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THE EUPODOIDEA OF HAWAII (ACARINA: PROSTIGMATA)¹

By **R. W. Strandtmann**² and **M. L. Goff**³

Abstract: This paper describes the free-living eupodoid prostigmatic mites collected in Hawaii during 1970-1971. Collections were from soil and litter samples and from steam vents. Twelve species were collected, including 2 new genera and 4 new species. They are Eupodidae, *Eupodes sigmoidensis*, n. sp., *E. voxencollinus* Sig Thor, *E. hawaiiensis*, n. sp., *Cocceupodes trisetatus* Strandtmann & Prasse, *C. mollicellus* (Koch), *Hawaiieupodes thermophilus*, n. gen. et n. sp.; Penthalodidae, *Penthalodes ovalis* (Duges); Rhagidiidae, *Rhagidia longisensilla* Shiba, *R. whartoni* Strandtmann, *R. shibai* Strandtmann, *Pilorhagidia hirsuta*, n. gen. et n. sp. and *Coccorhagidia clavifrons* Sig Thor. It is probable that *Eupodes hawaiiensis*, n. sp., *Hawaiieupodes thermophilus*, n. sp., and *Pilorhagidia hirsuta*, n. sp. are endemic. *Eupodes sigmoidensis*, n. sp., is found on the Ivory Coast of Africa as well as on Hawaii I and is apparently austral in origin. All other species are boreal forms with holarctic distribution. All are new records for Hawaii.

Terrestrial mites were intensively collected on the island of Hawaii (the Big Island) during 1970 and 1971, chiefly in the Hawaii Volcanoes National Park (HVNP), by Frank Radovsky and Lee Goff. The survey was supported by a grant-in-aid from the National Science Foundation to the Bishop Museum as part of the International Biological Program.

Specimens were collected from soil and litter samples at altitudes ranging from a few meters to over 2000 m above sea level. Some of the material, including a new genus and species, was collected from steam vents with a recorded temperature of 40°-41°C. The specimens collected were sorted into major groups by JoAnn Tenorio, F. Radovsky, and L. Goff and sent to specialists for specific determination.

The Eupodoidea are an interesting group of white, yellow, red or red and black mites. They are delicate, soft-bodied, but quite hardy mites. Their distribution includes temperate grasslands, hot and cold deserts, alpine and polar regions including tundra, and apparently to a lesser extent, marshes and heavily wooded areas. Records from rain forests are few.

The chief diagnostic characters of the Eupodoidea are the presence of a small epivertical lobe on the propodosoma and rhagidial organs on tarsi I and II.

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POSSIBLE ORIGINS OF THE HAWAII EUPODOIDS

Eight of the 11 species of eupodoids known to occur in the Hawaiian Islands are boreal forms with holarctic distribution: *Eupodes voxencollinus*, *Cocceupodes trisetatus*, *C. mollicellus*, *Penthalodes ovalis*, *Rhagidia longisensilla*, *R. whartoni*, *R. shibai* and *Coccorhagidia clavifrons*. They were presumably introduced into Hawaii from Europe, North America, or northern Asia. *Eupodes sigmoidensis*, n. sp., the most abundant eupodid in Hawaii (at least on Hawaii I), also occurs on the Ivory Coast of West Africa. It therefore seems to be austral in origin and probably was introduced to the Pacific Oceanic Region from the more ancient continental area. *Eupodes hawaiiensis* may have evolved in Hawaii from an ancestral form similar to *E. voxencollinus*, which it resembles in many respects.

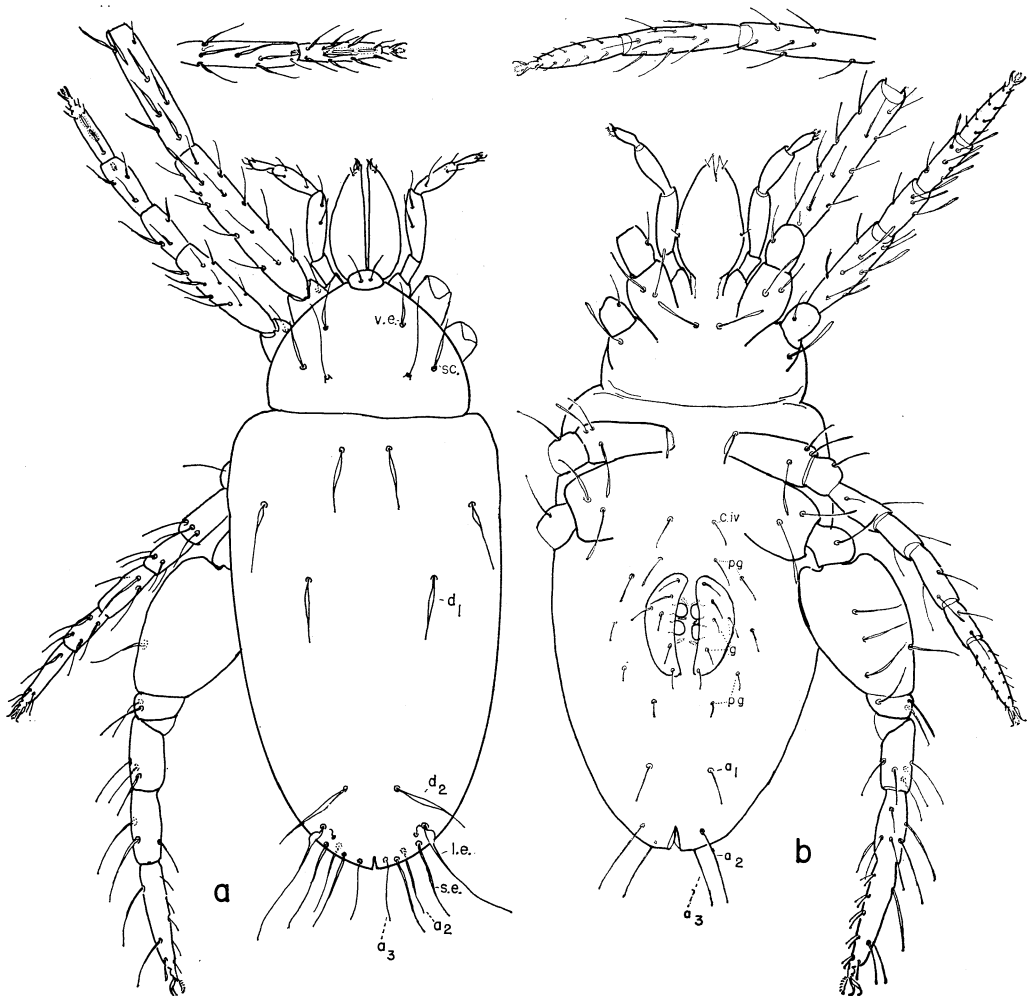


FIG. 1. *Eupodes sigmoidensis*, n. sp., ♀: a, dorsum; b, venter (note: setal ciliations not indicated).

The 2 new genera, *Hawaii eupodes* and *Pilorhagidia*, are strikingly distinct forms and nothing like either has so far been recorded from outside Hawaii. Until contrary evidence arises, we may assume that both forms evolved on Hawaii. *Hawaii eupodes* possibly evolved from some form of *Protereunetes*. *Pilorhagidia* shares clavate trichobothria with *Coccorhagidia* and quite possibly evolved from some earlier form of that genus.

That most of the species of Hawaiian eupodids are boreal forms may be a reflection of the sampling method rather than the true state. Most of the collecting was done at elevations above 2000 m. Intensive collecting at lower elevations, in warmer and more humid areas, ought logically to turn up more austral forms. All specimens with BBM numbers, as well as the African types, are at Bishop Museum, Honolulu (BISHOP).

FAMILY EUPODIDAE

GENUS *Eupodes* C. L. Koch

Eupodes sigmoidensis Strandtmann & Goff, new species FIG. 1, 2, 3

A medium to large-sized *Eupodes*, characterized by dorsal, fusiform body setae, a much greater distance between dorsals 1 and 2 than between dorsals 1 and internal humerals, and greatly reduced, S-shaped, internal lumbar (hence, the name). Average body length of female, exclusive of gnathosoma, 400 μm .

♀. Average length, 400 μm ; range, 340–450 μm . Body typically elongate; dorsal suture prominent. Leg I about the same length as body; femur IV swollen. *Dorsal side* (FIG. 1a). All dorsal setae except internal verticals, trichobothria, and internal lumbar swollen basally but not to same extent, or in same manner. FIG. 2a, b show differences in swellings of various setae and lengths relative to each other. Dorsals 2 much farther posterior than in most species of *Eupodes*. Lumbar, sacral, and anal clustered at posterior margin. Longest dorsal seta is external lumbar (1e), which averages 110 μm . *Ventral side* (FIG. 1b). Prominent suture between coxae II and III. Coxal formula 3-1-4-3. Coxal setae long and slender, either basally or apically swollen (FIG. 2c). *Genitalia*: 2 pairs of genital knobs, several internal genital setae, and 2 flaps covering orifice. Each flap bears 5 setae along inner margin and 1 near outer margin. Paragenital setae, 5 pairs, the longest anterior, and shortest posterior. Anal pore terminal, with 3 pairs of unmodified setae, 1st pair shortest and considerably anterior to pore. *Gnathosoma*. Hypostome with 2 pairs of small setae, 1 pair mediolateral, the other apical (typical of genus). Chelicera (FIG. 3e) typical of genus. Cheliceral seta apparently nude. Pedipalps (FIG. 3d): 2nd and 3rd segments equally long; 2nd segment with 2 setae, both fusiform; 3rd segment with 3 setae, 1 basal fusiform and 2 apical thread-like. Fourth or tibiotarsal segment barely 1/2 as long as 3rd, with 7 setae of which mid-dorsal is longest and apparently divided apically. A recumbent solenidion lies in the middle of outer side of tibiotarsus. *Legs* (FIG. 3a, b). Leg I as long as body. Femur of leg IV noticeably swollen. Trochanter setal formula 1-1-1-1, setae progressively longer from I–IV. Femora I and II undivided, femur III divided medially, femur IV divided near apex. Many, but not all, of dorsal leg setae fusiform. Ventral setae on all tarsi short and pubescent; on other segments, long and slender, and, especially on femur, genu, and tibia of leg II, narrowly spatulate. Tarsi I and II each with 2 long, slender rhagidial organs lying tandem in common fields. Tibiae I and II each have a small, apical, recumbent solenidion (or rhagidial organ). Tibia I also has a longer, slender, erect solenidion dorsobasally. Tarsal claws simple, empodium pubescent.

♂ with capitate, reticulated, sperm sac (FIG. 3c). Otherwise as in ♀. Length of 3 specimens, 275 μm , 325 μm and 350 μm . (Note: ♂♂ all are from Africa; no ♂♂ were present in the Hawaii material).

Tritonymph with 3 pairs of genital setae and 4 pairs of paragenital setae; otherwise as ♀. 2 tritonymphs from Hawaii measured 280 and 300 μm .

