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Parholaspidae (Acari: Mesostigmata) from the Hawaiian Islands, with Description of a New Species of *Parholaspulus* [1]

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Abstract: Descriptions and records are given for 3 parholaspid species from the Hawaiian Islands: *Parholaspulus maunaloaensis,* n. sp., *Gamasholaspis gamasoides* Berlese, 1904, and *Holaspulus tenuipes* Berlese, 1904. The 3 species were collected from different sites along an altitudinal transect on Mauna Loa, Hawaii Island. *P. maunaloaensis* was limited to high altitudes (2134 to 2454 m). *G. gamasoides* was found in diverse habitats from 610 to 2044 m; it was not taken at the high-altitude sites inhabited by *P. maunaloaensis,* n. sp. *H. tenuipes* was collected in small numbers only at 1 site (1220 m) where *G. gamasoides* appeared to be absent. However, *H. tenuipes* has been collected at lower elevations on Hawaii I and in several locations on Oahu I and is probably widely distributed at lower altitudes on all the major islands.

In conjunction with the Island Ecosystems Stability and Evolution Subprogram of the International Biological Program (IBP), sampling of soil and duff-inhabiting arthropods was carried out on Hawaii I as part of the soil arthropod project directed by Dr Frank J. Radovsky, Bishop Museum. Field work was conducted along an altitudinal transect on the NE slope of Mauna Loa, the second highest mountain in the Hawaiian chain (4146 m). The transect passed through diverse vegetational communities, including well-developed rain forest, drier montane forest, subalpine shrubland, and alpine areas near the summit. For further information on vegetation, climate and other features of the study area and the sampling sites, see Doty & Mueller-Dombois (1966), Mueller-Dombois (1975), and Mueller-Dombois & Bridges (1975.)

From July 1971–July 1973, sampling was conducted at 12 sites on the Mauna Loa transect, from 1220 m to 2440 m in elevation, and 2 sites in the Kilauea Forest Reserve (1645 m), a montane forest with higher rainfall than at comparable elevations on the transect. Some sampling was done on a few occasions at lower elevations on Mauna Loa outside of the transect for purposes of faunal comparison.

One pitfall trap was set up at each of the 14 sites and sampled at least monthly during the 1st year and bimonthly during the 2nd. The same schedule was followed for Berlese sampling at each site. During the 1st year, loose surface litter and underlying humus and/or mineral soil to a depth of ca 2 cm were separately extracted. During the 2nd year (after July 1972), the single sample from each site consisted of 4 subsamples: a litter layer and 3 soil core fractions taken at depths of 0–3, 3–6, and 6–9 cm.

Three species of Parholaspidae were recovered in Berlese extractions: *Parholaspulus maunaloaensis,* n. sp., *Gamasholaspis gamasoides* Berlese, 1904, and *Holaspulus tenuipes* Berlese, 1904. Only *Holaspulus tenuipes* has been previously reported from the Hawaiian Islands. No parholaspids were collected in pitfall traps.

This paper presents description of a new species of *Parholaspulus,* as well as redescriptions of *G. gamasoides* and *H. tenuipes.* The male of *G. gamasoides* is known only from the very brief description of Berlese (1904); a redescription is given here from a long series of males collected on Hawaii I. The deutonymphs of *G. gamasoides* and of *H. tenuipes* are described here for the first time.

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Hawaiian specimens of *H. tenuipes* and *G. gamasoides* were compared with the English and Argentine material, respectively, upon which Evans (1956) based his descriptions of these 2 species; they were found to represent the same species. Specimens of *G. gamasoides* examined from the United Kingdom also were conspecific with Hawaiian specimens.

Body and leg chaetotaxy in the descriptions are based on Lindquist & Evans (1965) and Evans (1963), respectively. Details are given on abbreviations and numerical formulae in the description of the new species.

Parholaspulus (Parholaspidellus) maunaloaensis Tenorio & Marshall, **n. sp.** FIG. 1–14, 41

Diagnosis: Dorsal plate with 29 setal pairs, 18 podosomal and 11 opisthosomal. Female venter with 14 presternal plates and a number of smaller platelets laterad on presternal area; genital plate small, truncate in form, flap very short; ventrianal plate narrowly separated from or contiguous with genital plate; 4 elongate platelets between genital and anal plates; ventrianal plate with 4 pairs of preanal setae; femur II in ♀ with 2 adjacent medioventral bumps, palpal femur with al peg-like and genu with al_1 and al_2 apically flattened and truncated; movable chela with 2 teeth in ♀, 1 in ♂. Male femur II with large ventral spur; genu, tibia and tarsus II each with 1 small, conical spur ventrally.

♀ (FIG. 1–8, 11, 41). *Dorsum* (FIG. 1): Dorsal plate not covering entire dorsum laterally and posteriorly, broadest in area behind coxae II, straight on anterior margin; anterior margin in mounted specimens often reflexed under; surface with tiny puncta in reticulate pattern faintly defined on posterior 1/2; with 29 pairs of setae, 18 podosomal and 11 opisthosomal; j1 and z1 on anterior margin of plate; anterior setae slightly longer than most on posterior of plate; z1 shortest seta on plate, Z5 longest; opisthosomal region of plate apparently lacking J2 and J4, Z_2 and S_3; many posterior setae weakly serrated. Unarmed dorsum with about 7 pairs of setae, pair at level of coxae IV shortest (18μ). Pores and setae on dorsum distributed as in FIG. 1. *Venter* (FIG. 2–3): Tritosternum with laciniae sparsely haired, laciniae extending to about level of outer proximal hypostomal setae (hyp. 2). Presternal area with 14 transversely elongate plates, a group of 7 on each side below tritosternal base; posterior-most plates on each side sometimes incompletely separated; laterad of each group of 7 plates and extending diagonally toward coxa I are from 3–5 platelets–in some specimens these are poorly defined or absent. Sternal plate extending to level opposite posterior margin of coxae III, gently concave on anterior margin, medially concave on posterior margin; sculptured with strongly defined longitudinal lines and associated puncta as in FIG. 2 and 41; 1st pair of pores lyriform, 2nd elliptical; St3 4/5 length of St1. Metasternal plates round or oval, with 1 pair of circular pores and metasternal setae. Genital plate short, posterior margin gently convex; surface marked with puncta; flap very short, extending to level of metasternal setae, broadly rounded anteriorly. Space between genital and ventrianal plates with 4 transversely elongate plates (FIG. 3); these are sometimes obscured in mounted material by apparent contiguity of anal and genital plates (probably due to folding of unsclerotized interscutal area). Ventrianal plate large, wider than long, narrowly separated from genital plate, anterior margin fitting contour of posterior margin of genital plate; faintly defined puncta scattered on surface; with 4 pairs of preanal setae, 1st pair on anterolateral corners and slightly longer than other subequal pairs; adanals placed opposite middle of anal ring; postanal 2/3 length of adanals. Unarmed venter with 4 pairs of pores (P1–4) and 5 pairs of setae, posterior-most weakly serrated. One pair of elongate metapodal plates laterad of P_2 and P_3. Peritreme extending to anterior margin of coxa I; peritremal plate fusing anteriorly with dorsal plate and posteriorly with podal plates of coxa IV; plate extending posteriad almost to level opposite posterior margin of genital plate. *Legs:* In order of decreasing length, I,IV,II,III; leg II with segments stoutest. Tarsus I, dorsal view, as in Fig. 4; pretarsus I (FIG. 5) with small claws. Leg chaetotactic formula for coxa, trochanter, femur, genu, tibia and tarsus, respectively, as follows: I, 2:6:13:13:12:40(7); II, 2:5:11:11:10:18; III, 2:5:6:8:8:18; IV, 1:5:6:8:8:18. Tarsus I with 7 sensory rods included in ( ) tarsal formula. Femur II with distal posterodorsal seta longest on leg; ventromedially with 2 small, contiguous protuberances, proximal one larger than distal. Tarsus II with al_1 and pl_1 spiniform; no apical spiniforms on tarsi III and IV; tarsus IV with several long, fine setae. *Gnathosoma* (FIG. 6–8, 11): Deutosternum with 5 rows of multiple, small denticles. Capitular setae (c.s.) shorter than hypostomal setae; outer proximal hypostomal (hyp. 2) considerably shorter than subequal inner proximal (hyp. 3) and distal hypostomal (hyp. 1). Palpal chaetotaxy: 2, 5, 6, 14, 15; femur with al peg-like; genu with al_1 and al_2 modified, flattened and truncate apically (FIG. 7): genu proximally with a distinctive, sharply bi-pronged cuticular projection anterolaterally (FIG. 7); apotele of palpal tarsus as in FIG. 6. Epipharynx long and tapering, extending to about level opposite middle of palpal femur. Labrum long, narrow, pointed apically, extending to basal 1/3 of palpal femur. Corniculi about 100μ long. Fixed chela (FIG. 11) with 4 preapical teeth, and a bump proximal of last tooth; hooked apex appearing notched; with short dorsal seta and short, straight pilus dentilis. Movable chela (FIG. 11) with 2 widely separated teeth. Tectum with 2 lateral and a longer median projection, each with varying numbers of spicules; median projection with spicules developed distally only and on 1 side; margin of tectum between and laterad of projections smooth or with tiny to moderately long spicules; FIG. 8 shows 2 variants in tectal form.

