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HYPOASPIDINAE (ACARI: GAMASIDA: LAELAPIDAE) OF THE HAWAIIAN ISLANDS[1]

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Abstract. The current status of the *Hypoaspis* complex (Laelapidae: Hypoaspidinae) is summarized. The 12 hypoaspidine species known from the Hawaiian Islands are discussed in terms of known distribution, biotopes and available ecological information. Five species represent new records for the Hawaiian Is. New island records are presented for 5 others.

Seven species of the laelapid mite subfamily Hypoaspidinae have been reported previously from the Hawaiian Islands. These reports are scattered in the literature, additional species are now known, and some additional ecological information is available for many species. This paper serves to bring together what is currently known on the group in Hawaii.

I tackle this taxonomically muddled group with some trepidation. With the hope that it does not add to the existing confusion, brief background material follows in this introduction, with the objects of orienting the interested reader and summarizing the taxonomic state of the art in the *Hypoaspis* complex, viz., the species in and most closely related to *Hypoaspis* s. str.

The hypoaspidines belong to the family Laelapidae and appear to be the basic free-living stock from which other laelapids are derived (Evans 1955, Evans & Till 1966, Radovsky 1969). The subfamily embraces the most generalized of the dermanyssoids and contains a wide variety of biotypes that include free-living species found in litter, soil, mosses, and decaying organic materials; species associated with ants, bumble bees and beetles; and commensals in nests and on bodies of birds and mammals. Most species are probably predacious. While some groups (i.e., *Hypoaspis* s. str. and *Geolaelaps*) conform closely to the concept of the basic dermanyssoid type, the group as a whole shows wide diversity in external morphology. Because group limits are not easily or rigorously defined, the groups have been variously treated as full genera, as subgenera of *Hypoaspis* s. lat., and as species-groups (e.g., Costa 1966a, Hunter & Husband 1973 for *Pneumolaelaps*; Hunter 1967, Hunter & Costa 1971 for *Gymnolaelaps*; Hunter 1961 and Hunter & Glover 1968 for *Laelaspis*).

Evans & Till (1966) in their treatment of the British fauna declined to use subgeneric classifications, indicating that a stable classification of the *Hypoaspis* complex, based to that time largely on Palearctic forms, must await consideration of the extra-Palearctic species. However, they did present a key to the 9 subgenera represented

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in the British fauna: *Hypoaspis* s. str., *Alloparasitus, Stratiolaelaps, Cosmolaelaps, Pneumolaelaps, Gymnolaelaps, Holostaspis, Laelaspis,* and *Geolaelaps.* Costa (1968, 1974) agreed with Evans & Till and disregarded subgeneric divisions in treating the fauna of Israel.

Aswegen & Loots (1970) in their study of the Ethiopian fauna recognized 7 of the same subgenera keyed by Evans & Till; *Cosmolaelaps* and *Geolaelaps* were relegated to species-groups under the subgenus *Hypoaspis* s. str.

Barnard (1971), in a revised classification of the *Hypoaspis,* treated *Stratiolaelaps, Holostaspis, Laelaspis, Cosmolaelaps* and *Pneumolaelaps* as subgenera of *Hypoaspis,* while creating 2 new subgenera, *Hypoaspisella* and *Euryaspis.* He added to the existing confusion by merging *Gymnolaelaps* with *Hypoaspis* s. str. and *Hypoaspisella,* and including *Haemolaelaps* as a subgenus of *Hypoaspis.* While *Haemolaelaps* has close affinities to *Hypoaspis* and was once placed as a subgenus of *Hypoaspis,* most authors now treat *Haemolaelaps* and *Androlaelaps* as full genera within the Laelapinae or follow Till (1963) in accepting the synonymy of the former genus with the latter.

Karg (1971) presented keys and listings for the central European fauna of *Pseudoparasitus* and *Hypoaspis,* using a classification for the group that provided a foundation for his more recent reviews (1978, 1979) of the 2 taxa. Seven subgenera were included under *Hypoaspis* in addition to the nominate subgenus: *Hypohasta* (described as new), *Cosmolaelaps, Alloparasitus, Geolaelaps, Pneumolaelaps, Holostaspis* and *Laelaspis,* with the subgenera divided into species-groups. *Stratiolaelaps* was listed as a synonym of *Cosmolaelaps* (Karg 1971); *Gymnolaelaps* was considered a subgenus of *Pseudoparasitus.*

For his arrangement of the taxa, Karg utilized primarily what he considered to be synapomorphic characters without discernible functional significance: the form of the epistome ("Randfigur") and the development of the deutosternum. Based on the enlargement of the female genital plate, expanded exopodal shields of coxae IV and epistomal characters, *Gymnolaelaps* and *Ololaelaps* were placed as subgenera of *Pseudoparasitus. Ololaelaps* had previously been considered a distinct genus (Bregetova & Koroleva 1964, Ryke 1962, Evans & Till 1966).

Karg is to be commended for having taken on the monumental task of treating this large and complex group. Most species available to me worked out well in his subgeneric and species keys. However, there are problems with both the *Hypoaspis* and *Pseudoparasitus* treatments, aside from the judgments that might be made about Karg's classification scheme. While he has included many extra-Palearctic species (e.g., from Australasia and South America), most, but not all, species described from North America are inexplicably omitted (cf. Hunter & Husband 1973, Hunter & Davis 1962, Hunter 1961). Changes are made in established combinations without explanation; for example, *Gymnolaelaps shealsi* Hunter & Costa, 1971, a N American species associated with fire ants, is included in *Hypoaspis* (*Pneumolaelaps*). *Gymnolaelaps annectans* Womersley is treated under *Pseudoparasitus,* while *H. nidicorva* Evans & Till, its junior synonym, is listed under *Hypoaspis* (*Laelaspis*).

I conclude the above on the same note sounded by many previous workers in the last decade or so: that there is as yet no acceptable, widely applicable classification for the *Hypoaspis* complex. A reasonable approach to a solution, however, would seem to lie not only in a systematic revision on a world basis, a need expressed many times in the past, but also in a strong emphasis on bioecology. Hunter & Costa (1971) and Hunter & Husband (1973) argued that minimal consideration has been given to ecological and host associations in considering supraspecies groupings in the complex, and that these, taken together with morphological information, justify generic ranking for certain groups; they made the case in the above-cited papers for generic treatment of the myrmecophilous *Gymnolaelaps* and the bumble-bee–associated *Pneumolaelaps. Coleolaelaps,* often confused in the literature with *Hypoaspis*-related species, was definitively separated from these species by Costa & Hunter (1970) by a combination of morphology and host relationships. While *Hypoaspis*-complex species may be found on a variety of dynastine scarabs and other beetles, *Coleolaelaps* species appear to be obligate associates of melolonthine scarabs; they have been collected only beneath the elytra of *Anoxia* and *Polyphylla.* In keeping with the concept of biomorphological groups, Evans & Till (1979) modified their previous (1966) broad treatment of *Hypoaspis,* according the groups full generic status in their key to the fauna of Britain and Ireland.

