena and becomes heaviest on postgena; antenna with first antennal segment light purple, second antennal segment becoming dark distally, third and fourth antennal segments dark purple. Body with thoracic segmentation outlined in light purple; dorsally with a faint colorless stripe originating at the first thoracic segment and terminating $\frac{3}{4}$ distance of abdomen; posterior abdominal region light purple with setal sockets colorless; laterally thorax to abdomen with dark purple, interspersed with irregular maculae; lesser abdomen dusted with light purple; legs light purple; furcula cream with light purple dusting at base of dens. Fore tibiotarsus with 4 cup sensillae; hind and mid tibiotarsus with 5. First unguis with 2 and others with 1 inner tooth. All unguis with outer tooth, pseudonychia, and tunica. First 2 unguiculi with large inner tooth and filament usually longer than organ; hind unguiculus with 1-2 large corner and 1-2 smaller distal inner teeth and short filament. Dens with 10 E setae. Mucro with outer margin more finely serrate than inner and with a slightly larger tooth at half its length. Female subanal appendages acuminate, uniformly tapered from base, and straight to slightly curved in lateral view. Bothriothrix A well developed, on large papilla carrying a cup sensilla. Anterior spinelike setae of trunk absent, but posterior $\frac{1}{2}$ of dorsum with 6-8 rows of very short, mostly spinelike setae. Maximum length 1.0 mm.



Oahu 1

Remarks: The M setae are usually small and setaceous, but heavier and spine-like on a few specimens; possibly two taxa are involved. The usual number of M setae is three, but occasionally there are four or five. The large, spinelike A_0 seta distinguishes it from other members of the subgenus in Hawaii, except for *D. (C.) microdentata*.

Ecology: Found in low vegetation, litter, or moss in forest or grassland at middle elevations.

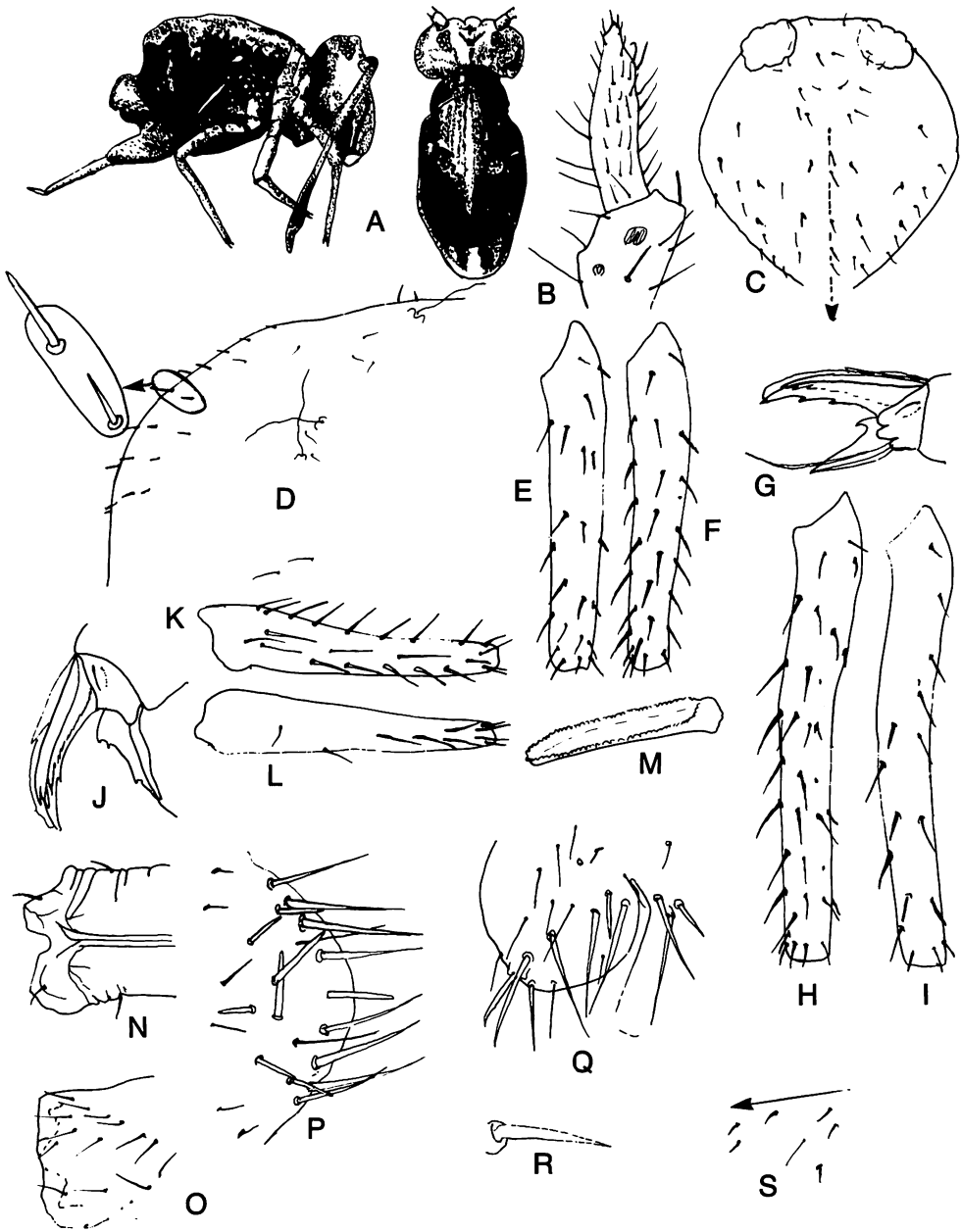


Plate 159—*Dicyrtoma (Calvatomina) maestrus*: A, habitus (after Snider); B, fourth antennal segment and apex of third segment (4729, Kauai); C, facial chaetotaxy (after Snider); D, thoracic and greater abdomen dorsal chaetotaxy, right side (4746, Kauai); E, anterior face, fore tibiotarsus (after Snider); F, posterior face, same (same); G, fore foot complex (same); H, anterior face, hind tibiotarsus (same); I, posterior face, same (same); J, hind foot complex (same); K, dorsal surface of dens (same); L, ventral surface of dens (same); M, mucro (same); N, anterior face of ventral tube (same); O, posterior face, same (same); P, lesser abdomen, seen from above (same); Q, lesser abdomen from side (same); R, female subanal appendage (same); S, parafurcular lobe setae (same).

Type locality: Kauai, glade by Wailua River, just above falls, I-16-1967, on ground and beaten from sticks, PB (4728, 4729).

Additional records: Oahu: 4797. Kauai: 4735, 4738, 4745, 4746, 5209.

Dicyrtoma (Calvatomina) microdentata Snider, 1990 (Plate 160)
Zool. Scr. 19:89.

Background cream-yellow with light purple pigment. Antenna light purple, becoming darker distally. Head with light dusting of purple on vertex, gena, and postgenal areas. Body with fine granules of purple dorsally, becoming darker laterally, giving the appearance of lateral bands. Legs light purple. Furcula cream. Fore tibiotarsus with 4 and mid and hind with 5 cup sensillae. All unguis with tunica, pseudonychia, 1 outer, and 2 inner teeth. All unguiculi with corner tooth and acuminate apical filament, the filament on the fore leg about $\frac{1}{2}$ as long as inner unguis and on mid and hind leg about $\frac{1}{3}$ as long. Dens with 9 E setae. Mucro with inner edge clearly more coarsely serrate than outer. Female subanal appendage acuminate and very slightly curved. Anterior spinelike setae absent, but posterior part of greater abdomen with 2-6 rows of short spinelike setae. Bothriotracha A-C normal, D missing. Maximum length 1.0 mm.

Remarks: *Dicyrtoma microdentata*, like *D. madestris*, falls in the *rufescens* group of Yosii (1969b). The hind unguis, E and L dental setae, and circumanal setae separate *D. microdentata* from all of these.

Type locality: Kauai, Kokee State Park, I-17-1967, grass by roadside, sweeping, PB (4740).

Dicyrtoma (Calvatomina) sylvestratilis Snider, 1990 (Plate 161)
Zool. Scr. 19:84.

Background color yellow; pigment with purple distributed in the following patterns. Head with rose-purple reaching below eyepatches, dark macula between eyes, remaining area yellow-cream; antenna rose-purple basally, becoming darker distally. Body with purple-blue reaching laterally, sometimes dorsum very light, giving the appearance of lateral stripes; lesser abdomen cream, with dusting of purple pigment; legs with light dusting of rose-purple. Fore and mid tibiotarsi with 4 and hind with 5 cup sensillae. Unguis with 2 small inner teeth. First 2 unguiculi with single corner tooth and apical filament of first unguiculus longer than unguiculus; hind unguiculus with 1 large and sometimes 1 minute corner teeth and a short acuminate apical filament. Dens with only 9 E setae. Mucro with inner edge slightly more coarsely serrate than outer. Female subanal appendage straight for basal $\frac{1}{3}$ of length, apically slightly curved and sharply tapered. Bothriothrix A well developed, on a prominent spine-bearing papilla. Anterior spinelike setae absent, but posterior dorsum with 6-8 rows of short setae, some of which are spine-like. Maximum length 1.1 mm.

Remarks: This species is distinguished from other Hawaiian members of the subgenus by the pattern and the circumanal spines.

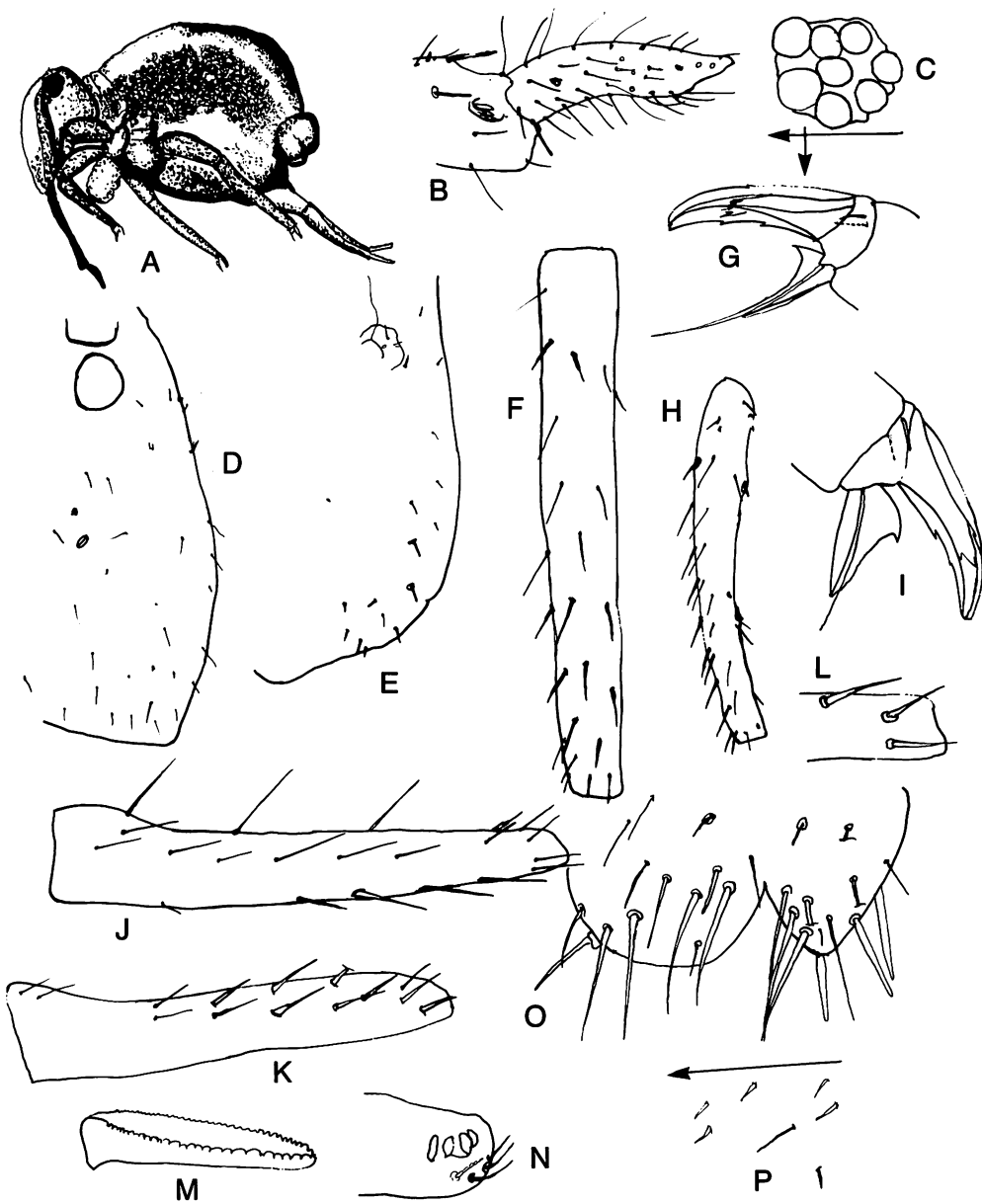


Plate 160—*Dicyrtoma (Calvatomina) microdentata*: A, habitus (after Snider); B, dorsum of fourth antennal segment and apex of third, mid portion of fourth obscured by pigment (holotype); C, left eyepatch (after Snider); D, facial chaetotaxy (composite of types); E, dorsal chaetotaxy, thorax and greater abdomen, left side (holotype); F, inner face, fore tibiotarsus (paratype); G, fore foot complex (after Snider); H, anterior face, hind tibiotarsus (holotype); I, hind foot complex (after Snider); J, outer surface, dens (holotype); K, inner surface, dens (same); L, apex of dorsal surface, dens (after Snider); M, mucro (same); N, tenaculum (same); O, lesser abdomen, from side (same); P, parafurcular lobe setae (same).

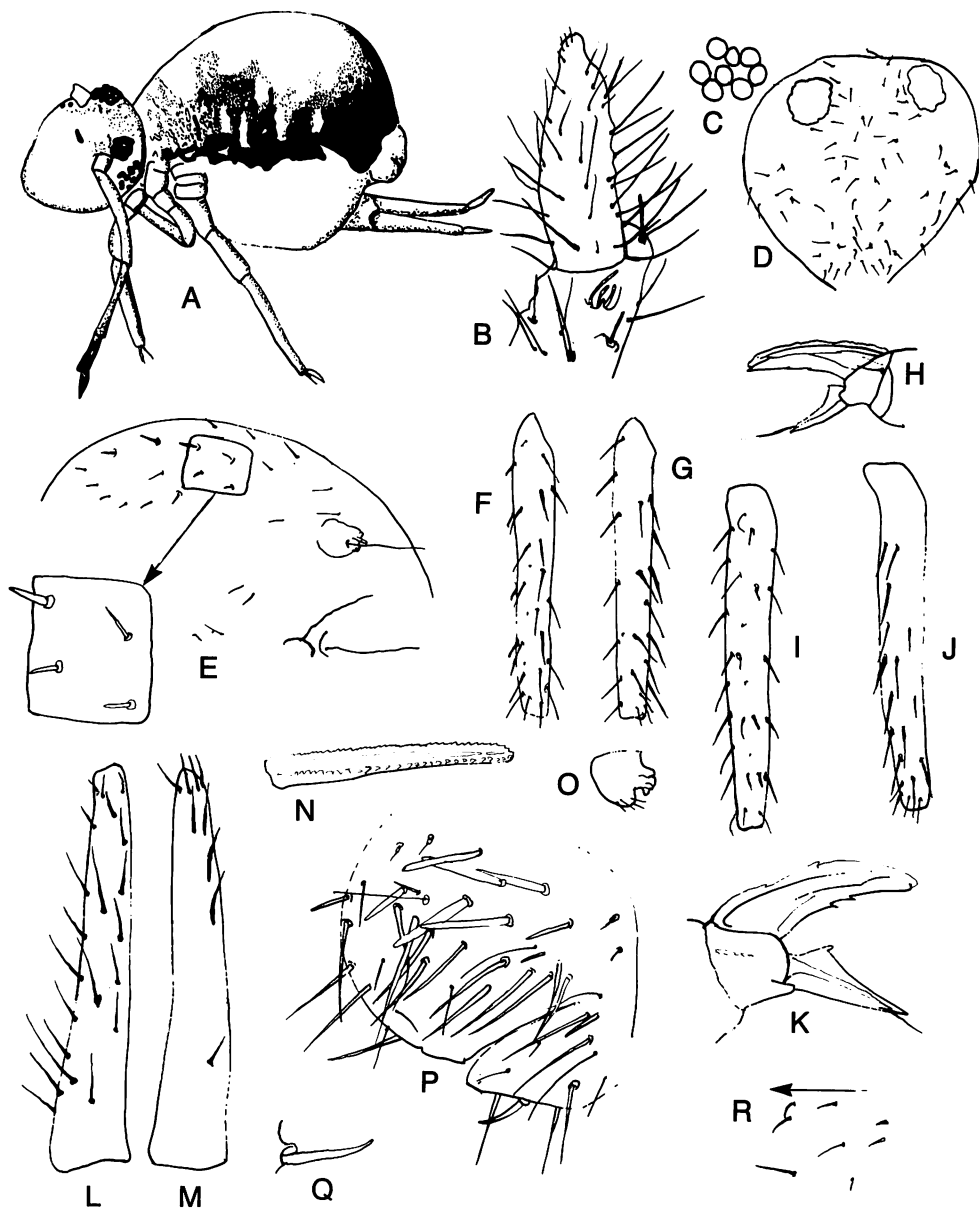


Plate 161—*Dicyrtoma (Calvatomina) sylvestratilis*: A, habitus (after Snider); B, fourth antennal segment and apex of third (holotype); C, eyepatch (after Snider); D, facial chaetotaxy (same); E, thoracic and greater abdominal dorsal chaetotaxy, right side (paratype); F, anterior face of fore tibiotarsus (same); G, posterior face, same (same); H, anterior foot complex (same); I, anterior face, hind tibiotarsus (same); J, posterior face, same (same); K, hind foot complex (same); L, dorsal surface of dens (same); M, ventral surface of dens (same); O, tenaculum (same); P, lesser abdomen, seen from above (same); Q, female subanal appendage (paratype); R, parafurcular lobe setae (after Snider).