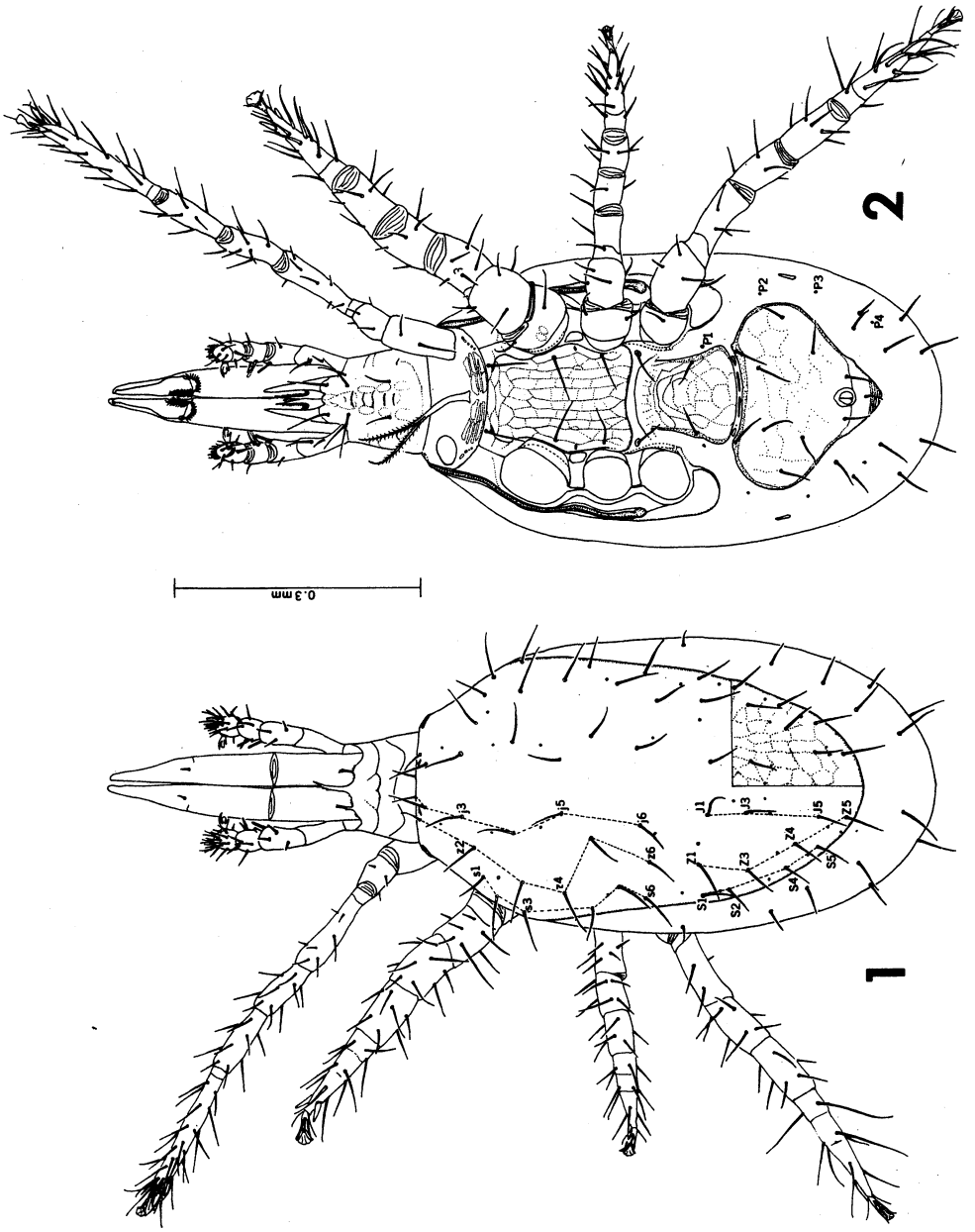


FIG. 1–2. *Parholaspulus (Parholaspidellus) maunaloaensis*, n. sp., ♀, (1) dorsum; (2) venter.

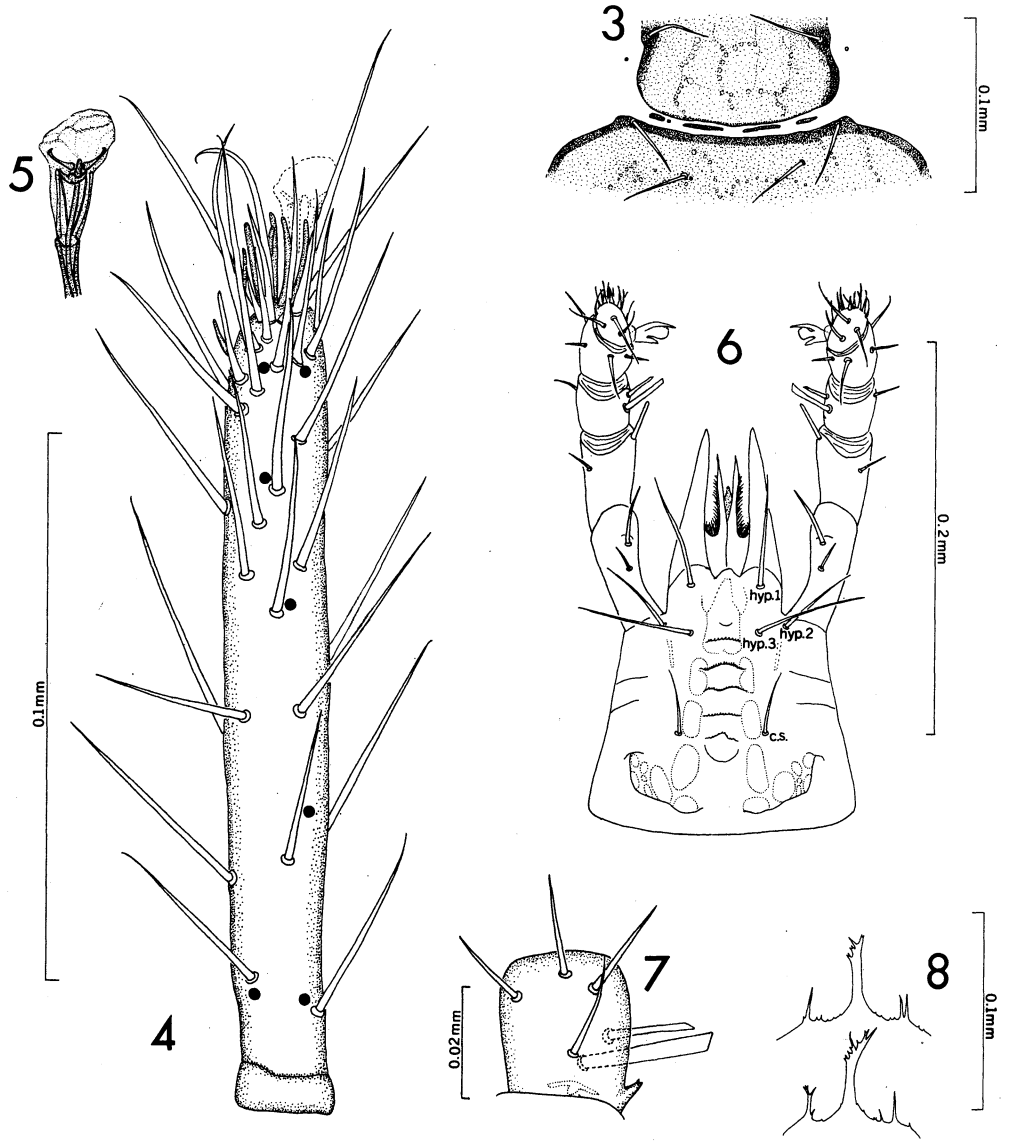


FIG. 3–8. *Parholaspulus (Parholaspidellus) maunaloaensis,* n. sp., ♀, (3) genital-ventrianal region showing postgenital platelets; (4) left tarsus I, dorsal view; (ventral setae indicated by black dots); (5) pretarsus I; (6) gnathosoma, ventral view; (7) palpal genu, dorsal view; (8) tectal variants.

Measurements [ranges and means ( ) in μ, based on 10 specimens]; Idiosomal L, 613–731 (656); dorsal plate L x W, 562–597 (576) x 328–357 (336); j1, 32–38 (35); j3, 48–57 (53); j5, 38–44 (42); z1, 30–31 (30); Z5, 51–63 (55); sternal plate L (median), 173–187 (181); anal plate L (to base postanal) X W, 152–170 (161) X 219–254 (234); St1, 53–60 (57); St3, 47–54 (49); 1st preanal setae, 44–47 (46); 2nd preanals, 38–44 (42); 3rd preanals, 38–41 (40); 4th preanals, 39–45 (42); adanals, 34–37 (34); postanal, 24–26 (25); leg I L, 578–696 (614); movable chela, 90–96 (93).

TABLE 1. Comparison of the ♀♀ of the 4 species of *Parholaspulus (Parholaspidellus)*.

	No. dorsal setae	No. presternal platelets	No. postegenital platelets	Pretarsus leg I	Length dorsal plate (μ)	Length z1 (μ)
P. minutus	30	18	0	Clawless	360	23
P. maturovae	30	16	0	Clawless	590	?
P. excentricus	29	10	0	Claw	650–680	15
P. maunaloaensis	29	14	4	Claw	560–597	30

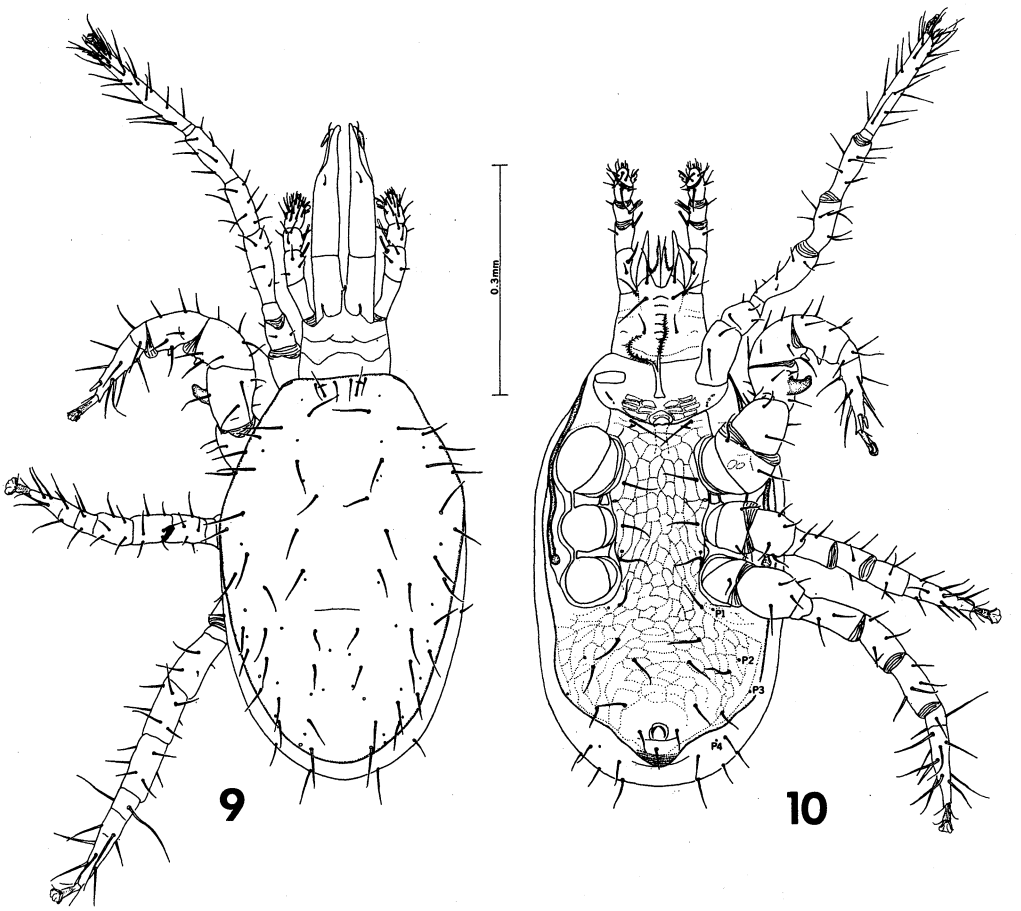
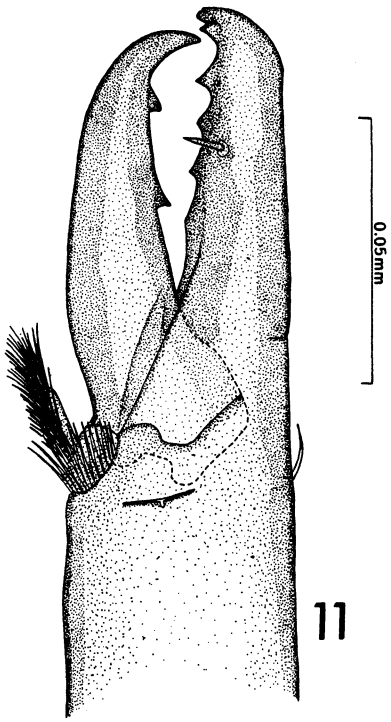