For convenience and for consistency in this paper, I follow Karg (1978, 1979) in the supraspecies designations for the species discussed below. Where Karg's treatment departs significantly from previous authorities, these are cited. No attempt is made to present a complete history of names for each species.

Twelve species are discussed herein. Seven of these have been reported previously from the Hawaiian Is; 5 represent new records for the Islands. New interisland distribution records are also given. With 1 possible exception, all species are known elsewhere, i.e., none is endemic.

Some species were recorded earlier by Radovsky et al. (1979) and Radovsky & Tenorio (1981a, b) from collections taken during a 2-year study (1971–73) on the southeastern slope of Mauna Loa, Hawaii I. These derived from 2 projects, both part of the U.S. International Biological Program, conducted concurrently along an altitudinal transect (840–2440 m) covering a wide range of vegetational and edaphic types. Additional species are reported here from these studies and some additional ecological information is provided for some species reported previously. These projects are briefly described below. For further details on sampling methods, Radovsky & Tenorio (1981a, 1981b) and Radovsky et al. (1979) may be consulted.

The Soil Arthropod Project involved 2 different sampling methods applied at each of the sampling sites concurrently: pitfall traps and berlese extraction. During the first year, 12 sites were sampled on the transect and 2 sites in the wetter Kilauea rain forest outside the transect (1645 m). During the second year, several sites were relocated. During the first year of berlese sampling, a circular area encompassing 0.05

m^2 of litter was demarcated and all litter within the circle was taken as a sample; the underlying soil to an amount equal to 0.5 litre was dug up as the 2nd sample. During the 2nd year, the sampling method was modified to include soil cores separable into 3 depths: 0–3 cm, 3–6 cm and 6–9 cm. Pitfall traps were operated in the same general locations as berlese sampling sites for 2 years, with some relocation corresponding to changes in berlese sites. The effective perimeter of each pitfall trap at ground level was 1 m.

The Rodent-Ectoparasite Project involved rodent trapping on or close to the main Mauna Loa transect and recovery of ectoparasites from *Mus musculus, Rattus exulans* and *R. rattus* by standardized washing techniques. Techniques and primary analyses of parasitological data are covered in the above references.

Samples of all species, except where noted, were sent to Dr M. Costa for identification or confirmation.

Hypoaspis (Geolaelaps) aculeifer (Canestrini) Fig. 1

Laelaps aculeifer Canestrini, 1884, Atti Ist. Veneto (6) **2:** 698.

H. aculeifer is common in many parts of the world in soil and litter, stored food products, and nests of birds and rodents (e.g., Bregetova 1956; Hughes 1961, 1976; Evans & Till 1966; Karg 1961; Costa & Nevo 1969; Sinha 1968). It has been frequently taken in caves in Europe (Cooreman 1959). This species is predacious on other mites, Collembola, insect larvae, and nematodes (Karg 1961). Kevan & Sharma (1964) studied the biology of *H. aculeifer* in the laboratory with specimens from Quebec, rearing them on the collembolan *Isotoma notabilis* and the acarid mite *Tyrophagus putrescentiae*; the latter was preferred as food. The authors indicated that the species was never observed to feed on detritus; in the absence of living prey, *H. aculeifer* apparently starves to death.

This species was reported as new to the Hawaiian Is by Radovsky & Tenorio (1981a) from specimens from Mauna Loa, Hawaii I. Of approximately 112 specimens taken during their 2-year study, most were from 2 sites, at 1220 m and 1585 m, in savannah and mountain parkland, respectively. One specimen was taken as high as 1890 m in subalpine scrub forest. Specimens were collected essentially year-round in litter and soil 0–6 cm deep. About 18% of the total individuals were taken in pitfall traps, as opposed to material being berlesed from litter and soil.

A few specimens not part of the Mauna Loa study are reported below. The Pearl & Hermes Atoll females are probably *aculeifer,* but a few morphological differences from typical *aculeifer* are worth note: Z5 is shorter and thicker, anterior marginals on the dorsal plate are shorter relative to remainder of setae, and paragenital platelets are somewhat different in shape from other *aculeifer* females on hand.

Specimens examined (in addition to Mauna Loa collections noted above). HAWAII I: Mauna Kea, Kipuka Puahuluhulu, 15–22.I.1974, 1890 m, pitfall #392, 1♀. PEARL & HERMES ATOLL: North I, 14.XII.1970, ex *Eragrostis* and sand (J.L. Gressitt) 6♀.

