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Aethosolenia laselvensis gen. nov., sp. nov., a new eupodoid mite from Costa Rica (Acari: Prostigmata)

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Abstract

A new genus and species of eupodoid mite is described from leaf litter of lowland tropical rainforest in Costa Rica. *Aethosolenia laselvensis* **gen. nov., sp. nov.** possesses a combination of morphological characters which does not match the current definition for any eupodoid family. The decision to place it in the Eupodidae is discussed and an amended definition of the family proposed. The new taxon is unique amongst the Acari in having dorsal idiosomal setae h_1 in the form of trichobothria.

Key words: *Aethosolenia laselvensis*, new genus, new species, Eupodoidea, Eupodidae, Costa Rica

Introduction

Mites of the superfamily Eupodoidea (Acari: Prostigmata) are fungivorous, phytophagous or predatory. They are distributed throughout the world and have colonized a wide variety of terrestrial habitats. Most of the several hundred species described to date are found in forest and pasture humus, others occur on bracket fungi or the aerial parts of vegetation, in coastal, montane, subnivean or cavernicolous habitats, while one was discovered living inside Hawaiian steam vents.

The biodiversity and systematics of selected groups of the mite fauna of primary and secondary lowland tropical rainforest are the subject of ongoing research as part of the Arthropods of La Selva (ALAS) Project at La Selva Biological Station in Costa Rica (Colwell 1996). The total area of La Selva is approximately 1600 hectares (3954 acres), ranging in altitude from 35 to 150 metres, in Atlantic coastal plain lowlands (McDade et al. 1994). Although the Eupodoidea has not been a focal group in this project, extensive sampling of free-living mites has yielded a considerable variety of mites of this superfamily. Among the eupodoids collected by modified Berlese funnel extraction of forest floor leaf litter by the parataxonomist staff of Project ALAS are two specimens of an undescribed eupodoid taxon, which was subsequently recognized by us to be of unusual taxonomic interest. The mites possess a combination of morphological attributes that fit neither existing generic definitions nor current familial concepts. This paper presents a description of the mite, *Aethosolenia laselvensis* gen. nov., sp. nov., and discusses its placement within the superfamily.

Observations and measurements (given in micrometres, μm) were made after the specimens had been slide-mounted in Hoyer's medium. Notations for the prodorsal setae follow Lindquist and Zacharda (1987), the remaining nomenclature is that applied to eupodoids by Baker (1990). Setal formulae (with solenidia and famulus, ε, in square brackets) are given in the order leg I-II-III-IV for individual leg segments or from the proximal to distal segment for the palp (trochanter-femorogenu-

tibia-tarsus) and legs (trochanter-femur(basifemur+telofemur)-genu-tibia-tarsus). Illustrations are of the holotype unless stated otherwise in the figure legends.

Superfamily Eupodoidea Koch 1842

Family Eupodidae Koch 1842

***Aethosolenia* gen. nov.**

Diagnosis. Known only from the type species, *Aethosolenia* can be distinguished from all other genera of the family Eupodidae by the following unique character states: opisthodorsal seta h_1 is trichobothroidal in form; a pair of adanal setae is present; the palp tibia has only two setae (*l″* is absent); leg tarsus I has three rhagidial organs; trochanter III bears two setae.

Definition. Small (idiosomal length 378-429), integument lightly sclerotized; sejugal furrow present. Idiosoma-dorsum: prodorsal naso small, lobe-like, not delimited dorso-basally, bears setal pair v_1; 4 pairs prodorsal, 8 pairs opisthodorsal setae; setal pairs sc_1 and h_1 trichobothroidal, both filiform and finely spiculated; f_2 located directly posterior to f_1; lyrifissures oval in elongate pits, 3 pairs present (*ia*, *im*, *ip*). Idiosoma-venter: coxisternal setal formula 3-1-4-3; 3 pairs eugenital setae; 5 pairs genital setae, arranged in single paired file; 5 pairs aggenital setae; 3 pairs pseudanal setae; 1 pair adanal setae; 1 pair lyrifissures (*ih*), same form as dorsals. Palp setal formula 0-2-2-7[ω], tibial seta *l″* absent, tarsus ovoid. Chelicerae: digits weakly chelate; seta *cha* absent. Legs: all shorter than body; tarsus and tibia I enlarged, femur IV slightly enlarged; rhagidial organs roughly T-shaped, i.e., extend both anteriorly and slightly posteriorly from attachment point; tarsi I-II with 3 rhagidial organs, tibiae I-II with 1; tibiae I-IV and genua I-II with minute semi-recumbent solenidion; stellate famulus, comprised of central papilla surrounded by ca. 12 finger-like extensions, present in pit of proximal rhagidial organ of tarsus I; trochanteral setal formula 1-1-2-1.