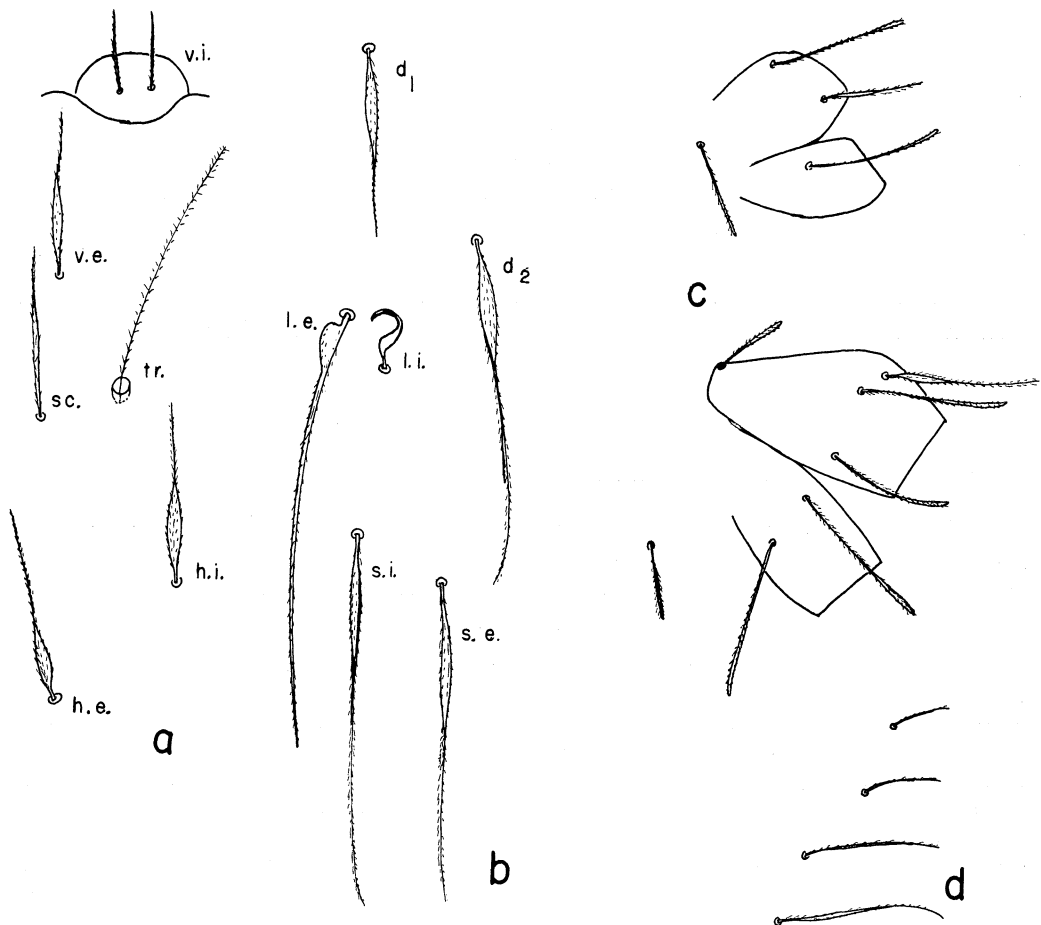


FIG. 2. *Eupodes sigmoidensis*, n. sp.: a, epivertical lobe, propodosomal setae, and external and internal humerals; b, hysterosomal dorsal setae; c, coxae I-IV; d, trochantal setae I-IV (top to bottom, respectively).

Deutonymph. 250 μ m long. 2 pairs of genital setae, 2 pairs of paragenital setae. Coxal formula 3-1-4-2; trochanter formula 1-1-1-0. Tarsus I with 2 r.o.'s plus basal spine; tibia I with a basal and an apical solenidion.

DISTRIBUTION. Described from 60 females, 6 tritonymphs, 1 deutonymph taken from soil samples on Hawaii I, and 3 females, 3 males, 4 tritonymphs and 4 deutonymphs taken from soil samples from the Ivory Coast in West Africa. Two females from Africa measured 300 μ m and 380 μ m. Except for smaller size, there was no discernible difference between the Hawaiian and the African material. It does seem a bit odd, though, that there were no males among the Hawaiian specimens.

Most of the females from Hawaii contained eggs, ranging from 1 to 12 per female. The average was about 5.

COLLECTION DATA (GENERAL). All Hawaiian specimens were collected on Hawaii I, east slope of Mauna Loa, during June and July 1970 and February, June and July 1971, between elevation 1220 m (Bird Park) and 2240 m (Mauna Loa Trail). Habitats included exposed grasses, koa forests, *Metrosideros* forests, *Metrosideros* savanna, volcanic desert, and moss in lava tubes. The greatest single collection consisted of 20 ♀♀ and 4 nymphs from an open koa forest in Bird Park. Most specimens were extracted by Berlese funnel.

Holotype ♀ (BISHOP 11,027), with 2 eggs, field identification No. BBM-145870, HAWAIIAN IS: Hawaii I: Hawaii Volcanoes National Park (HVNP), Crater Rim Rd, 15.VI.1970, volcanic desert, M.L. Goff & F.J. Radovsky. Paratypes: 1 ♀ (BBM-X 145870), same data as holotype; 20 ♀♀, 3 Ny III, 1 Ny II (BBM-X 145871), 3 ♀♀ (BBM-X 145872), 1 ♀, 1 Ny III (BBM-145873), HVNP, Bird Park, 15.VI.1970, open koa forest, Goff & Radovsky; 4 ♀♀ (BBM-X 145876), same location, 16.VI.1970, *Sophora-Metrosi-*

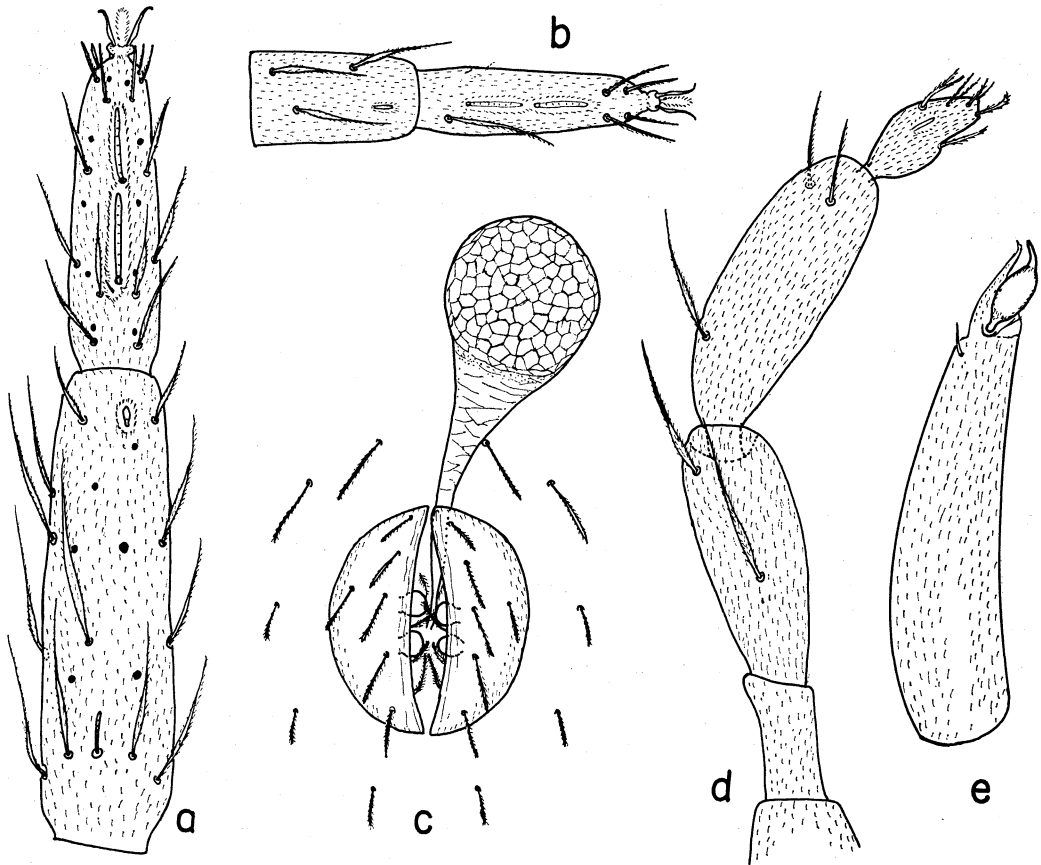


FIG. 3. *Eupodes sigmoidensis*, n. sp.: a, dorsal view of tarsus and tibia I; b, dorsal view of tarsus and tibia II; c, external genitalia and sperm sac of ♂; d, lateral view of pedipalp; e, lateral view of chelicera.

deros forest, Goff & Radovsky; 2 ♀♀ (BBM-X 145879), HVNP, Bird Park, 1220 m, 16.VI.1970, *Metrosideros*-lichen forest, Goff & Radovsky; 2 ♀♀ (BBM-X 145886), HVNP, Mauna Loa Trail, 2000 m, 16.VI.1970, *Metrosideros* scrub zone, Goff & Radovsky; 2 ♀♀ (BBM-X 145887), HVNP, Mauna Loa Trail, 2020 m, 16.VI.1970, moss in lava tube, Goff & Radovsky; 1 ♀ (BBM-X 145890), same data except 2150 m; 1 ♀ (BBM-X 145892), HVNP, Mauna Loa Trail, 2040 m, 16.VI.1970, alpine *Metrosideros* scrub, Goff & Radovsky; 4 ♀♀ (BBM-X 145893), same data except 2240 m; 2 ♀♀ (BBM-Berlese 00095), HVNP, Mauna Loa Strip Rd, 3.5 km below rest house, 1860 m, 22.II.1971, koa duff #35, Radovsky; 1 ♀, 1 Ny III (BBM-Berlese 00098), same except 12.24 km below rest house, 1430 m, exposed grasses #37; 2 ♀♀, (BBM-Berlese 00202), HVNP, Steaming Bluff Trail, Fumarole Vent II, 3.VI.1971, grass-bracken-moss, at surface, 25°C, Goff; 6 ♀♀ (BBM-Berlese 00250), HVNP, Mauna Loa Strip Rd, Plot 19, 12-20.VII.1971, in pitfall trap, Goff; 1 ♀ (BBM-Berlese 00251), same data except 5-12.VII.1971; 1 ♀ (BBM-Berlese 00268), Kipuka Ki weather station, Ref. #9, nr pitfall trap, 1175 m, 20.VII.1971, *Metrosideros* and koa duff, Radovsky; 1 ♀ (BBM-Berlese 00270), HVNP, Ref. #8, nr pitfall trap, 1280-1340 m, 21.VII.1971, koa and mostly thick grass, Radovsky; 4 ♀♀ (BBM-Berlese 00271), HVNP, Ref. #5, nr pitfall trap, 1585 m, 20.VII.1971, koa litter and humus, Radovsky; 1 ♀ (BBM-Berlese 00279), HVNP, Ref. #8, nr pitfall trap, 1280-1340 m, 21.VII.1971, soil and humus, Radovsky; 1 Ny III (BBM-Berlese 00287), Kilauea Forest Reserve, Ref. #13, nr pitfall trap, 1645 m, 21.VIII.1971, humus under koa-*Metrosideros* duff, Radovsky.

COLLECTION DATA FOR THE AFRICAN SPECIMENS. WEST AFRICA: Ivory Coast, Lamto-Pakobo savanna. Biotope: a savanna of herbs and grasses (*Andropogon-Hypparhenia*), the soil a red, tropical sand, low in organic material. Specimens were extracted from soil samples taken of 2 types of savanna: sta. FSI, burned-over savanna; sta. FSII, nonburned-over savanna. All samples were 5 cm in diam. by 2.5 cm in depth.