Ecology: Known only from lowland forest areas, under bark, in litter, and on low vegetation.

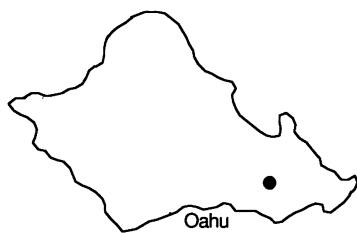
Type locality: Kauai, Wailua-Hanalei Trail, 2 mi. from paved road, on Wailua side, I-18-67, rotten wood, fern litter, sweeping, and under bark, PB (4743, 4744).

Additional record: Oahu: 4829.

Dicyrtoma (Calvatomina) tessellata Snider, 1990 (Plate 162)

Zool. Scr. 19:87.

Background yellow with purple pigment laid down in irregular polygons. Antenna purple. Vertex of head with dark purple macula between eyepatches, light purple stripe connected to dark macula of frontal interocular area; lateral purple band on gena with light suffusion of purple. Body with dark purple lateral bands that join near the posterodorsal area; anal papilla light purple. Legs with light purple, distal portion of femur darker. Furcula light purple on manubrium and dens or unpigmented, mucro with small amounts of purple. Posteriormost ocular seta straight and spiniform. Fore tibiotarsi with 4 cup sensillae and others with 5. All unguis with tunica and pseudonychia. Fore unguis with 1 and others with 2 inner teeth. Unguiculi with 1 corner tooth and an apical filament about $\frac{1}{2}$ length of inner unguis on fore, and $\frac{1}{3}$ on mid foot. The hind foot has an additional minute unguiculus tooth. Dens with only 9 E setae. Mucro with outer margin slightly more finely serrate than inner. Female subanal appendages straight for basal $\frac{1}{3}$ but sharply upturned and tapered at apex. Bothriotricha A-C normal, D absent. Anterior trunk setae slender and small, but 4 rows of posterior greater abdomen setae are spinelike. Maximum length 1.0 mm.



Remarks: This is one of the closely related Hawaiian species of the subgenus *Calvatomina*, which have a number of distinctive features such as the large gap between dental setae E_1 and E_2 . *D. (C.) tessellata* is unique in its pattern and distribution of circumanal spines.

Ecology: Found at middle elevations in litter.

Type locality: Oahu, below pali above Anouai Place, upper Manoa Valley, XI-30-1966, dead leaves among rocks, PB (4819).

Additional records: Oahu: 4761, 4766, 4818.

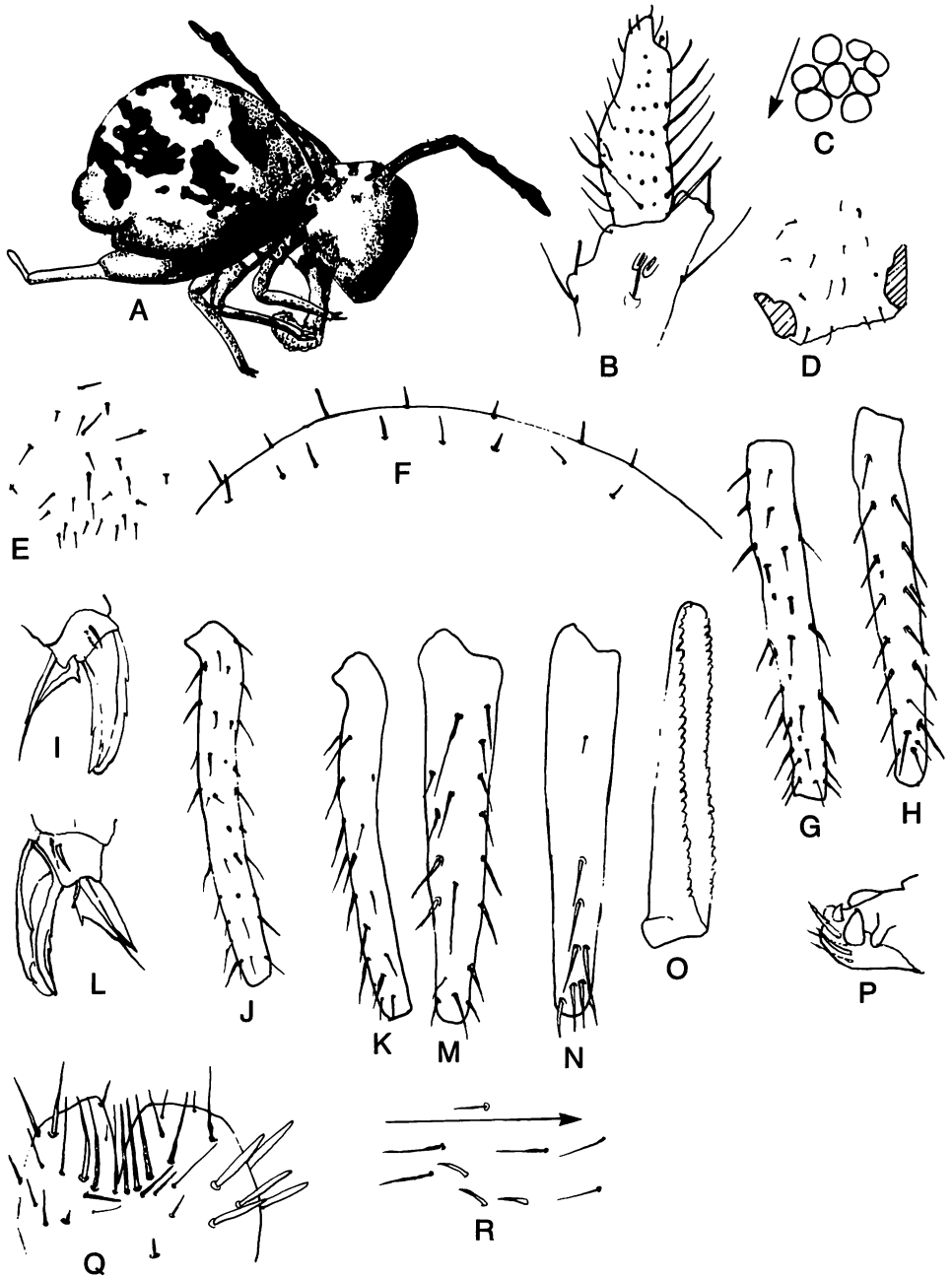


Plate 162—*Dicyrtoma (Calvatomina) tessellata* (all specimens from Oahu): **A**, habitus (after Snider); **B**, dorsum of fourth and apex of third antennal segments, median portion obscured (4761); **C**, right eyepatch (after Snider); **D**, dorsal facial setae (after Snider); **E**, ventral facial setae (same); **F**, median thoracic and greater abdomen chaetotaxy (paratype); **G**, anterior face, fore tibiotarsus (after Snider); **H**, posterior face, same (same); **I**, fore foot complex (same); **J**, anterior face, hind tibiotarsus (same); **K**, posterior face, same (same); **L**, hind foot complex (same); **M**, dorsal surface, dens (same); **N**, ventral surface, dens (same); **O**, mucro (same); **P**, tenaculum (same); **Q**, lesser abdomen, from side (same); **R**, parafurcular lobe setae (same).

LIST OF NUMBERED LOCALITIES REFERRED TO IN THIS WORK

PB = collected by Bellinger, KC = collected by Christiansen

- 2994 Hawaii, cave, IV-1951.
- 2995 Hawaii, Kazumura Cave, VII-25-1971, dark zone, 200 ft. in.
- 2996 As above, 700 ft. in.
- 3100 Hawaii, Kaumana Cave, V-26-1972, upper section, 290 m in, Howarth.
- 3101 Oahu, Judd St. cave, V-21-1972, 30 m in, dark zone, Howarth.
- 3102 Maui, Hana, Holoinawawai St. cave, XII-14-1971, 290 m in, Howarth.
- 3138 Hawaii, Mauna Loa strip road, 5020 ft., cave, I-10-1971, Howarth.
- 3139 As above, different site.
- 4694 Oahu, Honolulu, IX-06-1966, tree trunk, Wright.
- 4716 Oahu, Honolulu (quarantine in San Diego), VII-07-1965, lychee cuttings, Rinder.
- 4724 Hawaii, Hilo, Keaau Orchard, XII-29-1966, Norfolk pines stand, soil, Mitchell.
- 4725 Hawaii, Saddle Road, halfway point, I-22-1967, ohia forest, grass and ferns, PB.
- 4726 Hawaii, 2 ½ mi. E of Kulani Honor Camp, I-22-1967, ohia fern forest, roadside, PB.
- 4727 Hawaii, Volcanoes National Park, 1 mi. from Volcano House, Niaulani cabin, I-24-1967, lawn, sweeping, PB.
- 4728 Kauai, Wailua River, glade above falls, I-16-1967, damp grass, sweeping, PB.
- 4729 Kauai, Wailua River, glade above falls, I-16-1967, beaten from sticks, PB.
- 4730 Kauai, Wailua River, glade above falls, I-16-1967, flotation extraction of soil and litter, PB.
- 4731 Kauai, under Mt. Waialeale, on main tributary of Wailua River, road end near intake house, I-16-1967, sweeping, PB.
- 4732 Kauai, under Mt. Waialeale, on main tributary of Wailua River, road end near intake house, I-16-1967, flotation extraction of soil with moss cover, PB.
- 4733 Kauai, Lihue, airport parking lot, I-17-1967, sweeping, PB.
- 4734 Kauai, Kokee, Hanapepe and Wailua Canyon lookouts, I-17-1967, roadside, PB.
- 4735 Kauai, Alakai Swamp Trail, forest beyond first bog, I-17-1967, moss on logs, PB.
- 4736 Kauai, Alakai Swamp Trail, forest beyond first bog, I-17-1967, beaten from sedges, PB.
- 4737 Kauai, Alakai Swamp Trail, forest beyond first bog, I-17-1967, beaten from rotten wood, PB.
- 4738 Kauai, Alakai Swamp Trail, forest beyond first bog, I-17-1967, flotation extraction of litter, PB.
- 4739 Kauai, Alakai Swamp Trail, first bog, I-17-1967, sweeping, PB.
- 4740 Kauai, Kokee State Park, I-17-1967, roadside, sweeping, PB.
- 4741 Kauai, Hawaii 55, near Kokee State Park, I-17-1967, roadside, beaten from sticks in litter, PB.
- 4742 Kauai, Hawaii 55, near Waimea River lookout, I-17-1967, soil and humus under *Grevillea*, PB.
- 4743 Kauai, Wailua-Hanalei Trail, 2 mi. from paved road on Wailua side, I-18-1967, sweeping, PB.

- 4744 Kauai, Wailua-Hanalei Trail, 2 mi. from paved road on Wailua side, I-18-1967, rotten wood, fern litter, and under bark, PB.
- 4745 Kauai, Wailua River crossing (paved road), inland from experiment station, I-18-1967, sweeping, PB.
- 4746 Kauai, Wailua River crossing (paved road), inland from experiment station, I-18-1967, rotten wood, vegetation, or soil, PB.
- 4747 Kauai, beach at Kapaa River outlet, I-18-1967, sweeping, PB.
- 4748 Kauai, off Wailua Falls Road, across from new cemetery, I-19-1967, forest litter, PB.
- 4749 Kauai, off Wailua Falls Road, across from new cemetery, I-19-1967, soil, PB.
- 4750 Maui, Waikamoi, IX-19-1966 and XII-1966, Murphy.
- 4751 Maui, Silversword Inn, State 377, I-28-1967, grass, rotten wood, and debris, PB.
- 4752 Oahu, Manoa, Fall 1966, soil litter under brush, Elikewela.
- 4753 Oahu, Anouai Place, upper Manoa Valley, VIII-1966, general collecting, PB.
- 4754 Oahu, University of Hawaii campus, Maile Way, center strip, IX-07-1966, grass, PB.
- 4755 Oahu, Alani Drive, Manoa Valley, IX-1966, overgrown lawn with *Mimosa*, PB.
- 4756 Oahu, Manoa Falls Trail, IX-11-1966, sweeping, PB.
- 4757 Oahu, Manoa Falls, IX-11-1966, in moss on rocks, PB.
- 4758 Oahu, University of Hawaii campus, Maile Way, center strip, IX-14-1966, grass, PB.
- 4759 Oahu, Manoa Falls Trail, bottom of trail, IX-15-1966, sweeping, PB.
- 4760 Oahu, Mt. Tantalus, IX-16-1966, sweeping, PB.
- 4761 Oahu, Mt. Tantalus, IX-16-1966, bamboo stand, rotten wood, PB.
- 4762 Oahu, Mt. Tantalus, IX-16-1966, bamboo stand, litter and soil, PB.
- 4763 Oahu, Honolulu, XI-13-1965, on ocean water, Mitchell.
- 4764 Oahu, Hawaii Kai, XI-14-1965, on surface of puddles, Arakiki.
- 4765 Oahu, Manoa, park near university, IX-21-1966, grass, PB.
- 4766 Oahu, Manoa Falls Trail, flats near beginning, IX-23-1966, litter, PB.
- 4767 Oahu, Maili, II-02-1966, mango litter, Hale.
- 4768 Oahu, Waianae, II-02-1966, chicken litter, Hale.
- 4769 Oahu, Alani Drive, Manoa Valley, IX-26-1966, litter, PB.
- 4770 Oahu, Alani Drive, IX-26-1966, pile of dead grass, PB.
- 4771 Oahu, Manoa Falls Trail, IX-30-1966, moss on rock, PB.
- 4772 Oahu, Manoa Falls Trail, IX-30-1966, litter in stream bed, PB.
- 4773 Oahu, Manoa Falls Trail, small ridge, IX-30-1966, litter, PB.
- 4774 Oahu, University of Hawaii campus, "Mitchell's Lab," III-02-1966, soil, litter, Hale.
- 4775 Oahu, Maili, II-02-1966, cow manure, Hale.
- 4776 Oahu, Makiki Trail no. 2 and Tantalus Drive, X-05-1966, PB.
- 4777 Oahu, Tantalus Drive, X-05-1966, open dry woods, litter and dark brown soil, PB.
- 4778 Oahu, Nuuanu Valley, X-04-1966, Bermuda grass and soil, PB.
- 4779 Oahu, Tantalus Drive, X-10-1966, open dry woods, soil, PB.
- 4780 Oahu, Tantalus Drive, X-10-1966, open dry woods, beaten from sticks on ground, PB.
- 4781 Oahu, Waimanalo, IV-18-1966, bird nest, Hale.
- 4782 Oahu, Manoa, III-01-1966, soil litter, Hale.
- 4783 Oahu, II-01-1966, tree litter, Hale.