Male and immatures. Unknown.

Type species. Aethosolenia laselvensis sp. nov., by monotypy.

Etymology. The generic name is derived from the Greek ‘aethes’, meaning irregular, and ‘solenos’, meaning pipe, to denote the unusual solenidial form and complement possessed by this mite.

Remarks. It is difficult to distinguish between generic and specific characters in a monotypic genus, especially when, as is the case for *Aethosolenia*, the generic classification of the superfamily to which it belongs lacks stability. The characters chosen to define *Aethosolenia* are those used to define the majority of other eupodoid genera. Where intrageneric variation in the state of these characters occurs, it is within heterogeneous and evidently paraphyletic genera such as *Eupodes* and many of those of the Rhagidiidae.

Of the diagnostic features of *Aethosolenia*, the trichobothroidal form of setae h_1 is uniquely apomorphic and newly recorded for the Acari. Opisthodorsal trichobothria are present in the eupodid genus *Benoinyssus* Fain (Olivier & Theron 1997) and the ereynetid genus *Ereynetes* Berlese (superfamily Tydeoidea), but they occur in, respectively, setal position f_1 and f_2. Within the Eupodoidea, the absence of the posterolateral palp tibial seta is shared with another monotypic genus, *Pentapalpus* Olivier & Theron (family Pentapalpidae) (Olivier & Theron 2000). In those members of the rhagidiid genera *Coccorhagidia* Thor and *Crassocheles* Zacharda that have only two setae on this segment, it is the dorsal one that is missing (Zacharda 1980). A combination of two setae on trochanter III with one on trochanter IV has only previously been seen in *Pentapalpus*. Both segments bear two setae in the Rhagidiidae and Strandtmanniidae; in other taxa, the chaetotaxy 1-1

or, rarely, 1-0 occurs. The complement of three rhagidial organs on tarsus I is plesiomorphic and a new character state for the Eupodidae, which is shared with strandtmanniids and penthaleids, most penthalodids and some eriorhynchids and rhagidiids. Another new familial and plesiomorphic attribute, the presence of adanal setae, only occurs in the Pentapalpidae, Rhagidiidae and Strandtmanniidae and they, like *Aethosolenia*, have a single pair. Adanal setae first appear at the protonymphal stage (Grandjean 1939), but, with only an adult of *Aethosolenia* to examine, the location of the setae on the differentiated integument of the anal flaps is considered to indicate its adanal status.

Aethosolenia qualifies for inclusion in the Eupodoidea due to the presence of a prodorsal naso and rhagidial organs, but its further classification is problematical because of unclear familial boundaries within the superfamily. Preliminary cladistic analyses (Qin 1996, Qin & Halliday 1997) suggested that only two families (the Eriorhynchidae and Penthalodidae) are monophyletic. Of the other four, the Rhagidiidae plus Strandtmanniidae formed a monophyletic group, the Penthaleidae was paraphyletic while the status of the Eupodidae was not resolved. *Aethosolenia* best fits the current concept of the Eupodidae as defined by Kethley (1982, 1990), differing by having four pairs of setae on the subcapitulum, oval-elongate lyrifissures and three rhagidial organs on tarsus I (two setal pairs, round lyrifissures and two rhagidial organs according to Kethley). The presence of four pairs of setae on the subcapitulum in the present and previously described eupodid genera (Figs 16d, e, Baker 1990; Fig. 6, this paper) suggests that Kethley (1982, 1990) overlooked the minute adoral setae. The other two differences are not considered sufficient to exclude *Aethosolenia* from the family not only because they are plesiomorphic, but also because precise lyrifissure form varies amongst eupodids (Figs 15a, c, Baker 1990), as does the number of rhagidial organs on tarsus I within other families (Eriorhynchidae, Penthaleidae and Rhagidiidae). *Aethosolenia* runs out closest to the Eupodidae in the most recent key to eupodoid families (Qin & Halliday 1997), conflicting in possessing five rather than six pairs of genital setae. However, Qin & Halliday (1997) based their work predominantly on the Australian and New Zealand fauna and therefore did not take into account the variable number of genital setae found in species from other geographical areas, e.g., those of the genus *Cocceupodes* Thor have three, four or six pairs (Strandtmann & Tilbrook 1968; Strandtmann & Prasse 1976), while *Niveupodes* Barilo has seven (Barilo 1991).

