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A NEW GENUS OF FUNGUS-INHABITING MITES OF THE FAMILY BLATTISOCIIDAE (ACARI MESOSTIGMATA PHYTOSEIOIDEA) FROM COSTA RICA, WITH AN UPDATED KEY TO GENERA OF THE SUBFAMILY BLATTISOCIINAE

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Lindquist E.E., Moraza M.L. – A new genus of fungus-inhabiting mites of the family Blattisociidae (Acari Mesostigmata Phytoseioidea) from Costa Rica, with an updated key to genera of the subfamily Blattosociinae.

The genus *Discoseius* gen. nov**.** is described, based on adult females of one newly described species collected from one sample of bracket fungi in Costa Rica. These ovoid mites bear a pair of large, pliable, disclike structures of unknown function, which flank a ventrianal shield that is strangely formed to accommodate the discs ventrally on the opisthosoma. Such uniquely formed structures have been found otherwise only in females of the monobasic eviphidid genus *Canestriniphis,* from specimens phoretic on erotylid beetles that live in bracket fungi. As female *Discoseius* are endowed with a sperm access system of the more derivative phytoseioid-type, while female *Canestriniphis* retain the sperm access system of the plesiomorphic laelapoid-type, this similarity is thought to be convergent. An updated key to the world genera of the subfamily Blattisociinae is presented to accommodate this and another recently proposed genus.

KEY WORDS: Blattisociidae, Phytoseioidea, fungus mites, *Discoseius* n. gen., *Canestriniphis*, convergent attributes.

INTRODUCTION

This is the fourth of a series of papers centered on description of new taxa of mites of the superfamilies Ascoidea and Phytoseioidea found to exist in just one small area of lowland tropical rainforest in Costa Rica (LINDQUIST, 2001, LINDQUIST & MORAZA, 2008), and the third to deal with the remarkable diversity of mesostigmatans that co-occupy bracket fungi there (LINDQUIST & MORAZA, 2010; MORAZA & LINDQUIST, 2011). As this new genus and another recently proposed one (SEEMAN, 2012) are members of the blattisociid subfamily Blattisociinae Garman 1948, *sensu* LINDQUIST *et al.*, (2009) and MORAZA & LINDQUIST (2011), we present an updated key to the genera of that subfamily.

The new genus is distinguished above all other attributes by a pair of prominent, pliable, disclike structures of unknown function which flank a ventrianal shield that is peculiarly formed to accommodate the discs ventrally on the opisthosoma. Closely similar structures have been found otherwise only in females of the monobasic eviphidid genus *Canestriniphis* Potter & Johnston,1976, associated phoretically with erotylid beetles that also live in bracket fungi. We discuss the issue of whether these two mites may represent sister-taxa or may be phylogenetically distant but presenting a remarkably convergent attribute.

MATERIALS AND METHODS

Mites were collected from funnel-extractions of field-collected samples of fungi and preserved in 80% ethanol, from which some specimens were mounted into Hoyer's medium on microslides and sealed with Glpt insulating varnish. Morphological observations, measurements, and illustrations were made using compound microscopes equipped with differential interference contrast and phase contrast optical systems, drawing tubes and stage-calibrated eyepiece micrometers. Setal notation for the idiosoma follows that of LINDQUIST & EVANS (1965) as modified slightly by LINDQUIST (1994) and adapted for superfamilies of mesostigmatic mites in general by LINDQUIST *et al.*, (2009). Measurements of structures are given in micrometers (µm) and indicate the ranges among specimens measured. Dorsal shield lengths were taken as midline length from the anterior margin anterior to the bases of vertex setae *j1* to the caudal margin posterior to the bases of clunal setae *J5*. Ventrianal shield lengths were taken midline, from the anterior margin to the posterior edge of the cribrum. Notation for leg and palpal setation follows that of EVANS (1963, 1964, 1969). Leg lengths are taken from the base of the coxa to the apex of the tarsus excluding the pretarsus. Distinction of porelike structures on the idiosomal integument as either poroids (lyrifissures) or glandular openings (solenostomes), as distinguished morphologically by ATHIAS-HENRIOT (1969) and physiologically by KRANTZ & REDMOND (1987), is applied and their notation generally follows JOHNSTON & MORAZA (1991).