1 Ny II (sta. FSII, Cib No. 131), 6.XII.1969 at a depth of 5-7.5 cm. All others, 3 ♂♂, 3 ♀♀, 4 Ny III, 3 Ny II (FSI, Cib Nos. 131, 288, 289, 285, 204, 267, 3462), 6 & 18.XII.1969, and 15.XI.1970 at depths varying from 2.5-5 cm to 12.5-15 cm. All the African material was collected by Mille. F. Athias (now Mme F. Athias-Binche.⁴)

REMARKS. *Eupodes sigmoidensis* appears to be the most abundant eupodid mite on the island of Hawaii, if not on all the archipelago.

***Eupodes voxencollinus* Sig Thor, 1934**

FIG. 4a-g

♀. Length 450 μ m (400-525 μ m). Leg I slightly longer than body. Coxal setae, 3-1-4-3; genital setae, 6+6, 1 pair more lateral than other 5; paragenital setae, 7+7, occasionally 6+6 or 6+7. Ventral setae slenderly clavate, leg and dorsal setae hair-like; all setae with close, fine, short ciliations. Average lengths of dorsal setae (6 specimens): vi-28, ve-48, sc-52, tr-76, hi-83, he-65; d₁-85, d₂-86, li-88, le-55, si-86, se-55; al-18; a2-48, a3-73. Legs. Tarsus I with 2 equal rhagidial organs, tandem, subtended by small stellate seta having only 3 or 4 small rays. Tibia I with faintly ciliated, nob-like seta dorsoapically and slender

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solenidion dorsobasally. There is no apical rhagidial organ as in *E. hawaiiensis*. Tarsus II with 2 tandem rhagidial organs, apical only 1/2 as long as basal. Small spine subtends basal r.o. Tibia II with dorsoapical r.o. and dorsobasal solenidion. Tarsus III has 2 dorsobasal setae, differing from most other *Eupodes* species, including *E. hawaiiensis*, n. sp., which have only 1. Tibia III with dorsobasal solenidion.

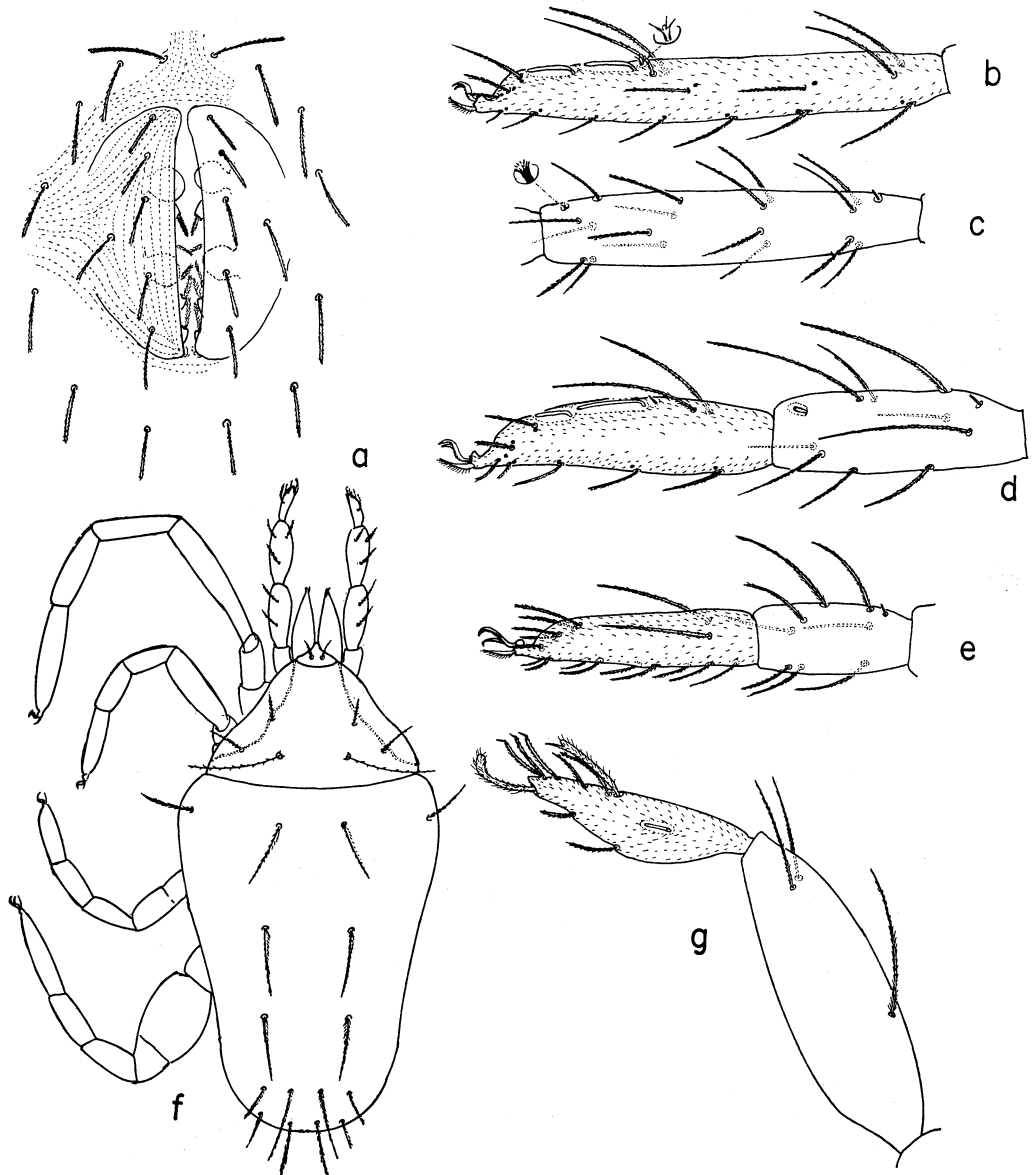
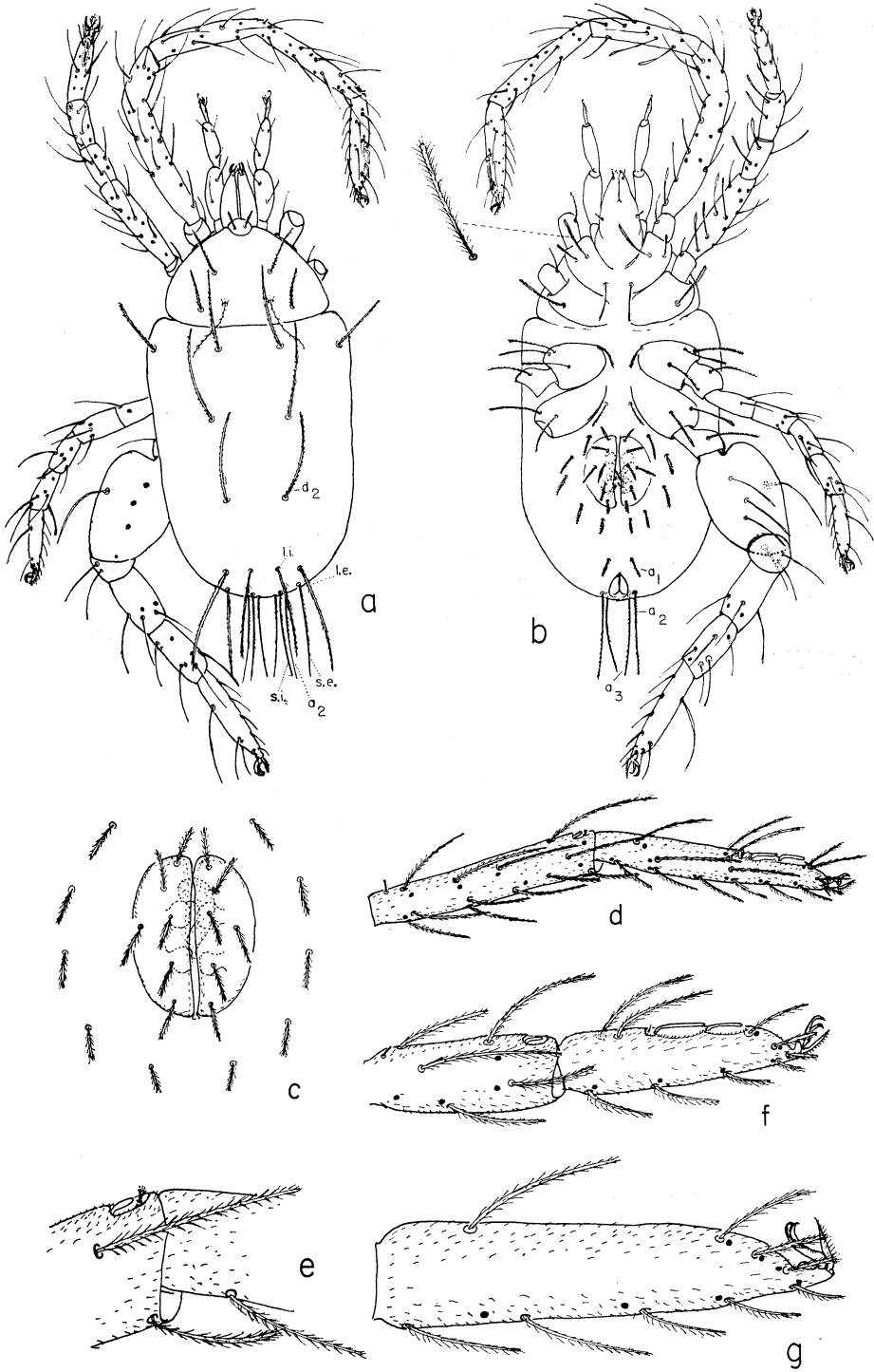


FIG. 4. *Eupodes voxencollinus*: a, genitalia of ♀; b, lateral view of tarsus I, ♀; c, lateral view of tibia I; d, lateral view of tarsus and tibia II; e, lateral view of tarsus and tibia III, adult; f, dorsum of tritonymph; g, lateral view of tibiotarsus and genu of pedipalp.



Tritonymph (FIG. 4f). Length, 330 μm (300–350 μm). Coxal setae, 3-1-4-3; genital setae, 3+3; paragenitals 5+5. Epivertical lobe pointed, narrow groove extending from lateral margin to posterior lateral margin of propodonotum. Sensory setae of legs as in ♀ .

COLLECTION DATA. 23 ♀♀ , 3 tritonymphs, as follows: HAWAIIAN IS: Hawaii I: 2 ♀♀ Ny III (BBM-Berlese 00095), HVNP, Mauna Loa Strip Rd, 3.3 km below rest house, 22.II.1971, ex koa duff, F. J. Radovsky; 1 ♀ (BBM-Berlese 00202), Steaming Bluff Trail, Vent II, cross transect at point 13, 1 m from mid-line, 12.VI.1971, grass, bracken, moss on soil, at surface, 25°C, M.L. Goff; 4 ♀♀ (BBM-Berlese 00249), 1 containing 2 eggs, HVNP, Mauna Loa Strip Rd, Plot #19, 28.VI–5.VII.1971, in pitfall trap, Goff; 3 ♀♀ (BBM-Berlese 00251), each with 1 egg, same data as preceding except 5–12.VII.1971; 4 ♀♀ (BBM-Berlese 00270), 2 with eggs (1 and 6), HVNP, Ref. #8, nr pitfall trap, 1280–1340 m, 21.VII.1971, koa and mostly thick grass, Radovsky; 8 ♀♀ (BBM-X 145871), 3 with eggs, HVNP, Bird Park, 15.VI.1970, open koa forest, Goff & Radovsky; 1 ♀ , with 5 eggs, 1 Ny III (BBM-X 145883), HVNP, Mauna Loa Rd, 1560 m, 16.VI.1970, koa duff, Goff & Radovsky.

REMARKS. A common and wide-spread species occurring abundantly in northern Europe, northern Canada, and Alaska. It is quite probably restricted to higher elevations in Hawaii.