The Eupodoidea are in evident need of comprehensive phylogenetic analysis, but until such work is carried out, we place *Aethosolenia* in the Eupodidae rather than propose a new family to accommodate it. This action will, however, require the definition of the family to be amended as follows: weakly sclerotized; naso without an associated epirostrum; 12 pairs of dorsal idiosomal setae; lyrifissures variously shaped; coxae III with three or four setae; anus ventro-terminal; adanal setae present or absent; four pairs of ventral setae on the subcapitulum, the two adoral pairs minute; chelicerae weakly chelate; palp femorogenu, tibia and tarsus longer than wide, femorogenu with two setae, tibia with two or three; leg tarsi I and II with two or three rhagidial organs; leg trochanter III with one or two setae, II and IV with never more than one; femur IV enlarged or slender.

Within the Eupodidae, *Aethosolenia* appears to be most closely related to the monotypic genus *Claveupodes* Strandtmann & Prasse. *Claveupodes delicatus* Strandtmann & Prasse and two undescribed congeners (pers. obs., ASB) share with *Aethosolenia* the unusual position of opisthosomal seta f_2 posterior (rather than lateral) to f_1, a coxal formula of 3-1-4-3, an ovoid palp tarsus, roughly T-shaped rhagidial organs and the possession of three pairs of eugenital setae (Strandtmann & Prasse 1976). A somewhat enlarged tarsus I and inflated tarsal I rhagidial organs were also observed in these two undescribed taxa. *Claveupodes* species can be distinguished from *Aethosolenia laselvensis* by the subclavate form of sc_1, the non-trichobothroid form of h_1, the presence of four pairs of both genital and aggenital setae, and their different leg chaetotaxies.