FIG. 9–10. *Parholaspulus (Parholaspidellus) maunaloaensis*, n. sp., ♂, (9) dorsum; (10) venter.



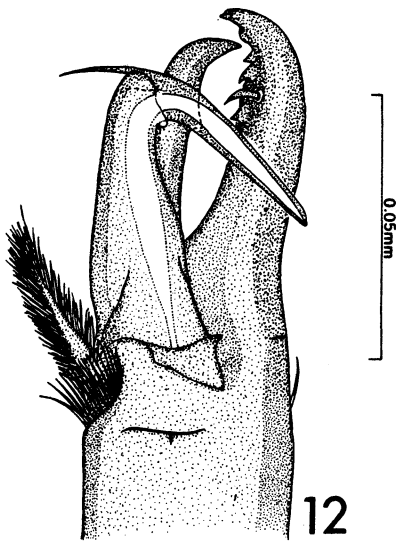


FIG. 11–12. *Parholaspulus (Parholaspidellus) maunaloaensis,* n. sp., ♀, (11) chelae, antiaxial surface; ♂, (12) chelae, antiaxial view.

♂ (FIG. 9–10, 12). *Dorsum* (FIG. 9): Dorsal plate covering nearly entire dorsum, with 29 pairs of setae of similar relative size and distribution to those in ♀. Unarmed dorsal integument with 3–4 pairs of setae. *Venter* (FIG. 10): Genital opening presternal. Holoventral plate with strong linear and punctuate sculpturing in sternogenital area, distinct puncta in reticulate pattern in ventrianal region; sternogenital region with 5 pairs of setae, preanal area with 5 pairs plus adanals and postanal. Peritreme extending to about middle of coxa I, peritremal plate fused posteriorly with holoventral plate. Pores P1–4 present, P4 off plate. Unarmed venter with 5 pairs of setae. *Legs:* Leg II modified, segments much enlarged. Trochanter IV swollen, almost as

wide as trochanter II. Leg chaetotactic formula as in ♀, except in leg II as follows: femur and genu each with 10 setae; tibia with 9; tarsus with 17. Femur with prominent, hooked spur medioventrally, hook directed distad; spur with small, blunt to pointed elevation at base; medioventral distal seta short, acute and arising from a bump. Genu and tibia each with a small conical spur medioventrally, in apical position on genu, about midway on tibia. Tarsus with tiny spur at base of seta mv. *Gnathosoma:* Chelae as in FIG. 12. Movable chela with 1 tooth. Fixed chela with 4 preapical teeth. Spermadactyl straight beyond curved portion, subacute apically; oriented either at right angle to movable chela or retrograde in 2 chelae examined; a seta-like process extending ventrally in area of curve. Dorsally projecting portion of spermadactyl (measured from beyond base of setiform structure) about 5/8 length of movable chela; setiform structure slightly less than 1/2 dorsally projecting part of spermadactyl. *Measurements* (in μ, based on 9 specimens): Idiosomal L, 527–608 (562); dorsal plate L X W, 521–573 (540) X 316–339 (329); movable chelae, 68–77 (66).

DEUTONYMPH (FIG. 13–14). Dorsal plate (FIG. 13) straight to slightly rounded on anterior margin, j1 and z1 on anterior margin; plate without noticeable surface ornamentation; incised laterally behind z6; bearing typically 29 setal pairs, but sometimes with 1 or more pairs missing. Venter (FIG. 14) with 1 pair of small, wedge-shaped presternal plates widely separated on each side of tritosternal base; sternal plate with strong linear sculpturing with puncta along lines; arising posterior of sternal plate are 6 elongate platelets, 4 arranged in a transverse line and an additional pair of platelets just posterolaterad to this line. Pores P1–4 and metapodal plates present. Ventrianal plate with 1 pair of preanal setae. Interspaces of coxae II–III with numerous (ca 10–14) sclerotized circular bodies. Peritreme extending to interspaces of coxae I–II; peritremal plate not fused with dorsal plate anteriorly and not developed posterior to stigma. Legs and gnathosoma generally as in ♀. *Measurements* (in μ, based on 8 specimens): Idiosomal L, 521–562 (545); dorsal plate L x W, 421–468 (444) x 252–287 (263).

Holotype ♀, allotype ♂, 2 ♀♀, 3 ♂♂ and 1 dny paratypes, HAWAIIAN IS., Hawaii I., Mauna Loa, Volcanoes National Park, 2135 m, site #3, 29.I.1973, in litter, J. Jacobi. Remaining paratypes, same general locality, same collector, as follows: 2 ♀♀, 2135 m, site 3, 25.I.1972, in litter; 1 ♀, 1 dny, 2288–2318 m, site 2, 2.III.1972, litter; 3 ♂♂, 2135 m, site 3, 2.III.1972, litter; 2 dny, 2135 m, site 3, 10.IV.1972, litter and soil; 1 ♀, 2288–2318 m, site 2, 6.V.1972, litter; 2 dny, 2135 m, site 3, 6.V.1972, litter and soil; 1 ♀, 2135 m, site 3, 21.XI.1972, soil 0–3 cm deep; 1 dny, 2135 m, site 3, 12.II.1973, soil 0–3 cm; 9 ♀♀, 2 dny, 2135 m, site 3, 20.III.1973, litter; 2 ♀♀, 1 dny, same, soil 0–3 cm; 1 ♂, 2440 m, site 1, 29.III.1973, litter; 1♀, 2 ♂♂, 2135 m, site 3, 17.IV.1973, soil 0–3 cm (1 ♂) and 3–6 cm (1 ♂, 1 ♀); 1 dny, 2135 m, site 3, 20.IX.1973, litter.

Holotype (BISHOP 10,447), allotype, and 24 paratypes in Bishop Museum, Honolulu; 10 paratypes in Pacific Forest Research Center, Victoria, British Columbia; 4 paratypes in National Museum of Natural History, Washington, D. C.

Differential diagnosis: Petrova (1967) created the subgenus *Parholaspidellus* for 3 species of the genus *Parholaspulus* that have 4 pairs of preanal setae on the female ventrianal plate: *P. minutus* Petrova, 1967, *P. maturovae* Petrova, 1967 and *P. excentricus* Petrova, 1967. TABLE 1 summarizes some of the distinguishing characters of the 4 species which now comprise the subgenus. *P. maunaloaensis* is easily distinguished from *P. minutus* and *P. maturovae,* which are macrochelid-like species with 30 pairs of dorsal setae, pretarsus I without claw and ventrianal shield longer than broad. The new species is closest to *P. excentricus* (cf Petrova 1968) which also has 29 pairs of dorsal setae, but it differs from *P. excentricus* in having 4 transversely elongate platelets between genital and ventrianal plates, 14 presternal platelets, and longer dorsal setae, especially in the Z series.

P. maunaloaensis, n. sp. is named after Mauna Loa, the mountain on which it was collected.

Ecology: P. maunaloaensis was collected in berlesed soil and litter only at the 3 highest altitudes of Mauna Loa routinely sampled. Most specimens (38, or 91%) were taken at site #3 (2134 m, open subalpine scrub forest with scattered *Metrosideros, Styphelia, Coprosma, Vaccinium,* and *Dubautsia*) in either litter (27 specimens) or soil 0–6 cm in depth (all except 2 were taken in 0–3 cm soil). The remaining material was collected in litter at sites 1 (2454 m, tree line ecosystem, vegetation similar to site 3) and 2 (2286 m, subalpine scrub as in site 3). Except for 1 ♀ and 1 dny collected in September and November, all individuals were taken