This species is similar in appearance to *E. hawaiiensis*, n. sp., but differs consistently in number of paragenital setae, number of dorsobasal setae of tarsus III, and in the dorsoapical tibial organ of leg I.

Strandtmann & Prasse (1977) established that *Eupodes alaskanensis* Strandtmann, 1971 is a junior synonym of *E. voxencollinus*.

***Eupodes hawaiiensis* Strandtmann & Goff, new species** FIG. 5a–g

Medium-sized species 340–450 μm long; legs I slightly longer than body. Genital setae 6+6, 1 pair more lateral; paragenital setae 5+5. Body and leg setae noticeably long. Posterior setae (including lumbar, sacral, and anal 2 and 3) clustered at posterior end and somewhat more slender than dorsals and humerals. Tarsus I with 2 subequal, tandem rhagidial organs, subtended by a stellate seta consisting of a few (3–5) rays and a central, rod-like core; tibia I with a tibial organ consisting of a small r.o. with apical spine (FIG. 5d, e). A small solenidion at the proximal end of the tibia. Tarsus II with 2 unequal, tandem rhagidial organs subtended by a spine; tibia II with a dorsoapical r.o. and a dorsobasal solenidion. Tibiae II and IV each with small dorsobasal solenidion in some specimens (quite small and difficult to find, may be present in all specimens). Tarsus III (FIG. 5g) has a single, dorsobasal, feathered seta. Pedipalpal tibiotarsus about 1/2 length of palp genu, with apparently 9 setae and a small, midlateral sensory seta lying in a depression. The internal lumbar setae (li) shorter and slightly more slender than external lumbar (le). Anal setae 2 and 3 about as long as sacral and lumbar (70–90 μm).

♂ . Sperm sac small (FIG. 5c), not reaching anterior edge of the genital pore, sac portion barely enlarged. Average length of 6 ♂♂ , 350 μm (340–450 μm). Average lengths of dorsal setae: vi-22, ve-44, sc-40, tr-73, hi-110, he-75, d₁-100, d₂-110, li-85, le-90, si-100, se-90, anal 2 and 3, ca 80 μm .

←

FIG. 5. *Eupodes hawaiiensis*, n. sp.: a, dorsum; b, venter of ♀ ; c, genitalia of ♂ (internal genital setae not indicated); d, tarsus and tibia of leg I; e, enlarged view of tip of tibia I, showing the sensory area; f, lateral view of tarsus and tibia II; g, lateral view of tarsus III.

♀ (FIG. 5a, b). Average length of 3 ♀♀, 380 μm (350–425 μm). One ♀ contained 3 eggs, another 5. Average lengths of dorsal setae: vi-20, ve-40, sc-37, tr-75, hi-90, he-68, d₁-90, d₂-75, li-80, le-87, si-83, se-78.

Tritonymph. Two specimens measured 320 μm and 325 μm . Genital setae 3+3, paragenitals 4+4. Average lengths of dorsal setae: vi-18, ve-38, sc-33, tr-66, hi-70, he-61, d₁-77, d₂?, li-66, le-77, si-67, se-66.

Holotype ♂ (BISHOP 11, 028) (BBM-Berlese 00288), HAWAIIAN IS: Hawaii I: Kilauea Forest Reserve, 1620 m, VIII.1971, nest, 1 m from ground in fork of small tree, F.J. Radovsky. Paratypes: 1 ♂, same data as holotype; 4 ♂♂ (BBM-Berlese 00204), Kohala Mts, upper edge of Waipio Valley, 1205 m, 9.VI.1971, bog, moss and liverwort, M.L. Goff; 1 ♀, 2 Ny III (BBM-X 145887), HVNP, Mauna Loa Trail, 2020 m, 15.VI.1970, moss in lava tube, Goff & Radovsky; 1 ♀ (BBM-X 145891), 1 ♀ (BBM-X 145892), HVNP, Mauna Loa Trail, 2040 m, 16.VI.1970, *Metrosideros* scrub, Goff & Radovsky.

REMARKS. This mite was found with the more abundant *E. voxencollinus* and superficially resembles closely that species. There are 4 differentiating characters, which are constant: only 5 pairs of paragenital setae; a small r.o. at the tip of tibia I; tarsus III with only 1 dorsobasal seta; and setae li shorter and more slender than le.

E. hawaiiensis also closely resembles *E. crozetensis* Strandtmann & Davies (1972), which, like *E. hawaiiensis*, also has 5 pairs of paragenital setae. However, *E. crozetensis* lacks the small rhagidial organ on tibia I and has setae li nearly 2× as long as setae le.

GENUS *Cocceupodes* Sig Thor

Cocceupodes trisetatus Strandtmann & Prasse, 1977

FIG. 4a-i

Distinguished by the small claws of tarsus I, genital setal formula 3+3, paragenital setal formula 3+3, and the leg chaetotaxy.

♀. Length of body, 260 μm (250–275 μm). Leg I slender and a bit longer than body. All leg and body setae ciliated. *Dorsum* (FIG. 6g, h). Internal vertical setae not swollen, inserted posterior to epivertex 36 μm long, about 3 × as long as external verticals, which are 12.5 μm . Scapulars, 20 μm , about 1/2 as long as ve and inserted near trichobothrium. Trochobothria slender, lightly ciliated, 70 μm long or 2 × as long as vi. Internal humerals measure 12 μm and are shortest of the dorsal body setae. External humerals (50 μm) longest body setae except trichobothria. Dorsals 1 and 2 about 1/2 as long as distance between bases. Sacral setae on posterior margin. *Venter* (FIG. 6a, b, c). Coxal formula, 3-1-3-3. Outer seta of coxa I very short, others longer and subequal. Genital seta 3+3; paragenital setae 3+3, anterior pair longest. Two pairs of genital knobs and 3 or 4 pairs of internal genital setae. Anal pore subterminal with 2 pairs of anal setae and 1 pair of circular pores characteristic of genus (FIG. 6c). *Gnathosoma* (FIG. 6e, f). Hypostome as illustrated. Terminal segment of pedipalps about 1/2 as long as preceding segment. *Legs* (FIG. 6b, i). Leg I slender and as long or longer than body; femora I and II undivided; femora III and IV divided. Femur IV swollen. Trochantal formula 1-1-1-1. Claws of tarsus I very small. Tarsi II, III, and IV with claws and empodia of normal size (FIG. 6i). Tarsus I with 2 long, equal rhagidial organs lying tandem in separate fields, with stellate seta at basal end of basal r.o. Tibia I long and slender with short r.o. at dorsal apex and another nearly 3 × as long, lying just posterior. Tarsus II with 2 r.o.'s, tandem, in separate fields, anterior shorter. Tibia II with 2 r.o.'s, 1 dorsoapical, other dorsobasal. We could find no solenidia.

♂ and immatures unknown.

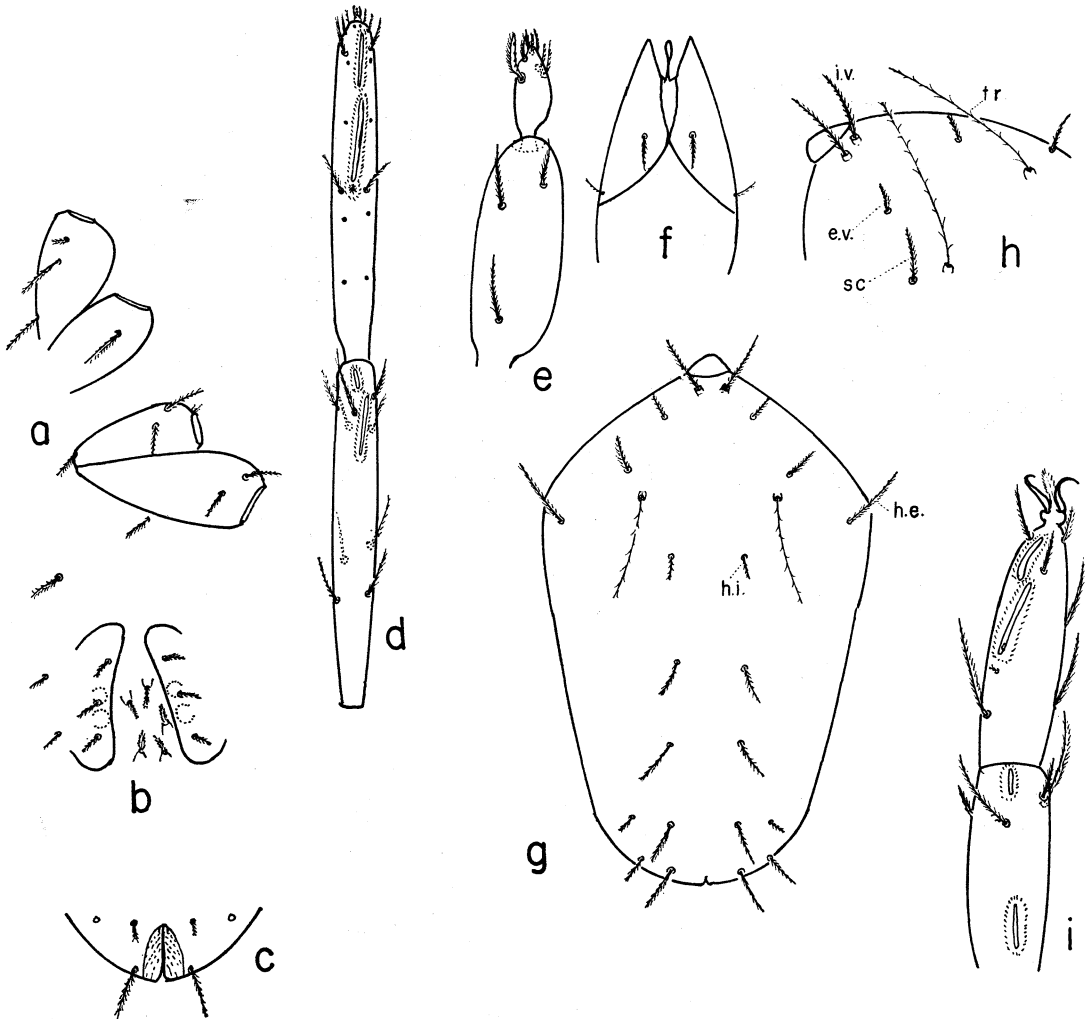


FIG. 6. *Cocceupodes trisetatus*: a, coxae I-IV; b, genitalia of ♀; c, anal pore and anal setae; d, dorsal view of tarsus and tibia I; e, dorsolateral view of terminal 2 segments of pedipalp; f, hypostome; g, dorsum; h, dorsolateral view of prodorsum, showing the propodosomal setae; i, dorsal view of tarsus and tibia II.

COLLECTION DATA. The above description is based on 4 ♀♀: 2 ♀♀ (BBM-X 145865), each containing 2 eggs, HAWAIIAN IS: Hawaii I: 1.6 km W of HVNP headquarters, 15.VI.1970, litter sample taken from *Metrosideros-Gleichenia* forest, M.L. Goff & F.J. Radovsky; 1 ♀ (BBM-145886), with 1 egg, 200 m, HVNP, Mauna Loa Trail, 16.VI.1970, from a litter sample taken in a *Metrosideros* scrub zone, Goff & Radovsky; 1 ♀ (BBM-Berlese 00270), Ref. #8, nr pitfall trap, 1280-1340 m, 21.VII.1971, koa and mostly thick grass, Radovsky.