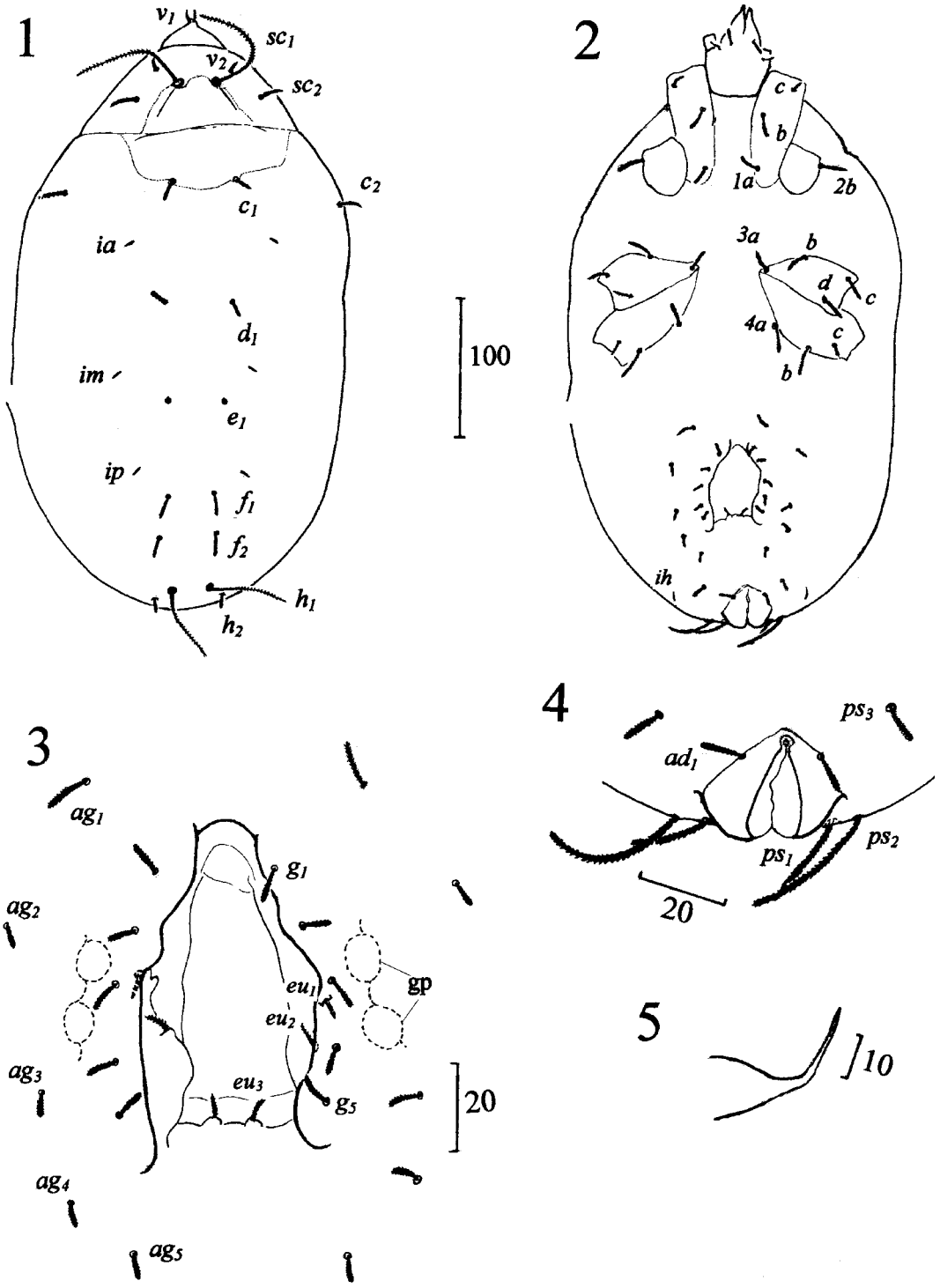
***Aethosolenia laselvensis* sp. nov.**
(Figs 1-18)

Female (holotype, paratype). Body length (from apex of naso to posterior limit of idiosoma) 429, 378, greatest width (just posterior to setae c_2) 248, ca. 186; idiosoma ovoid, posterior margin widely rounded; sejugal furrow present.