- 4784 Oahu, Waimanalo, I-24-1966, banana soil and litter, Hale.
4785 Oahu, Manoa, II-20-1966, soil and litter, Hale.
4786 Oahu, Manoa Falls Trail, X-14-1966, soil in bed of large joint grass, PB.
4787 Oahu, Manoa Falls Trail, X-14-1966, soil under canelike monocot, PB.
4788 Oahu, Manoa Falls Trail, X-14-1966, litter under tree, PB.
4789 Oahu, Waianae, II-04-1966, bull dung, PB.
4790 Oahu, Waimanalo, University of Hawaii farm, III-30-1966, bark, Fujii.
4791 Oahu, Tantalus, III-09-1966, decaying stump, Fujii.
4792 Oahu, Waimanalo, University of Hawaii farm, III-09-1966, grass litter, Fujii.
4793 Oahu, University of Hawaii campus, IV-27-1966, kiawe litter, Fujii.
4794 Oahu, valley NE of Palikea, Waianae Mts., X-20-1966, under ferns, litter and brown soil, PB.
4795 Oahu, valley NE of Palikea, Waianae Mts., X-20-1966, soil under grass, PB.
4796 Oahu, N of Palikea, Waianae Mts., X-20-1966, moss, PB.
4797 Oahu, Mauna Kapu, Waianae Mts., X-20-1966, litter under *Casuarina*, PB.
4798 Oahu, Mauna Kapu Rd., Waianae Mts., 1 mi. from end, X-20-1966, hardwood litter, PB.
4799 Oahu, Mauna Kapu Rd., X-20-1966, soil under hardwood litter, PB.
4800 Oahu, Waianae Mts., X-20-1966, PB.
4801 Oahu, valley NE of Palikea, Waianae Mts., X-20-1966, rotten wood, PB.
4802 Oahu, Mauna Kapu, Waianae Mts., lawn at road end, X-20-1966, PB.
4803 Oahu, Manoa, University of Hawaii campus, IV-21-1966, soil and litter, Fujii.
4804 Oahu, Manoa, University of Hawaii campus, IV-25-1966, hibiscus litter, Fujii.
4805 Oahu, Kahana Bay, III-24-1966, koahaole litter, Fujii.
4806 Oahu, Manoa, University of Hawaii campus, III-22-1966, sphagnum moss, Fujii.
4807 Oahu, Waimanalo, III-30-1966, *Acacia koa* litter, Fujii.
4808 Oahu, Waianae, II-29-1966, sawdust from calf bedding, Fujii.
4809 Oahu, Manoa, University of Hawaii campus, III-11-1966, moss, Fujii.
4810 Oahu, Waialua-Haleiwa area, X-28-1966, sugarcane field, litter and grass, PB.
4811 Oahu, Kaena Pt., X-28-1966, reddish earth under rock, plant debris, PB.
4812 Oahu, Weed Circle, near Waialua, X-28-1966, soil under grass, PB.
4813 Oahu, Weed Circle, X-28-1966, soil under sugarcane, PB.
4814 Oahu, Kaukonahua reservoir area, X-28-1966, under guava tree, soil and litter, PB.
4815 Oahu, Alani Drive, Manoa Valley, XI-02-1966, grass pile, PB.
4816 Oahu, Mt. Kaala, summit swamp, X-04-1966, moss, PB.
4817 Oahu, below pali, above Anouai Place, upper Manoa Valley, XI-30-1966, PB.
4818 Oahu, below pali, above Anouai Place, upper Manoa Valley, XI-30-1966, under rock overhang, nut shells, PB.
4819 Oahu, below pali, above Anouai Place, upper Manoa Valley, XI-30-1966, loose rocks on brown soil, dead leaves, PB.
4820 Oahu, below pali, above Anouai Place, upper Manoa Valley, XI-30-1966, rotten wood, PB.
4821 Oahu, Hawaii Kai, head of lagoon, XII-06-1966, grass and marsh plants, PB.
4822 Oahu, Hawaii Kai, head of lagoon, XII-06-1966, under plant mat, PB.
4823 Oahu, Hawaii Kai, head of lagoon, XII-06-1966, roadside, grass, PB.
4824 Oahu, Hawaii Kai, head of lagoon, XII-06-1966, soil and grass roots, PB.
4825 Oahu, University of Hawaii campus, near lab, XII-06-1966, grass, PB.

- 4826 Oahu, Mt. Tantalus, 1800 ft., X-29-1966, woods, pan trap, Vockeroth.
 4827 Oahu, Mt. Tantalus, 1000 ft., XI-1966, pan trap, J. Vockeroth.
 4828 Oahu, Mt. Tantalus, 1000 ft., XI-08-1966, acacia and cereus, pan trap, Vockeroth.
 4829 Oahu, as above, X-22-1966.
 4830 Oahu, Mt. Tantalus, XI-17-1966, 1800 ft., malaise trap, Vockeroth.
 4831 Oahu, Hawaii Kai, I-10-1967, coarse dark sand and gravel, beach pit.
 4832 Oahu, Hahaione Valley, I-10-1967, forest, soil and rotten wood, PB.
 4833 Oahu, Waimanalo experimental farm, I-11-1967, forest, soil and litter, PB.
 4834 Oahu, Waikiki Beach, Natatorium, I-11-1967, pitfall trap, PB.
 4835 Oahu, Sand Island, I-15-1967, swarming on water, PB.
 4836 Oahu, Hapapa Mt., IV-06-1969, soil, Lee.
 4837 Oahu, Kaupo, base, XII-29-1968, Lee.
 4838 Oahu, Makaha, II-07-1969, Lee.
 4839 Oahu, Bishop Museum, V-19-1969 soil, Lee.
 4840 Oahu, Pupukeya Forest Reserve, III-09-1969, berlese, Lee.
 4841 Oahu, Makua, I-25-1969, roadside bush, Lee.
 4842 Oahu, Sunset Beach, I-25-1969, Lee.
 4843 Oahu, Kaupo, cliff, halfway up, XII-29-1968, Lee.
 4844 Oahu, East-West Center woods, Manoa Valley, I-21-1969, litter, Lee.
 4845 Oahu, Kaneohe, I-04-1969, rotting wood, Lee.
 4846 Oahu, Kaupo, top, XII-29-1969, Lee.
 4847 Oahu, Kaneohe, I-04-1969, banana plantation, Lee.
 4848 Hawaii, Volcanoes National Park, near Thurston Lava Tube, X-16-1971, 3900 ft., ohia forest, spray sample, Howarth.
 4849 Oahu, Kaupo, base, XI-24-1968, Lee.
 4850 Hawaii, Mauna Loa Strip Trail, V-30-1971, 1000 m, *Acacia koa*, Hague.
 4851 Hawaii, Kilauea Forest Reserve, IBP study site, 1586 m, ohia, Gagne.
 4852 Hawaii, Mauna Loa Strip Trail, VIII-08-1971, 6600 ft., Gagne.
 4853 Hawaii, Volcanoes National Park, 1 mi. W of park headquarters, VI-15-1970, ohia, berlese, Goff & Radovsky.
 4854 Hawaii, jct. of Crater Rim Road and Hilo Road, 2 mi. W of Volcanoes National Park, VI-15-1970, ohia, berlese, Goff & Radovsky.
 4855 Hawaii, Volcanoes National Park, Crater Rim Road, VI-15-1970, volcanic desert, berlese, Goff & Radovsky.
 4856 Hawaii, Volcanoes National Park, Bird Park, VI-15-1970, open koa forest, berlese, Goff & Radovsky.
 4857 Hawaii, Volcanoes National Park, Bird Park, VI-16-1970, ohia forest, berlese, Goff & Radovsky.
 4858 Hawaii, Volcanoes National Park, Bird Park, VI-16-1970, 1220 m, ohia forest, berlese, Goff & Radovsky.
 4859 Hawaii, Volcanoes National Park, cross road for Bird Park from Crater Rim Road, VI-16-1970, 1220 m, ohia forest, berlese, Goff & Radovsky.
 4860 Hawaii, Volcanoes National Park, Mauna Loa Road, VI-16-1970, 1340 m, koa savanna, berlese, Goff & Radovsky.
 4861 Hawaii, Volcanoes National Park, Mauna Loa Road, VI-16-1970, 1560 m, koa duff, berlese, Goff & Radovsky.
 4862 Hawaii, Volcanoes National Park, Mauna Loa Road, VI-16-1970, 1690 m, koa savanna, berlese, Goff & Radovsky.

- 4863 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2000 m, ohia, berlese, Goff & Radovsky.
- 4864 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2020 m, moss in lava tube, berlese, Goff & Radovsky.
- 4865 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2150 m, ohia, berlese, Goff & Radovsky.
- 4866 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2240 m, ohia, berlese, Goff & Radovsky.
- 4867 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2040 m, ohia, berlese, Goff & Radovsky.
- 4868 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2240 m, ohia, berlese, Goff & Radovsky.
- 4869 Hawaii, Volcanoes National Park, Hilo Rd. (Route 11), VI-16-1970, 800 m, grass and lichen, berlese, Goff & Radovsky.
- 4870 Hawaii, Volcanoes National Park, Hilo Rd. (Route 11), VI-17-1970, 1040 m, ohia and tree fern forest, berlese, Goff & Radovsky.
- 4871 Hawaii, Hilo, canefields above town, VI-18-1970, 140 m, guava thicket, berlese, Goff & Radovsky.
- 4872 Hawaii, Hilo, 7000 ft. W of H.S.P.A. headquarters, VI-18-1970, 800 ft., Nass.
- 4873 Hawaii, Mauna Kea slope, 1 mi. from benchmark 4141 on Saddle Rd., VII-21-1970, 4300 ft., marshy area, edge of dying ohia, ohia duff and moss, Radovsky.
- 4874 Hawaii, Mauna Kea slope, 100 yd. from benchmark 4141 on Saddle Rd., VII-21-1970, 4300 ft., ohia forest, duff and lichens, Radovsky.
- 4875 Hawaii, Mauna Kea Park Station, VII-01-1970, 9250 ft., *Sophora chrysophylla* duff in fine soil, Radovsky.
- 4876 Hawaii, Mauna Loa Trail, transect #1, VII-22-1970, 8200 ft., *Styphelia*, duff and soil, Radovsky.
- 4877 Hawaii, Mauna Loa Trail, transect #1, VII-22-1970, 8100 ft., ohia, *Coprosma montana*, *Styphelia*, *Vaccinium* duff, Radovsky.
- 4878 Hawaii, Mauna Loa Strip Rd., transect #1, Kipuka Kulalio, VII-22-1970, 5400 ft., duff under *Acacia koa*, Radovsky.
- 4879 Hawaii, Volcanoes National Park, steam vent area of benchmark 3944, VII-22-1970, fumarole, dead grasses and soil, Radovsky.
- 4880 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent #1, 5 yd. from road, X-19-1970, 1040 m, moss from upper edge of vent, Goff.
- 4881 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent #1, 5 yd. from road, X-19-1970, 1040 m, moss from bottom edge of vent, Goff.
- 4882 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent #2, 10 yd. from road, X-19-1970, 1040 m, bottom of vent, Goff.
- 4883 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent #3, 50 yd. from road, X-19-1970, 1040 m, 1 ft. from top of vent, Goff.
- 4884 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent #4, X-19-1970, 1040 m, 3 ft. from top of vent, on decaying vegetation, Goff.
- 4885 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquar-

- ters, steam vent #5, 100 yd. from road, X-19-1970, 1040 m, 1 ft. from top of vent, decaying vegetation, Goff.
- 4886 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent #6, X-19-1970, 3.5 ft. from top of vent, slime and decaying vegetation, Goff.
- 4887 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent #7, 30 yd. from road, X-19-1970, 1040 m, 1.5 ft. from top of vent, moss and decaying vegetation, Goff.
- 4888 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.9 mi. from park headquarters, steam vent area, 30 yd. from road, X-19-1970, 1040 m, lichens on exposed surface, Goff.
- 4889 Hawaii, Mauna Loa Trail, Mueller-Dombois zone #5, X-20-1970, 8000 ft., leaf debris, Goff.
- 4890 Hawaii, Mauna Loa Trail, X-20-1970, 2100 m, lichen, Goff.
- 4891 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2140 m, leaf litter, Goff.
- 4892 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2140 m, lichens on exposed lava, Goff.
- 4893 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2160 m, lichens on exposed lava, Goff.
- 4894 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2160 m, soil and leaf litter, Goff.
- 4895 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2190 m, leaf litter, Goff.
- 4896 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2220 m, lichen on pahoehoe, Goff.
- 4897 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2220 m, leaf litter, Goff.
- 4898 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2240 m, goat excrement, Goff.
- 4899 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2240 m, grasses and leaf debris, Goff.
- 4900 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2280 m, soil and leaf debris, Goff.
- 4901 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2280 m, lichen, Goff.
- 4902 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2300 m, leaf litter, Goff.
- 4903 Hawaii, Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2300 m, lichen, Goff.
- 4904 Hawaii, IBP test plot, trail along plot edge, X-21-1970, 1440 m, koa, ohia, tree fern forest, 10 ft. from trail, leaf litter, etc., Goff.
- 4905 Hawaii, Volcanoes National Park, Crater Rim Rd., 0.8 mi. from park headquarters, X-21-1970, 1040 m, moss, etc., Goff.
- 4906 Hawaii, Volcanoes National Park, 0.7 mi. from park headquarters, on rim of crater, X-21-1970, 1040 m, 1.5 ft from surface of vent, decaying vegetation, Goff.
- 4907 Hawaii, Volcanoes National Park, Crater Rim Rd., Halemaumau Lookout, X-21-1970, 1060 m, grass and soil, Goff.

- 4908 Hawaii, Thurston Lava Tube, 50 yd. inside, X-22-1970, moss and ferns, Goff.
4909 Hawaii, Waulu Forest, IBP plot #5, X-21-1970, ohia, under bark, Gressitt.
4910 Pearl and Hermes Reef, SE Island, XII-15-1970, Gressitt.
4911 Pearl and Hermes Reef, N Island, XII-15-1970, Gressitt.
4912 Pearl and Hermes Reef, NE Island, XII-14-1970, black-footed albatross nest, Gressitt.
4913 Pearl and Hermes Reef, SE Island, XII-13-1970, soil and crucifer, Gressitt.
4914 Hawaii, Kilauea, *Chasiempis sandwichensis* nest, Gagne.
4915 Oahu, Waianae, Gagne.
4916 Oahu, Kului Gulch, I-31-1971, Gagne.
4917 Oahu, Bishop Museum grounds, VI-15-1971, grass and soil, Goff.
4918 Oahu, base of Manoa Falls, VII-25-1970, moss, Goff.
4919 Hawaii, Mueller-Dombois transect #5, 13.3 mi. W of Kalapana Church, II-23-1971, 100 ft., Radovsky.
4920 Hawaii, 11.6 mi. W of Kalapana Church, #43, zone 3, II-23-1971, *Heteropogon* on lava, Radovsky.
4921 Hawaii, Mueller-Dombois transect #5, 8.8 mi. W of Kalapana Church, site #3, II-23-1971, Radovsky.
4922 Hawaii, 6.8 mi. W of Kalapana Church, zone #5, site #4, II-23-1971, Radovsky.
4923 Hawaii, 1.8 mi. W of Kalapana Church, site #5, mauka of road #50, zone 6, II-23-1971, area of dead and live *Pandanus*, Radovsky.
4924 Hawaii, 0.6 mi. E of Kalapana Church, site #6, #51, zone 6, II-23-1971, *kukui*, *hau*, passionfruit, Radovsky.
4925 Hawaii, Kilauea Forest Reserve, IBP study site, II-22-1971, Radovsky.
4926 Hawaii, Mauna Loa strip road, study site, II-22-1971, 1660 m, Radovsky.
4927 Hawaii, Mauna Loa strip road, 4 mi. from Bird Park, II-22-1971, 1365 m, under ohia, koa, and *Styphelia*, Radovsky.
4928 Hawaii, Mauna Loa strip road, rest house at end, II-22-1971, 2065 m, koa, *Styphelia* litter, Radovsky.
4929 Hawaii, as above, different site.
4930 Hawaii, Mauna Loa strip road, 2.2 mi. below rest house, II-22-1971, 1860 m, litter and soil, Radovsky.
4931 Hawaii, Mauna Loa strip road, 7.6 mi below rest house, II-02-1971, 1430 m, grass and duff, Radovsky.
4932 Hawaii, Volcano Hwy., 11.9 mi. W of N. Kulani, II-21-1971, 1360 m, soil and litter, Radovsky.
4933 Hawaii, 2.1 mi E, 9.8 mi. W of Kulani, II-21-1971, 1360 m, Radovsky.
4934 Hawaii, 7.9 W of N. Kulani, II-21-1971, 1160 m, Radovsky.
4935 Hawaii, 5.1 mi. W of N. Kulani, II-21-1971, 1160 m, Radovsky.
4936 Hawaii, as above, different site.
4937 Hawaii, 2.6 mi W of N. Kulani, II-21-1971, 760 m, Radovsky.
4938 Hawaii, 0.3 mi. W of N. Kulani, II-21-1971, 560 m, Radovsky.
4939 Hawaii, intersection Stainback Hwy. and N. Kulani Rd., II-21-1971, 360 m, Radovsky.
4940 Hawaii, 6.6 mi. E of N. Kulani, II-21-1971, 140 m, ohia forest, Radovsky.
4941 Hawaii, Stainback Hwy. end, II-21-1971, 80 m, ohia, Radovsky.
4942 Midway Atoll, Sand Island, barracks area, III-22-1971, under dead bird, Goff.
4943 Midway Atoll, as above, edge of runway, occupied gooney bird nest.