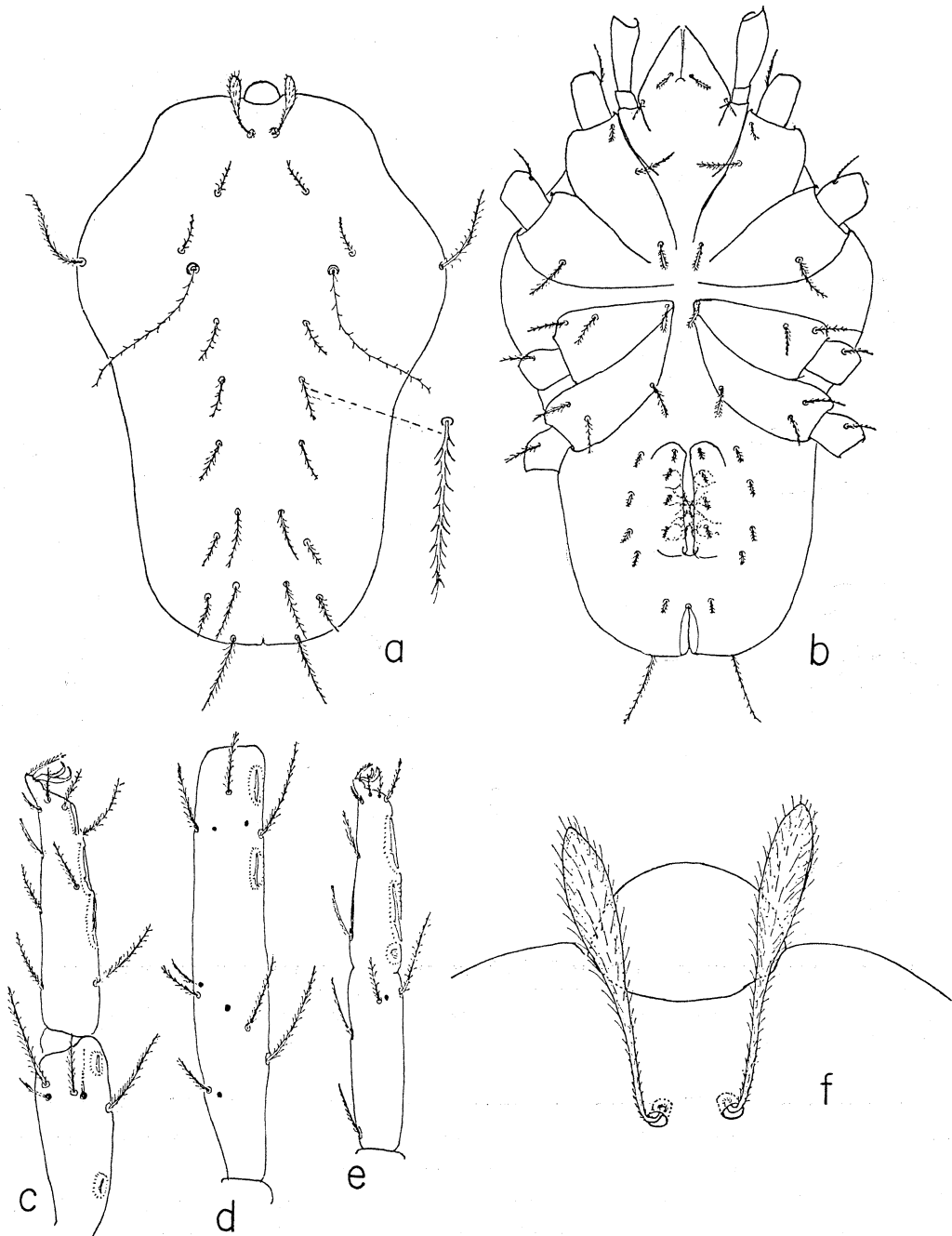


FIG. 7. *Cocceupodes mollicellus*: a, dorsum; b, venter of ♂; c, lateral view of tarsus and tibia II; d, lateral view of tibia I; e, lateral view of tarsus I; f, internal vertical setae and epivertical lobe, enlarged.

REMARKS. These specimens seem identical in all respects to the specimens collected in East Germany by J. Prasse and described recently by Strandtmann & Prasse (1977).

Cocceupodes mollicellus (Koch, 1838)

FIG. 7a-f

♀. Length, 300 μm . Leg I, 350 μm . Trochanter formula, 1-1-1-1; coxal formula, 3-1-3-3; genital setae, 4+4; paragenital setae, 4+4; anal setae, 2+2. Leg and body setae loosely feathered. No transverse body suture. Epivertical lobe distinct. Epivertical setae (*verticales internae*) pedicellate, clavate, and 30 μm long; clavate portion of 1 seta slightly concave on 1 side. *Verticales externae* and scapulares each 20 μm long. Legs (FIG. 7c-e). Tarsus I shorter than tibia I, with 2 long rhagidial organs, tandem, subtended by a distinct stellate seta; tarsal segment slightly constricted at about middle, just basad of stellate seta. Tibia I with 2 dorsoapical rhagidial organs, tandem, well separated. Tarsus II longer than tibia II, with 3 r.o.'s lying tandem. Tibia II with 2 small rhagidial organs, 1 dorsoapical, 1 dorsobasal. Apparently no other sensory organs on legs.

The above remarks are based on a single female (BBM-Berlese 00288) containing 2 eggs, collected on Hawaii I, in Kilauea Forest Reserve, 1.VIII.1971, from a nest 1 m up in a tree, by F.J. Radovsky.

Strandtmann & Prasse (1977) established that *Cocceupodes curviclava* Thor, 1934 and *Cocceupodes australis* Strandtmann & Tilbrook, 1968 are junior synonyms of *C. mollicellus*.

GENUS **Hawaieupodes** Strandtmann & Goff, new genus

A small, delicate mite with laterally compressed body, slender legs shorter than body, femora IV not swollen, leg and body setae small and sparsely feathered, no transverse body suture. Distinguished from other genera of Eupodidae primarily by the laterally compressed body and the very small setae.

Type-species: *Hawaieupodes thermophilus*, n. sp. Monotypic.

Hawaieupodes thermophilus Strandtmann & Goff, new species

FIG. 8a-d

♀. Length, 255 μm (250-280 μm). Leg I longest, but shorter than body. Trochanters apparently 0-0-1-1. (We could find no seta on trochanters I or II in the 9 specimens available.) Coxae, 3-1-3-3; anal setae, 3+3; genitals, 6+6; paragenitals, 4+4; 2 pairs of genital knobs, several pairs of internal genital setae. Body not divided by transverse suture. Epivertical lobe small, discrete, subterminal and bears the *verticales internae*, which are small, very fine and nude (FIG. 8c). Trichobothria 25-30 μm long, all other body setae, both dorsal and ventral, very small and loosely feathered. Legs (FIG. 8d, e). Tarsi I and II each with 2 rhagidial organs lying one behind the other but slightly overlapping. Apparently no stellate seta or spine associated with r.o.'s. Tibiae I and II each with dorsoapical r.o. and a slender, rather long, solenidion posterior to r.o. Tibia III and IV apparently without a solenidion but all 4 genera have each a slender, mid-dorsal solenidion. *Gnathosoma*. Similar to other eupodids, i.e., hypostome with 2 pairs of setae, chelicera with well-formed digit and malformed or poorly developed fixed digit, cheliceral seta small and apparently nude, pedipalpal seta formula 0-2-3-8 or 9, and a small sensory seta on outer (posterior) side of tibiotarsus. Subterminal segment (genu) of pedipalp sharply angulate anteroventrally (FIG. 8b).

The description is based on 10 females, including the holotype. All but 2 were collected in Hawaii Volcanoes National Park, along Steaming Bluff Trail. Eight were taken from steam vent microhabitats of 41°C; hence the specific epithet.

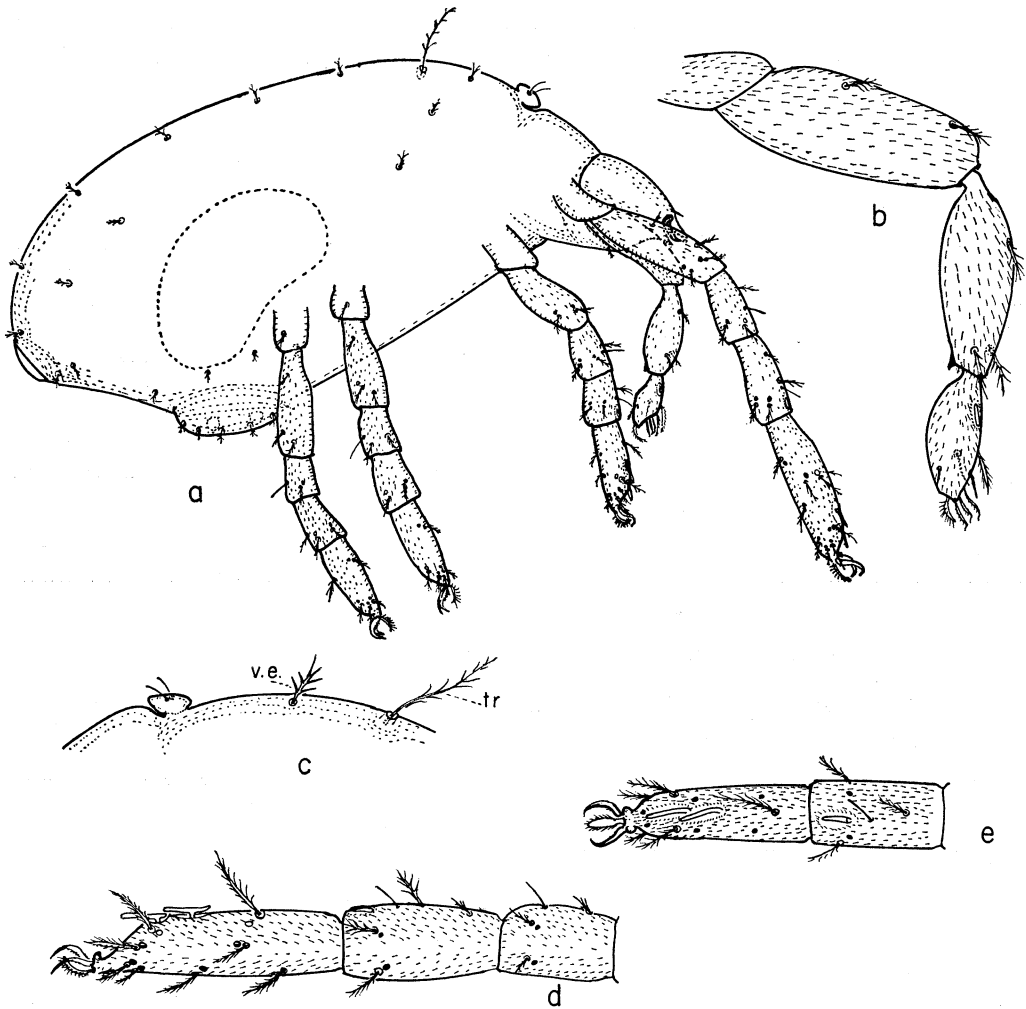


FIG. 8. *Hawaieupodes thermophilus*, n. gen. et n. sp., ♀: a, lateral view; b, lateral view of pedipalp; c, enlarged lateral view of prodorsum, showing epivertical lobe with the 2 internal vertical setae, 1 external vertical seta (e.v.), and 1 trichobothrium (tr.); d, lateral view of leg I; e, dorsal view of tarsus and tibia II.