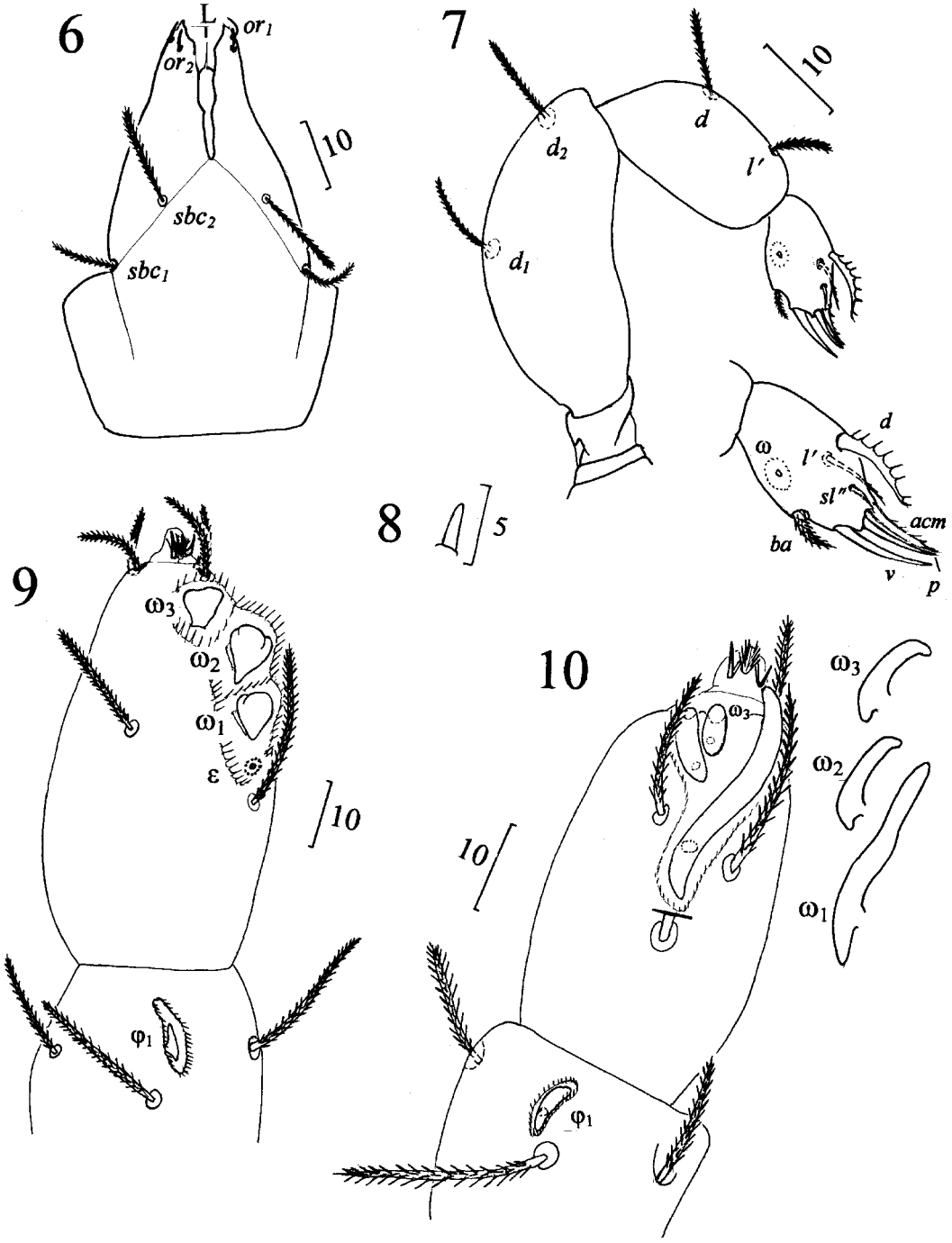
Idiosoma - dorsum (Figs 1, 15-17). Papillate shield extends from setae sc_1 to c_1 (Fig. 15), forms roughly triangular and trapezoidal area on respectively pro- and opisthodorsum, remainder of integument with lobed striae (Fig. 17). Naso (Fig. 15) a small lobe, not delimited dorso-basally from prodorsum, longitudinally striated, bears setae v_1. Eyes not discerned. Setae: simple; sc_1 and h_1 trichobothroidal, sensilli filiform, spiculated (markedly so in ca. distal three-quarters), bothridia cylindrical, those of sc_1 with narrow sclerite extending posterolaterally (arrow, Fig. 16); other setae densely pilose (Fig. 16), lengths – v_1 8, 6, v_2 ca. 9, 8, sc_1 ca. 86, 84, sc_2 ca. 19, 19, c_1 13, 13, c_2 19, 22, d_1 13, 13, e_1 missing, 14, f_1 19, 19, f_2 17, 14, h_1 ca. 61, 62, h_2 ca. 10, 13; sc_2 and v_2 located respectively posterolaterally and slightly anterolaterally to sc_1; f_2 inserted directly posterior to f_1. Lyrifissures: oval in elongate pit (Figs 1, 17); *ia*, *im* and *ip* located laterally and respectively ca. midway between c_1 and d_1, just over halfway between d_1 and e_1, and just anteriorly to f_1.