- 4944 Midway Atoll, as above, deserted gooney bird nest.
- 4945 Midway Atoll, Sand Island, refuse dump, III-22-1971, grass and sand, Goff.
- 4946 Midway Atoll, Eastern Island, refuse dump, III-23-1971, rat nest, Goff.
- 4947 Hawaii, Volcanoes National Park, vent #1, IV-25-1971, Radovsky.
- 4948 Hawaii, Volcanoes National Park, Steaming Bluffs Trail, vent #1, IV-25-1971, Goff.
- 4949 through 4986 are all taken at the same site and day as 4948 at different depths and temperatures.
- 4987 Hawaii, Volcanoes National Park, Steaming Bluffs Trail, vent #2, V-26-1971, grass and soil, Goff.
- 4988 through 5067 are all from vent #2 on 4 dates in May and June 1971. The samples are at different depths and temperatures.
- 5068 Hawaii, Volcanoes National Park, Steaming Bluffs Trail.
- 5070 Hawaii, Kilauea Forest Preserve, I-09-1971, pitfall trap, Jacobi.
- 5071 Kauai, Alakai Swamp, VI-06-1973, 1200 m, bog margin, liverworts, sifting, Howarth.
- 5072 Oahu, Pukukea Forest Preserve, II-09-1969, Lee.
- 5109 Kauai, Alakai Swamp, jeep trail, XI-27-1963, ohia, Thornton.
- 5110 Hawaii, vic. Honokaa, Nienie gulch, E tributary, V-21-1967, forest, litter, Haas.
- 5111 Hawaii, Kukuiahae, XII-14-1961, inactive bird nest, Wilson.
- 5112 Oahu, Makaha Valley, head, VII-06-1965, Steffan.
- 5113 Molokai, Hanalilo, VII-03-1965, 3500 ft., Suman.
- 5114 Hawaii, Kulani, Stainback Hwy., III-11-1962, 4800 ft., ohia forest, litter, Haas.
- 5115 Hawaii, 2.5 mi. ENE of Puu Anahulu, III-28-1964, Haas.
- 5116 Hawaii, Hamakua Forest Reserve, VII-28-1963, 2200 ft., Haas.
- 5117 Kauai, Kokee, IX-12-1965, 3500 ft., Suman.
- 5118 Hawaii, Kohala Mts., E ridge, VII-06-1966, 4500 ft., forest, litter, Haas.
- 5119 Hawaii, Kohala Mts., VII-29-1966, 3500 ft., moss under trees, Beardsley.
- 5120 Hawaii, Mokumanu, V-02-1962, shearwater nest, Clagg.
- 5121 Molokai, Kamoku flats, III-19-1966, 3500 ft., Yoshimoto.
- 5122 Kauai, near Kokee, VII-13-1937, Zimmerman.
- 5123 Oahu, vic. Kailua, IV-01-1962, beach, Wilton.
- 5124 Oahu, Makaha Valley, head, VII-06-1965, 500 ft., Philips.
- 5125 Hawaii, vic. Hilo, Rainbow Falls, I-19-1982, under roots, ants, KC.
- 5126 Hawaii, vic. boiling pots, Hilo, I-19-1982, debris, KC.
- 5127 Hawaii, Hilo, Banyan Drive, I-19-1982, under bark, KC.
- 5128 Hawaii, as above, under stones.
- 5129 Hawaii, Hilo, Liliuokalani Park, I-19-1982, litter, sifting, KC.
- 5130 Hawaii, Hilo, Banyan Drive near Uncle Billy's Hotel, I-19-1982, rocky shore, porous lava, high-tide zone, KC.
- 5131 Hawaii, vic. Lava Tree State Park, I-20-1982, vegetation, beating, KC.
- 5132 Hawaii, vic. MacKenzie State Park, I-20-1982, forest, vegetation, beating, KC.
- 5133 Hawaii, Lava Tree State Park, I-20-1982, low grass, sweeping, KC.
- 5134 Hawaii, Hilo, I-19-1982, banyan litter, KC.
- 5135 Hawaii, vic. Kamuela airport, I-21-1982, bunch grass, sweeping, KC.
- 5136 Hawaii, between Waimea and Hawi, Kohala Mts., I-21-1982, grass, sweeping, KC.
- 5137 Hawaii, as above, berlese funnel.

- 5138 Hawaii, Keokea Beach Park, I-21-1982, sea wall, debris, KC.
5139 Hawaii, same, high-tide zone, debris.
5140 Hawaii, Pololu Valley, I-21-1982, under stones, ant nests, KC.
5141 Hawaii, Captain Cook, I-21-1982, orchard, under stones, KC.
5142 Hawaii, City of Refuge, I-25-1982, supralittoral fringe, debris, sifting, KC.
5143 Hawaii, Disappearing Sands Beach, I-25-1982, supralittoral fringe, debris, sifting, KC.
5144 Hawaii, Mauka State Forest, I-26-1982, lava rock with roots, KC.
5145 Hawaii, as above, under bark.
5146 Hawaii, Whittington Beach Park, between Honuapo and Punaluu, I-26-1982, drift debris, berlese, KC.
5147 Hawaii, Bird Park, I-27-1982, forest, under and on bark, KC.
5148 Hawaii, vic. Volcano, Koa track, I-27-1982, tree fern forest, under debris, KC.
5149 Hawaii, vic. Volcano, Olaa track, I-27-1982, tree ferns, sweeping, KC.
5150 Hawaii, Steaming Bluffs Trail, I-28-1982, near vents, on grass, KC.
5151 Hawaii, Bird Park, I-28-1982, forest, under bark of fallen logs, KC.
5152 Hawaii, Bird Park, I-27-1982, forest, understory shrubs and grasses, sweeping, KC.
5153 Hawaii, vic. Volcano Village, Olaa track, I-27-1982, ohia and tree fern forest, under bark and dead wood, KC.
5154 Hawaii, top of Mauna Loa Road, I-28-1982, 7000 ft., under and in lava rock, KC.
5155 Hawaii, vic. Volcano Village, I-28-1982, ohia in swamp, sweeping, KC.
5156 Hawaii, Mauna Loa Road, I-29-1982, 3500 ft., forest, under bark, KC.
5157 Hawaii, Mauna Loa Road, I-29-1982, 3500 ft., forest, sweeping ground cover, KC.
5158 Hawaii, Hilo Beach Park, I-29-1982, near margin of tide, in leaves and under lava rock, KC.
5159 Maui, halfway between Kahului and Hana, I-30-1982, heavy forest, under leaves and rotten wood, KC.
5160 Maui, Waianapanapa Cave State Park, I-30-1982, pandanus leaf litter and soil, berlese, KC.
5161 Maui, between Waianapanapa State Park and Hana, coastal trail, I-30-1982, under bark and in debris, KC.
5162 Maui, near entrance of Waianapanapa Cave, I-30-1982, moist, mixed woods, leaf litter, berlese, KC.
5163 Maui, near Haleakala Park, I-30-1982, rain forest, leaf litter, berlese, KC.
5164 Maui, Puaa Kaa State Park, between Keanae and Hana, II-01-1982, open forest, sweeping, KC.
5165 Maui, Honomanu State Park, vic. Keanae, II-01-1982, in litter, KC.
5166 Maui, Honomanu State Park, I-01-1982, beach, debris at high-tide mark, KC.
5167 Maui, 5 mi. W of Hana, II-01-1982, on and under taro leaves, KC.
5168 Maui, Waianapanapa State Park, I-01-1982, sweeping and beating vegetation, KC.
5169 Maui, Waianapanapa State Park, II-02-1982, black sand cobble beach, under stones near high-tide mark, KC.
5170 Maui, Waianapanapa State Park, cave entrance, II-02-1982, sweeping, KC.
5171 Maui, Waianapanapa State Park, II-02-1982, open meadow, sweeping, KC.

- 5172 Maui, 6 mi. S of Lahaina, hills away from road, II-04-1982, 1000 ft., in roots of grass, KC.
- 5173 Maui, Iao Valley State Park, up footpath 1 mi. beyond "Needle," II-03-1982, scrub forest and fescue grass, KC.
- 5174 Maui, Iao Valley State Park, up footpath 1 mi. from "Needle," II-04-1982, under bark of fallen trees and under stones, KC.
- 5175 Maui, Iao Valley State Park, up footpath 1 mi. from "Needle," II-04-1982, mesquite thicket, beating understory vegetation, KC.
- 5176 Maui, 6 mi. S of Lahaina, edge of clearing for planting sugarcane, II-04-1982, 200 ft., under bark and wood, KC.
- 5177 Maui, vic. Lahaina seashore, II-05-1982, near high-tide mark, under porous lava rock, KC.
- 5178 Maui, Iao Valley State Park, 2 mi. W of Needle trail, II-06-1982, ohia and koa forest, sweeping, KC.
- 5179 Maui, Iao Valley State Park, 2 mi. W of Needle trail, II-06-1982, koa thicket, sweeping, KC.
- 5180 Maui, Iao Valley State Park, 2 mi. W of Needle trail, II-06-1982, under bark of dead trees, KC.
- 5181 Maui, vic. Silversword Inn cabins, II-07-1982, leaf mold under trees, berlese, KC.
- 5182 Maui, Haleakala National Park, near paved road, II-07-1982, 7000 ft., under rocks, KC.
- 5183 Maui, Haleakala National Park, Hosmer Grove, II-08-1982, mixed forest, beating low vegetation, KC.
- 5184 Maui, Haleakala National Park, Hosmer Grove, II-08-1982, sweeping, KC.
- 5185 Maui, Visitor Center, just below peak, II-08-1982, moss, flotation sample, KC.
- 5186 Maui, Haleakala National Park, Halemau Trail, near jump-off point, II-08-1982, 8000 ft., under rocks, KC.
- 5187 Maui, vic. Kalahaku overlook, II-08-1982, 9300 ft., under stones, KC.
- 5188 Maui, Haleakala crater floor, II-08-1982, 6900 ft., sweeping, KC.
- 5189 Maui, Haleakala crater floor, II-08-1982, 6900 ft., under rocks, KC.
- 5190 Kauai, Spouting Horn Park, vic. Lihue, II-09-1982, near high-tide mark, under rocks, KC.
- 5191 Kauai, 5 mi. W of Lihue, II-09-1982, mixed broadleaf forest, leaf litter in tree hole, berlese, KC.
- 5192 Kauai, 5 mi. W of Lihue, II-09-1982, under rotted wood, KC.
- 5193 Kauai, Anini Beach Park, edge of lagoon, II-10-1982, near high-tide mark, sifting litter, KC.
- 5194 Kauai, Waikanaloa Trail, 0.5 mi. from head of trail, II-10-1982, wet broadleaf forest, beating understory vegetation, KC.
- 5195 Kauai, outskirts of Kapaa, II-10-1982, grass, sweeping, KC.
- 5196 Kauai, 5 mi. up Wailua River, along edge of road, II-10-1982, sweeping, KC.
- 5197 Kauai, Kokee State Park, vic. of cabin, II-11-1982, coniferous forest, sweeping, KC.
- 5198 Kauai, Kokee State Park, vic. of cabin, II-11-1982, under bark on rotten logs and bark on ground, KC.
- 5199 Kauai, Kokee State Park, Trail 13, 4 mi. from cabin, II-11-1982, mixed broadleaf forest, beating vegetation, KC.
- 5200 Kauai, Kokee State Park, vic. of cabin, II-11-1982, berlese, KC.

- 5201 Kauai, Puuhinahina, Waimea Canyon State Park, VII-09-1981, berlese, Goff.
5202 Kauai, Kapaa, forest reserve, IX-26-1980, litter under paperbark tree, berlese, Goff.
5203 Kauai, behind Kapaa, canefield area, moss on paperbark tree, berlese, Goff.
5204 Kauai, Power Line Trail, IX-25-1980, berlese, Goff.
5205 Kauai, Kapaa, forest reserve, IX-26-1980, along stream, litter under hau tree, Goff.
5206 Kauai, Power Line Trail, IX-25-1980, berlese, Goff.
5207 Kauai, Kapaa, forest reserve, IX-26-1980, 1 m above stream surface, moss on hau tree, berlese, Goff.
5208 Kauai, Alakai Swamp Trail, 1.5 mi. from end of road, IX-24-1980, ohia litter and moss, berlese, Goff.
5209 Kauai, Hanakapiai Stream Trail, 0.5 mi. from beach, I-13-1981, moss on tree, berlese, Goff.
5210 Kauai, Hanakapiai Stream, IX-25-1980, 1 m above water, moss on stream bank, berlese, Goff.
5211 Kauai, Alakai Swamp, 3 mi. from trail head, II-12-1982, under dead wood and sifting lichens, KC.
5212 Kauai, unpaved road to Alakai Swamp, 3 mi. before trail head, II-12-1982, mixed broadleaf forest, sweeping, KC.
5213 Kauai, Alakai Swamp, II-12-1982, club moss and grass, sweeping, KC.
5214 Kauai, Alakai Swamp, II-12-1982, beating shrubby ohia plants, KC.
5215 Kauai, unpaved road to Alakai Swamp, 2 mi. from trail head, II-12-1982, mixed broadleaf forest, under bark of standing and fallen dead trees, KC.
5216 Kauai, Kokee State Park, vic. cabin, II-13-1982, under bark of decayed log, KC.
5217 Oahu, Kuliouou Beach Park, vic. Hawaii Kai, II-25-1982, near high-tide mark, under rocks, KC.
5218 Oahu, Kuliouou Beach Park, vic. Hawaii Kai, II-25-1982, near high-tide mark, sifting wet debris, KC.
5219 Oahu, Kuliouou Beach Park, vic. Hawaii Kai, II-25-1982, debris, berlese, KC.
5220 Oahu, Hanauma Bay, II-25-1982, small grove of woods near shore, under stones, KC.
5221 Oahu, Hanauma Bay, II-26-1982, small grove of woods near shore, sweeping, KC.
5222 Oahu, Waimea Arboretum, Hawaiian domesticated plant section, II-27-1982, on water in pools and on decorative lava rock, KC.
5223 Oahu, Waimea Arboretum, near arboretum headquarters, II-27-1982, under wet wood, KC.
5224 Oahu, Waianae Mts., Dillingham Airfield, base of track up mountains, II-27-1982, under rocks, KC.
5225 Oahu, Dillingham Airfield, 50 yd. up trail, II-27-1982, sweeping grass, KC.
5226 Oahu, Dillingham Airfield, up trail, II-27-1982, 1500 ft., deciduous "dry" forest, under bark and stones, KC.
5227 Oahu, Dillingham Airfield, up trail, II-27-1982, 1500 ft., beating trees and high understory vegetation, KC.
5228 Oahu, Dillingham Airfield, up trail, II-27-1982, 1500 ft., sweeping understory, KC.
5229 Oahu, Dillingham Airfield, base of trail, II-27-1982, in and near ant nest and under stones, KC.

- 5230 Oahu, Waianae Mts., third peak S of Kolekole Pass, partway up trail, II-28-1982, 2400 ft., under rocks and in rotten log, KC.
- 5231 Oahu, same trail as above, II-28-1982, 3000 ft., sweeping ohia and ferns, KC.
- 5232 Oahu, summit as above, II-28-1982, 4000 ft., scattered brushy woods, under rocks, KC.
- 5233 Oahu, trail as above, II-28-1982, 3500 ft., sifting ohia and other leaf litter, KC.
- 5234 Oahu, trail as above, II-28-1982, 3000 ft., rotten log, KC.
- 5235 Oahu, same region as above, II-28-1982, heavy wooded area, sweeping, KC.
- 5236 Oahu, same region as above, II-28-1982, 2500 ft., deep in woods, intermittent stream bed, under rocks, KC.
- 5237 Oahu, summit as above, II-28-1982, 4000 ft., moss and soil in crotch of ohia tree, KC.
- 5238 Oahu, same region as above, II-28-1982, 3500 ft., heavy forest, leaf litter, KC.
- 5239 Oahu, Kahana Bay, windward shore beach park, III-01-1982, high-tide mark, leaf litter and debris, KC.
- 5241 Oahu, vic. Kahana Bay ridge, NW of bay, III-01-1982, between 1000 and 2500 ft., low shrubs and grass under stones, KC.
- 5242 Oahu, Kahana Bay, III-01-1982, under bark and decayed wood, KC.
- 5243 Oahu, Koolau Mts., Koolau Loa Dist., Kahuku Forest Reserve, summit trail near Puu Kainapuaa, II-11-1982, 2200 ft., leaf litter, Gagne.
- 5244 Hawaii, Puu Pili, Kohala Mts., VII-06-1964, forest floor debris, Haas.
- 5245 Oahu, Honolulu, Ala Moana Canal, XII-18-1939, on intertidal mud, Zimmerman.
- 5246 Hawaii, Old Mauna Loa Observatory Road, III-20-1964, 7750 ft., debris under ohia and pukiawe, Haas.
- 5259 Hawaii, I-11-1929, from pineapple fruit.
- 5260 Maui, Haleakala, II-06-1964, 8500 ft., under bare rock, Tsuda.
- 5261 Maui, Haleakala, I-28-1964, 8500 ft., grass and leaves, berlese.
- 5262 Kauai, Kokee, VII-04-1961, Yoshimoto.
- 5263 Maui, W. Maui Mts., X-24-28-1966, 2000 ft., Yoshimoto.
- 5264 Hawaii, Kaumana Cave, cave entrance, II-09-1962, among plants, Haas.
- 5265 Maui, Haleakala Crater, II-07-1964, 7000 ft., moss on rock, Koolau Gap, berlese, Tsuda.
- 5266 Hawaii, Hamakua Forest Reserve, Kalopa Section, V-17-1963, 2125 ft., debris under ohia, Haas.
- 5267 Oahu, Mt. Tantalus, Puualakaa Park, VI-19-1963, berlese, Young.
- 5268 Oahu, Ulumawao, east slope, VII-19-1966, 150 ft.
- 5269 Hawaii, Akaka Falls, I-21-1982, rain forest, vegetation, KC.
- 5270 Hawaii, Kalopa State Park, I-21-1982, forest, under bark, KC.
- 5271 Hawaii, Waipio Valley Road, 1/3 way down, I-21-1982, lava, KC.
- 5272 Hawaii, as above, taro patch at bottom of road.
- 5273 Hawaii, as above, under stones.
- 5274 Hawaii, Old Govt. Rd. from Honakaa to Waimea, I-21-1982, cave, on debris, KC.
- 5275 Hawaii, Bird Park, I-28-1982, flotation in soil, KC.
- 5276 Hawaii, Kalopa State Park, I-22-1982, mixed forest, under stones, KC.
- 5277 Kauai, Kalalau Lookout, litter under false staghorn fern, berlese, Goff.
- 5278 Kauai, Hanakapiai Trail, beach camp area, VII-08-1981, lichens on *Pandanus*, berlese, Goff.