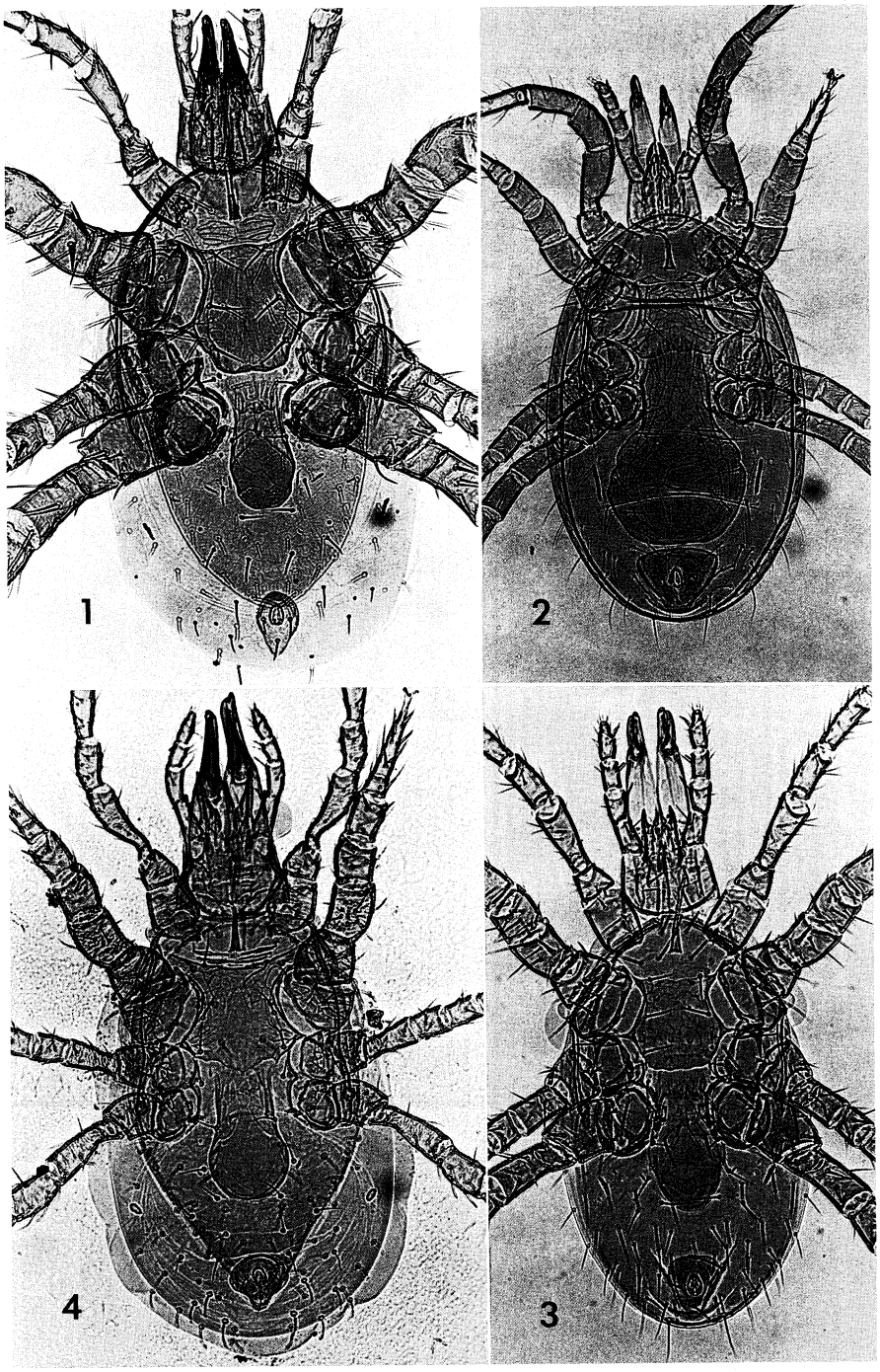

FIG. 1–4. *Hypoaspis* spp., ♀: **1,** *H. aculeifer*; **2,** *H. austriaca*; **3,** *H.* sp. nr *glabrosimilis*; **4,** *H. miles,* variant from Oahu duff. 34×.

Distribution. Hawaiian Is (Hawaii, Pearl & Hermes), Europe, USSR, N America, Israel, Japan. Probably cosmopolitan.

Hypoaspis (Laelaspis) austriaca (Sellnick) Fig. 2

Laelaspis austriacus Sellnick, 1935, Zool. Jahrb. Syst. **66:** 351.

H. austriaca has been found previously in moss, lichens, litter, decaying wood, on various plants shipped into the U.S. from abroad, and from *Sorex longirostris longirostris* in Virginia, USA (Willmann 1951, Hunter 1966). Solomon (1969) reported it from *Apodemus flavicollis* in Austria.

Hunter (1961), after studying specimens of this species and finding several characters not typical of *Laelaspis* but common to *Gymnolaelaps,* transferred it to *Gymnolaelaps.* Hunter (1966) redescribed and illustrated *austriaca* and placed it in the genus *Pseudoparasitus.*

This is a new record for the Hawaiian Is, as well as a new host association.

Specimens examined. HAWAII I: Hawaii Volcanoes National Park, Mauna Loa Strip Rd, 27.X.1972, 2895 m, M674, ex ♂ *Mus musculus,* 1♀.

Distribution. Hawaiian Is (Hawaii), Europe, N America.

Hypoaspis (Geolaelaps) nr **glabrosimilis** Hirschmann Fig. 3

Hypoaspis glabrosimilis Hirschmann, 1969, Acarologie **12:** 134.

Specimens of this species, new to Hawaii, were examined by Dr Michael Costa, who could not place them definitively to species. It keys to *glabrosimilis* Hirschmann (Europe; from ants, *Lasius fuliginosus*) in Karg (1979), and seems very similar to that species and to *Hypoaspis glaber* (Trägårdh) (Tahiti). However, it differs from these species in having ornamentation on the dorsal and sternal shields, 2 rather than 3 unpaired setae in the J series, and a broadly rounded rather than pointed epistome. Comparison material of *glabrosimilis* and *glaber* is not available to me and this may well be an undescribed species.

All specimens collected were taken off *Rattus* spp. All specimens from Hawaii I were from the Kilauea Forest Reserve, a closed primary montane rain forest at 1645 m elevation. None was recovered from other areas sampled on Mauna Loa, either from rodents or from pitfall or berlese samples. Specimens from Maui I were from native rain forest in Waihoi Valley. This species may be adapted to wetter habitats.

Specimens examined. HAWAII I: Hawaii Volcanoes National Park, Kilauea Forest Reserve, 1645 m, ex *Rattus rattus* (11♂♀), 24.IX.1971–24.III.1973 (11 collections), 14♀. MAUI I: Waihoi Val, 610 m, 13–16.VI.1972, ex *Rattus exulans,* 3♀; same data, except *R. rattus,* 2♀.

Hypoaspis (Cosmolaelaps) miles (Berlese) Fig. 4

Laelaps (Iphis) miles Berlese, 1892, Acari, Myriopoda Scorpiones Ital. **63**(9).
Cosmolaelaps gurabensis Fox, 1946, J. Parasitol. **32:** 449.—Syn. by Evans & Till, 1966, Bull. Br. Mus. Nat. Hist. **14**(5): 222.

This species was first reported in Hawaii under the name *Stratiolaelaps gurabensis* (Fox) by Mitchell (1964) from Oahu *Rattus rattus* and subsequently under the same name by Garrett & Haramoto (1967) from a *Rattus* nest on Hawaii I and treehole debris on Oahu. Specimens on which these reports were based are in Bishop Museum. In examining this material, I have found that some specimens previously published and others identified as *H. miles* (=*S. gurabensis*) are actually *H. scimita* (Womersley) (see discussion under latter species); both species were sometimes represented in the same series. All material in the Bishop collection that I determine to be *H. miles* is listed below. Two females from Oahu duff fit all characteristics of *miles* except that the dorsal plate is abruptly tapered posteriorly, giving it a pronounced triangular shape (Fig. 4). These were sent to Dr M. Costa for examination and he confirmed them to be *H. miles*.