Idiosoma - venter (Figs 2-4). Integument papillate over coxisternal faces and anal flaps, remainder with lobed striae; all setae simple, densely pilose, blunt distally apart from tapering eugenital setae. Coxisternal area (Fig. 2): setal formula 3(*1a-c*)-1(*2b*)-4(*3a-d*)-3(*4a-c*); *1c* and *4c* distinctly shorter and slightly thinner than other setae; setal lengths – *1a* ca. 17, 16, *1b* ca. 19, 20, *1c* 9, 8, *2b* 21, 23, *3a* 15, 15, *3b* 19, 18, *3c-d* and *4a* 16, 16, *4b* 17, ca. 16, *4c* 8, 8. Genital area (Fig. 3): genital shields narrow, not well-defined, 66, 62 long; 2 pairs subequal genital papillae, ca. 8, 8 in diameter; 3 pairs eugenital setae, $eu_{1\ \&\ 2}$ 6, 6 long, located slightly separately from eu_3, 4, 6 long; 5 pairs subequal genital setae ($g_{1\text{-}5}$), 8, 8 long, arranged in single paired file near free edges of shields; 5 pairs aggenital setae bracket genital shields, ag_1 14, 13 long, remainder 7, 6. Anal area (Fig. 4): anus ventro-terminal, bordered by two flaps bearing one pair adanal setae (ad_1) (12, 12 long) at limit of papillate integument; three pairs pseudanal setae, $ps_{1\ \&\ 2}$ located just dorsally to anus, respectively 26, 26 and 40, 38 long, ps_1 slightly the thicker, ps_3 12, 10 long, located slightly anterolaterally to ventral limit of anal opening. Lyrifissure *ih* located slightly posterolaterally to bases of ps_3, same form as dorsal lyrifissures.

Gnathosoma (Figs 5-8). Integument papillate. Subcapitulum (Fig. 6) roughly triangular; two pairs minute smooth adoral setae ($or_{1\ \&\ 2}$), located subapically; subcapitular setae densely pilose, sbc_1 located laterally at level of proximal margin of palp trochanters, 10, 8 long, slightly thinner than sbc_2, sbc_2 inserted ventrally one third to one quarter of distance between sbc_1 and tip of subcapitulum, 14, 16 long; labrum acuminate. Palp (Figs 7, 8): tarsus ovoid, length 13, 13, greatest width 8, 8; supracoxal seta *e* (Fig. 8) (not seen in holotype) peg-like, ca. 3 long; setal formula for free segments 0-2-2-7[ω]; femorogenual and tibial setae densely pilose, thickness increases slightly from proximal to distal seta, femorogenual setae 10, 10 long, tibial seta *d* 10, 10 long, *l'* 8, 7; tarsal setae *d* and *acm* sparsely pilose along dorsal surface, *l'* pilose, *sl"* spiniform, *p* and *v* smooth, *ba* densely pilose, ca. half length of other setae; ω minute, in round pit. Chelicera: total length -, 54, chelate part -, 12 long, greatest width (at shaft base) -, 13, *cha* absent; digits weakly chelate, movable digit slender and acuminate distally (Fig. 5).



FIGURES 1-5. *Aethosolenia laselvensis* **gen. nov., sp. nov.** (Female). 1, idiosoma, dorsal view; 2, idiosoma, ventral view; 3, genital region; 4, anal region; 5, movable cheliceral digit, antiaxial view of distal part. gp=genital papillae. Scale bars in micrometres.



FIGURES 6-10. *Aethosolenia laselvensis* **gen. nov., sp. nov.** (Female). 6, gnathosoma, ventral view; 7, palp, antiaxial view, with detail of palp tarsus; 8, palp, supracoxal seta *e* (paratype); 9, tarsus I and distal part of tibia I, posterolateral-dorsal view; 10, tarsus II and distal part of tibia II, dorsal view, lateral views of solenidia of rhagidial organs detailed. L=labrum. Scale bars in micrometres.

FIGURES 11-14. *Aethosolenia laselvensis* **gen. nov., sp. nov.** (Female, paratype). 11, leg I, posterolateral view; 12, leg II, dorso-posterolateral (trochanter and femur) to posterolateral (genu-tarsus) view; 13, leg III, anterolateral view; 14, leg IV, anterolateral view. Scale bar in micrometres.