SYSTEMATICS

Placement of the new genus in the phytoseioid family Blattisociidae is based on the family-group concepts of

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LINDQUIST *et al.* (2009), along with the diagnoses by LINDQUIST & MORAZA (2010) and SEEMAN (2012) that present the following attributes which we enumerate here: Adult dorsal shield (1) entire or rarely retaining deutonymphal lateral incisions, (2) with 15 to 43 pairs of setae, including *J5* and almost always *j2*, and (3) without asymmetrical or symmetrical neotrichy; (4) adult female with usually more than four pairs of marginal setae on soft cuticle. Adult female ventrally with (5) sternal shield usually bearing setae *st1-st3* and poroids *iv1-iv2*, but *st4* and *iv3* on metasternal plates or soft cuticle; (6) epigynal shield usually with setae *st5* and truncate or slightly convex posterior margin; (7) usually a ventrianal shield, which rarely reduced to oval anal shield. Adult male ventrally with (8) sternitigenital shield usually delineated from, though often abutting, ventrianal shield; (9) endopodal strips beside coxae III-IV usually fully integrated with sternitigenital shield; (10) ventrianal shield with entire anterolateral margins and with posterolateral margins free from dorsal shield. (11) Peritrematal shield of adults usually broadly fused posteriorly to exopodal plate curving behind coxae IV. (12) Palptarsal apotele two-tined. Fixed cheliceral digit with (13) setiform pilus dentilis, and (14) zero to many teeth. Movable cheliceral digit with (15) zero to many teeth, often tridentate, and (16) lacking a pointed process (mucro) on its midventral surface. (17) Subcapitular gutter with a smooth anterior margin and six or seven rows of deutosternal denticles, the basal rows sometimes slightly widened. (18) Leg I femur with maximum of 12 setae (*v-4* absent). (19) Genu III usually with nine or fewer setae (*pl-2* usually absent); (20) genu IV usually with nine or fewer setae (*pv* absent). (21) Tibia IV generally with ten setae, rarely as few as seven but retaining *pv*. (22) Larval pygidial shield well developed, with usually four or five pairs of setae; (23) protonymphal pygidial shield with four to eight pairs of setae; (24) deutonymphal dorsal shield with lateral incisions or rarely divided. The above attributes are admittedly either plesiomorphic or subject to homoplasy, such that the concept of this family remains uncertain phylogenetically and awaits clarification by other means, including molecular analyses such as those initiated by DOWLING & OCONNOR (2010), albeit inadequately (see critique by MORAZA & LINDQUIST, 2011). Also, as the new genus is based only on adult female material, attributes (8)-(10) and (22)-(24) remain unaccounted for.

With respect to subfamilial placement, most aspects of the setation on legs I to IV in the new genus (plesiomorphic retentions of seta *v-3* on femora I and II, and *pv-1* on genu II) are typical of the subfamily Blattisociinae, rather than the Platyseiinae, *sensu* LINDQUIST *et al*., (2009), and this genus lacks all other apomorphic attributes of the Platyseiinae, as presented in the key to world genera of Blattisociidae by LINDQUIST & MORAZA (2010). The apomorphic suppression of seta *pl-2* on genu and tibia II in the new genus is unusual for both the Blattisociinae and Platyseiinae, though typical of the ascid subfamily Arctoseiinae sensu LINDQUIST & EVANS (1965). Argument for subfamilial placement of the new genus, then, is based on plesiomorphic attributes in diagnosis of the Blattisociinae, which remains the least morphologically cohesive subfamily in the superfamily Phytoseioidea. Ultimately, superfamilial and familial placement of *Discoseius* rests on its females having the phytoseioid-type spermathecal apparatus, which is an apomorphic combination of structures peculiar only to that superfamily among all taxa of the Mesostigmata, the complexity of which renders the option of convergence highly improbable (WALTER & LINDQUIST, 1997; ALBERTI, 2002; ALBERTI & DI PALMA, 2002); see also the remarks, below. On the other hand, if the sperm access systems may be determined to be more homoplasious, as hypothesized by KARG (2003) and as indicated from a preliminary molecular analysis by DOWLING & OCONNOR (2010), or if the phytoseioid-type spermathecal apparatus is simply regarded to be plesiomorphic, as hypothesized by KARG (1998), an entirely different taxonomic scenario could be contemplated.

Discoseius new genus
(Figs. I-V)

Type species: *Discoseius perplexus* new species. Monotypic.