Hypoaspis miles has been widely recorded in the literature from a variety of rodents and their nests and from stored food products.

Collections from Kure I represent new records.

Specimens examined. HAWAII I: Hamakua Distr, 9.I.1964, pooled from several [rodent?] nests (T. Saguicio) 3♀. OAHU I: Manoa Val, 12.V.1962, *R. rattus* ♀ (C. Mitchell) 2♀ (reported by Mitchell 1964); Ala Wai Canal, mauka bank, 21.II.1972 (F.J. Radovsky) duff under trees 3 m from canal retaining wall, 2♀. KURE I: 1.IX.1976, 21.IV.1978, ex *R. exulans* (D. Grady) 5♀.

Distribution. Hawaiian Is (Hawaii, Oahu, Kure). Many records worldwide; probably cosmopolitan.

Hypoaspis (Geolaelaps) queenslandica (Womersley) Fig. 5

Androlaelaps queenslandicus Womersley, 1956, J. Linn. Soc. **42:** 577.
Hypoaspis queenslandicus (Womersley): Costa, 1966, Israel J. Zool. **15:** 141–47.

Elsewhere in the world, this species has been reported in leaf debris (Womersley 1956); soil, litter, and donkey manure (Costa 1966b); and pineapple field cores (Ryke 1963).

H. queenslandica was first recorded in Hawaii by Goff et al. (1979) from soil and vegetation samples from fumeroles (steam vents) on Hawaii I. Specimens were taken in areas of the vent where temperatures were 32 °C and 39 °C. An additional 11 specimens not reported were taken from a 2nd steam vent in the same area at temperatures ranging from 25–39 °C.

Radovsky & Tenorio (1981a) recorded this species from berlesed soil and litter from the Mauna Loa transect, where it was found to be restricted to a relatively narrow zone at lower elevations (1220–1340) of the transect in savannah. It was not taken in pitfall traps.

Specimens listed below from Pearl & Hermes Atoll and Midway Is represent new island records.

Specimens examined. HAWAII I: Hawaii Volcanoes National Park, fumerole vent II, site 49, 32 °C, 26.V.1971, 1♂,1♀; site 86, 39 °C, 1♀; site 38, at surface, 25 °C, 15.VIII.1975, 3♀, 4DN,1PN. PEARL & HERMES

FIG. 5–8. ♀: **5,** *Hypoaspis queenslandica*; **6,** *Hypoaspis sardoa*; **7,** *Hypoaspis scimita*; **8,** *Pseudoparasitus trincisus*. 34×.

ATOLL: Southeast I, 15.XII.1970, under frigate bird nest (J.L. Gressitt) 2♀. MIDWAY IS: Sand I, by runway, berlesed from occupied nest of Gooney Bird (*Diomedea immutabilis*), 22.III.1971 (M.L. Goff) 2♀,1♂.

Distribution. Hawaiian Is (Hawaii, Pearl & Hermes, Midway), Australia, S Africa, Israel.

Hypoaspis (Alloparasitus) sardoa (Berlese) Fig. 6

Laelaps (Androlaelaps) sardous Berlese, 1911, Redia **7:** 433.

This species has been reported from Europe and the USSR in litter, sweepings from warehouse floors, and in nests and, rarely, on bodies of rodents (e.g., Bregetova 1956; Evans & Till 1966; Hughes 1961, 1976). Costa & Nevo (1969) found it in nests of *Spalax ehrenbergi* in Israel on Mt Hermon, where mean annual temperatures range from 10–20 °C.

H. sardoa was first reported from the Hawaiian Is by Radovsky et al. (1979) off *Rattus rattus, R. exulans* and, rarely, *Mus musculus* on Mauna Loa, Hawaii I. Radovsky & Tenorio (1981b) discussed the distribution of *H. sardoa* on the Mauna Loa transect. The species ranged on *R. rattus* from closed rain forest at 1200 m to the subalpine scrub forest at 2135 m; it became increasingly abundant at higher altitudes. At lower elevation sites (840–900 m) it was nearly absent. From these results, it was suggested that *H. sardoa,* which has been found primarily in temperate climates in the Palearctic, cannot maintain itself in warmer, lower elevation habitats in Hawaii. It has not been collected elsewhere in Hawaii than Mauna Loa.

H. sardoa is apparently a vertebrate associate. It has not been collected in Hawaii from soil or litter or in pitfall traps.

Distribution. Hawaiian Is (Hawaii), Europe, USSR, Israel.

Hypoaspis (Cosmolaelaps) scimita (Womersley) Fig. 7

Cosmolaelaps scimitus Womersley, 1956, J. Linn. Soc. Zool. **42**(288): 580.

The type series of this species was described from Sansapore, "Dutch New Guinea" (Irian Jaya), ex *Rattus concolor*; Womersley also had 2 specimens before him from Brisbane, Australia, ex *R. norvegicus.*

Domrow (1974) synonymized *C. scimita* with *Hypoaspis miles* on the basis of specimens from Australia and New Guinea.. The Hawaiian material reported here as *scimita* was identified by Dr M. Costa and specimens were also sent to Dr D.C. Lee, The South Australian Museum, Adelaide, who determined them to be conspecific with the holotype of *scimita.* Based on Hawaiian material of *scimita* and on material of *miles* from Hawaii and elsewhere, I would consider these closely related but distinct species, which differ markedly in the length and form of dorsal plate setae and some leg setae and in the ornamentation of the dorsal plate.

Karg (1981) recently revised the subgenus *Cosmolaelaps* and formed 3 species-groups on the basis of the shape of the dorsal setae. I find his assignment of *miles* and *scimita*

to these groups totally confusing. Surely, if one is to follow Karg's definition of the species-groups, *miles* with its strongly leaf-shaped dorsal setae belongs in the *cuneifer*-group rather than the *claviger*-group where Karg has included it, and *scimita* with its much longer, less expanded, lanceolate setae deserves assignment to the *claviger*-group rather than the *cuneifer*-group. In any case, if one considers the similarities between *miles* and *scimita,* such as the nearly identical ventral plates and the unusually long corniculae and large, robust chelicerae, those features attest to a closer relationship of the 2 species than is accorded them by Karg.