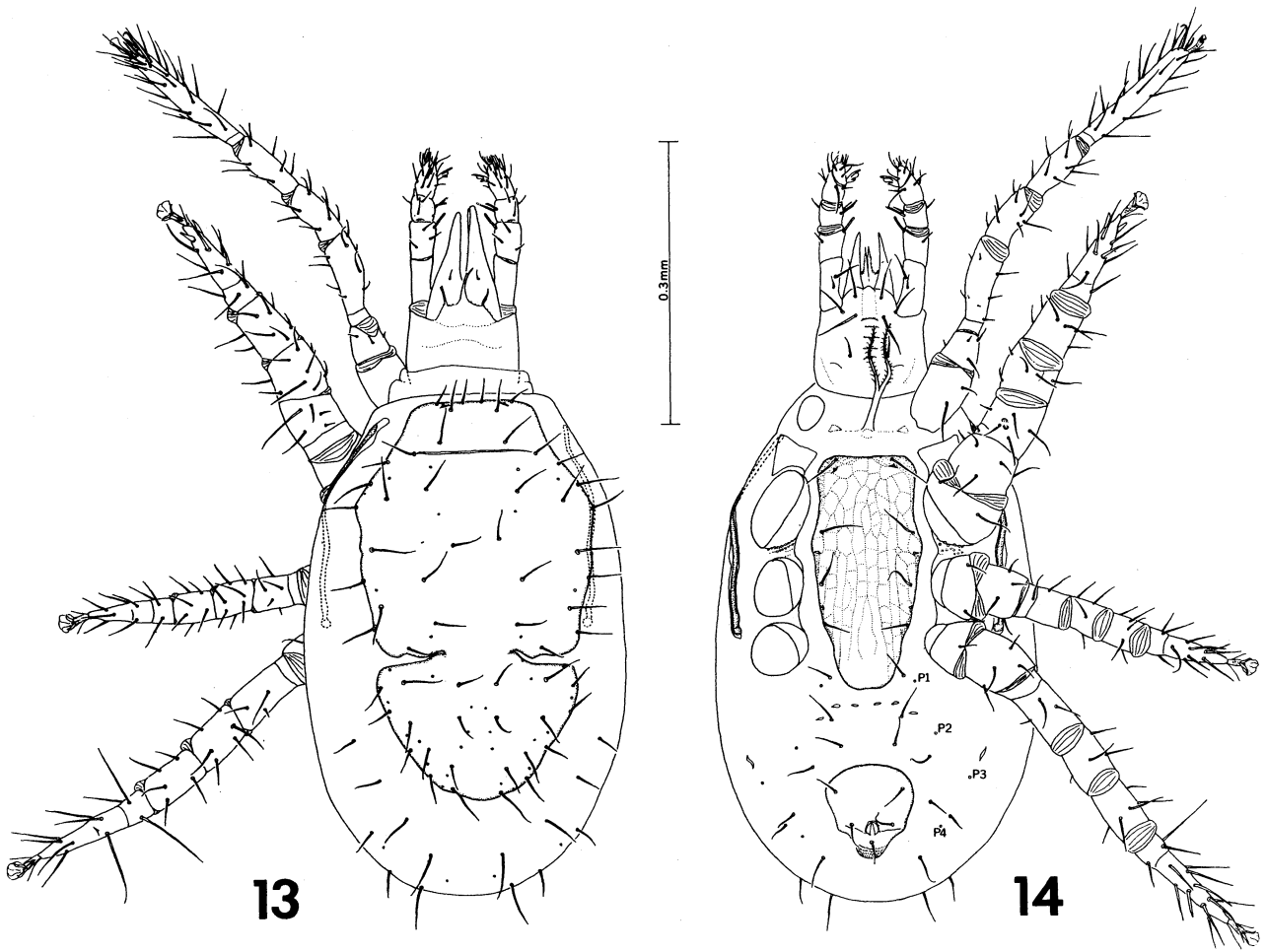


FIG. 13–14. *Parholaspulus (Parholaspidellus) maunaloaensis,* n. sp., deutonymph, (13) dorsum; (14) venter.

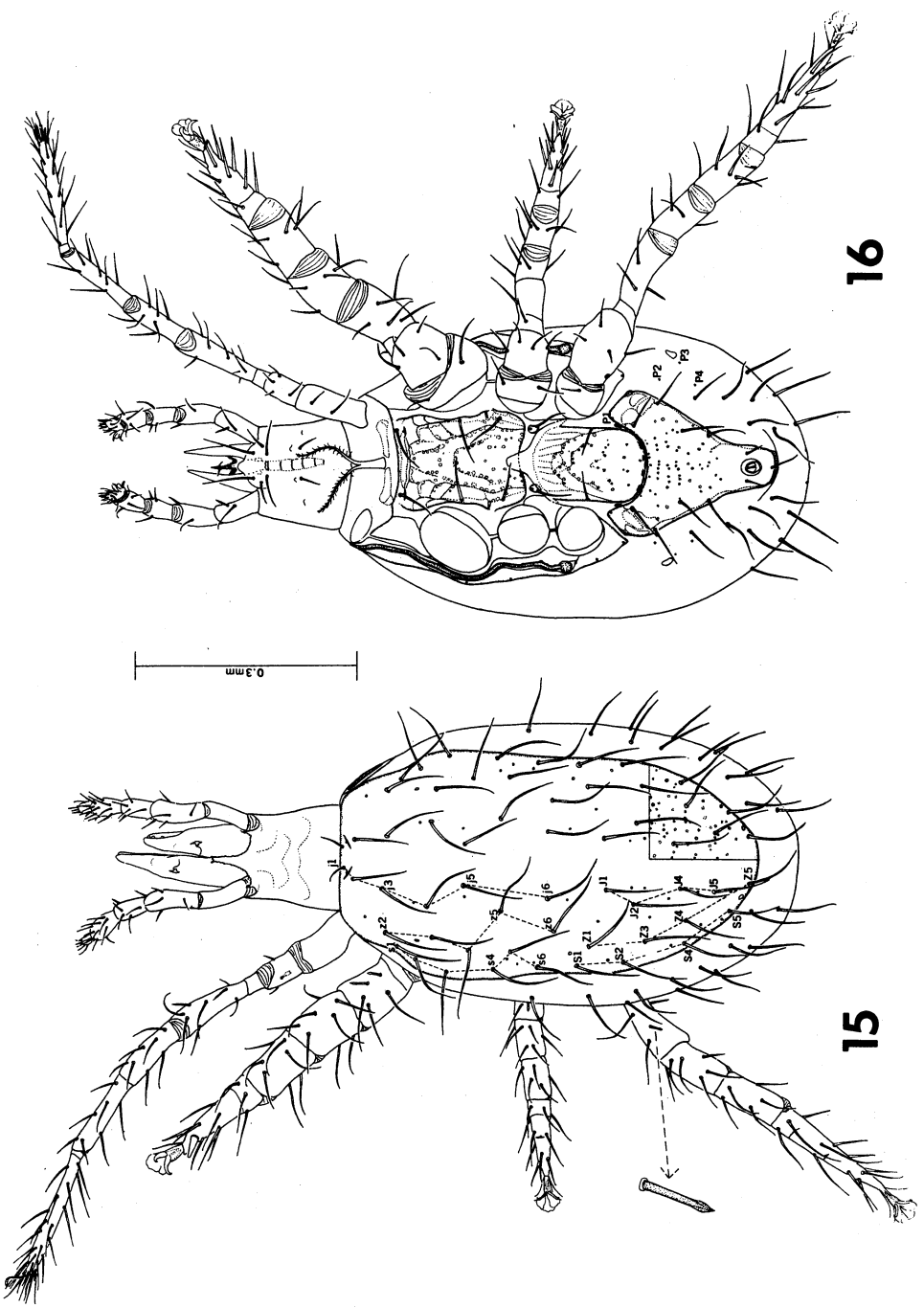


FIG. 15–16. *Gamasholaspis gamasoides*, ♀, (15) dorsum; (16) venter.

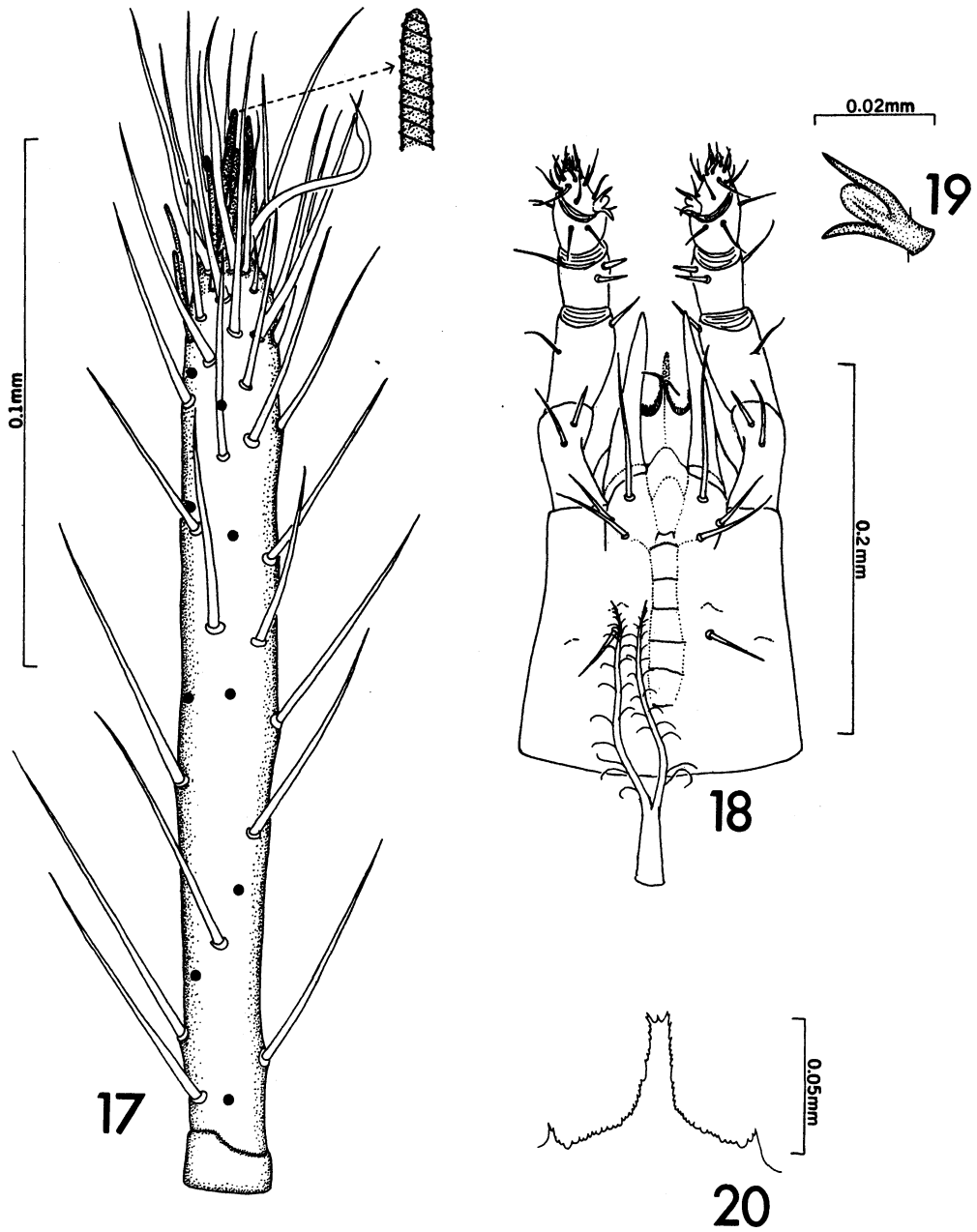


FIG. 17–20. *Gamasholaspis gamasoides*, ♀, (17) left tarsus I, dorsal view; (18) gnathosoma, ventral view; (19) palpal apotele; (20) tectum.