Holotype ♀ (BISHOP 11,029) (BBM-Berlese 00252), containing 1 egg, HAWAIIAN IS: Hawaii I: HVNP, Steaming Bluff Trail at Vent II, cross transect at pt. 28, 0.6 m from midline, 0.3 m below surface, 8.VII.1971, 40°C, M.L. Goff. Paratypes: 1 ♀ (BBM-Berlese 00195), same locality as holotype except 6 m from end, 0.3 m below surface, 3.VI.1971, 41°C, from moss, Goff; 2 ♀♀ (BBM-Berlese 00232), 1 with 1 egg, same locality except cross transect at pt. 22, 0.3 m from midline, 0.3 m below surface, 21.VI.1971, 41°C, moss and grass on soil, Goff; 4 ♀♀ (BBM-Berlese 00252), 2 with 1 egg each, 1 with 2 eggs, same data as holotype; 1 ♀ (BBM-Berlese 00279), with 1 egg, HVNP, Mauna Loa

Strip Rd, Ref. #8, nr pitfall trap, 21.VII.1971, soil and humus under koa and thick grass, F.J. Radovsky; 1 ♀ (BBM-Berlese 00288), Kilauea Forest Reserve, 1.VIII.1971, nest 1 m from ground in fork of small tree, F.J. Radovsky. Found with *Cocceupodes mollicellus*.

REMARKS. One might think that this is a heat-adapted species and not likely to occur under cooler conditions. Perhaps the last 2 records above are in error in recording?

Males and immatures are unknown at present.

FAMILY PENTHALODIDAE

GENUS *Penthalodes* Murray

Penthalodes ovalis (Duges, 1834)

FIG. 9a-e

A very pretty mite, either alive or mounted. In life it is red and black; when mounted the color is lost but a pretty pattern of polygons prevails. The body is broadly ovoid with a dorsal Y-shaped suture; a pair of smooth ocelli on the propodosoma; a small, circular epivertical lobe more or less submerged on the anterior body. The dorsal setae are small, loosely feathered, and inconspicuous. Some of the dorsal setae are lacking, probably the sacral. The epirostrum is fairly prominent, triangular, reticulate.

Contrary to the description given by Strandtmann (1971: 92), tarsus I has 3 rhagidial organs, rather than 2. The 3rd organ is lateral, basad of the other 2, and not readily seen (FIG. 9d). Also, there is no stellate seta (note: this was verified by rechecking the material on which the 1971 description was based). On tarsus II, the 3 rhagidial organs are staggered, not in a straight, tandem row. All 4 tibiae and genuae each have a slender solenidion.

Five females were studied. Length 350 μ m (290-415 μ m). One ♀, 350 μ m long, contained 3 eggs; 2 others contained 1 and 2 eggs, respectively, and 2 were barren. Coxae, 3-1-3-3; genitals, 9+9 (sometimes 8+8) of which 1 pair is more lateral (FIG. 9a); paragenitals, 16 to 18.

COLLECTION DATA. HAWAII IS: Hawaii I: 1 ♀ (BBM-X 145894), Volcano-Hilo road (Rt. 11), 800 m, 16.VI.1970, grass and lichen sample, M.L. Goff & F.J. Radovsky; 3 ♀♀ (BBM-X 145903), Volcano-Hilo road, 1040 m, 17.VI.1970, *Metrosideros*-treefern forest, Goff & Radovsky; 1 ♀ (BBM-X 145905), Hilo, cane fields above town, 140 m, 18.VI.1970, guava thicket, Goff & Radovsky.

FAMILY RHAGIDIIDAE

GENUS *Rhagidia* Thorell

Rhagidia longisensilla Shiba, 1969

FIG. 10a-e

Characterized by: only 1 cheliceral seta; rhagidial organs on all 4 tibiae and on genuae I, II, and III; an obvious, albeit small, brushy seta at the middorsal apex of tarsus I apical to the 4 parallel rhagidial organs; no stellate seta; trichobothria (or sensillae) relatively longer than in most other species of *Rhagidia*.

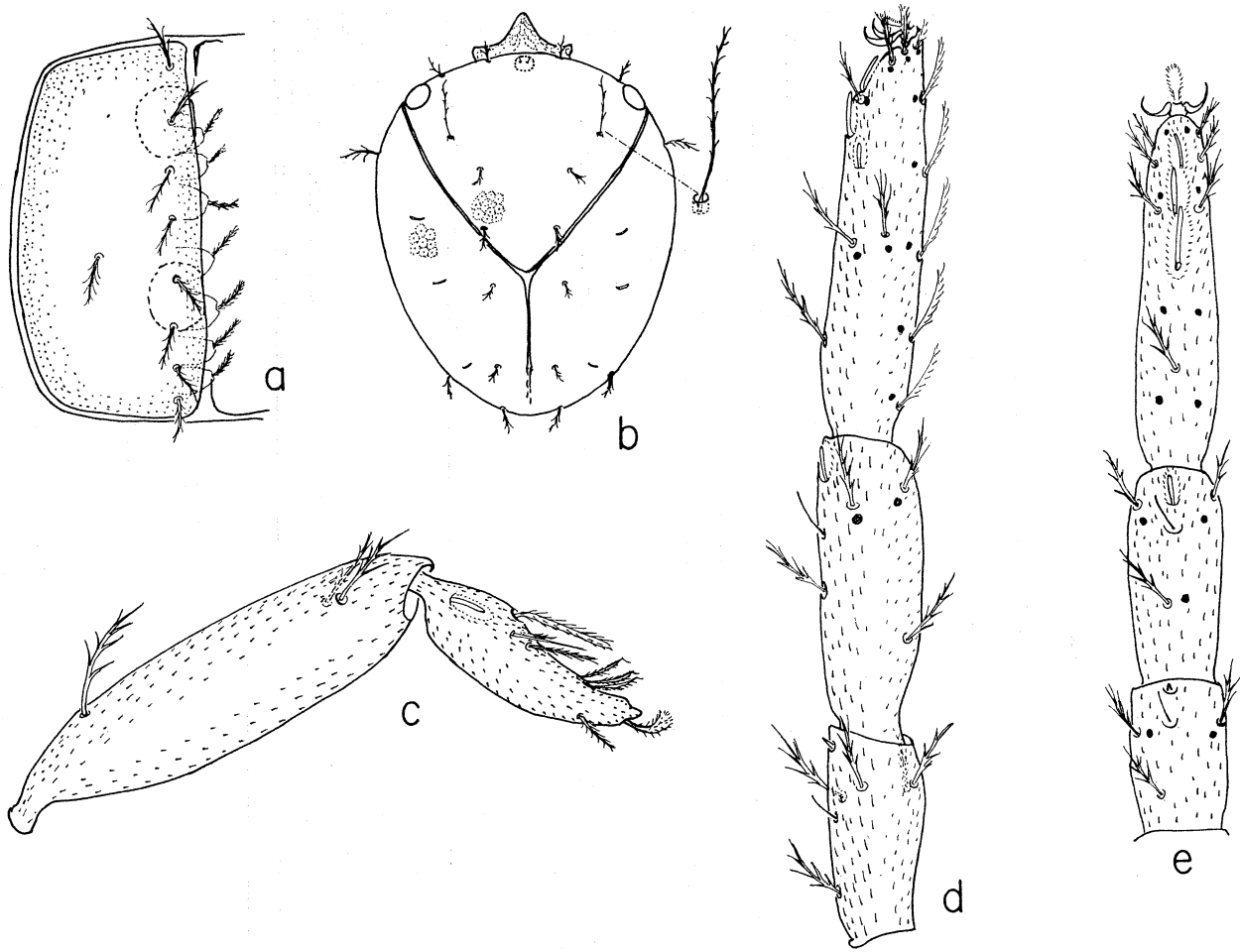


FIG. 9. *Penthalodes ovalis*: a, right 1/2 of ♀ genitalia; b, dorsal view of idiosoma; c, lateral view of terminal 2 segments of pedipalp; d, lateral view of leg I; e, dorsal view of leg II.

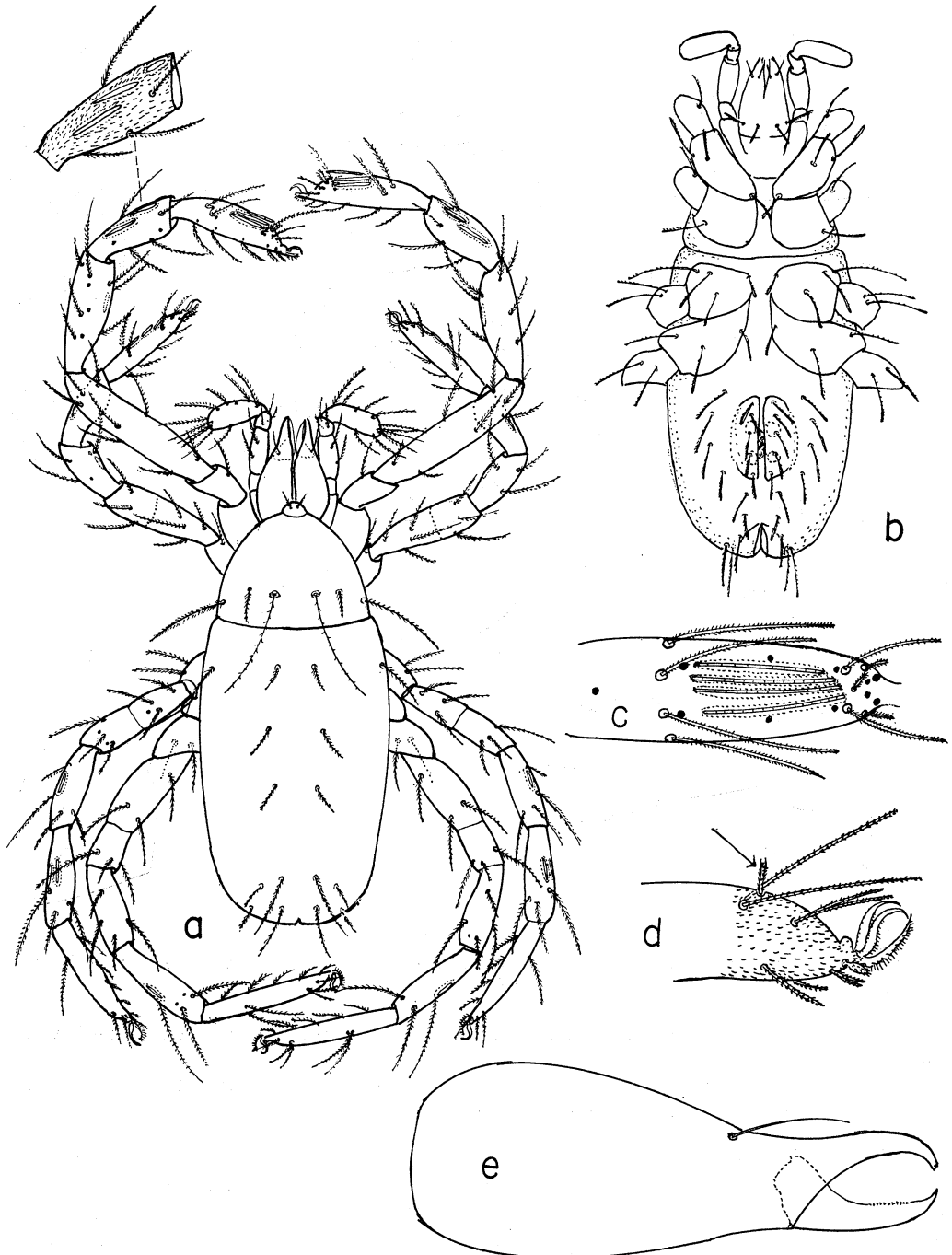


FIG. 10. *Rhagidia longisensilla*: a, dorsal view; b, venter of ♀; c, dorsal view of tarsus I, showing the 4 parallel rhagidial organs; d, tip of tarsus I showing the unique anteriodorsal seta; e, side view of chelicera.