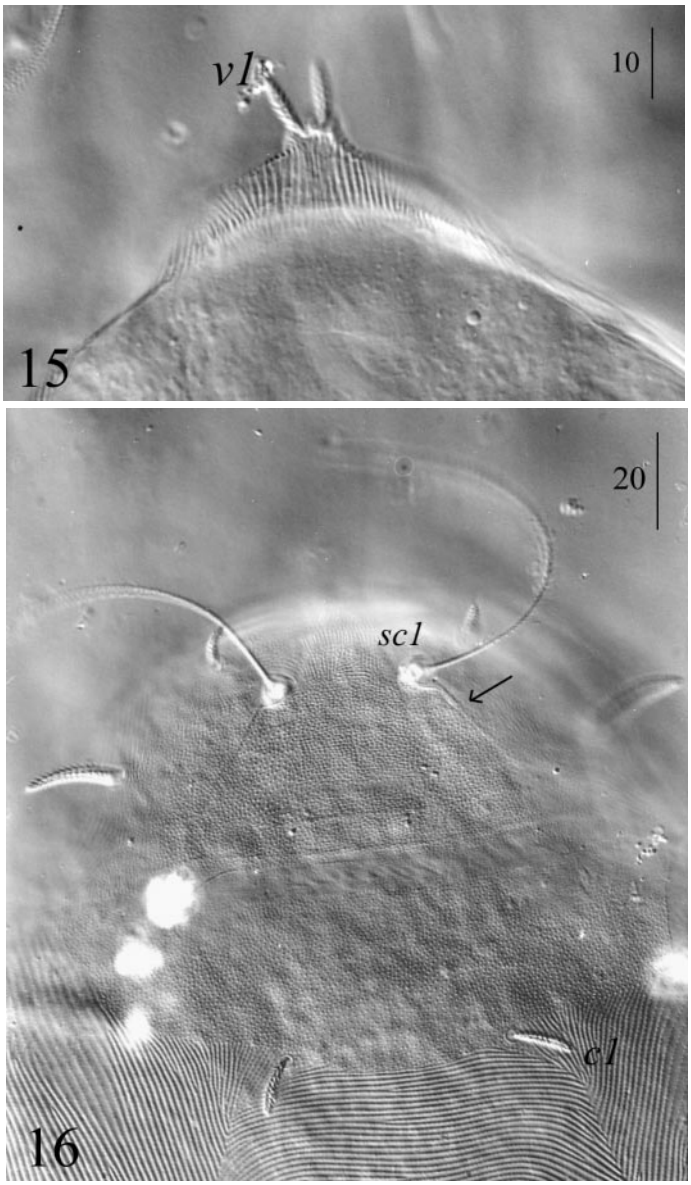
Legs (Figs 9-14, 18). Integument papillate; leg I more robust than others, slightly longer than half body length; tarsus and tibia I enlarged, femur IV slightly enlarged; all femora subdivided, only evident faintly on I and II; leg lengths (from base of trochanter to distal limit of tarsus, excluding apotele) – I 221, 205, II 157, ca. 147, III ca. 186, 170, IV -, 211. Setae: supracoxal seta *eI* (not seen in holotype) same form and size as *e*; formulae – I 1-12(7+5)-7[σ]-6[$\varphi_{1\ \&\ 2}$]-18[$\omega_{1\text{-}3}$+ε], II 1-10(5+5)-6[σ]-5[$\varphi_{1\ \&\ 2}$]-14[$\omega_{1\text{-}3}$], III 2-8(4+4)-5-4[φ]-12, IV 1-6(3+3)-7-4[φ]-11; ventral tarsal setae and ventral seta on tibiae and genua eupathidial (ζ); rhagidial organs of tarsus I short, inflated (Figs 9, 18), arranged slightly obliquely in contiguous pits, stellate famulus (ε), located near posterolateral margin of proximal pit; rhagidial organs of tarsus II elongate (Fig. 10), arranged more or less parallel in confluent pits, ω_1 ca. twice length of $\omega_{2\ \&\ 3}$, famulus not seen; tibiae I-II with distal, slightly posterolateral rhagidial organ (φ_1) (Figs 9, 10); minute semi-recumbent solenidion present ca. dorsally on tibiae (I-II, φ_2; III-IV, φ) and genua (σ) (Figs 11-14). Apotele: comprises two rayed claws flanking pad-like empodium bearing ventral rows of fine filaments; increase in size slightly posteriorly, measurement of gap between base and tip of claws – I -, 8, II 9, 10, III 10, 10, IV 10, 11.