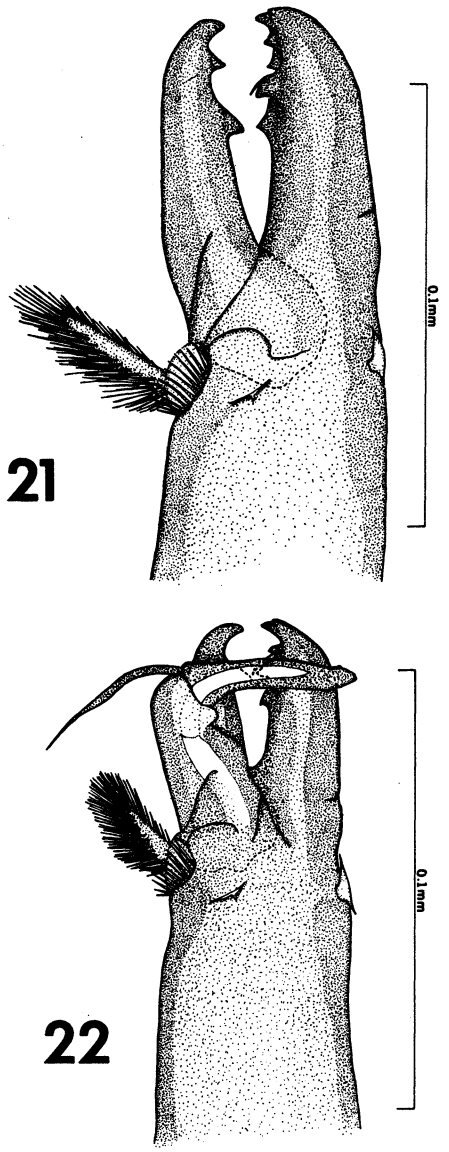


FIG. 21–22. *Gamasholaspis gamasoides*, ♀, (21) chelae, antiaxial; ♂, (22) chelae, antiaxial.

from January through May in both years. This species was not collected at the next site lower in elevation (2042 m), comprising an *Acacia koa* forest with *Sophora* and *Styphelia.*

P. maunaloaensis n. sp. appears to be a cold-adapted, xerophilic species found in litter and upper soil layers. Since it was not caught in pitfall traps during the 2-year study period, it is probably not active on the litter surface.

Gamasholaspis gamasoides (Berlese) FIG. 15–27, 42

Holostaspis (Gamasholaspis) gamasoides Berlese, 1904, Redia 1: 265. – Evans, 1956, Proc. Zool. Soc. Lond. 127: 367–68.

Diagnosis: Dorsal plate with 29 setal pairs, 17 podosomal, 12 opisthosomal; z1 absent. Presternal area with 1 pair of transversely elongate platelets. Genital plate linguiform, straight-sided; anal plate anterior margin deeply concave and fitting contours of posterior margin genital plate; ventrianal plate with 4 pairs of preanal setae. Tarsus I with sinuous dorsoapical seta enlarged distally; femora II, III and IV each with flanged dorsal setae. Fixed chela with 4 preapical teeth, movable chela with 2 teeth. Male femur II with large, blunt ventromedial spur and genu, tibia and tarsus II each with small ventral projection; ♂ fixed chela with 3 preapical teeth.

♀ (FIG. 15–21, 42). *Dorsum* (FIG. 15): Dorsal plate ovate, truncate on anterior margin, broadest in area of coxae II, slightly concave in region of coxae III–IV interspaces; surface with randomly scattered, sparse puncta more marked on posterior 1/2 of plate; with 29 setal pairs, 17 podosomal, 12 opisthosomal; z1 absent; j1 shortest seta on plate, remainder of setae long, subequal; opisthosoma apparently lacking J3, Z2 and S3. Unarmed dorsum with about 13 setal pairs. Pores and setae on dorsum distributed as in FIG. 15. *Venter* (FIG. 16, 42): Tritosternum with laciniae extending to level about midway between capitular and outer proximal hypostomal setae. Presternal area with 1 pair of transversely elongate platelets. Sternal plate extending to level opposite middle of coxae III, slightly concave to straight on anterior margin, posterior margin medially concave; surface with large puncta on disc and lateral lines forming reticulations, as in FIG. 16 and 42; St1 and St3 subequal. Metasternal plates irregularly round, bearing 3rd sternal pore and metasternal setae. Genital plate with lateral margins more or less parallel, posterior margin broadly rounded; genital flap abruptly narrowed at level of metasternal plates, narrowly rounded on anterior margin and extending slightly beyond posterior margin of sternal plate; surface of plate with scattered large puncta; with 1 pair of genital setae. Area between genital and ventrianal plates appearing to have several platelets, most of which lie under the posterior edge of the genital plate and are thus obscured by latter; most laterad platelet on each side is usually visible. Ventrianal plate deeply concave anteromedially, conforming to posterior margin of genital plate; flared out and away from genital plate anterolaterally; surface with scattered large puncta and with small distinct bump on anterolateral corner; with 4 pairs of subequal preanal setae; 1 pair of pores, P1, on anterolateral corner; P2, P3, P4 and P6 on unarmed venter; P5, present in deutonymph, not seen in ♀. Adanal setae placed at level opposite anterior margin of anal ring, 3/4 length of postanal seta. Unarmed venter with about 8 setal pairs and 3 pairs of pores. One pair of elongate metapodal plates. Peritreme extending to level of posterior margin of coxa I; peritremal plate fused posteriorly with elements of coxa IV, but free from other ventral plates; posterior extension reaching to about level of preanal setae I. *Legs:* Tarsus I, dorsal view, as in FIG. 17; with a conspicuous sinuous dorsoapical seta which is enlarged preapically; tarsus lacking apotele. Leg chaetotactic formula: I, 2:5:13:12:12:42(7); II, 2:5:11:11:10:18; III, 2:5:6:8:8:18:IV, 1:5:6:8:8:18. Tarsus I with 7 annulated sensory clubs (inset of FIG. 17) and shown in ( ) in the tarsal formula; tarsus II with Pl_1 heavily spinose. Femur I to IV each with 2 setae flanged distally (inset of FIG. 15): al_1 and ad_3 on femur I, ad_2 and ad_3 on femur II, pd and pl on femora III and IV. Trochanter I with conspicuous "pore" dorsolaterally associated with an internal dict and atrium. *Gnathosoma* (FIG. 18–21): Deutosternum with 5–6 rows of teeth. Hypostomal setae in order of increasing length; c.s. <hyp. 2 <hyp. 3 <hyp. 1, the last about as long as corniculi. Palpal chaetotaxy, 2:5:6:14:15; al_1 on palpal genu short and stout; palpal apotele as in FIG. 19. Fixed chela (FIG. 21) with 4 preapical teeth and 1 distal tooth which is slightly dorsad of apical hook; pilus dentilis fairly short, setiform; dorsal seta anvil-shaped. Movable chela (FIG. 21) with 2 teeth. Tectum with 2 short lateral and a longer median projection, median projection terminating in 2 lateral and a shorter median spine (FIG. 20). *Measurements* [ranges and means ( ) in μ, based on 8 specimens]: Idiosomal L, 766–908 (805); dorsal plate L X W, 597–708 (670) X 328–410 (368); sternal plate L (median), 175–196 (185); ventrianal plate L (to base postanal) x W (widest point) x W (level of preanal setae 4), 181–245 (215) x 207–257 (239) x 102–155 (135); j1, 35–41 (39); j5, 80–100 (90); Z5, 85–107 (98); St1, 59–73 (63); St3, 58–70 (64); 1st preanal setae, 48–67 (61); 3rd preanals, 57–65 (62); 4th preanals, 57–58 (63); adanals, 33–39 (37); postanal, 41–54 (47); movable chela, 81–90 (84).

♂ (FIG. 22–25). *Dorsum* (FIG. 23): Dorsal plate with 29 setal pairs similar in size and distribution to those of ♀. Unarmed dorsum with about 10 pairs of setae. *Venter* (FIG. 24): Genital opening on anterior margin of holoventral plate. Holoventral plate with distinctive large puncta and linear sculpturing in sternogenital region (with 5 setal pairs); ventral region with puncta associated with marked linear ornamentation, lines sometimes forming reticulate pattern laterally, sculpturing limited medially; anal area smooth; ventrianal region with 4 pairs of setae, plus adanals and postanal; pores P1–4 present. Peritreme extending to level from about middle to anterior margin of coxa I. *Legs* (FIG. 24–25): Leg chaetotactic formula as in ♀ except: femur and genu II with 10 setae, tibia II with 9 and tarsus II with 17. Femur II with a blunt ventromedial spur, and genu, tibia and tarsus II each with a small ventral projection, as shown in FIG. 25; anteroventral seta distad of spur on femur II tiny; tarsus II with Pl_1 setiform. Other setae as in ♀. *Gnathosoma:* Chelae as in FIG. 22. Fixed chela with only 3 preapical teeth. Dorsally projecting portion of spermadactyl (measured from beyond base of setiform structure) about 3/5 length of movable chela; setiform structure slightly longer than length of above-measured part of spermadactyl. Tectum with lateral projections relatively shorter than in ♀. *Measurements* (based on 8 specimens): Idiosomal L, 626–708 (672); dorsal plate L X W, 573–690 (627) X 339–380 (366).