DIAGNOSIS – Adult females with the autapomorphic attribute of a phytoseioid-type spermathecal apparatus. Adults of *Discoseius* are distinguished apomorphically from those of other blattisociid genera by the following attributes: dorsal shield with lateral margins extending toward ventral side and with podonotal setation reduced (lacking protonymphal setae *s5*, *r2* and deutonymphal setae *z1*, *z3*, *z6*, *s3*, *r4*, *r6*; genu II and tibia II with 10 and 9 setae, respectively, lacking *pl-2*; genu IV with 9 setae, lacking *pv-1*; claws on legs I-IV with a basal swelling. On females, sternal region with poroids *iv3* either symmetrically or asymmetrically on sternal shield's posterior margin or narrowly isolated from that shield on soft cuticle or with setae *st4* on metasternal platelets; epigynal shield with bluntly pointed posterior margin; opisthogaster with a pair of disc-like structures bulging from soft cuticle, flanking a narrowed median extension of ventrianal shield, and with deep postgenital and postanal furrows.

DESCRIPTION – Adult female. *Idiosomal dorsum* (Fig. I, 1, 2, 3, 4). Dorsal shield entire, without lateral incisions, well sclerotized, ornate and with lateral margins extending to ventral side. Dorsal shield with a maximum complement of 28 pairs of setae (Fig. I, 1), including 14 podonotal (*j1-j6*, *z2, z4, z5*, *s1, s2*, *s4*, *s6*, *r3*) and 14 opisthonotal pairs (*J1-J5*, *Z1-Z5*, *S2-S5)* (Fig. I, 1); dorsal setae heterogeneous in lengths. Dorsal shield with complement of 20 pairs of discernible pore-like structures (9 podonotal, 11 opisthonotal), of which 8 pairs (4 podonotal, 4 opisthonotal) superficially appear secretory (gland pores) and 12 pairs (5 podonotal, 7 opisthonotal) non-secretory (poroids). Soft surrounding cuticle with setae *r5* and 3 *R* marginal pairs of setae and pair of marginal poroids *idRp*. Peritrematal shield united with dorsal shield anteriorly at level of setae *s1*; peritremes well developed, reaching to level between setae *j1* and *s1*.

Idiosomal venter (Fig. II, 1, 2, 3). Tritosternum with laciniae free for most of length, without basal elaborations (Fig. IV, 5). Ventral shields well sclerotized. Sternal shield entire, with strongly developed endopodal extensions between coxae I-II and II-III, that between legs I-II with a gland pore (*gst1*) apically where abutting peritrematal/exopodal shield (Fig. I, 1; Fig. II, 1); sternal shield with three pairs of setae and two or three pairs of lyrifissures, *iv3* on or off the shield (Fig. III, 1), or on metasternal plates (Fig. II, 1); setae *st4* and sometimes