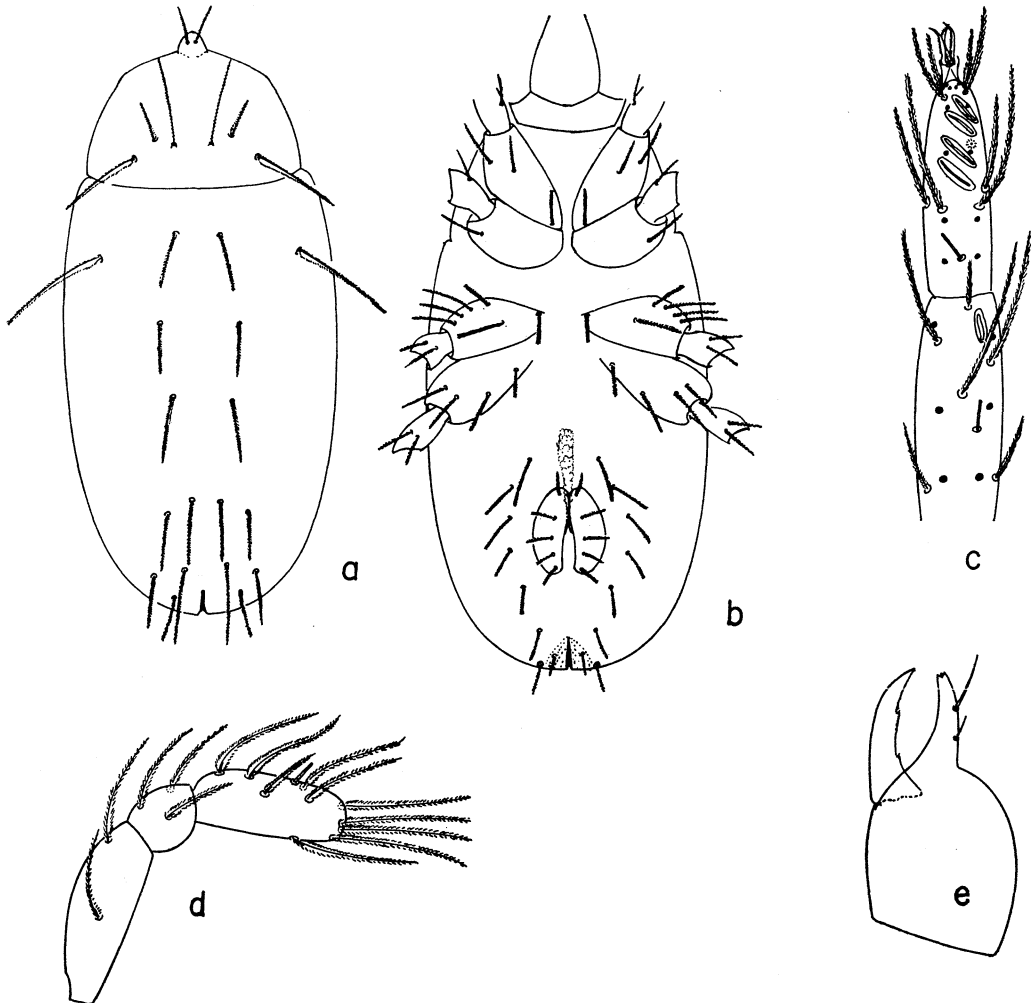


FIG. 11. *Rhagidia whartoni*: a, dorsum; b, venter of ♂; c, dorsal view of tarsus and tibia I; d, lateral view of pedipalp; e, lateral view of chelicera.

♀. Length 450–500 μm . Trochanters, 1-1-2-2; coxae, 3-1-4-3; genitals, 5+5; paragenitals: 5+5, anals, 4+4.

Tritonymph. Length, 325–500 μm . Trochanters, 1-1-2-2; coxae, 3-1-4-3; genitals, 3+3 (3+4 in one of 4 specimens available); paragenitals, 4+4; anals, 4+4.

COLLECTION DATA. HAWAIIAN IS: Hawaii I: 1 ♀ (BBM-Berlese 00206), Kohala Mts, upper edge of Waipio Valley, 1185 m, 9.VI.1971, ex *Selaginella*, bog, M.L. Goff; 2 Ny III (BBM-X 145865), HVNP, 1.6. km W of Park Headquarters, 15.VI.1970, *Metrosideros-Gleichenia*, Goff & F. J. Radovsky; 1 Ny III (BBM-X 145867), junction of Crater Rim Rd and Hilo Rd, ca 3.25 km W of HVNP, 15.VI.1970, *Metrosideros* savannah, Goff & Radovsky; 1 ♀ (BBM-X 145879), with 1 egg, HVNP, crossroad for Bird Park

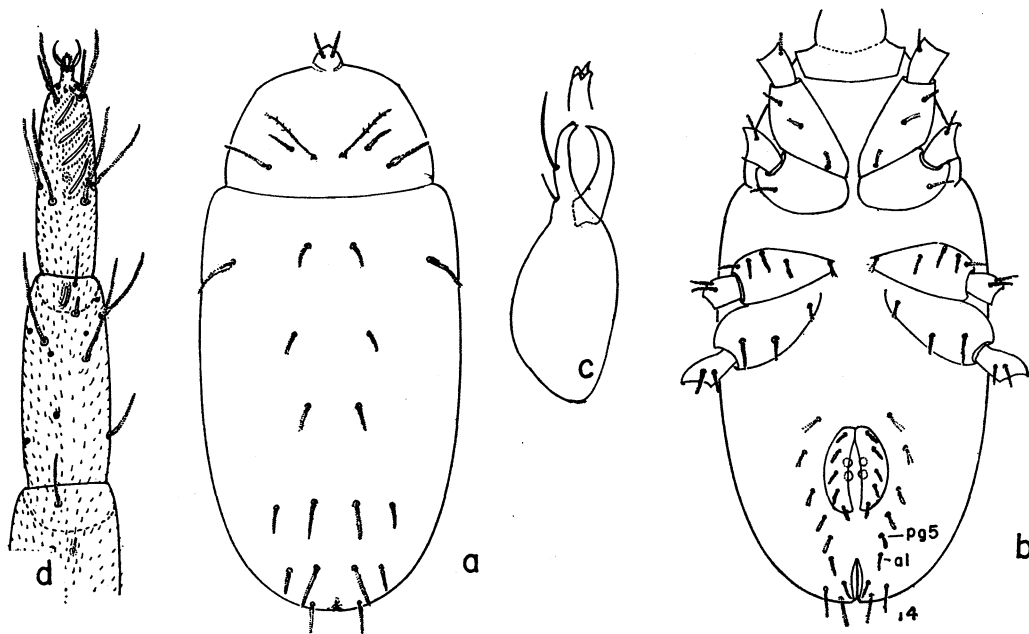


FIG. 12. *Rhagidia shibai*: a, dorsum; b, venter of ♀; c, lateral view of chelicera, with enlarged view of tip of fixed digit; d, dorsal view of tarsus and tibia I.

from Crater Rim Rd, 1280 m, 16.VI.1970, *Metrosideros*-lichen forest, Goff & Radovsky; 1 Ny III (BBM-X 145888), HVNP, Mauna Loa Trail, 2150 m, 16.VI.1970, *Metrosideros* scrub zone, Goff & Radovsky; 1 ♀ (BBM-X 145904), Volcano-Hilo road (Rt. 11), 1040m, 17.VI.1970, *Metrosideros*-tree fern forest, Goff & Radovsky;

REMARKS. This is a widely distributed species of *Rhagidia*. It has been reported from Japan (Shiba 1969), caves in Arkansas, U.S.A. (Elliott & Strandtmann 1971), in Alaska at latitude 70°N (Strandtmann 1971), as well as the several localities on Hawaii I reported herein.

***Rhagidia whartoni* Strandtmann, 1971**

FIG. 11a-e

A medium-large mite, characterized by a prominent solenidion near the base of tarsus I.

♀. Length 650–1000 μm ; trochanters, 1-1-2-2; coxae, 3-1-6-4; genitals, 5+5; paragenitals, 5+5; anals, 4+4. Tarsus I with 4 oblique rhagidial organs with a stellate seta between the middle 2; tarsus II with 3 tandem r.o.'s.

COLLECTION DATA. HAWAIIAN IS: Hawaii I: 1 Ny III (BBM-X 145870), HVNP, Crater Rim Rd, 15.VI.1970, volcanic desert, M.L. Goff & F.J. Radovsky; 1 ♀ (BBM-X 145891), 2 eggs, HVNP, Mauna Loa Trail, 2240 m, 16.VI.1970, alpine *Metrosideros* scrub, Goff & Radovsky; 1 Ny II (BBM-X 145893), HVNP, Mauna Loa Trail, 2240 m, 16.VI.1970, alpine *Metrosideros* scrub zone, Goff & Radovsky; 1 ♀, 1 egg (BBM-X 145894), Volcano-Hilo road (Rt. 11), 800 m, 16.VI.1970, grass and lichen, Goff & Radovsky.