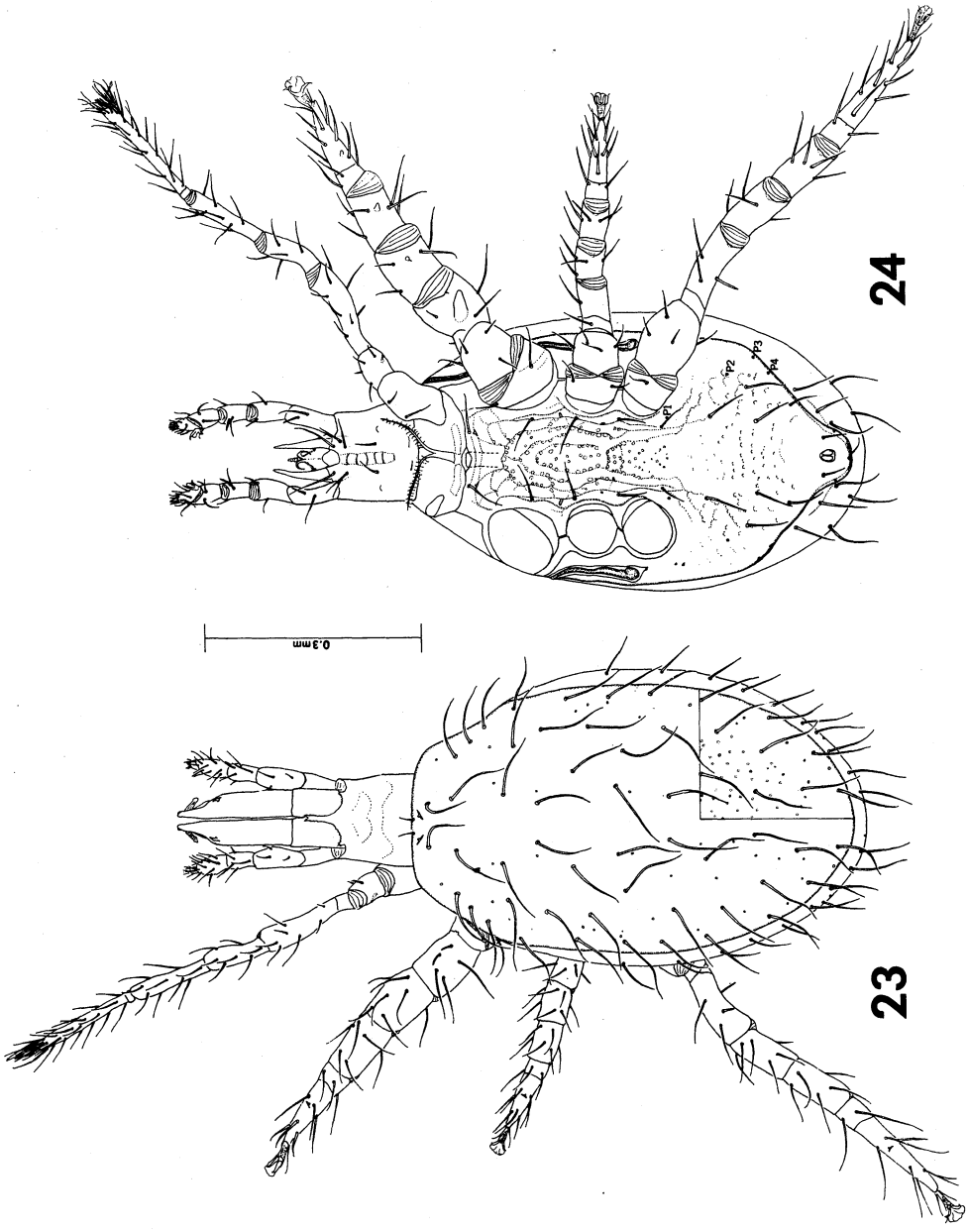


FIG. 23–24. *Gamasholaspis gamasoides*, ♂, (23) dorsum; (24) venter.

DEUTONYMPH (FIG. 26–27). Dorsal plate (FIG. 26) straight on anterior margin, with puncta and lines distinct on posterior 1/2 of plate; plate incised laterally behind z6; 29 setal pairs. Sternal plate with distinct puncta and lines. Integument posterior of sternal plate with 4 platelets in a transverse line and an additional platelet laterad of each posternal seta 2; 1 pair of round metapodals. Anal plate with only adanals and postanal seta, oval and without sculpturing pore. Pores P1–6 present. Peritreme extending almost to level of posterior margin of coxa I, plate poorly developed posterior to stigma and for only a short distance anteriad of termination of peritreme anteriorly, not fused with dorsal plate. Other features as in ♀. *Measurements* (based on 5 specimens): Idiosomal L, 515–632 (589); dorsal plate L X W, 474–567 (503) X 257–287 (264); sternal plate L X W 260–281 (271); anal plate L (to base postanal) X W, 70–79 (76) X 58–73 (64).

Material examined: 53 ♂♂, ♀♀, dny, HAWAIIAN IS., Hawaii I., E slope of Mauna Loa, 610–2044 m, 30.VII.1971–28.I.1974, berlesed soil and litter at sites 4–6, 8, 9, 11, 13A, 14, 15, 18, 20, J. Jacobi, F. J. Radovsky and others. 1 ♂, E. slope of Mauna Loa, 2134 m, 16.XII.1972, ex *Rattus rattus,* J. Jacobi & P. Q. Tomich; 1 ♀, ARGENTINA, Avellaneda Park, Tucumán City, 22.III.1953, vegetable debris, P. Wygodzynsky; 1 ♀, 1 ♂, UNITED KINGDOM, Royal Botanical Gardens, Kew, fern house, soil under *Diplazium esculentum,* A. H. G. Alston.

Known distribution: Argentina, Hawaiian Is, Italy, United Kingdom.

Ecology: Except for the higher altitudes, *G. gamasoides* is fairly widely distributed along the Mauna Loa transect; it was also found in the Kilauea Forest Reserve and lower elevations on Mauna Loa. It ranged in altitude from 610 to 2044 m. Specimens were taken in approximately equal numbers in litter, soil 0–3 cm and soil 3–6 cm deep; the species was rare in soil 6–9 cm deep and never collected in pitfall traps.

G. gamasoides was not found at the 3 highest berlese-pitfall sampling sites of subalpine scrub and tree line ecosystems (2134, 2286 and 2454 m). However, the species was recovered (1 specimen) from washings of a *Rattus rattus* captured at 2134 m in environs with similar vegetational components to the berlese sites. This may indicate that the species can survive at higher elevations in microniches, such as vertebrate nests or vertebrate bodies, where the mite is, to a certain degree, buffered from effects of an otherwise unfavorable clime.

Holaspulus tenuipes Berlese FIG. 28–40, 43

Holostaspis (Holaspulus) tenuipes Berlese, 1904, Redia **1**: 266.

Holaspulus tenuipes: Evans, 1956, Proc. Zool. Soc. Lond. **127**: 354.

Diagnosis: Dorsal plate with 30 setal pairs, 18 podosomal, 12 opisthosomal; all setae, except for tiny simple z1, expanded leaf-like; 1 pair of elongate presternal plates. Sternal plate very strongly reticulate and punctate. Female genital plate fused with ventrianal shield. Ventrianal fused with endopodal and peritremal plates; 4 pairs of subequal, preanal setae. Ventral plate with a pair of large prominent internal structures, 1 each in area behind coxae IV. Femur, genu, tibia and tarsus II–IV with long, flanged, sickle-shaped setae. Female fixed chela with 3 teeth; movable with 2 teeth; dorsal seta bent near midlength and abruptly attenuate. Male femur II with slightly curved spur medioventrally; genu, tibia and tarsus II each with ventral bump. Male fixed chela with 2 teeth, movable with 1 tooth; spermadactyl very long, slender and straight.

♀ (FIG. 28–30, 32, 34, 35, 37, 43). *Dorsum* (FIG. 28): Dorsal plate truncate on anterior margin, concave anterolaterally to level opposite s2, broadly rounded posteriorly; surface reticulated, particularly posterolaterally, median line on posterior 1/2 to 2/3 with tiny puncta; 30 pairs of setae, 18 podosomal, 12 opisthosomal; J1, Z2 and S3 apparently lacking; all setae expanded distally (inset of FIG. 28) except for the tiny, simple z1; setae of lateral series slightly longer than remainder, S2 longest on plate. Unarmed dorsum with 7 pairs of setae. Setae and pores distributed as in FIG. 28. *Venter* (FIG. 29, 43): Tritosternal laciniae not quite reaching to interspaces of inner and outer proximal hypostomal setae; tritosternum flanked on each side by an irregularly shaped, elongate presternal plate. Sternal plate about as long as wide (measured through shortest points), gently concave on anterior margin, deeply emarginate medially on posterior margin; fused with endopodal shields of coxae II; with 3 pairs of setae and 2 pairs of pores; St3 about 3/5 length of St1 and placed only a short distance posteriad of line of St2 and very close to median longitudinal line of plate; plate strongly reticulate and coarsely punctate. Metasternal setae and 3rd pair of pores on metasternal plate. Genital plate lateral margins arched inwards, plate fused posteriorly with ventrianal shield; genital flap extending into a sharp point on anteromedial margin, ending approximately at posteromedial margin of sternal plate. Ventrianal plate fused with genital, endopodal and peritremal plates; shield with 4 pairs of subequal preanal setae, as well as subequal adanals and postanal which are slightly longer than other plate

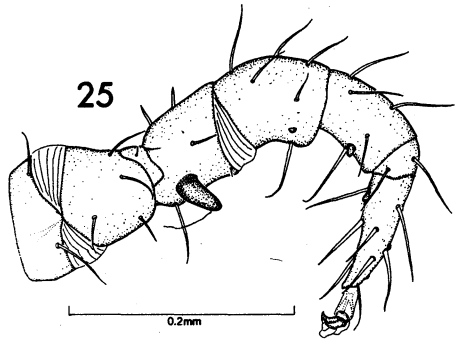
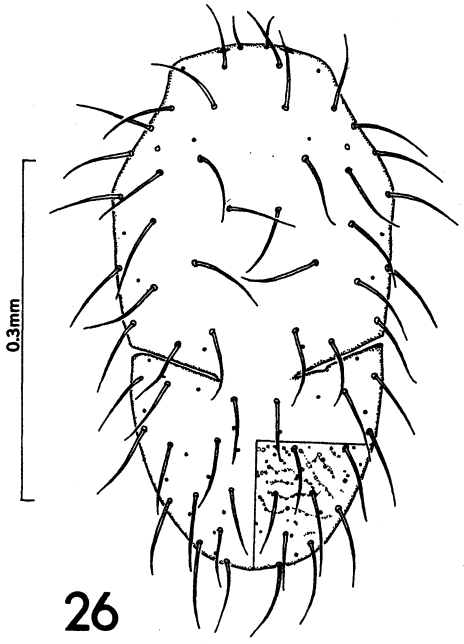


FIG. 25. *Gamasholaspis gamasoides*, ♂, leg II, anteroventral view.



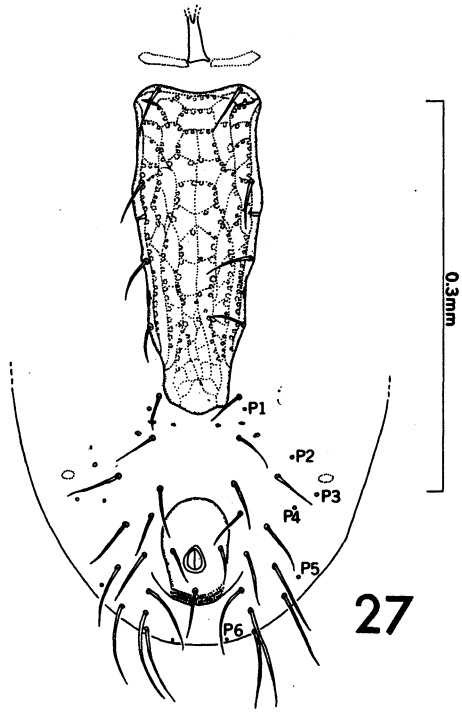


FIG. 26–27. *Gamasholaspis gamasoides*, deutonymph, (26) dorsum; (27) venter.