- 5279 Kauai, upper rim of Kalalau, VII-09-1981, moss on ohia, berlese, Goff.
5280 Kauai, Hanakapiai Stream Trail, 0.5 mi. from beach, VII-08-1981, moss on rocks, Goff.
5281 Kauai, Hanakapiai Stream Trail, 0.5 mi. from beach, VII-08-1981, moss on rocks in stream, Goff.
5282 Kauai, Hanakapiai Stream Trail, 0.5 mi. from rocks, VII-08-1981, moss on rocks, Goff.
5283 Kauai, base of "B," Waimea Canyon, Goff.
5284 Kauai, Palihale Beach, VII-1981, canefield, berlese, Goff.
5285 Kauai, Kalalau Lookout, VII-09-1981, ohia, banana poka, berlese, Goff.
5286 Kauai, Waimea River, I-14-1981, mango litter, berlese, Vargas.
5287 Kauai, Waimea River, I-14-1981, Java plum litter, berlese, Vargas.
5288 Kauai, Waimea River, I-16-1981, Java plum litter, berlese, Vargas.
5289 Kure Atoll, leaf litter, berlese, Saviola.
5290 Kauai, Waimea, Kalalau, X-26-1963, 4000 ft., ohia forest, litter, Thornton.
5291 Oahu, Kaala, IV-19-1966, 4000 ft., moss under trees, Yoshimoto.
5292 Hawaii, Hamakua Forest Reserve (Nienie section), III-27-1961, 2600 ft., mixed forest, debris.
5293 Oahu, Mt. Kaala, XII-29-1963, 3000 ft., beating ohia, Thornton.
5294 Oahu, University of Hawaii campus, VII-09-1964, near Manoa stream, litter, Suman.
5295 Hawaii, Mauna Kea, near Snow Howarths Stone, near road, I-02-1982, 12,400 ft., rocky habitat.
5296 Laysan, IX-1961, under tree, Butler.
5297 Kure, IX-1961, Butler.
5298 Hawaii, Mauna Kea, Puu Wekiaiu, I-02-1982, 4200 m, edge of snow, Howarth.
5299 Hawaii, Mauna Kea, summit cone, IX-02-1979, 4200 m, Howarth.
5300 Hawaii, Mauna Kea, I-02-1982, 12,400 ft., near snow, Howarth.
5301 Oahu, Koolau Mts., Pomoho Trail, VI-02-1977, litter, sifting, Howarth.
5302 Oahu, Manoa Valley, IV-26-1961, berlese, Yatake.
5303 Hawaii, upper Waiakea Forest Reserve, IX-23-1961, 5638 ft., ohia forest, litter, Haas.
5304 Molokai, East, VII-1963, 3000 ft.
5305 Kauai, Alakai Swamp, VII-22-1964, on ridge beside jeep trail, 4000 ft., Suman.
5306 Midway Atoll, Sand Island, I-25-1964, bird nest, Clagg.
5307 Hawaii, 4 mi. E of S. Hookena, IX-10-1961, litter, berlese, Voss.
5308 Kauai, Kokee, vic. Kumuweia ridge, VII-21-1964, 4000 ft., Suman.
5309 Hawaii, Mauna Kea, VII-13-1967, 4140 m, blue and green pans, Hansen.
5310 Midway Atoll, I-22-1955, Clagg.
5311 Midway Atoll, Eastern Island, II-01-1964, Clagg.
5312 Hawaii, Mauna Loa, E slope, VII-20-1971, 6200 ft., koa litter, berlese, Radovsky.
5313 Hawaii, Mauna Loa, E slope, VII-21-1971, soil, Radovsky.
5314 Hawaii, Kilauea Forest Reserve, VII-21-1971, 5400 ft., soil, Radovsky.
5315 Hawaii, Kilauea Forest Reserve, VIII-29-1971, 5400 ft., litter, Jacobi.
5316 Hawaii, Mauna Loa, E slope, VIII-30-1971, 5200 ft., soil, Jacobi.
5317 Hawaii, Mauna Loa, E slope, VIII-30-1971, 8000 ft., soil, Jacobi.
5318 Hawaii, as above, 4000 ft.
5319 Hawaii, as above, 7500 ft., litter.

- 5320 Hawaii, Mauna Loa, weather station, X-04-1971, 5200 ft., soil, Jacobi.
 5321 Hawaii, Kilauea Forest Reserve, X-04-1971, 5400 ft., litter, Jacobi.
 5322 Hawaii, Mauna Loa, E slope, X-31-1971, 8000 ft., litter, Jacobi.
 5323 Hawaii, Mauna Loa, E slope, XI-02-1971, 6500 ft., litter, Jacobi.
 5324 Hawaii, Kilauea Forest Reserve.
 5325 Hawaii, XI-22-1971, 5400 ft., litter, Jacobi.
 5326 Hawaii, as above, different sample.
 5327 Hawaii, as above, soil.
 5328 Hawaii, Mauna Loa, E slope, Kipuka Ki weather station, XI-28-1971, 4000 ft., soil, Jacobi.
 5329 Hawaii, Mauna Loa, E slope, XI-28-1971, 4000 ft., litter, berlese, Jacobi.
 5330 Hawaii, as above, different sample.
 5331 Hawaii, Kilauea Forest Reserve, VII-09-1971, 5400 ft., pitfall, Jacobi.
 5332 Hawaii, as above, VII-30-1971.
 5333 Hawaii, as above, VIII-16-1971, 4000 ft.
 5334 Hawaii, as above, 5400 ft.
 5335 Hawaii, Mauna Loa, E slope, IX-01-1971, 7600 ft., pitfall, Jacobi.
 5336 Hawaii, IX-29-1971, 4000 ft., as above.
 5337 Hawaii, Kilauea Forest Reserve, IX-29-1971, 5400 ft., pitfall, Jacobi.
 5338 Hawaii, as above, X-10-13-1971.
 5339 Hawaii, Mauna Loa, E slope, X-27-1971, 4000 ft., pitfall, Jacobi.
 5340 Hawaii, Kilauea Forest Reserve, X-27-1971, 5400 ft., pitfall trap, Jacobi.
 5341 Hawaii, east slope of Mauna Loa, X-31-1971, 8000 ft., pitfall, Jacobi.
 5342 Hawaii, Kilauea Forest Reserve, XI-02-1971, 5400 ft., pitfall, Jacobi.
 5343 Hawaii, Bird Park, Kipuka Puauulu, IX-24-1971, pitfall, Jacobi.
 5344 Hawaii, Kilauea Forest Reserve, XI-24-1971, 5400 ft., pitfall, Jacobi.
 5345 Hawaii, Mauna Loa, E slope, XII-08-1971, 6500 ft., pitfall, Jacobi.
 5346 Hawaii, as above, XI-29-1971, 7500 ft.
 5347 Hawaii, Mauna Loa, E slope, Kipuka Ki weather station, XII-08-1971, 4000 ft., pitfall, Jacobi.
 5348 Hawaii, Mauna Loa, E slope, XI-29-1971, 8000 ft., pitfall, Jacobi.
 5350 Hawaii, Mauna Kea summit, III-9 to V-21-1982, 4050 m, Howarth.
 5351 Hawaii, as above, pitfall.
 5352 Hawaii, as above, different sample.
 5353 Hawaii, as above, III-09-1982, 4075 m, soil.
 5354 Hawaii, as above, different sample.
 5355 Hawaii, Keauhou Ranch, XII-10-1976, 1900 m, litter, Howarth.
 5356 Hawaii, as above, vegetation.
 5357 Hawaii, Kazumura Cave, XII-08-1976, 480 m, dark zone, Howarth.
 5358 Hawaii, Mauna Loa, XII-09-1976, 2065 m, vegetation, Howarth.
 5359 Hawaii, Keauhou Ranch, XII-10-1976, 1900 m, Davis.
 5360 Hawaii, Keamoku Cave, Keauhou Ranch, XII-11-1976, 1870 m, Howarth.
 5361 Hawaii, Kazumura Cave, XII-08-1976, 480 m, entryway, Howarth.
 5362 Hawaii, Mauna Loa, Bird Park, XII-9-11-1976, 1220 m, vegetation, Howarth.
 5363 Hawaii, Hilo, Akaka Falls, XII-12-1976, Davis.
 5364 Maui, Haleakala National Park, Puu Nianiau, XII-03-1976, 2210 m, vegetation, Davis.
 5365 Hawaii, Mauna Loa, Bird Park, cave #2, XII-09-1976, 1250 m, Davis.

- 5366 Maui, Haleakala National Park, Holua Cave, XII-05-1976, 2258 m, Davis.
5367 Hawaii, Mauna Loa, Bird Park, XII-9-11-1976, 1220 m, vegetation, Howarth.
5368 Hawaii, Mauna Loa, Lockwood lua, XII-07-1976, 2600 m, cave entrance, roots, Howarth.
5369 Hawaii, Kilauea Crater, rim trail, XII-07-1976, 1300 m, vegetation, Howarth.
5370 Hawaii, same as 5368, litter.
5371 Hawaii, Kazumura Cave, XII-08-1976, 480 m, Howarth.
5372 Hawaii, Mauna Loa, XII-09-1976, 2065 m, koa litter, Davis & Howarth.
5373 Maui, Haleakala National Park, Halemauu Trail, XII-05-1976, 2300-3200 m, moss, Davis & Howarth.
5374 Maui, Haleakala National Park, Halemauu Trail, XII-04-1976, 2300-3200 m, moss, Davis & Howarth.
5375 Hawaii, Mauna Loa, XII-09-1976, 2065 m, ohia bark, Davis & Howarth.
5383 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, III-08 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5384 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, III-08 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5385 Hawaii, Mauna Kea, S slope, vic. of Keanakakoi Quarry, VI-07-1982, margin of snow patches, Montgomery, Howarth, Banko & Gagne.
5386 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, III-08 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5387 Hawaii, Mauna Kea, CIT site, III-09 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5388 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, III-08 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5389 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, III-08 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5390 Hawaii, Mauna Kea, CIT site, III-08 to V-21-1982, 4050 m, pitfall trap, Howarth & Banko.
5391 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, III-08 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5392 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, III-08 to V-22-1982, 4050 m, pitfall trap, Howarth & Banko.
5398 Hawaii, 5 mi. W of Kulani, 0.8 mi. E of guardhouse, 960 m, PB.
5404 Oahu, Mt. Kaala, E ridge, II-04-1945, 2000-3000 ft., beating bushes, Werner.
5405 Oahu, Mt. Konahuanui, N ridge, I-14-1945, 1500-2000 ft., Werner.
5406 Oahu, Mt. Kaala, SE valley, II-03-1945, 2000 ft., beating vegetation, Werner.
5407 Hawaii, Ainahou Ranch, Pa Nene Cave, XII-30-1981, twilight upper entrance, rat dropping, Howarth.
5408 Hawaii, Puna, Paradise Park Cave, I-05-1982, deep zone, 175 m, Howarth.
5409 Hawaii, Kiholo Bay, Analima Kipo, I-10-1982, lava tube, Howarth.
5410 Hawaii, Volcanoes National Park, Ainahou Cave, I-04-1982, deep zone, 900 m, Howarth.
5411 Hawaii, Hilo Forest Preserve, Great Meander Cave, I-06-1982, 1230 m, 1855 lava flow, Howarth.
5412 Hawaii, Pink Pistillaria Cave, I-09-1982, Howarth.
5413 Hawaii, Pahoia Cave, VIII-20-1977, deep zone, Howarth.
5414 Hawaii, Keauhou Ranch, Sandy's Cave, VII-06-1974, 1770 m, Howarth.

- 5415 Hawaii, Volcanoes National Park, Bird Park, cave #1, I-03-1979, deep zone, Howarth.
- 5416 Hawaii, Volcanoes National Park, Thurston Lava Tube, I-03-1979, Howarth.
- 5417 Hawaii, Keauhou Ranch, Sandy's Cave, III-IV-1974, Smith.
- 5418 Hawaii, Volcanoes National Park, Bird Park, cave #1, VII-06-1976, deep zone, Howarth.
- 5419 Hawaii, Charcoal Cave, I-04-1979, deep zone, Howarth.
- 5420 Hawaii, Keauhou Ranch, Keamoku Cave, VII-10-1976, 1725 m, Howarth.
- 5421 Hawaii, Kazumura Cave, VII-30-1976, dark zone, 370 m, Howarth.
- 5422 Hawaii, Kau, Manu Cave, VII-21-1976, deep zone, Howarth.
- 5423 Hawaii, Volcanoes National Park, Bird Park, cave #2, XII-09-1976, twilight zone, rat dropping, Howarth.
- 5424 Hawaii, Petroglyph Cave, VII-13-1976, deep zone, Howarth.
- 5425 Hawaii, Keauhou Ranch, Keamoku Cave, VII-08 and XII-11-1976, 1600 m, Howarth.
- 5426 Hawaii, Volcanoes National Park, Bird Park, cave #2, XII-09-1976, twilight zone, rat dropping, Howarth.
- 5427 Hawaii, Kazumura Cave, XII-08-1976, deep zone, 400 m, Howarth.
- 5428 Hawaii, Lockwood luas #7, XII-09-1976, ohia aerial roots, Howarth.
- 5429 Hawaii, Kazumura Cave, IX-04-1976, deep zone, Howarth.
- 5430 Hawaii, Kazumura Cave, VII-08-1973, deep zone, 400 m, wall slime, Howarth.
- 5431 Hawaii, Kaumana Cave, makai section, III-27-1981, deep zone, 290 m, Howarth.
- 5432 Hawaii, Pahoa Cave, VII-07-1973, dark zone, 120-150 m, rat dropping, Howarth.
- 5433 Hawaii, Kahuku Ranch, Pa Nene Cave, VII-10-1973, deep zone, 2050 m, Howarth.
- 5434 Hawaii, Saddle Road, Esmine Cave, VII-11-1973, deep zone, 1700 m, Goff.
- 5435 Hawaii, Orchid Land Estates Cave, II-18-1974, dead roots, Howarth.
- 5436 Oahu, Pupukea lava tube, IX-4-25-1981, 50 m, pitfall trap, Howarth.
- 5437 Oahu, Pupukea lava tube, IX-30-1979, wet zone, rotting wood, Howarth.
- 5438 Oahu, Pupukea lava tube, XI-10-1979, Howarth.
- 5439 Oahu, Hawaii Loa, cave #1, VI-28-1975, deep zone, Howarth.
- 5440 Maui, Waikau Cave, Koolau Gap, XII-04-1976, deep zone, 1980 m, Howarth.
- 5441 Maui, Waikau Cave, VI-19-1976, deep zone, Howarth.
- 5442 Maui, Waikau Cave, XII-05-1976, deep zone, Howarth.
- 5443 Maui, Waikau Cave, XII-04-1976, deep zone, Howarth.
- 5444 Maui, Ulupalakua Cave, VIII-27-28-1977, deep zone, 2670 m, rat dung, Howarth.
- 5445 Maui, Ulupalakua Cave, VIII-28-1977, Howarth.
- 5446 Hawaii, Volcanoes National Park, Kipuka Keana Bihopa, I-04-1979, 2500 ft., Howarth.
- 5447 Hawaii, Kipuka Puaulu, 1200 m, Howarth.
- 5448 Hawaii, Ainahou Ranch, Pa Nene Cave, XII-30-1981, twilight lower entrance, 800 m, Howarth.
- 5449 Hawaii, Mauna Kea, Science Reserve, VII-11-12-1982, 4120 m, Howarth.
- 5450 Hawaii, Mauna Kea, Keanakakoi Quarry, VI-08 to VII-12-1982, 3900 m, pitfall trap, Howarth.
- 5451 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, V-22 to VII-10-1982, 4050 m, pitfall trap, Howarth.