H. scimita represents a new record for the Hawaiian Is. It has been taken from at or near sea level on the Northwestern Hawaiian Is to 1645 m on Mauna Loa on Hawaii I. It appears to be associated primarily with *Rattus* species and their nests, though several specimens have been taken from litter samples. On the Mauna Loa transect, it occurs in both relatively wet and dry sites ranging from 870 m–1495 m primarily in open forest and grassland; a few specimens were collected in the wetter closed primary montane forest of the Kilauea Forest Reserve (1645 m).

Specimens examined. HAWAII I: Hawaii Volcanoes National Park (HVNP), Kilauea Forest Reserve, 1645 m, ex *Rattus rattus:* K101, 23.IX.1971, 1 ♀; K670, 27.X.1972, 2 ♀; K1053, 24.III.1973, 1 ♀. HVNP, Mauna Loa transect, ex *R. rattus:* M460, 23.VI.1972, 900 m, 1 ♀; M824, 16.XII.1972, 870 m, 4 ♀; M804, 15.XII.1972, 870 m, 1 ♀; M979, 23.III.1973, 870 m, 2 ♀; same locality, ex *Rattus exulans:* M208, 18.XII.1971, 900 m, 1 ♀; M278, 23.I.1972, 1495 m, 1 ♀; M634, 23.IX.1972, 900 m, 1 ♀; M639, 24.IX.1972, 870 m, 2 ♀; M1423, 23.IX.1973, 870 m, 1 ♀; same locality, litter in open *Metrosideros*-lichen forest, 1220 m, 27.XI.1972 (J. Jacobi) 2 ♀. Paauilo, 3.II.1964, ex rat nests, 3 ♀. Hamakua Distr, 9.I.1964, pooled from several nests, 1 ♀. MAUI I: Waihoi Val, 610 m, 13–14.VI.1972, ex *R. exulans* (P. Conant) 2 ♀. KURE I: ±2.5 m, 1.IX.1976, ex *R. exulans* (D. Grady) 1 ♀. MIDWAY ATOLL: Sand I, 13.V.1973, *Coccoloba* leaf litter (W.C. Gagné) 9 ♀.

Distribution. Hawaiian Is (Hawaii, Maui, Kure, Midway), Australia, New Guinea.

Pseudoparasitus (Gymnolaelaps) annectans (Womersley) Fig. 9

Gymnolaelaps annectans Womersley, 1955, Aust. J. Zool. **3:** 419.
Hypoaspis nidicorva Evans & Till, 1966, Bull. Br. Mus. Nat. Hist. **14:** 179.—Syn. by Domrow, 1973, Proc. Linn. Soc. N.S.W. **98**(2): 63.

This species was first reported in Hawaii as *Hypoaspis nidicorva* (Radovsky & Tenorio 1974) and since then under that name in several reports on Hawaiian material (Radovsky et al. 1979, Tenorio & Goff 1980, Radovsky & Tenorio 1981b). Since these reports, I have discovered the synonymy of *H. nidicorva* and *G. annectans* by Domrow (1973). At my request, Mr Domrow has kindly compared Hawaiian specimens sent him with Womersley's paratypes and other Australian specimens and found them to be conspecific. According to Domrow (in litt.), Australian specimens agree in all details with the illustrations and descriptions of Evans & Till's (1966) *H. nidicorva* and, while a direct comparison of types of the 2 species has not been made, I see no reason to dispute this synonymy.

Pseudoparasitus annectans has been found associated with both birds (Short-tailed Shearwater, Fairy Penguins) and mammals (rodents, lagomorphs, marsupials) and