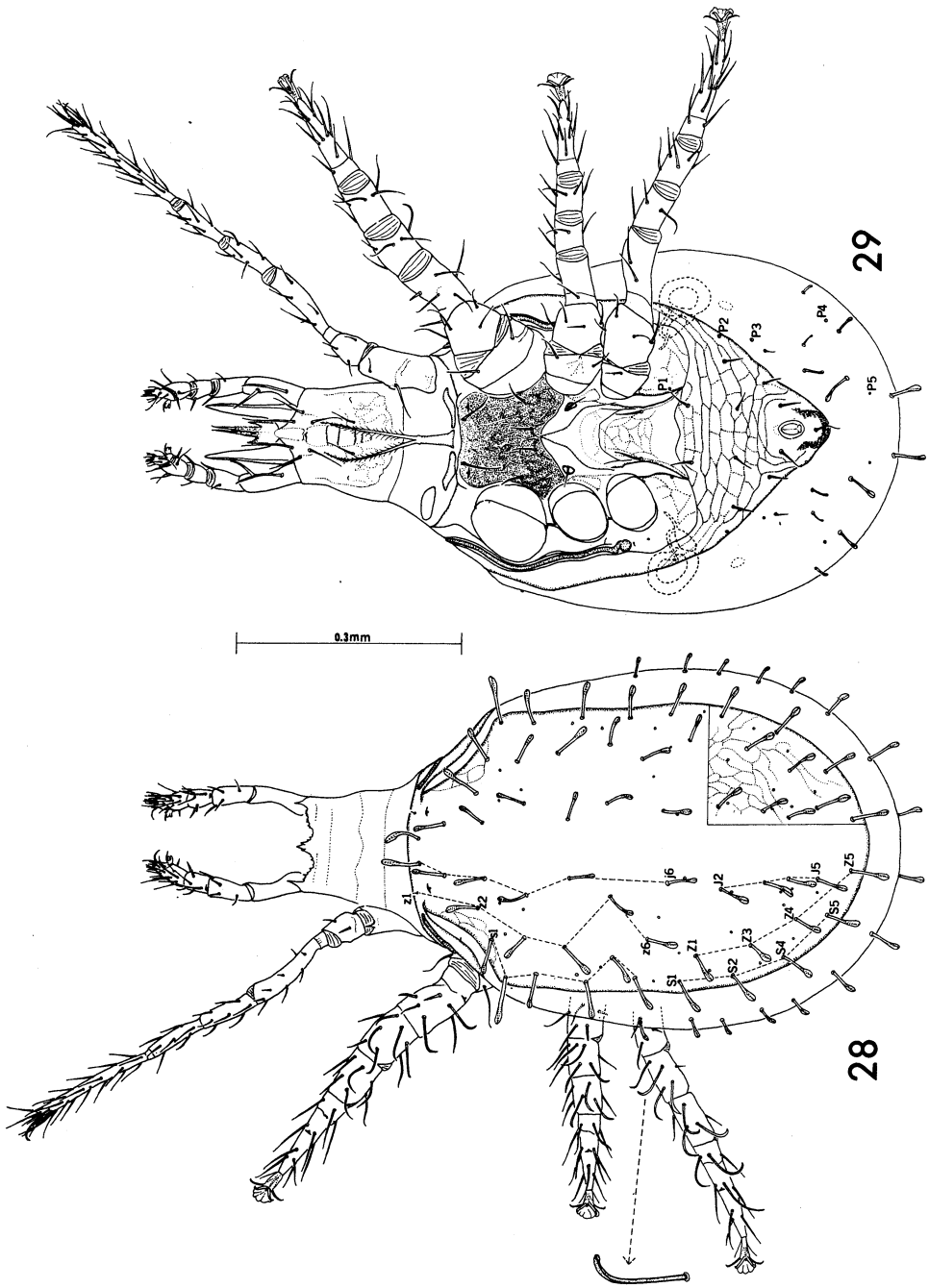


FIG. 28–29. *Holaspulus tenuipes*, ♀, (28) dorsum; (29) venter.

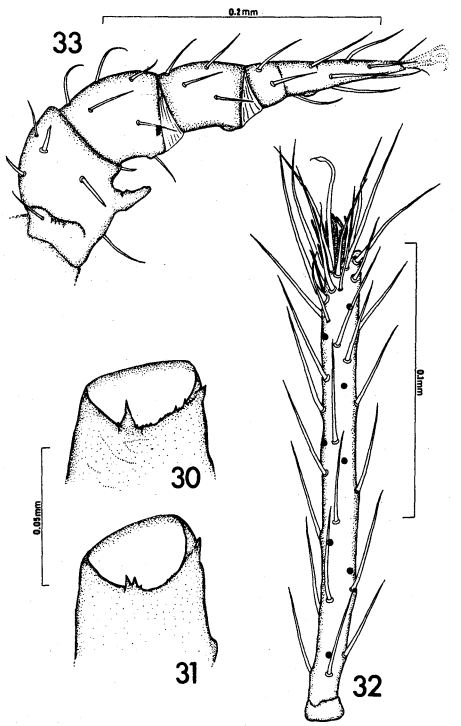


FIG. 30–33. *Holaspulus tenuipes*, ♀, (30) coxa I, ventral view; ♂, (31) coxa I, ventral view; ♀, (32) left tarsus I, dorsal view; ♂ (33) leg II, anterior view.

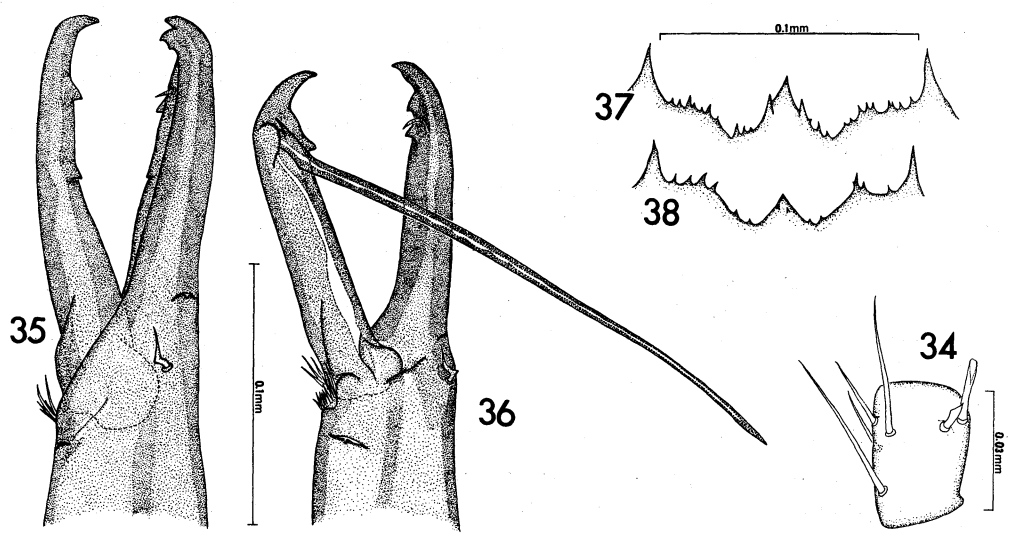


FIG. 34–38. *Holaspulus tenuipes*, ♀, (34) palpal genu, dorsal view; ♀, (35) chelae, oblique antiaxial; ♂, (36) chelae, antiaxial; ♀, (37) tectum; ♂, (38) tectum.

setae; ventral region with 5 pores: 1 pair of paragenital pores, and 1 or 2 pairs on ventrianal plate (P3 may be off plate); P4 and P5 in interscutal membrane. Ornamentation of ventral plates as in FIG. 29 and 43. Unarmed venter with 7 pairs of setae, anteriormost pair smallest and simple, other setae inflated, 2 most mediad pairs longest. Peritremal plate fused with ventrianal and exopodal plates and anteriorly with dorsal plate; peritreme ending at level opposite j1. A large, prominent internal structure lies posterolaterad of each coxa IV and opens into the ventral plate posterior of coxa IV [Evans (1956) termed these structures "expulsory vesicles"]. *Legs:* Leg chaetotactic formula as follow: I, 2:5:12:12:12:39[4](9); II, 2:5:11:10:10:18; III, 2:5:6:8:8:18: IV, 1:5:6:8:8:18. Coxa I often with prominent dorsal spurs (FIG. 30). Trochanter I with 5 (1 dorsal, 2 laterals, 2 ventrals) setae rather than the 6 found by Evans (1963) to be normal for most free-living gamasines; dorsal seta spine-like. Femur I with ad_4 minute. Tarsus I clawless, but with an apical membranous lobe which may represent remnant of tarsal apotele (FIG. 32); 1 long, curved capitate seta and 9 sensory setae apically. Femur, genu, tibia and tarsus II–IV with many long, sickle-shaped setae which are flanged on about the distal 1/2. Tarsi without spiniform setae. *Gnathosoma* (FIG. 34, 35, 37): Deutosternum with 6–7 rows of multiple, fine denticles. Capitular setae shorter than subequal inner (hyp. 3) and outer proximal hypostomal setae (hyp. 2); distal hypostomal (hyp. 1) almost 2 X length of hyp. 2. Palpal chaetotaxy, 2:5:6:14:15; genu with al_1 and al_2 modified as in FIG. 34. Epipharynx extremely slender, extending to posterior margin of genu. Corniculi extending to about level opposite middle of palpal genu. Chelicerae very broad and robust; movable chela with 2 teeth; fixed chela with 3 teeth, 1 of these preapical and larger than others; dorsal seta bent near midlength and abruptly attenuate (FIG. 35). Tectum (FIG. 37) with a medial and 2 lateral projections which may be single or multiple, margins between projections multispinate. *Measurements* [ranges and means ( ) in μ, based on 4 specimens]: Idiosomal L, 625–696 (669); dorsal plate L X W, 626–655 (639) X 386–404 (398); sternal plate L. (median), 109–117 (114); tarsus I L X W, 175–184 (180) X 15; j1, 48–58 (54); j5, 34–38 (37); z1, 7; Z5, 50–53 (52); s2, 66–67 (66); St1, 45–60 (55); St3, 26–37 (34); adanals, 35–39 (37); postanal, 37–39 (38); movable chela, 156–160 (159).