- 5452 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, V-22 to VII-10-1982, 4500 m, pitfall trap, Howarth.
- 5453 Hawaii, Mauna Kea, Keanakakoi Quarry, VI-02-1982, 3790 m, under rock near snow patch, Howarth.
- 5454 Hawaii, Mauna Kea, Puu Hauoki, VII-10 to VIII-12-1982, 4140 ft., pitfall trap, Howarth.
- 5455 Hawaii, Mauna Kea, Science Reserve, VII-12 to VIII-11-1982, 3900-4100 m, pitfall trap, Howarth.
- 5456 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, V-22 to VII-10-1982, 450 m, pitfall trap, Howarth.
- 5457 Hawaii, Volcanoes National Park, Ainahou, II-13-1974, 975 m, on 1969 lava flow, cheese trap, Howarth.
- 5458 Hawaii, Mauna Kea, Puu Wekiu, VII-12 to VIII-10-1982, 4150 m, pitfall trap, Howarth.
- 5459 Oahu, Waianae Mts., Waianae Kai Valley, III-18-1978, 300 m, Howarth.
- 5460 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, V-22 to VII-10-1982, 4050 m, pitfall trap, Howarth.
- 5461 Hawaii, Mauna Kea, plateau N of Puu Hau Kea, V-22 to VII-10-1982, 4050 m, pitfall trap, Howarth.
- 5462 Hawaii, Mauna Kea, Keanakakoi Quarry, VI-08 to VII-12-1982, pitfall trap, Howarth.
- 5463 Hawaii, Kurtistown lava tube, II-19-1974, deep zone, 200-300 m, Howarth.
- 5464 Hawaii, Keamoku lava tube, II-26-1980, deep zone, 1720 m, Howarth, Stone & Smith.
- 5465 Hawaii, Keamoku lava tube, IX-06-1979, deep zone, 1720 m, near bait and roots, Howarth, Stone & Smith.
- 5466 Hawaii, Huehue Ranch lava tube, VIII-29-1979, transitional-dark zone, 610 m, Howarth.
- 5467 Hawaii, Kaumana lava tube, II-26-27-1980, deep zone, 290 m, Howarth.
- 5468 Hawaii, Alahaka lava tube, Kau, mauka section, VII-22-1976, dark zone, Howarth.
- 5469 Hawaii, Volcanoes National Park, Ainahou Ranch, II-17-1974, near 1909 lava flow, cheese trap, Howarth.
- 5470 Hawaii, Volcanoes National Park, Ainahou Ranch, II-13-1974, 975 m, near 1909 lava flow, Howarth.
- 5471 Hawaii, Volcanoes National Park, Ainahou Ranch, petroglyph lava tube, II-10-1974, 750-800 m, Howarth.
- 5472 Hawaii, Volcanoes National Park, Ainahou Ranch, II-21-1980, 975 m, Howarth.
- 5473 Hawaii, Volcanoes National Park, Ainahou Ranch, Pa Nene lava tube, II-23-1980, twilight zone, Howarth.
- 5474 Hawaii, Kazumura lava tube, VIII-12-1979, deep zone, 400 m, Howarth.
- 5475 Hawaii, Kazumura lava tube, III-06-1976, cheese bait, Howarth.
- 5476 Hawaii, Kazumura lava tube, VIII-14-1967, Howarth.
- 5477 Hawaii, Kazumura lava tube, II-25-1980, Howarth.
- 5478 Hawaii, Kazumura lava tube, III-06-1976, cheese bait, Howarth.
- 5479 Hawaii, Waiakea forest, VIII-21-1977, vegetation.
- 5480 Maui, Waikau lava tube, V-26 to VI-21-1976, 1980 m, dark zone, Howarth.
- 5481 Maui, 1 km W of Paliku, Bone Cave, VI-23-1976, 200 m, twilight zone, Howarth.

- 5482 Maui, Paliku, VI-24-1976, litter, sifting, Howarth.
5483 Maui, Kapalaoa, VI-18-22-1976, 2220 m, baited trap, aeolian zone, Howarth.
5484 Molokai, Wheelchair Cave, Kawela, I-06-1981, 1265 m, dung, Howarth.
5485 Molokai, Lua Lolo Cave, Kawela, I-06-1981, 1200 m, deep zone, Howarth.
5486 Molokai, Kalaupapa crater rim, III-10-1974, 120 m, baited trap, Howarth.
5487 Oahu, U.H. Quarry cave, III-17-1979, 0.12 m, dark zone, fish bait, Howarth.
5488 Hawaii, Saddle Rd., Puu Huluhulu, VIII-11-1982, under stones, Howarth.
5489 Hawaii, Hawaii Volcanoes National Park, Olaa track, VIII-05-1982, 1170 m, forest, litter.
5490 Hawaii, Volcanoes National Park, Ainahou Ranch, Panene Cave #1, II-23-1980, 2600-2700 ft., twilight zone.
5491 Hawaii, Kilauea, Waiakea Forest Reserve, VIII-21-1977, 1240 m, vegetation, Uchida.
5492 Maui, Haleakala National Park, Paliku-Kuiki tr., VI-24-1976, 200 m, litter, sifting, Teves.
5493 Hawaii, Kilauea, Waiakea Forest Reserve, VIII-21-1977, 1240 m, vegetation, Uchida.
5494 Molokai, Palaa State Park, VII-15-1982, 1600 ft., decaying wood, Luther.
5495 Molokai, as above, different site.
5496 Molokai, road between Hwy. 46 and Molokai Sheraton, VII-15-1982, 350 ft., decaying grass, Luther.
5497 Molokai, vic. Hoolehua airport, VII-15-1982, 440 ft., grove, litter, Luther.
5498 Molokai, Halawa valleyhead or trail to Moaula Falls, VII-15-1982, 100 ft., under bark, ants, Luther.
5499 Molokai, as above, VII-15-1982, 250 ft., vegetation.
5500 Molokai, Halawa Valley, VII-15-1982, Luther.
5501 Molokai, as 5499, debris, Luther.
5502 Molokai, Hwy 45, 25 mi. E of Kaunakakai, VII-15-1982, decaying leaves, Luther.
5503 Molokai, 10 mi. E of Kaunakakai, near ocean, VII-15-1982, litter, Luther.
5504 Molokai, junction Hwy 46 & 47, VII-15-1982, 475 ft., litter, Luther.
5518 Hawaii, Mauna Loa, E slope, VII-20-1971, 5200 ft., koa forest, vegetation, Jacobi.
5519 Hawaii, as above, IX-29-1971, 7000 ft.
5520 Hawaii, Kilauea Forest Reserve, IX-29-1971, 5400 ft., glade, Jacobi.
5521 Hawaii, Mauna Loa, E slope, XI-24-1971, 4000 ft., litter, Jacobi.
5522 Hawaii, Kilauea Forest Reserve, X-04-1971, 5400 ft., dense forest, litter, Jacobi.
5524 Oahu, Hanauma Bay, near beach, XII-27-1982, grass clippings, KC.
5525 Oahu, road up Mt. Kaala, I-18-1983, vegetation, sweeping, KC.
5526 Oahu, as above, litter, sifting, KC.
5527 Oahu, as above, 4 mi. up road, vegetation, sweeping, KC.
5528 Oahu, as above, litter, sifting, KC.
5529 Oahu, as above, under wood, KC.
5530 Oahu, as above, under rocks, KC.
5531 Oahu, Mt. Kaala, near top, I-18-1983, 4000 ft., dwarf forest, KC.
5532 Oahu, Mt. Kaala, near top, I-18-1983, scrub forest, sifting litter, KC.
5333 Oahu, Mt. Kaala, near top, I-18-1983, under bark, KC.
5534 Oahu, Mt. Kaala, near top, I-18-1983, sifting moss from tree trunk, KC.
5535 Oahu, Mt. Kaala, near radar station, I-18-1983, 4200 ft., sifting grass and roots, KC.

- 5639 Oahu, Honolulu, Keehi Lagoon Park, I-19-1983, high-tide mark, debris, KC.
5640 Oahu, Honolulu, Keehi Lagoon Park, I-19-1983, rocks below high-tide mark, KC.
5641 Oahu, vic. Honolulu, Kuliouou Beach Park, I-19-1983, high-tide mark, sifting grass and debris, KC.
5642 Oahu, vic. Honolulu, Kuliouou Beach Park, I-19-1983, intertidal zone, under rocks, KC.
5643 Hawaii, Ohiaula Beach Park, XII-29-1982, sandy soil, under debris, KC.
5644 Hawaii, 8 mi. W of Kamuela, XII-31-1982, 2000 ft., mature forest, under stones, KC.
5645 Hawaii, 8 mi. W of Kamuela, XII-31-1982, 2000 ft., sweeping vegetation, KC.
5646 Hawaii, 8 mi. W of Kamuela, XII-31-1982, 2000 ft., soil under trees, KC.
5647 Hawaii, 8 mi. W of Kamuela, XII-31-1982, 2000 ft., moss on fallen tree, KC.
5648 Hawaii, 8 mi. W of Kamuela, XII-31-1982, 2000 ft., sweeping grass in cut area, KC.
5649 Hawaii, 4-5 mi. W of Kamuela, 2500 ft., XII-31-1982, small ohia-tree fern forest in grazed parkland, on moss, KC.
5650 Hawaii, 4-5 mi. W of Kamuela, XII-31-1982, 2500 ft., small ohia-tree fern forest in grazed parkland, soil sample, KC.
5651 Hawaii, 4-5 mi. W of Kamuela, XII-31-1982, grazed parkland, sifting grass, KC.
5652 Hawaii, 4-5 mi. W of Kamuela, XII-31-1982, grazed parkland, soil sample, KC.
5653 Hawaii, 2 mi. W of Kamuela, XII-31-1982, 2700 ft., grazed meadow, sweeping grass, KC.
5654 Hawaii, Saddle Road, trail to Puu Laau, I-01-1983, 7500 ft., open woods, sweeping vegetation, KC.
5655 Hawaii, Saddle Road, trail to Puu Laau, I-01-1983, 7500 ft., under lava rocks, KC.
5656 Hawaii, Saddle Road, 10 mi. E of jct. with Mauna Kea Road, I-01-1983, 7000 ft., ohia forest, sweeping, KC.
5657 Hawaii, Saddle Road, 10 mi. E of jct. with Mauna Kea Road, I-01-1983, 7000 ft., knocked out of lava rocks, KC.
5658 Hawaii, Kohala Mts., 5 mi. N of Kamuela foothills, I-01-1983, 3800 ft., grassland, sweeping, KC.
5659 Hawaii, Kohala Mts., 5 mi. N of Kamuela foothills, I-01-1983, 3800 ft., sifting grass stems, KC.
5660 Hawaii, 2 mi. S of Kailua-Kona, I-02-1983, high-tide mark of rocky beach, sifted from debris, KC.
5661 Hawaii, 5 mi. S of Kailua-Kona, Kahului Beach Park, I-01-1983, high-tide mark, sifting debris, KC.
5662 Hawaii, Saddle Road, 35 mi. E of W end of road, I-03-1983, ohia-fern woods, sweeping, KC.
5663 Hawaii, Saddle Road, 35 mi. E of W end of road, I-03-1983, ohia-fern woods, sifting litter, KC.
5664 Hawaii, Saddle Road, 35 mi. E of W end of road, I-03-1983, ohia-fern woods, soil sample, KC.
5665 Hawaii, Saddle Road, near 48 mi. marker, I-03-1983, eucalyptus forest, KC.
5666 Hawaii, road between Kamuela and Hawi, I-04-1983, *Casuarina* grove, sweeping grass and herbs, KC.
5667 Hawaii, road between Kamuela and Hawi, I-04-1983, *Casuarina* grove, under rotten wood and in ant nests, KC.

- 5668 Hawaii, 2 mi. S of Kahua, I-04-1983, 3500 ft., sifting litter, KC.
5669 Hawaii, vic. Kamuela, near road marker 7, I-04-1983, sweeping leaves of leguminous tree, KC.
5670 Hawaii, vic. Kamuela, I-04-1983, intermittent stream bed, under lava rock, KC.
5671 Hawaii, 40 mi. from W end of Saddle Road, I-04-1983, 4000 ft., scrub forest, lava stone "soil," KC.
5672 Hawaii, 40 mi. from W end of Saddle Road, I-04-1983, 4000 ft., scrub forest, sifting litter, KC.
5673 Hawaii, 40 mi. from W end of Saddle Road, I-04-1983, 4000 ft., scrub forest, sweeping, KC.
5674 Hawaii, 38 mi. from W end of Saddle Road, I-04-1983, in lava rock "soil," KC.
5675 Hawaii, 38 mi. from W end of Saddle Road, I-04-1983, sifting moss and lichens, KC.
5676 Hawaii, 38 mi. from W end of Saddle Road, I-04-1983, sweeping, KC.
5677 Hawaii, Kipuka Puu Huluhulu, opposite base of road up Mauna Kea Kipuka, I-04-1983, koa mixed forest, under rotten wood, KC.
5678 Hawaii, Kipuka Puu Huluhulu, opposite base of road up Mauna Kea Kipuka, I-04-1983, under lava rocks, KC.
5679 Hawaii, Kipuka Puu Huluhulu, opposite base of road up Mauna Kea Kipuka, I-04-1983, sifting leaf litter, KC.
5680 Hawaii, Volcanoes National Park, near laboratory building, I-06-1983, ohia forest, KC.
5681 Hawaii, Volcanoes National Park, vic. Volcano House, I-08-1983, ohia-fern woods, on decaying wood, KC.
5682 Hawaii, Volcanoes National Park, vic. Volcano House, I-08-1983, ohia-fern woods, sifting litter, KC.
5683 Hawaii, Volcanoes National Park, vic. Volcano House, I-08-1983, ohia-fern woods, sweeping, KC.
5684 Hawaii, Volcanoes National Park, vic. Visitors' Information Center, I-08-1983, ohia-fern forest, sifting moss, KC.
5685 Hawaii, Volcanoes National Park, vic. Visitors' Information Center, I-08-1983, ohia-fern forest, sweeping grass, KC.
5686 Hawaii, Disappointment Rd., near Stainback Hwy., I-09-1983, rain forest, sweeping, KC.
5687 Hawaii, Disappointment Rd., near Stainback Hwy., I-09-1983, rain forest, sweeping epiphytic moss and bromeliads, KC.
5688 Hawaii, Disappointment Rd., near Stainback Hwy., I-09-1983, rain forest, sifting deep hole litter, KC.
5689 Hawaii, Disappointment Rd., near Stainback Hwy., I-09-1983, rain forest, sweeping cut grass, KC.
5690 Hawaii, Disappointment Rd., I-09-1983, open forest, sweeping, KC.
5691 Hawaii, Disappointment Rd., I-09-1983, open forest, sifting litter, KC.
5692 Hawaii, Olaa State Forest, vic. Volcano Village, I-10-1983, rain forest, sweeping, KC.
5693 Hawaii, Olaa State Forest, vic. Volcano Village, I-10-1983, rain forest, sifting litter, KC.
5694 Hawaii, Olaa State Forest, vic. Volcano Village, I-10-1983, rain forest, sifting moss and soil, KC.

- 5695 Hawaii, Olaa State Forest, vic. Volcano Village, I-10-1983, rain forest, roadside grass, KC.
- 5696 Hawaii, behind Volcano solid waste transfer station, I-10-1983, edge of mesic rain forest, sweeping, KC.
- 5697 Hawaii, behind Volcano solid waste transfer station, I-10-1983, mesic rain forest, sweeping, KC.
- 5698 Hawaii, behind Volcano solid waste transfer station, I-10-1983, mesic rain forest, sifting litter, KC.
- 5699 Hawaii, behind Volcano solid waste transfer station, I-10-1983, mesic rain forest, beating vegetation, KC.
- 5700 Hawaii, behind Volcano solid waste transfer station, I-10-1983, mesic rain forest, low vegetation and shrubs in tree hole litter, KC.
- 5701 Hawaii, behind Volcano solid waste transfer station, I-10-1983, mesic rain forest, under rotten wood, KC.
- 5702 Hawaii, behind Volcano solid waste transfer station, I-10-1983, edge of mesic rain forest, sweeping, KC.
- 5703 Hawaii, behind Volcano solid waste transfer station, I-10-1983, grassy area near edge of mesic rain forest, under lava rock, KC.
- 5704 Molokai, Kaunakakai, vic. Pau Hana Inn, I-12-1983, beach, under coconuts, KC.
- 5705 Molokai, road to Kalahuapueo Lookout, I-12-1983, 3800 ft., clearing in ohia-eucalyptus forest, sweeping, KC.
- 5706 Molokai, Kalahuapueo Lookout, I-12-1983, 4000 ft., eucalyptus paperbark forest, sifting litter, KC.
- 5707 Molokai, vic. Kalahuapueo Lookout, 100 yd. above Hanolilolilo Trail, I-12-1983, open scrub forest, sifting grass roots and stems, KC.
- 5708 Molokai, vic. Kalahuapueo Lookout, Hanolilolilo Trail, I-12-1983, scrub forest, sweeping, KC.
- 5709 Molokai, vic. Kalahuapueo Lookout, Hanolilolilo Trail, I-12-1983, scrub forest, sifting litter, KC.
- 5710 Molokai, vic. Kalahuapueo Lookout, Hanolilolilo Trail, I-12-1983, mixed forest, sweeping, KC.
- 5711 Molokai, vic. Kalahuapueo Lookout, Hanolilolilo Trail, I-12-1983, mixed forest, beating vegetation, KC.
- 5712 Molokai, vic. Kalahuapueo Lookout, Hanolilolilo Trail, I-12-1983, ohia-tree fern forest, soil sample, KC.
- 5713 Molokai, Kalahuapueo Lookout, I-12-1983, 4000 ft., eucalyptus paperbark forest, soil sample, KC.
- 5714 Molokai, hills above Kawela, I-13-1983, 2000 ft., semiarid open grassland, under rocks and in ant nests, KC.
- 5715 Molokai, vic. Cabin Puu Kolekole, I-13-1983, 3900 ft., ohia forest, sifting litter, KC.
- 5716 Molokai, vic. Cabin Puu Kolekole, I-13-1983, ohia forest, under exposed rocks, KC.
- 5717 Molokai, vic. Cabin Puu Kolekole, I-13-1983, 3500 ft., open forest, sifting litter, KC.
- 5718 Molokai, vic. Cabin Puu Kolekole, I-13-1983, large clump of mature cedars, sifting litter, KC.