Etymology. The specific epithet is based on 'La Selva', meaning 'forest' or 'jungle' in Spanish and the name of the research station and reserve from where the specimens were collected.

Material described. Holotype (female): Costa Rica, Heredia Province, La Selva Biological Station, 50-150m asl, 10°26'1"N, 84°1'2"W, parcelas de sucesión (successional plots in secondary forest), *ex* hojarasca (soil litter), coll. D. Brenes, R. Vargas, M. Paniagua & N. Oconitrillo, 14 October 1998; accession no. INBIOCRI001424978; deposited in Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. Paratype (female): same data as holotype except 10°26'N, 84°01'W; accession no. INBIOCRI001425318; deposited in The Natural History Museum, London.

Remarks. The complete eupathidiotaxy for *Aethosolenia laselvensis* was not established, either because the position in which setae were lying obscured their form or because the eupathidic/normal state could not be confidently determined. Eupathidia and normal setae respectively have a hollow and solid central canal, but they may also exhibit differences in their ornamentation (Grandjean 1943). Eupathids have previously been described in seven eupodoid species; Lindquist and Zacharda (1987) and Baker (1995) distinguished them by differences in ornamentation, while Booth et al. (1985) and Edwards and Usher (1987) used the hollowness of the shaft and widely open base for identification. In *Aethosolenia laselvensis*, the ventral tarsal setae and the thick disti-ventral seta on the tibiae and genua are clearly hollow and so labelled as eupathids, while a solid shaft can be seen in most dorsal and lateral setae of the femora, genua and tibiae, and all of those on the trochanters. In those setae of uncertain status, the shaft appeared to be hollow on one leg but solid in its equivalent on the other side of the body or, alternatively, to be hollow but with only a narrow base.

Current knowledge and classificatory framework of the superfamily Eupodoidea is based largely on faunas from temperate, boreal and polar regions of both northern and southern hemispheres of the world. In order to resolve the problematical delineation of some families, especially the Eupodidae and Penthaleidae as already noted, future phylogenetic analyses would undoubtedly benefit from having data available from taxa of Eupodoidea that await discovery and description from a variety of tropical regions of the world. Our description and discussion of *Aethosolenia laselvensis* is one such example. We are aware of another undescribed taxon from the same La Selva rainforest area, known thus far from just one damaged specimen (a female, lacking most segments of both of legs I) which, based on gnathosomatic attributes, defies placement in any of the families of Eupodoidea as currently defined. A more robust classification and phylogenetic construct of the families of Eupodoidea may well depend on bringing to light a much greater representation of taxa of this superfamily from tropical regions throughout the world.



FIGURES 15-16. *Aethosolenia laselvensis* **gen. nov., sp. nov.** (Female). 15, naso, dorsal view; 16, prodorsal and anterior opisthodorsal region, sclerite arrowed. Scale bars in micrometres.

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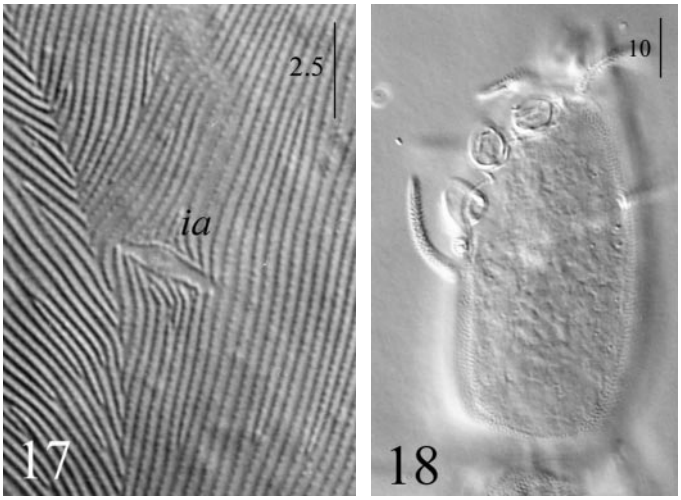

FIGURES 17-18. *Aethosolenia laselvensis* **gen. nov., sp. nov.** (Female). 17, lyrifissure *ia*, 18, tarsus I, posterolateral view. Scale bars in micrometres.

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