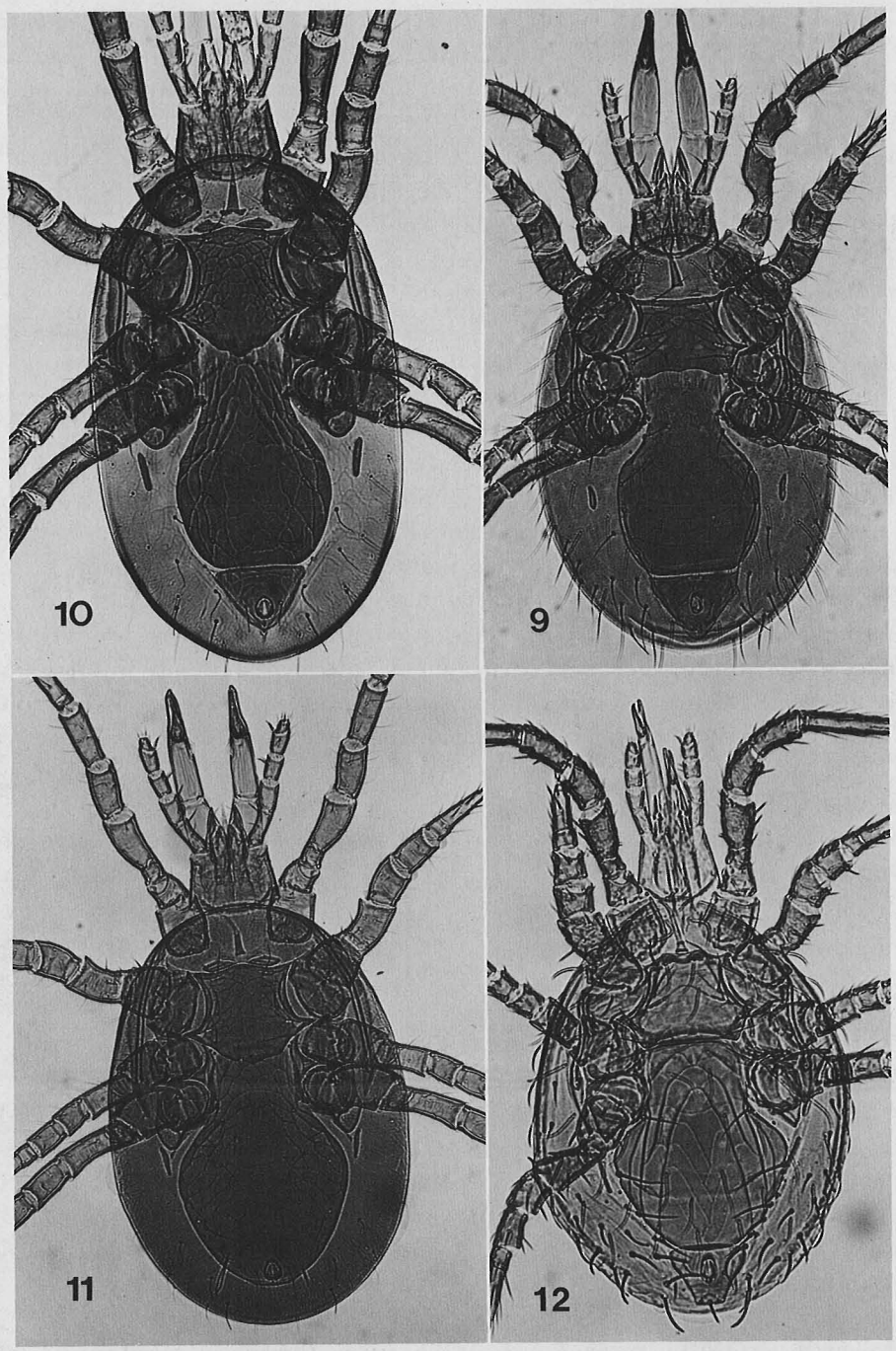

FIG. 9–12. *Pseudoparasitus* spp., ♀: **9,** *P. annectans*; **10,** *P. stigmaticus*; **11,** *P. tasmanicus*; **12,** *P. vitzthumi*. 34×.

their nests in Australia (e.g., Domrow 1961, 1963, 1973, 1977), *Rattus exulans* and *Mustela erminea* in New Zealand and *R. exulans* and *R. norvegicus* in the Kermadecs (Ramsay & Patterson 1977), and the nest of *Corvus monedula* in Britain (type series of *H. nidicorva*).

Karg (1979) included S America in the distribution for *H. nidicorva,* without supporting records. According to Dr H.J. Müller (in litt., for Dr Karg), this report was based on material from the Hungarian Soil Zoological Expedition to South America, with data as follows: Argentina, Rio Negro, nr El Bolson, Mt Piltriquitron, nest of *Akodon olivaceus* (South American Field Mouse).

All records from the Hawaiian Is (all Hawaii I) are from rodents, with the few exceptions given below. Early collections in the Bishop Museum not previously identified are all from *Rattus* and *Mus* bodies or from their nests.

In the Soil Arthropod Project carried out on Mauna Loa, Hawaii I (Radovsky & Tenorio 1981a), 13 females of *P. annectans* were taken over a 2-year period in only 4 berlese collections. All specimens were found in litter components, none in sublitter cores (0–6 cm soil). None were taken in pitfall traps.

Ramsay & Paterson (1977: 389) stated that this species ". . . is probably ectoparasitic." That *P. annectans* is found primarily in association with vertebrates and rarely under free-living conditions strongly suggests that this species has developed a dependency on its hosts or their nest environment. Information on life history, biology, etc., is necessary before we can conclude whether this vertebrate association is a facultative or obligatory one and whether any degree of hematophagy is involved.

Ecological information and hosts for this species in Hawaii are discussed by Radovsky et al. (1979).

Distribution. Hawaiian Is (Hawaii), Europe, Australia, New Zealand, Kermadecs, S America.

Pseudoparasitus stigmaticus (Fox) Fig. 10

Myzolaelaps stigmaticus Fox, 1946, J. Parasitol. **32:** 449.

This species was not included in Karg (1978), but it fits his concept of the subgenus *Pseudoparasitus.*

The female of *P. stigmaticus* was first described from *R. rattus* in Puerto Rico. Hunter (1966) transferred the species to the genus *Pseudoparasitus* and redescribed the female from specimens in the U.S. National Museum, Washington, D.C., from Cuba, Brazil, Puerto Rico, Costa Rica, Mexico, and Florida and Georgia in the continental U.S. Fox indicated that available distribution suggests that the species is limited to warmer parts of the world.

P. stigmaticus was first reported from Hawaii by Radovsky & Tenorio (1981a) from their soil arthropod study on Hawaii I. In that study, the species was found (ca. 13 ♀ over 2 years) in a limited altitudinal rangė (all sites at approximately 1220 m), restricted mainly to savannah and low elevation *Metrosideros* dry forest. At the lower

elevation sites, the species was taken only in pitfall traps and berlesed litter, but not in cored soil samples. One female taken at ca. 2300 m in subalpine scrub forest was in soil beneath the litter layer (depth not measured), indicating that the species may occur at higher elevations and in colder areas in deeper soil layers where some insulation from adverse temperature extremes would be expected.

Additional specimens, representing new host records from *Mus musculus* and *R. rattus,* are listed below. The records from Maui are new.

Specimens examined. HAWAII I: Kilauea Forest Reserve, 23.I.1972, 1695 m, ex *Mus musculus* ♂, 1♀; Kilauea Forest Reserve, 23.I.1972, ex *Rattus rattus* ♂, 1♀. MAUI I: Waihoi Val, 15.VI.1972, 610 m, ex *Mus musculus* (Pat Conant) 1♀.

Distribution. Hawaiian Is (Hawaii, Maui), N America, S America, Cuba, Costa Rica, Puerto Rico.

Pseudoparasitus (Ololaelaps) tasmanicus (Womersley) Fig. 11

Pristolaelaps tasmanicus Womersley, 1956, J. Linn. Soc. Lond. **42**(288): 571.

Originally described from strawberry plants imported into Australia from Tasmania, the distribution in Australia was later confirmed from moss from S Australia (Womersley 1960).

The following records from Hawaii represent the first report of *P. tasmanicus* outside Australia.

Specimens examined. HAWAII I: Hawaii Volcanoes National Park, 28.IV.1973, 1495 m, ex *Rattus rattus* ♂ taken in tree, shrub, and grassland (mesic), 1♀. PEARL & HERMES ATOLL: "N.E. Island," 14.XII.1970, soil and grass (J.L. Gressitt) 9♀.

Distribution. Hawaiian Is (Hawaii, Pearl & Hermes), Australia.

Pseudoparasitus trincisus Hunter Fig. 8

Pseudoparasitus trincisus Hunter, 1966, J. Ga. Entomol. Soc. **1**(3): 4.

This species is not treated in Karg (1978) but would fit into his concept of the subgenus *Pseudoparasitus.*

The type series was based on 6 specimens taken off imported orchids and cactus plants intercepted at Brownsville, Texas, USA and Hawaii from various tropical areas: Guatemala, Costa Rica, and Colombia (at Brownsville) and the Philippines (at Hawaii).