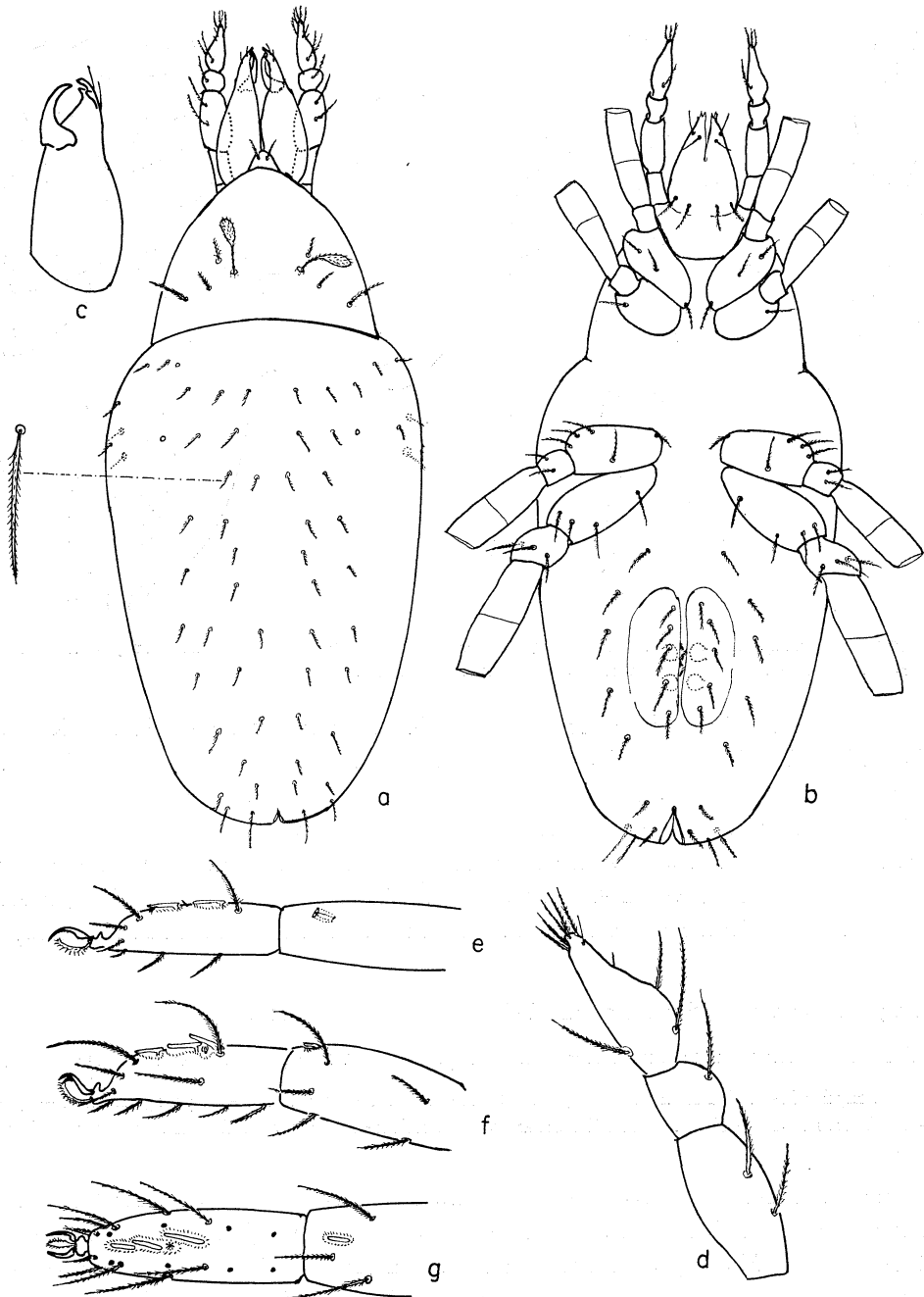


FIG. 13. *Pilorhagidia hirsuta*, n. gen. et n. sp., ♀: a, dorsum; b, venter; c, ventrolateral view of chelicera; d, lateral view of terminal 3 segments of pedipalp; e, lateral view of tarsus and tibia II; f, lateral view of tarsus and tibia I; g, dorsal view of tarsus and tibia I.

Rhagidia shibai Strandtmann, 1971

FIG. 12a-d

♂. Length 500 μm . Trochanters, 1-1-2-2; coxae, 3-1-5-3; genitals, 5+5; paragenitals, 5+5; anals, 4+4. Tarsus I with 4 oblique rhagidial organs and a stellate seta between the basal 2; tarsus II with 3 tandem r.o.'s. Dorsal setae quite short.

COLLECTION DATA. HAWAIIAN IS: Hawaii I: 1 ♂, HVNP, 1.6 km W of Park Headquarters, 15.VI.1970, *Metrosideros-Gleichenia*, M.L. Goff & F.J. Radovsky.

GENUS **Pilorhagidia** Strandtmann & Goff, new genus

Dorsum with numerous accessory setae, pedipalp with terminal segment attenuated and subterminal segment with only 1 seta; trichobothria clavate; chelicera with 2 setae.

Type-species: *Pilorhagidia hirsuta*, n. sp. Monotypic.

Pilorhagidia hirsuta Strandtmann & Goff, new species

FIG. 13a-g

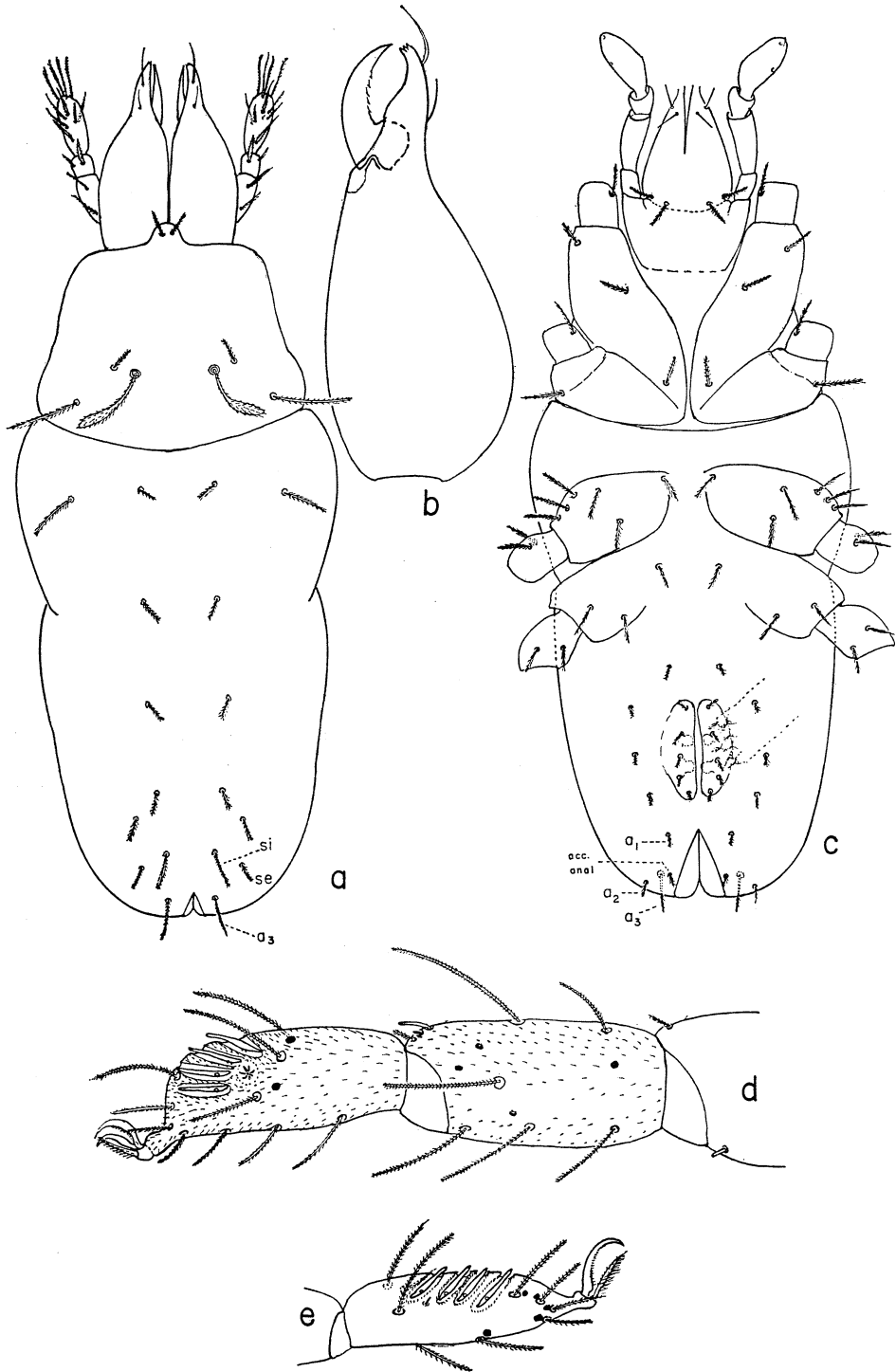
A small species, less than 400 μm long, distinguished by the supernumerary dorsal setae, the reduced palpal chaetotaxy, and the apically narrowed terminal palp segment.

♀ ca 375 μm long without gnathosoma. Coxal formula, 3-1-5-4; trochantal setae, 1-1-2-3; genital setae, 5+5; paragenitals, 5+5. Anal setae, 4+4. Body shape typical of Rhagidiidae. *Dorsal side* (FIG. 13a). Trichobothria distinctly clavate, pedicellate, finely ciliated, longer than scapulars. Scapulars 2 \times as long as internal and external verticals. An accessory pair of setae about as long as verticals between scapulars and trichobothria. Dorsal hysterosoma with 20-30 pairs of setae (both specimens were torn and it was difficult to get an accurate count). All dorsal setae quite short. *Venter* (FIG. 13b). Coxal formula 3-1-5-4. Genitalia typical, i.e., 2 pairs of knobs, an internal ovipositor with numerous setae, 5 pairs genital setae, and 5 pairs paragenital setae. All ventral setae subequal and about 2 \times as long as dorsals. Excretory pore terminal, with 4 pairs anal setae. *Gnathosoma* (FIG. 13b, c, d). Cheliceral shears about 1/3 total length of chelicera. Cheliceral setae apical, fine, overlapping. Fixed digit with prominently tridentate apex. Rostrum quite ordinary, with 4 basal ciliated setae and 4 apical nude setae. Pedipalp with terminal segment attenuated, which makes species unique in family, and with 9 setae, of which 6 are shorter and apical and 3 longer and basal; an erect solenidion dorsally between the 2 groups. 3rd segment with only 1 seta (unique for family); 2nd segment with 2 setae. All setae ciliated. *Legs* (FIG. 13e, f, g). Leg I about as long as body. Tarsal claws without basal clawlets. Tarsus I with 3 rhagidial organs, tandem, in separate fields, with stellate seta between basal 2. Tibia I apparently with only a dorsoapical r.o. Tarsus II with 2 tandem r.o.'s. Tibia II apparently with a cryptic solenidion, characteristic of most members of the family.

♂ and immatures unknown.

Description based on 2 ♀♀, both broken. The illustrations represent a composite of the 2.

Holotype ♀ (BISHOP 11,030) (BBM-X 145892), HAWAIIAN IS: Hawaii I: HVNP, Mauna Loa Trail, 2040 m, 16.VI.1970, *Metrosideros* scrub (Class 6), M.L. Goff & F.J. Radovsky; paratype ♀ (BBM-X 145886), same data as holotype except 2000 m.



←
 FIG. 14. *Coccorhagidia clavifrons*, ♀: a, dorsum; b, side view of chelicera; c, venter, showing outline of ovipositor (dotted lines); d, lateral view of tarsus and tibia I; e, lateral view of tarsus II.

GENUS *Coccorhagidia* Sig Thor

Coccorhagidia clavifrons (R. Canestrini, 1886)

FIG. 14a-e

Length, 500 μ m. Leg I shorter than body. All body setae rather short, closely ciliated. Trochantal setae 1-1-2-2; coxae, 3-1-6-3; genitals, 5+5; paragenitals, 4+4. Tarsus I with 4 irregularly oblique rhagidial organs crowded at apex, with prominent stellate seta near bases (FIG. 14d). Tarsus II with 4 oblique r.o.'s on middle of segment. Chelicerae larger than pedipalps, the fixed digit tricusped, the movable finely serrate along inner margin. Posterior cheliceral seta not reaching base of anterior seta; 3rd segment (genu) of pedipalp with 2 setae.

COLLECTION DATA. HAWAIIAN IS: Hawaii I: 1 ♀ (BBM-X 145879), HVNP, cross-road for Bird Park from Crater Rim Rd, 1220 m, 16.VI.1970, *Metrosideros*-lichen forest, M.L. Goff & F.J. Radovsky; 1 ♀ (BBM-X 145886), HVNP, Mauna Loa Trail, 2000 m, 16.VI.1970, *Metrosideros*-scrub zone (Class 6), Goff & Radovsky.

REMARKS. This mite is a fairly common species throughout Europe.

Acknowledgments: We are indebted to Dr Frank J. Radovsky, Chairman of the Entomology Department, Bishop Museum, and principal investigator of the soil-arthropod project of the Hawaii I.B.P. that made this study possible; and to Dr JoAnn Tenorio, also of the Bishop Museum, for sorting the great amount of material collected. Special thanks are due Mlle F. Athias of the Ecole Normale Supérieure, Univ. of Paris, for the specimens of *Eupodes sigmoidensis* from West Africa. Ana Valencia Kelly is appreciated for the painstaking care she gave to preparing the material for study.

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