- 5719 Molokai, 1 mi. from Cabin Pua Kulekole, I-13-1983, 3000 ft., ohia scrub forest, sweeping, KC.
- 5720 Molokai, 1 mi. from Cabin Pua Kulekole, I-13-1983, 3000 ft., sweeping grass and scattered shrubs, KC.
- 5721 Molokai, 1 mi. from Cabin Pua Kulekole, I-13-1983, 3000 ft., sifting grass roots, KC.
- 5722 Molokai, vic. Cabin Pua Kulekole, I-13-1983, rain forest, sweeping, KC.
- 5723 Molokai, vic. Cabin Pua Kulekole, I-13-1983, rain forest, beating trees, KC.
- 5724 Molokai, vic. Cabin Pua Kulekole, I-13-1983, rain forest, sifting litter, KC.
- 5725 Molokai, vic. Cabin Pua Kulekole, I-13-1983, sifting fruticose lichens, KC.
- 5726 Molokai, vic. Cabin Pua Kulekole, I-13-1983, 3700 ft., Zealand flax patch, sifting old leaves and flax plants, KC.
- 5727 Molokai, vic. Cabin Pua Kulekole, I-13-1983, 3600 ft., below edge of rain forest, sweeping, KC.
- 5728 Molokai, vic. Cabin Pua Kulekole, cave near transect 7, I-13-1983, KC.
- 5729 Molokai, 1 mi. above Cabin Pua Kulekole, I-14-1983, 4000 ft., rain forest, sweeping and beating vegetation, KC.
- 5730 Molokai, 1 mi. above Cabin Pua Kulekole, I-14-1983, 4000 ft., rain forest, sifting litter, KC.
- 5731 Molokai, 1 mi. above Cabin Pua Kulekole, I-14-1983, 4000 ft., rain forest, sifting moss on tree trunks, KC.
- 5732 Molokai, vic. of Cabin Pua Kulekole, I-16-1983, ohia forest, axils of dead tree fern leaves, KC.
- 5733 Molokai, trail from Cabin Pua Kulekole to Hanalilolilo Rd., I-16-1983, scrub forest of mostly foreign trees, under exposed rocks, KC.
- 5734 Molokai, 5 mi. W of Kaunakakai, I-17-1983, open mesquite forest, under debris with ants, KC.
- 5735 Molokai, 5 mi. W of Kaunakakai, I-17-1983, mangrove swamp, in leaf litter, KC.
- 5746 Hawaii, Kazumura Cave, I-07-1983, Chapman.
- 6189 Oahu, Poamoho Trail, Koolau Range, VI-15-1972, 650 m, wet leaf litter, Gagne.
- 6190 Maui, Haleakala National Park, near Hosmer Grove, XI-12 to XII-12-1983, 7000 ft., alpine shrubland, pitfall trap, Gagne.
- 6191 Laysan, VII-26-1983, under guano slabs, Gagne.
- 6192 Midway Atoll, Sand Island, VII-16-1983, beach strand following rain, Gagne.
- 6193 Nihoa, Miller Valley, IV-20-25-1983, 20 m, pitfall trap under shrubs, Gagne.
- 6194 Midway Atoll, Sand Island, VII-15-1983, beach, under dead fish, Gagne.
- 6195 Nihoa, W. Palm Valley, IV-25-1983, 100 m, vesicular basalt, Gagne.
- 6196 Laysan, VII-24-1983, unexposed reef, Gagne.
- 6197 Pearl and Hermes Reef, Southeast Island, VII-20-1983, intertidal zone, on lagoon, Gagne.
- 6381 Molokai, trail to Kalaupapa Peninsula, VI-1984, 500 ft., under rocks, Luther.
- 6382 Molokai, Kalaupapa Peninsula, VI-1984, sea level, in leaves and dirt, Luther.
- 6383 Molokai, Hwy. 45, 25 mi. E of Kaunakakai, VI-1984, dry stream bed, under rocks, Luther.
- 6384 Molokai, Hwy. 45, 20 mi. E of Kaunakakai, VI-1984, in dirt and decaying leaves, Luther.
- 6385 Oahu, Malaekahana Beach Park, VII-1984, under decaying leaves, Luther.
- 6386 Oahu, 0.5 mi. S of Kaaawa, VII-1984, next to stream, under decaying leaves, Luther.

- 6387 Oahu, 1 mi. up Waiahole Valley Rd. from Hwy. 83, VII-1984, beside stream, under rocks, Luther.
- 6388 Oahu, Kamehameha Hwy., 1.3 mi. S of jct. with Hwy. 83, VII-1984, next to ocean, under decaying leaves, Luther.
- 6389 Oahu, NW Kailua, btwn. Mokapu Blvd. and H-3 freeway, VII-1984, in decaying leaves and dirt, Luther.
- 6390 Midway Atoll, Eastern I., refuse dump, III-23-1971, rat nest, Goff.
- 6391 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2000 ft., berlese, Goff & Radovsky.
- 6392 Hawaii, Volcanoes National Park, Mauna Loa Trail, VI-16-1970, 2240 m, shrubs, berlese, Goff & Radovsky.
- 6393 Hawaii, Volcanoes National Park, Steaming Bluffs Trail, vent III, VI-29-1971, pitfall trap, Goff.
- 6394 Hawaii, Mauna Loa Strip Road, VI-28 to VII-5-1971, pitfall trap, Goff.
- 6395 Hawaii, Mauna Loa Strip Road, VII-12-20-1971, pitfall trap, Goff.
- 6396 Hawaii, Volcanoes National Park, Bird Park, VII-05-12-1971, pitfall trap, Goff.
- 6398 Maui, Lahaina, XI-06-1977, in leaves, Scott.
- 6482 Oahu, Honolulu, Nuuanu Pali Dr., II-20-1985, Norfolk pine litter, Roth.
- 6483 Oahu, Honolulu, V-09-1928, pineapple soil, Folsom.
- 6484 Oahu, Honolulu, III-07-1927, canefield soil, Folsom.
- 6485 Oahu, III-12-1928, pineapple soil, Folsom.
- 6486 Oahu, Honolulu, V-04-1928, pineapple soil, Folsom.
- 6487 Oahu, Honolulu, X-04-1928, pineapple soil, Folsom.
- 6488 Oahu, X-01-1928, pineapple soil, Folsom.
- 6489 Oahu, Honolulu, V-09-1928, pineapple soil, Folsom.
- 6490 Oahu, Wahiawa, VII-28-1928, pineapple soil, Folsom.
- 6491 Oahu, Wahiawa, XII-03-1928, pineapple soil, Folsom.
- 6492 Oahu, Honolulu and Wahiawa, XII-03-1928, pineapple soil, Folsom.
- 6493 Oahu, Honolulu, X-04-1928, pineapple soil, Folsom.
- 6494 Hawaii, Hawaii Volcanoes National Park, Mauna Loa Trail, X-20-1970, 2280 m, lichen, Goff.
- 6495 Hawaii, 2.1 mi E, 9.8 mi W of N. Kulani, II-21-1971, 1360 m, soil, berlese, Radovsky.
- 6525 Oahu, Palikea, VIII-15-1957, beating ohia, Mockford.
- 6526 Oahu, Honolulu, Mt. Tantalus, VIII-17-1957, dry ginger leaves, berlese, Mockford.
- 6527 Kauai, Kokee, VIII-25-1957, moss on bark, berlese, Mockford.
- 6528 Kauai, Kokee, Short Nualolo Trail, VIII-18-1957, beating branch with dead leaves, Mockford.
- 6529 Kauai, near Kokee Inn, VIII-19-1957, beating ohia leaves, Mockford.
- 6530 Oahu, Honolulu, Mt. Tantalus, VIII-17-1957, wide-bladed grass, berlese, Mockford.
- 6531 Hawaii, Kohala Watershed Reserve, IX-04-1957, vegetation, beating, Mockford.
- 6532 Hawaii, Hawaii National Park, Bird Park, IX-01-1957, litter, Mockford.
- 6533 Hawaii, Hilo, Saddle Road, VIII-30-1957, 2000 ft., beaten from ohia trees, Mockford.
- 6534 Kauai, Alakai Swamp, VIII-22-1957, vegetation, beating, Mockford.
- 6535 Kauai, Kokee, Puu o Kilo Trail, VIII-20-1957, dried leaves, beating, Mockford.
- 6536 Oahu, Honolulu, nest, Van.

- 6537 Kauai, Kokee, VIII-25-1957, litter, berlese, Mockford.
6538 Oahu, Honolulu, VII-1933, compost heap, Van.
6539 Kauai, Kokee, Puu o Kilo Trail, VIII-20-1957, vegetation, beating, Mockford.
6540 Oahu, Honolulu, Mt. Tantalus, VIII-17-1957, litter, berlese, Mockford.
6614 Oahu, Koolau Mts., Sacred Falls, VIII-03-1985, under rocks and rotting wood, Luther.
6664 Maui, West Maui, 4 mi. NW of Waihee, VII-04-1986, damp mesophytic forest, under stones, KC.
6665 Maui, West Maui, 4 mi. NW of Waihee, VII-04-1986, damp mesophytic forest, in rotten wood, KC.
6666 Maui, West Maui, 4 mi. NW of Waihee, VII-04-1986, damp mesophytic forest, vegetation, sweeping, KC.
6667 Maui, West Maui, vic. Honokahua Bay, Rt. 30, mile marker 34, VII-05-1986, *Casuarina* grove in grassland, in ant nest, KC.
6668 Maui, West Maui, 1 mi. N of Fleming Park, VII-05-1986, mixed forest, under rocks, KC.
6669 Maui, West Maui, 1 mi. N of Fleming Park, VII-05-1986, mixed forest, lawn vegetation, sweeping, KC.
6670 Maui, West Maui, 1 mi. N of Fleming Park, VII-06-1986, mixed forest, soil sample, berlese, KC.
6671 Maui, East Maui, Rt. 377, 1.6 mi. from jct. Rt. 37, VII-06-1986, eucalyptus grove, rotten wood, KC.
6672 Maui, East Maui, Agricultural Experiment Station, VII-06-1986, grass, sweeping, KC.
6673 Maui, Hana Rd., 3 mi. from jct. Rt. 36, VII-06-1986, 2000 ft., open woods, under rocks, KC.
6674 Maui, Hana Rd., 3 mi. from jct. Rt. 36, VII-06-1986, 2000 ft., open woods, leaves on rotted wooden table, KC.
6675 Maui, Hana Road, 2 mi. E of previous site, wet forest, under rocks, KC.
6676 Maui, Hana Road, as above, wet forest, sifting litter, KC.
6677 Maui, East Maui, Makawa State Forest, VII-08-1986, native woods, under rocks, KC.
6678 Maui, East Maui, Makawa State Forest, VII-08-1986, meadow, under stones, KC.
6679 Maui, East Maui, Makawa State Forest, VII-08-1986, meadow, trapped on water pools under large stones, KC.
6680 Maui, East Maui, Makawa State Forest, VII-08-1986, native woods, under bark of rotted logs, KC.
6681 Maui, East Maui, Makawa State Forest, VII-08-1986, native woods, vegetation, beating, KC.
6682 Maui, East Maui, Makawa State Forest, VII-08-1986, native woods, lichens and moss, berlese, KC.
6683 Maui, West Maui, 1 mi. above scout camp road, VII-09-1986, mixed forest, near stream, under rocks, KC.
6684 Maui, West Maui, 1 mi. above scout camp road, VII-09-1986, mixed forest, vegetation, sweeping, KC.
6685 Maui, West Maui, 1 mi. above scout camp road, VII-09-1986, mixed forest, litter, sifting, KC.
6686 Maui, jct. Waihee Valley Rd., VII-09-1986, vegetation, sifting, KC.

- 6687 Maui, vic. Waikapu, VII-09-1986, sugarcane field, soil, berlese, KC.
- 6688 Maui, West Maui, 1 mi. N of Fleming Park, VII-10-1986, mixed forest, under debris, KC.
- 6689 Lanai, Monroe Jeep Trail, 2 mi. from W trail head, VII-11-1986, 1200 ft., paperbark tree grove, under rotten wood, KC.
- 6690 Lanai, Monroe Jeep Trail, 2 mi. from W trail head, VII-11-1986, 1200 ft., paperbark tree grove, sifting litter, KC.
- 6691 Lanai, Monroe Jeep Trail, 2 mi. from W trail head, VII-11-1986, 1200 ft., paperbark tree grove, vegetation, sweeping, KC.
- 6692 Lanai, Monroe Jeep Trail, 3 mi. from W trail head, VII-12-1986, 2000 ft., eucalyptus forest, in rotten wood with ants, KC.
- 6693 Lanai, Monroe Jeep Trail, 4 mi. from W trail head, VII-12-1986, 2200 ft., grove of native trees, rotten wood, KC.
- 6694 Lanai, Monroe Jeep Trail, 4.5 mi. from W trail head, VII-12-1986, 2500 ft., eucalyptus grove, rotten wood, KC.
- 6695 Lanai, Monroe Jeep Trail, near summit, VII-12-1986, 2800 ft., cloud forest, *Araucaria* clump with grass, sifting grass roots, KC.
- 6696 Lanai, Monroe Jeep Trail, 0.25 mi. beyond summit, VII-12-1986, moss, KC.
- 6697 Lanai, Monroe Jeep Trail, 0.5 mi. beyond summit, VII-12-1986, 3000 ft., elfin cloud forest, ferns, sweeping, KC.
- 6698 Lanai, Monroe Jeep Trail, 0.5 mi. beyond summit, VII-12-1986, elfin cloud forest, under bark, KC.
- 6699 Lanai, Monroe Jeep Trail, 1 mi. beyond summit, VII-12-1986, elfin cloud forest, beating branches, KC.
- 6700 Lanai, Monroe Jeep Trail, 1.75 mi. beyond summit, VII-12-1986, 2500 ft., elfin cloud forest, under bark, KC.
- 6701 Lanai, Monroe Jeep Trail, 2.75 mi. beyond summit, VII-12-1986, 2000 ft., edge of cloud forest, eucalyptus grove, rotten wood, KC.
- 6702 Lanai, Rt. 44, 3 mi. from Lanai City, VII-13-1986, 1500 ft., *Casuarina* woods, under bark, KC.
- 6703 Lanai, Monroe Jeep Trail, 2 mi. from W trail head, VII-13-1986, 1200 ft., paperbark tree grove, soil, berlese, KC.
- 6704 Maui, West Maui, Waianapanapa State Park, vic. caves, VII-15-1986, sweeping, KC.
- 6705 Maui, West Maui, Waianapanapa State Park, vic. caves, VII-15-1986, under stones and debris, KC.
- 6706 Maui, Puaakaa State Wayside Park, VII-15-1986, forest and grass, sweeping, KC.
- 6707 Maui, West Maui, btwn. Wainapanapa and Puaakaa, VII-15-1986, under stones, KC.
- 6708 Kauai, Hoary Head Range, Haupu Forest Preserve, VII-17-1986, soil from edge of paperbark tree, berlese, KC.
- 6709 Kauai, Hoary Head Range, Haupu Forest Preserve, VII-17-1986, ginger patch, soil, berlese, KC.
- 6710 Kauai, Hoary Head Range, Haupu Forest Preserve, 1 mi. into forest, VII-17-1986, 500 ft., litter, KC.
- 6711 Kauai, Hoary Head Range, Haupu Forest Preserve, 2 mi. into forest, VII-17-1986, under bark, KC.
- 6712 Kauai, near Menchune ditch foot bridge, VII-18-1986, forest, debris, KC.

- 6713 Kauai, near Menehune ditch foot bridge, VII-18-1986, forest, under stones, KC.
6714 Kauai, midway btwn. Kalaheo and Lawai, Rt. 30, VII-18-1986, mixed forest, under wet bark, KC.
6715 Kauai, Waimea Canyon, Waimea River, VII-19-1986, kukui forest, sifting litter, KC.
6716 Kauai, Rt. 56, btwn. Kalaheo and Anahola, near Molooa Stream, VII-20-1986, woods, sifting litter, KC.
6717 Kauai, Hanakoa camp site, VII-20-1986, mixed forest, under bark, KC.
6718 Kauai, Hanakoa camp site, VII-22-1986, mixed forest, vegetation, sweeping, KC.
6719 Kauai, as above, under bark.
6720 Kauai, as above, under stones.
6721 Kauai, as above, vegetation, beating.
6722 Kauai, as above, litter, sifting.
6723 Kauai, as above, under bark.
6724 Kauai, as above, vegetation, sweeping.
6725 Kauai, Na Pali Wilderness, Wailaukua Valley, VII-22-1986, dead pandanus bark, KC.
6726 Kauai, Na Pali Wilderness, 1/2 way between Hanakoa and Hanakapiai, VII-22-1986, stream bed, under bark, KC.
6727 Kauai, Nahumaalo, VII-21-1986, watered garden, soil, berlese, KC.
6728 Kauai, Hanalei Valley State Conservation Area, VII-25-1986, dry forest, under bark, KC.
6729 Kauai, Nahumaalo, VII-26-1986, watered garden, sweeping, KC.
6730 Oahu, Waikiki, VII-28-1986, watered garden, soil, berlese, KC.
6731 Oahu, Tantalus Drive, W. end, VII-30-1986, soil, berlese, KC.
6732 Oahu, Puu U Alakaa State Park, VII-30-1986, forest, soil, berlese, KC.
6733 Oahu, Keaiwa Heiau State Rec. Area, VIII-03-1986, forest, under bark, KC.
6734 Oahu, as above, soil, berlese.
6735 Oahu, vic. Kawela, VIII-03-1986, edge sugarcane field, soil, berlese, KC.
6736 Oahu, Pali Hwy. lookout, VIII-03-1986, forest, soil, berlese, KC.
6737 Oahu, Manana Ridge Trail, 4 mi. up trail, VIII-03-1986, ohia fern scrub forest, soil, berlese, KC.
6738 Oahu, as above, 3 & 1/2 mi. up trail.
6739 Oahu, as above, moss.
6740 Oahu, as above, roots and soil, berlese.
6741 Oahu, as above, 300 yds. down trail, meadow.
6742 Oahu, as above, 2 mi. up trail.
6743 Oahu, as above, different site.
6744 Oahu, as above, 1 & 1/2 mi. up trail.
6745 Oahu, as above, 1 mi. up trail.
6746 Oahu, as above, 1/2 mi. up trail.
6747 Oahu, Aiea Loop trail, 2 mi. up trail, VIII-04-1986, forest, soil, berlese, KC.
6748 Oahu, as above, litter sifting.
6749 Oahu, as above, dry soil berlese.
6750 Oahu, as above, 100 yds. up trail, wet.
6751 Oahu, as above, 3 mi. from trail base, moss.
6752 Oahu, as above, dry soil berlese.