P. trincisus was reported for the first time since its description by Radovsky & Tenorio (1981a) from Hawaii I. Like *P. stigmaticus,* it was found in the lower elevation *Metrosideros* dry forest and savannah (1220 m). Unlike *P. stigmaticus, P. trincisus* has not been collected in association with rodents. About 30 females were taken over the 2-year study period in both pitfall traps and in berlese samples from litter and soil (0–3 cm and 6–9 cm levels).

One female, probably *trincisus,* is reported from Oahu; it is considerably smaller (body L × W, 480 × 310 μm) than Hawaii I specimens (avg. 574 × 350 μm).

Specimens examined (other than Mauna Loa transect specimens noted above). OAHU: Aiea, Keiawa, Heiau Campsite, 5.VII.1981, ex soil litter (S.F. Swift) 1♀.

Distribution. Hawaiian Is (Hawaii, Oahu); quarantine interceptions from various tropical areas, as noted above.

Pseudoparasitus (Gymnolaelaps) vitzthumi (Womersley) Fig. 12

Gymnolaelaps vitzthumi Womersley, 1956, J. Linn. Soc. Lond., Zool. **42:** 584.

This is the first record of this species from Hawaii. The single female on hand fits well the redescription of the female (as *Laelaspis vitzthumi*) by Hunter (1961). Domrow (1957) described the male and transferred the species to the genus *Laelaspis.*

Hunter (1964) studied the biology of this mite in the laboratory from specimens taken from soil and litter in Georgia, USA. Mites were reared on parts of freshly killed houseflies, feeding apparently on soft tissue or fluids; they refused to feed on live flies or whole, unpunctured dead flies. Nymphs and adults were seen to feed on live immatures of their own species. Females reproduced either parthenogenetically (arrhenotokous) or sexually.

Specimens examined. PEARL & HERMES ATOLL: Southeast Island, 15.XII.1970, Brown Booby nest (*Diomedea* sp.) (J.L. Gressitt) 1♀.

Distribution. Hawaiian Is (Pearl & Hermes), N America, Australia.

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LITERATURE CITED

Aswegen, P.I.M. Van & G.C. Loots. 1970. A taxonomic study of the genus *Hypoaspis* Canestrini sens. lat. (Acari: Laelapinae) in the Ethiopian region. *Publ. Cult. Cia. Diamante Angola* **82:** 162–213.

Barnard, Friedrich. 1971. Die Gattung *Hypoaspis* G. Canestrini 1885. *Acarologie* **15:** 1–10.

Bregetova, N.G. 1956. Gamasid mites (Gamasoidea). *Opred. Faune SSSR* **61:** 1–246. [In Russian.]

Bregetova, N.G. & E.V. Koroleva. 1964. Mites of the genus *Ololaelaps* Berlese, 1904 (Acarina: Laelaptidae). *Parazitol. Sb.* **22:** 61–87. [In Russian.]

Cooreman, Jean. 1959. Notes sur quelques acariens de la faune cavernicole. *Inst. R. Sci. Nat. Belg. Bull. Meded.* **35**(34): 1–40.

Costa, Michael. 1966a. The biology and development of *Hypoaspis* (*Pneumolaelaps*) *hyatti* (Acari: Mesostigmata). *J. Zool.* **148:** 191–200.

1966b. A redescription of *Hypoaspis queenslandicus* (Womersley, 1956) comb. nov. (Acari, Mesostigmata) with notes on the genus *Hypoaspis* Canestrini. *Isr. J. Zool.* **15:** 141–47.

1968. Little known and new litter-inhabiting laelapine mites (Acari, Mesostigmata) from Israel. *Isr. J. Zool.* **17:** 1–30.

1974. Mesostigmatic mites (Acari: Mesostigmata) from the Mediterranean shores of Israel. I. The genus *Hypoaspis* Canestrini, 1884. *Isr. J. Entomol.* **9:** 219–28.

Costa, Michael & Preston Hunter. 1970. The genus *Coleolaelaps* Berlese, 1914 (Acarina: Mesostigmata). *Redia* **52:** 323–60.

Costa, Michael & Eviatar Nevo. 1969. Nidicolous arthropods associated with different chromosomal types of *Spalax ehrenbergi* Nehring. *Zool. J. Linn. Soc.* **48:** 199–215.

Domrow, Robert. 1957. Some Acarina Mesostigmata from the Great Barrier Reef. *Proc. Linn. Soc. N.S.W.* **81**(3): 197–216.

1961. New and little-known Laelaptidae, Trombiculidae and Listrophoridae (Acarina) from Australian mammals. *Proc. Linn. Soc. N.S.W.* **86**(1): 60–95.

1963. New records and species of Austromalayan laelapid mites. *Proc. Linn. Soc. N.S.W.* **88**(2): 199–220.

1973. New records and species of *Laelaps* and allied genera from Australasia (Acari: Dermanyssidae). *Proc. Linn. Soc. N.S.W.* **98**(2): 62–85.

1974. Miscellaneous mites from Australian vertebrates. 1–48. *Proc. Linn. Soc. N.S.W.* **99**(1): 15–35.

1977. New records and species of *Laelaps* and allied genera from Australasia (Acari: Dermanyssidae), Part 2. *Proc. Linn. Soc. N.S.W.* **101**(4): 185–217.

Evans, G.O. 1955. Review of the laelapid paraphages of the Myriapoda with descriptions of three new species (Acarina: Laelaptidae). *Parasitology* **45:** 352–68.

Evans, G. Owen & W.M. Till. 1966. Studies on the British Dermanyssidae (Acari: Mesostigmata). Part II. Classification. *Bull. Br. Mus. (Nat. Hist.), Zool.* **14**(5): 109–370.

1979. Mesostigmatic mites of Britain and Ireland (Chelicerata: Acari-Parasitiformes). An introduction to their external morphology and classification. *Trans. Zool. Soc. Lond.* **35**(2): 139–270.

Garrett, L.E. & F.H. Haramoto. 1967. A catalog of Hawaiian Acarina. *Proc. Hawaii Entomol. Soc.* **19**(3): 381–414.

Goff, M. Lee, JoAnn M. Tenorio & Frank J. Radovsky. 1979. Mesostigmata (Acari) associated with a fumerole in Hawaii Volcanoes National Park. *Pac. Insects* **21**(1): 83–89.

Hughes, A.M. 1961. The mites of stored food. *Tech. Bull. Ministry Agric. Lond.* **9:** 1–287.