♂ (FIG. 31, 33, 36, 38–40). Dorsal plate covering entire dorsum, with 30 pairs of setae shaped and distributed as in ♀. (FIG. 39). *Venter* (FIG. 40): Holoventral plate covering much of venter, broadly rounded posteriorly, slightly concave on margin bordering anal region; sculpturing and setal distribution as in ♀, except St3 placed closer to lateral margins of plate; 1 pair of pores in genital region, 3 pairs in ventrianal region. Lacking internal structure ("expulsory vesicles") found in ventral opisthosoma of ♀. Legs generally as in ♀; coxa I with a few prominent dorsal spines (FIG. 31); femur II with strong, only slightly curved spur medioventrally; genu, tibia and tarsus II each with ventral bump (FIG. 33). Movable chela with 1 tooth; spermadactyl very long (not quite 2 X length of movable digit), slender and straight; fixed chela with 2 preapical teeth; (FIG. 36), tectum as in FIG. 38. *Measurements* [ranges and means ( ) in μ, based on 2 specimens]; Idiosomal L, 562–597 (580); dorsal plate L X W, 556–585 (571) X 392–421 (407).

DEUTONYMPH: Dorsal plate truncate on anterior margin; incised laterally behind s6 to j6; reticulate on posterior and punctate on anterior region. Thirty pairs of dorsal setae as in ♀. Venter with 1 pair of wedge-shaped presternal plates. Sternal plate entirely punctate with lateral lines; 3 pairs of setae on sternal shield; a pair of setae on unarmed cuticle flanking posterior edge of sternal shield. Anal shield with 2 adanals and 1 postanal seta. Four pairs of preanal setae in region occupied by ventral shield in adult. Peritreme not much developed posterior of stigmata, extending to interspace of coxae I and II and not fused with dorsal shield. Venter without "expulsory vesicles." Legs and gnathosoma generally as in ♀. *Measurements* (in μ) based on 2 specimens); Idiosoma L, 543–553; dorsal shield L X W, 446–457 X 315–320.

Material examined: 2 ♀♀, 2 ♂♂, 1 dny, HAWAIIAN IS., Hawaii I., Hawaii Volcanoes National Park, 1220 m, 27.XI.1972, Ref. #12, litter and soil 0–3 cm deep, J. Jacobi; 1 ♀, same data, 22.VIII.1972, Ref. #12, litter. 1 ♀, Hawaii I, on road behind Puu Haile, Hilo, 83 m, 22.I.1974, exotic open forest (*Trema* sp., *Pluchea odorata, Nephrolepis* sp.), J. Jacobi. 1 ♂, 1 ♀, Oahu I, Pupukea Heights, 28.XI.1964, berlese, W. J. Voss; 1 ♀, Oahu I, Mt Tantalus, 16.VII.1965, moss, D. M. Tsuda. 6 ♀♀, 4 ♂♂, 2 dny, UNITED KINGDOM, Aroid House, Royal Botanical Garden, Kew, 6.VII.1955, soil and organic matter under *Caryota mitis*, P. N. Lawrence.

Distribution: Europe; Hawaiian Is (Hawaii I., Oahu I.)

Ecology: Holaspulus tenuipes was previously reported from Oahu from guava litter by Garrett & Haramoto (1967). In Mauna Loa transect collections, it was taken only at site #12,

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[4] Two setae considered "ordinary" do not have obvious bases, but otherwise appear to be true setae.

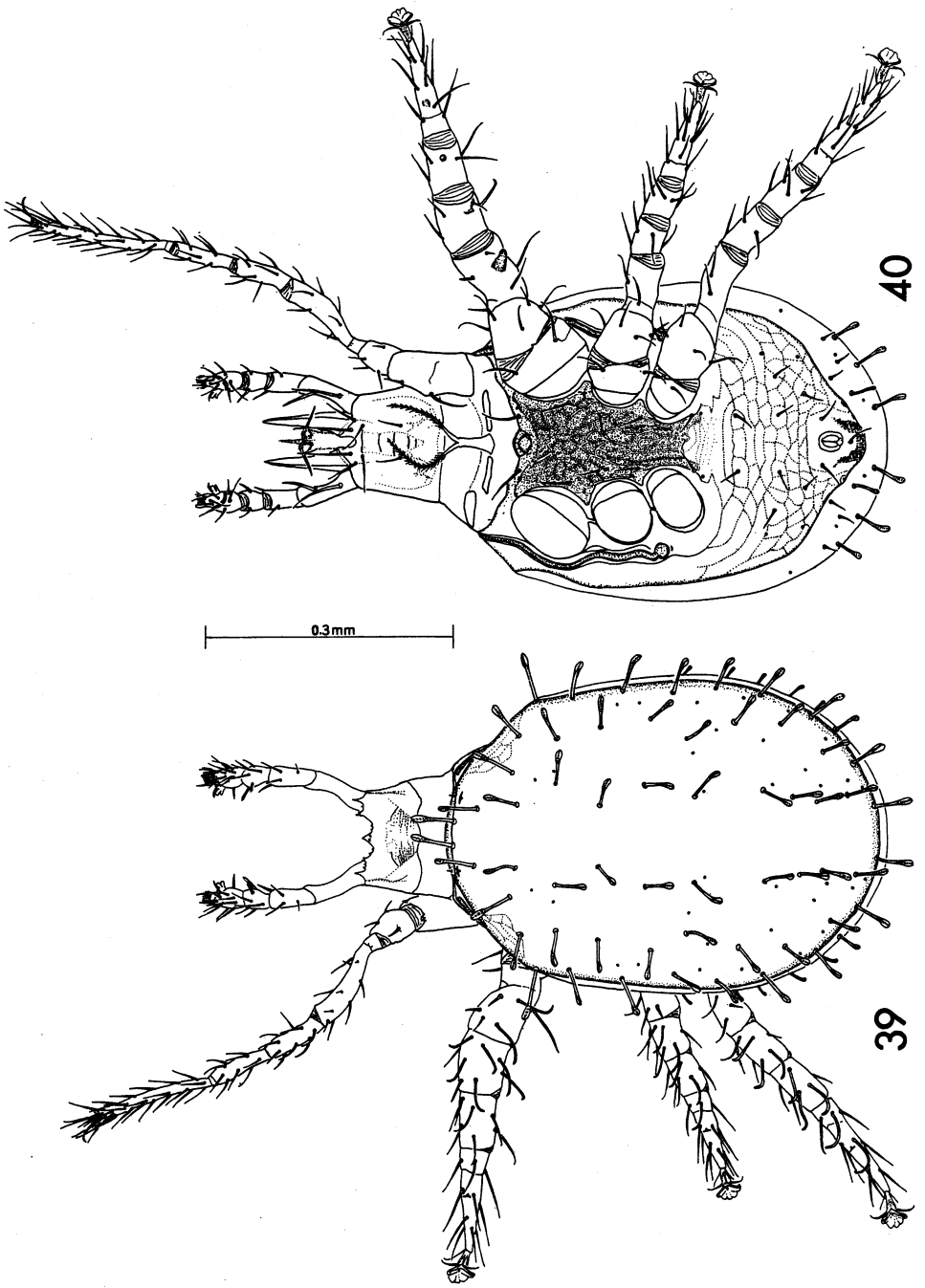

FIG. 39–40. *Holaspulus tenuipes*, ♂, (39) dorsum; (40) venter.

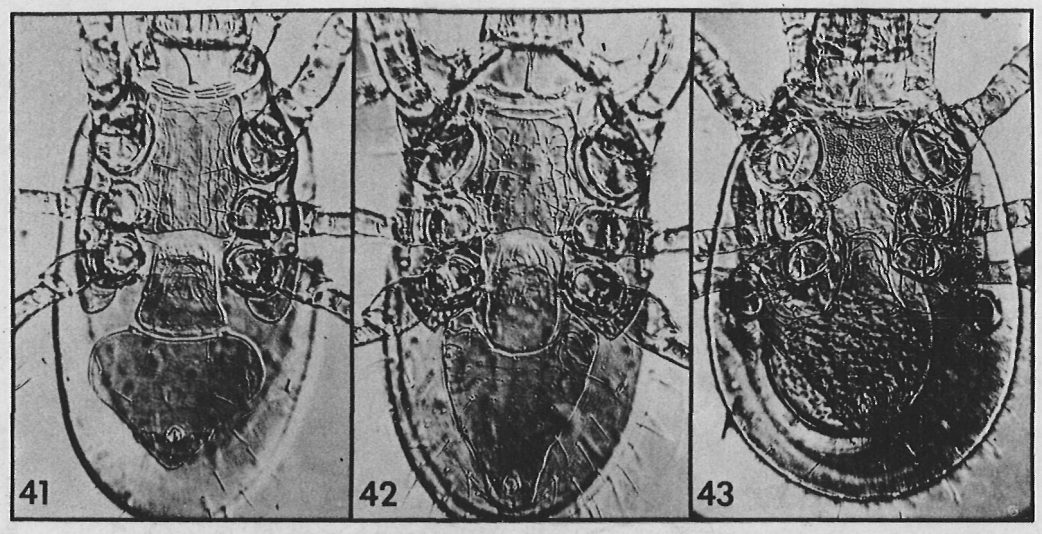

FIG. 41–43. ♀♀ venters. (41) *Parholaspulus (Parholaspidellus) maunaloaensis*, n. sp.; (42) *Gamasholaspis gamasoides;* (43) *Holaspulus tenuipes.*

1220 m (open *Metrosideros* and native shrub forest), in either litter or soil 0–3 cm deep; it was not collected in soil cores 3–6 or 6–9 cm deep, nor was it captured in pitfall traps at same site. Only 6 specimens were taken in 2 years of soil collections in Hawaii Volcanoes National Park. Since *H. tenuipes* has been found, though neither abundantly nor frequently, at higher and lower elevations on Hawaii, in both native and exotic forest habitats, and in several locations on Oahu, this species is probably fairly widely distributed in the Hawaiian Islands.

Acknowledgments: We thank Mr K. H. Hyatt, British Museum (Natural History), London, England, for lending us specimens of *Holaspulus tenuipes* and *Gamasholaspis gamasoides.* Mr David Kemble prepared the illustrations.

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