- 6753 Oahu, as above, wet.
6754 Oahu, as above, under bark.
6755 Oahu, as above, 100 yds. up trail, soil, berlese.
6756 Oahu, as above, 2 & 1/2 mi. from base of trail.
6757 Oahu, Haiku stairs (or ladder), top of stairs, VIII-05-1986, scrub + grass, soil, berlese, KC.
6758 Oahu, as above, 100 yds. down.
6759 Oahu, as above, 200 yds. down.
6759 Oahu, as above, 300 yds. down.
6760 Oahu, as above, sifting litter.
6761 Oahu, as above, ohia thicket, soil, berlese.
6762 Oahu, as above, 400 yds. from top, fern bed.
6763 Oahu, as above, 500 yds. from top, scrub forest.
6764 Oahu, as above, 2/3 way down.
6765 Oahu, as above, 3/4 way down.
6766 Oahu, as above, base of trail, roadside.
6767 Oahu, as above, near top, moss, sifting.
6768 Oahu, Waahila Ridge Recreation Area, vic. Honolulu, VIII-06-1986, forest, paperbark grove, soil, berlese, KC.
6769 Oahu, as above, litter.
6770 Oahu, as above, *Casuarina* grove.
6771 Oahu, as above, *Araucaria* grove.
6772 Oahu, as above, deep soil.
6773 Oahu, Waianae Kai, above Waianae, edge of crest, VIII-07-1986, scrub forest, grass, soil, berlese, KC.
6774 Oahu, as above, 20 yds. down, ferns, litter and soil.
6775 Oahu, as above, 25 yds. down, ohia grove, soil.
6776 Oahu, as above, 35 yds. down, fern bed, litter.
6777 Oahu, as above, 50 yds. down, guava grove.
6778 Oahu, as above, 150 yds. down, koa-guava grove, soil and litter.
6779 Oahu, as above, 160 yds. down, koa grove, soil and roots.
6780 Oahu, as above, 1 mi. down, guava and koa grove, soil.
6781 Oahu, as above, 2 mi. down, ti thicket.
6782 Oahu, Mt. Kaala, summit, VIII-07-1986, dwarf forest, soil, berlese, KC.
6783 Oahu, Waianae Kai, base of trail, VIII-07-1986, kukui grove, soil, berlese, KC.
6784 Oahu, as above, unknown site, soil and roots.
6785 Oahu, Manoa, V-15-1985, under dead cat, day 51, Goff.
6785 Oahu, as above, day 66.
6786 Oahu, as above, V-30-1984.
6787 Oahu, as above, V-09-1984, day 45.
6788 Oahu, as above, V-30-1984, day 66.
6789 Oahu, as above, V-22-1984, day 58.
6790 Oahu, as above, V-10-1984, day 46.
6791 Oahu, as above, IV-05-1984, soil, day 48.
6792 Oahu, as above, VII-13-1984, day 110.
6793 Maui, E Rt. 377, 1.6 mi. jct. Rt. 37, VII-06-1986, eucalyptus grove, under log, ant nest, KC.
6794 Maui, as above, under bark.

- 6795 Maui, vic. Olinda junction, VII-07-1986, eucalyptus grove, rotten wood, KC.
6796 Hawaii, Kilauea Forest Reserve, VIII-23-1971, 5400 ft., pitfall, Jacobi.
6797 Hawaii, Mauna Loa, Stainback Hwy., 1972, 305-457 m.
6798 Hawaii, Mauna Loa, E slope, 1890 m, ohia scrub.
6799 Hawaii, Mauna Loa, E slope, 1972, 2286-2316 m, Jacobi.
6800 Hawaii, Mauna Loa, E slope, I-17-24-1972, 2440 m, Jacobi.
6801 Hawaii, BBM P-0209.
6802 Hawaii, Mauna Loa, E slope, II-14-21-1972, 2286 m.
6803 Hawaii, Mauna Loa, Stainback Hwy., IX-6-8-1974, 365-465 m.
6804 Hawaii, Kilauea Forest Reserve, I-09-1971, pitfall, Jacobi.
6805 Hawaii, Hawaii Volcanoes National Park, Mauna Loa, E slope, I-17-24-1972, 2286-2316 m.
6806 Hawaii, Mauna Loa, IX-20-1972.
6807 Hawaii, I-22-24-1974, 0-305 m, exotic forest.
6808 Hawaii, Hawaii Volcanoes National Park, Kilauea forest, IX-01-1972, 1646 m, koa grove, Jacobi.
6811 Hawaii, Kilauea Forest Reserve, VII-30-1971, 5400 ft., Jacobi.
6812 Hawaii, Kilauea Forest Reserve, IX-15-1973, 1646 m, pitfall, Jacobi.
6813 Hawaii, Hawaii Volcanoes National Park, tree mold area, II-14-16-1972, 1220 m, ohia scrub.
6814 Hawaii, Hawaii Volcanoes National Park, Mauna Loa, E slope, Kipuka Ki weather station, VIII-23-1971, shrubs, beneath koa, Jacobi.
6815 Hawaii, Kilauea Forest Reserve, IX-15-1973, 1646 m, pitfall, Jacobi.
6816 Hawaii, Mauna Kea, Kipuka Puahuluhulu, IX-4-11-1974, 1890 m, Jacobi.
6817 Hawaii, Hawaii Volcanoes National Park, tree mold area, V-9-1971, 1220 m.
6818 Midway Atoll, Sand I., I-25-1964, albatross nest.
6819 Hawaii, site?, 1973, pitfall trap.
6820 Hawaii, Mauna Loa, VII-20-1973, pitfall.
6821 Hawaii, Mauna Loa, I-28-1974, litter.
6822 Hawaii, Mauna Loa, IX-20-1973, pitfall.
6823 Hawaii, as above, different site.
6824 Hawaii, site?, 1973, pitfall.
6825 Hawaii, Mauna Loa, IX-20-1973, pitfall.
6826 Hawaii, as above, different trap.
6827 Hawaii, site?, date?, pitfall.
6828 Hawaii, as above.
6829 Oahu, Mt. Kaala, IV-09-1970, scraping tree trunk, Radovsky.
6830 Lanai, III-25-1966, Yoshimoto.
6831 Pearl and Hermes Reef, seal kittery, VIII-10-1983, on raised coral beach, Gagne.
6832 Midway Atoll, Sand I., VII-16-1983, beach, Gagne.
6833 Hawaii, Kilauea Forest Reserve, II-28-1972, 1646 m, pitfall, Jacobi.
6834 Hawaii, Mauna Loa, Stainback Hwy., XI-10-1974, 1220-1372 m, Jacobi.
6835 French Frigate Shoals, East I., III-23-1984, under debris, Gagne.
6836 Pearl and Hermes Reef, East I., IV-28-1969, Allred.
6837 Pearl and Hermes Reef, V-28-1969, shearwater burrow, Allred.
6838 French Frigate Shoals, Tern I., III-22-1984, under *Chenopodium*, Gagne.
6839 Hawaii, Mauna Kea, Kipuka Puahuluhulu, IX-4-11-1974, 1890 m, Jacobi.
6840 Hawaii, Mauna Loa, Stainback Hwy., XI-10-1974, 1220-1372 m, Jacobi.

- 6841 Midway Atoll, Sand I., VII-17-1983, *Casuarina* litter near beach, Gagne.
6842 Lisianski I., VII-07-1983, dead coconut base, Gagne.
6843 Hawaii, Mauna Loa, Stainback Hwy., I-28-1974, 610-762 m, Jacobi.
6844 Hawaii, Mauna Kea, upper Wailuku Road, XI-15-1971, 2800 m, under silver-swords, Gressitt.
6845 Hawaii, Kipuka Nene, I-11-13-1975, ohia, Jacobi.
6846 Hawaii, Mauna Kea, IX-4-11-1974, scrub above treeline, Jacobi.
6847 Hawaii, exotic forest, I-22-1974, 0-305 m, pitfall, Jacobi.
6848 Hawaii, East slope of Mauna Loa, V-22-1973, 2135 m, soil, pitfall, Parman.
6849 French Frigate Shoals, Tern I., IV-13-1985, under rubble, Gagne.
6850 Hawaii, Hilo, University of Hawaii campus, IX-15-17-1974, 0-305 m, Jacobi.
6851 Hawaii, I-11-13-1975, 0-305 m, exotic forest, Jacobi.
6852 Hawaii, Volcanoes National Park, Kipuka Puauulu, 1220 + m, koa forest, litter.
6853 Hawaii, VII-21-31-1971, 1585 m, koa colony, Radovsky.
6854 Hawaii, Volcanoes National Park, E slope of Mauna Loa, Kipuka Ki weather station, XI-02-1971, 1220 m.
6855 Hawaii, Volcanoes National Park, E slope of Mauna Loa, X-31-1971, 2286-2316 m, Jacobi.
6856 Hawaii, Volcanoes National Park, E slope of Mauna Loa, XI-29-1971, 2286-2316 m, Jacobi.
6857 Lanai, Lanaihale, III-25-1966, KC.
6858 Hawaii, Mauna Loa, IX-29-1971, 7500-7600 ft., pitfall trap, Jacobi.
6859 Hawaii, Mauna Loa, Stainback Hwy., I-28-30-1974, 305-457 m, Jacobi.
6860 Hawaii, Mauna Loa, Stainback Hwy., IX-6-8-1974, 1006 m, pitfall, Jacobi.
6861 Hawaii, Mauna Loa, IX-08-1971, 8000 ft., pitfall trap, Jacobi.
6862 Maui, Kipahulu Valley, VII-21-1983, 4000 ft., vegetation, Montgomery.
6863 Molokai, Kamoku Flats, III-19-1966, 3500 ft., Yoshimoto.
6864 Hawaii, Mauna Loa, X-12-1973, 1280-1341 m, soil, pitfall trap.
6865 Hawaii, Thurston Lava Tube, II-06-1974, 1204 m, soil, pitfall trap.
6866 Hawaii, Kilauea Forest Reserve, 1646 m, soil, pitfall trap, Parman.
6867 Hawaii, Thurston Lava Tube, X-18-1973, soil, pitfall trap.
6868 Hawaii, Kilauea Forest Reserve, 1646 m, soil, pitfall trap, Parman.
6869 Hawaii, Thurston Lava Tube, XII-21-1974, soil, pitfall trap, Jacobi.
6870 Hawaii, Volcanoes National Park, E slope of Mauna Loa, VI-24-1973, 2440 m, soil, pitfall, Jacobi.
6871 Hawaii, Volcanoes National Park, E slope of Mauna Loa, V-21-1973, 2135 m, soil, pitfall trap, Parman.
6872 Hawaii, Thurston Lava Tube, IV-12-24-1973, soil, pitfall trap.
6873 Hawaii, Volcanoes National Park, E slope of Mauna Loa, power line area, V-25-1973, soil, pitfall trap, Parman.
6874 Hawaii, Mauna Loa, I-22-1974, 0-305 m, exotic forest, soil, pitfall trap, Jacobi.
6875 Hawaii, Thurston Lava Tube, II-06-1974, soil, pitfall trap.
6876 Hawaii, Thurston Lava Tube, VII-16-18-1973, 1204 m, litter, Parman.
6877 Hawaii, Thurston Lava Tube, IV-12-24-1973, soil, pitfall trap.
6878 Hawaii, Volcanoes National Park, E slope of Mauna Loa, power line area, V-25-1973, soil, pitfall trap, Parman.
6879 Hawaii, Thurston Lava Tube, VII-16-18-1973, soil, pitfall trap, Parman.
6880 Hawaii, Thurston Lava Tube, I-11-13-1975, 1204 m, ohia, Jacobi.

- 6881 Hawaii, Volcanoes National Park, E slope of Mauna Loa, X-06-1971, 2286-2316 m, soil and litter, pitfall trap, Jacobi.
- 6882 Hawaii, Volcanoes National Park, E slope of Mauna Loa, power line area, III-31-1973, 1493 m, soil, pitfall trap.
- 6883 Hawaii, Thurston Lava Tube, III-30-1973, 1204 m, soil, pitfall trap.
- 6884 Hawaii, Volcanoes National Park, E slope of Mauna Loa, VII-25-27-1973, soil, pitfall trap, Parman.
- 6885 Hawaii, Mauna Loa, IX-20-1973.
- 6886 Hawaii, Thurston Lava Tube, III-30-1973, 1204 m, soil, pitfall, Jacobi.
- 6887 Hawaii, Volcanoes National Park, E slope of Mauna Loa, II-28 to III-1-1972, ohia and koa, Jacobi.
- 6888 Hawaii, Volcanoes National Park, E slope of Mauna Loa, III-28-1971, 2440 m, litter, pitfall trap, Jacobi.
- 6889 Hawaii, Thurston Lava Tube, VII-16-18-1973, soil, pitfall trap, Parman.
- 6890 Hawaii, Mauna Loa, E slope, IX-22-1971, 2440 m, litter, pitfall, Jacobi.
- 6891 Midway Atoll, Sand Island, III-22-1971, gooney bird nest, Goff.
- 6892 Hawaii, Volcanoes National Park, E slope of Mauna Loa, IX-20-1973, soil, pitfall trap, Parman.
- 6893 Hawaii, Volcanoes National Park, E slope of Mauna Loa, V-06-1973, soil, pitfall trap, Parman.
- 6894 Hawaii, Mauna Loa, Stainback Hwy., I-28-1974, 610-762 m, soil, pitfall trap, Jacobi.
- 6895 Hawaii, Volcanoes National Park, E slope of Mauna Loa, V-06-1973, 2440 m, soil, pitfall trap, Parman.
- 6896 Hawaii, Volcanoes National Park, E slope of Mauna Loa, VIII-28-1971, soil, pitfall trap, Jacobi.
- 6897 Hawaii, Volcanoes National Park, E slope of Mauna Loa, V-06-1973, 2440 m, soil, pitfall trap, Parman.
- 6898 Hawaii, Volcanoes National Park, E slope of Mauna Loa, Kipuka Ki weather station, IX-01-1971, 1200 m, beneath vegetation, Jacobi.
- 6899 Hawaii, Volcanoes National Park, E slope of Mauna Loa, VII-21-1971, koa forest, pitfall, Radovsky.
- 6900 Hawaii, Volcanoes National Park, E slope of Mauna Loa, IX-01-1971, 2135 m, on vegetation, Jacobi.
- 6901 Hawaii, Volcanoes National Park, E slope of Mauna Loa, Kipuka Ki weather station, III-13-15-1972, 1220 m, beneath koa, Jacobi.
- 6902 Midway Atoll, Sand Island, III-22-1977, gooney bird nest, Goff.
- 6903 Hawaii, Volcanoes National Park, E slope of Mauna Loa, X-10-13-1971, 1585 m, koa colony, Jacobi.
- 6904 Hawaii, Volcanoes National Park, E slope of Mauna Loa, IX-01-1971, 1890 m, open koa forest, Jacobi.
- 6905 Hawaii, Volcanoes National Park, E slope of Mauna Loa, Kipuka Ki weather station, IV-10-12-1972.
- 6906 Hawaii, Volcanoes National Park, E slope of Mauna Loa, II-21-31-1971, 1981 m, koa forest, pitfall, Radovsky.
- 6907 Hawaii, Volcanoes National Park, E slope of Mauna Loa, Kipuka Ki weather station, IX-29-1971, Jacobi.
- 6908 Hawaii, Mauna Kea, XII-10-1974, 2896 m, scrub above treeline, pitfall, Jacobi.

- 6909 Hawaii, Hawaii Volcanoes National Park, Mauna Loa, E slope, II-28-III-1-1972, 1220 m, ohia, Jacobi.
- 6910 Hawaii, Hawaii Volcanoes National Park, Mauna Loa, Strip road weather station, III-13-15-1972, 1585 m, pitfall, Jacobi.
- 6911 Hawaii, Hawaii Volcanoes National Park, Mauna Loa, E slope, III-13-15-1972, 1585 m, koa grove, Jacobi.
- 6912 Hawaii, Kilauea Forest Reserve, IX-01-1971, 1646 m, ohia-koa grove, Jacobi.
- 6913 Hawaii, Thurston Lava Tube, XII-21-1974, 1204 m, pitfall.
- 7053 Hawaii, Kipuka Puaulu, Bird Park lava tube, XI-10-1971, dark zone, Howarth.

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