1976. The mites of stored food and houses. *Tech. Bull. Ministry Agric., Fisheries, and Food, Lond.* **9:** 1–400.

Hunter, Preston E. 1961. The genus *Laelaspis,* with descriptions of three new species (Acarina: Laelaptidae). *Ann. Entomol. Soc. Am.* **54:** 672–83.

1964. Observations on the biology of *Laelaspis vitzthumi* (Acarina: Laelaptidae). *J. Kansas Entomol. Soc.* **37:** 289–92.

1966. Some mites of the genus *Pseudoparasitus* Oudemans, 1902 (Acarina: Laelaptidae). *J. Ga. Entomol. Soc.* **1**(3): 1–20.

1967. Comments on *Hypoaspis* (*Gymnolaelaps*) Berlese, 1916, with description of a new species (Acarina: Dermanyssidae; Laelapinae). *J. Ga. Entomol. Soc.* **2**(4): 100–02.

Hunter, Preston E. & Michael Costa. 1971. Description of *Gymnolaelaps shealsi* n. sp. (Acarina: Mesostigmata) associated with the imported fire ant. *J. Ga. Entomol. Soc.* **6**(1): 51–53.

Hunter, Preston E. & Robert Davis. 1962. Two new species of *Laelaspis* mites. *Entomol. Soc. Wash.* **64**(4): 247–52.

Hunter, Preston E. & Sandra J. Glover. 1968. *Hypoaspis* (*Laelaspis*) mites from North America and Mexico (Acarina: Dermanyssidae; Laelapinae). *Fla. Entomol.* **51**(2): 63–73.

Hunter, Preston E. & Robert W. Husband. 1973. *Pneumolaelaps* (Acarina: Laelapidae) mites from North America and Greenland. *Fla. Entomol.* **56**(2): 77–91.

Karg, Wolfgang. 1961. Ökologische Untersuchungen von edaphischen Gamasiden (Acarina, Parasitiformes). *Pedobiologia* **1**(1): 53–74.

1971. Teil 59. Die freilebenden Gamasina (Gamasides), Raubmilben. *In: Die Tierwelt Deutschlands und der angrenzenden Meeresteile.* Gustav Fischer Verlag, Jena. 475 p.

1978. Die Gattung *Pseudoparasitus* Oudemans, 1902. *Mitt. Zool. Mus. Berlin* **54**(2): 203–12.

1979. Die Gattung *Hypoaspis* Canestrini, 1884 (Acarina, Parasitiformes). *Zool. Jahrb. Syst.* **106:** 65–104.

1981. Die Untergattung *Cosmolaelaps* Berlese, 1903, der Raubmilbengattung *Hypoaspis* Canestrini, 1884 (Acarina, Parasitiformes). *Mitt. Zool. Mus. Berlin* **57:** 213–32.

Kevan, D. Keith McE. & Ganga D. Sharma. 1964. Observations on the biology of *Hypoaspis aculeifer*

(Canestrini, 1884), apparently new to North America (Acarina: Mesostigmata: Laelaptidae). *Acarologia* **6**(4): 647–58.

Mitchell, Carl J. 1964. Ectoparasitic and commensal arthropods occurring on the rats of Manoa Valley, Oahu (Acarina, Anoplura, and Siphonaptera). *Proc. Hawaii Entomol. Soc.* **18**(3): 413–15.

Radovsky, Frank J. 1969. Adaptive radiation in the parasitic Mesostigmata. *Acarologia* **11**(3): 450–83.

Radovsky, F.J. & JoAnn M. Tenorio. 1974. Notes and exhibitions. *Hypoaspis nidicorva* Evans and Till. *Proc. Hawaii. Entomol. Soc.* **21:** 306.

1981a. Soil arthropods. p. 156–65. *In:* D. Mueller-Dombois, K.W. Bridges & H.L. Carson, eds., *Island ecosystems. Biological organization in selected Hawaiian communities.* US/IBP Synthesis Series 15.

1981b. Ectoparasites of rodents. p. 110–17. *In:* D. Mueller-Dombois, K.W. Bridges & H.L. Carson, eds., *Island ecosystems. Biological organization in selected Hawaiian communities.* US/IBP Synthesis Series 15.

Radovsky, Frank J., JoAnn M. Tenorio, P. Quentin Tomich & James D. Jacobi. 1979. Acari on murine rodents along an altitudinal transect on Mauna Loa, Hawaii. p. 327–33. *In: Proc. 4th Int. Congr. Acarol.* Akadémiai Kiado, Budapest.

Ramsay, G.W. & S.E. Paterson. 1977. Mites (Acari) from *Rattus* species on Raoul Island. *N.Z. J. Zool.* **4:** 389–92.

Ryke, P.A.J. 1962. The genus *Ololaelaps* Berlese (Acarina: Laelaptidae). *Rev. Biol.* **3**(1): 124–30.

1963. Some free-living Hypoaspidinae (Acari: Mesostigmata) from South Africa. *Rev. Biol.* **5**(1–2): 1–15.

Sellnick, M. 1935. Milben-Neubeschreibungen. *In:* Ine Jans, Faunistischökologische Studien im Anningergebiet, mit besonderer Berücksichtigung der xerothermen Formen. *Zool. Jahrb., Abt. Syst.* **66:** 345–55.

Sinha, R.N. 1968. Seasonal changes in mite populations in rural granaries in Japan. *Ann. Entomol. Soc. Am.* **61:** 938–49.

Solomon, Libertina. 1969. Gamaside noi din România. *Stud. Cercet. Biol. Ser. Zool.* **21**(1): 11–23.

Tenorio, JoAnn M. & M. Lee Goff. 1980. *Ectoparasites of Hawaiian rodents.* Bishop Mus. Spec. Publ. 32 p.

Till, W.M. 1963. Ethiopian mites of the genus *Androlaelaps* Berlese s. lat. (Acari: Mesostigmata). *Bull. Br. Mus. (Nat. Hist.), Zool.* **10**(1): 1–104.

Willman, C. 1951. Untersuchungen über die terrestrische Milbenfauna im pannonischen Klimagebiet Österreiches. *Sitzungsber. Oesterr. Akad. Wiss.* **160:** 91–176.

Womersley, H. 1956. On some new Acarina-Mesostigmata from Australia, New Zealand and New Guinea. *J. Linn. Soc. Lond., Zool.* **42:** 505–99.

1960. A second species of *Pristolaelaps* (Acarina, Laelaptidae) from Australia. *Trans. R. Soc. S. Austr.* **83:** 33–35.