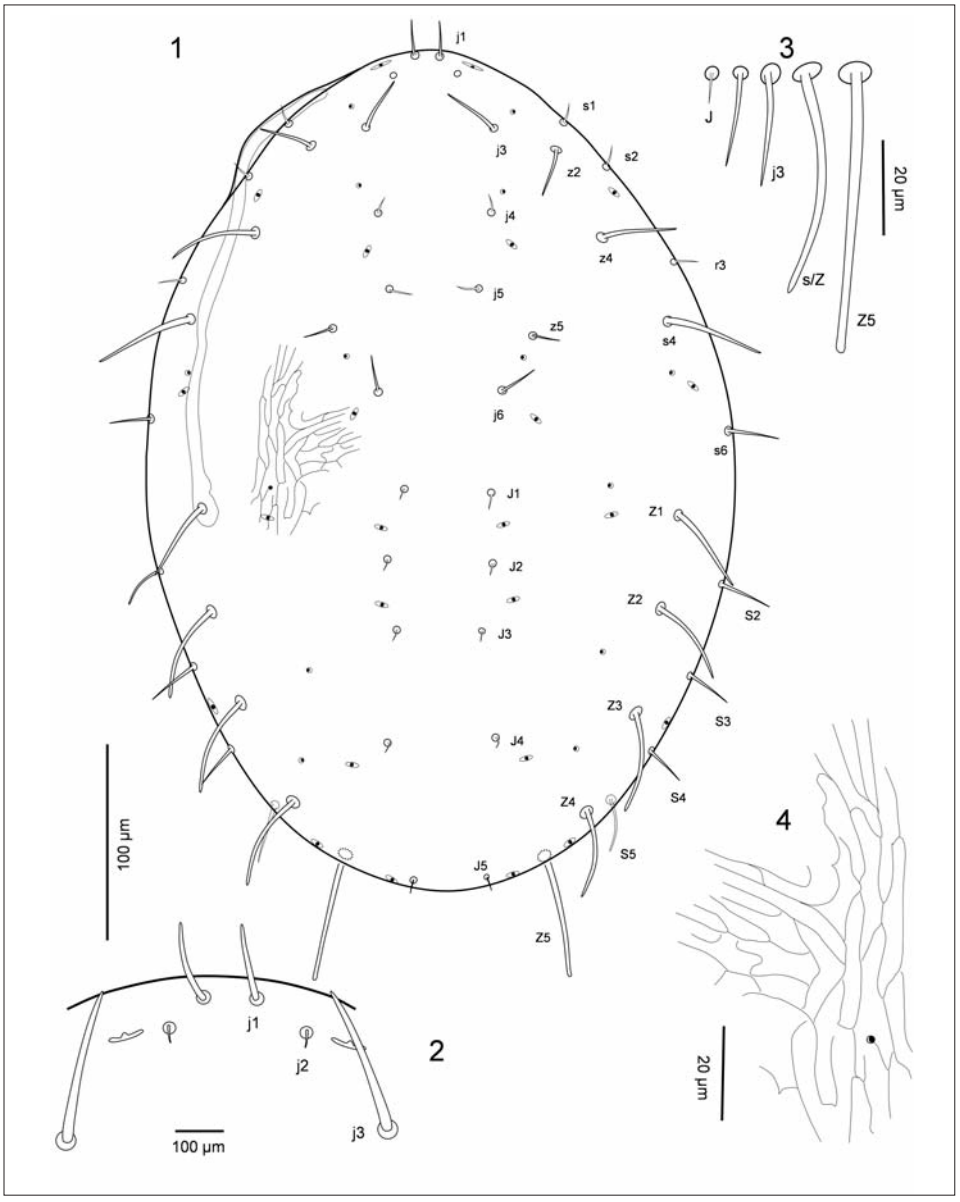

Figure I – *Discoseius perplexus* n. sp., adult female.
1. Idiosoma, dorsal aspect with detail of peritrematal shield; 2. Detail of anterior dorsal setae; 3. Detail of separate views of dorsal setae denoted; 4. Detail of dorsal ornamentation.

poroids *iv3* on free, poorly sclerotized metasternal plates (Fig. II, 1). Endopodal strips between coxae III and IV free, well defined. Epigynal shield with its rounded, hyaline anterior margin between legs III not reaching posterior edge of sternal shield, its posterior margin bluntly pointed, abutting ventrianal shield; setae *st5* on shield's lateral margins, paragenital poroids *iv5* on soft cuticle; deep postgenital furrow present, embedding postgenital platelets if present. Opisthosomatic venter with metapodal platelets, ten pairs of setae (*JV1-JV5, ZV1-ZV5*), and four pairs of poroids. Opisthogaster with a pair of large, soft cuticular, disc-like structures that appear to cover underlying platelets, sigillae and poroids flanking anteromedial extension of ventrianal shield (Fig. II, 1; Fig. III, 2). Ventrianal shield with narrow anteromedial extension reaching epigynal shield; paranal setae shorter than postanal seta and inserted at mid-level of anus; shield with a pair of gland pores *gv3* on lateral margins of anal region, and a well-developed cribrum behind level of postanal seta; deep postanal furrow present. Peritrematal shield broadly connected with exopodal strips beside coxae IV, with gland pore (*gp1*) at level of coxae II, gland pore (*gp2*) and poroid (*ip1*) along mid-length of peritrematal shield, and with one gland pore in area behind stigma (*gp3*) (Fig. II, 2); poroid *ip2* off shield; exopodal strip continuous alongside peritrematal shield by coxae I-IV, with extensions between bases of coxae II-III and III-IV. Spermathecal apparatus of phytoseioid-type, with minor duct emanating from embolus near base of sclerotized calyx, major duct short and wide (Fig. II, 3).

Gnathosoma. Gnathotectum with convex anterior margin (Fig. IV, 2). Chelicerae small (Fig. IV, 6), without any conspicuous process along antiaxial or paraxial

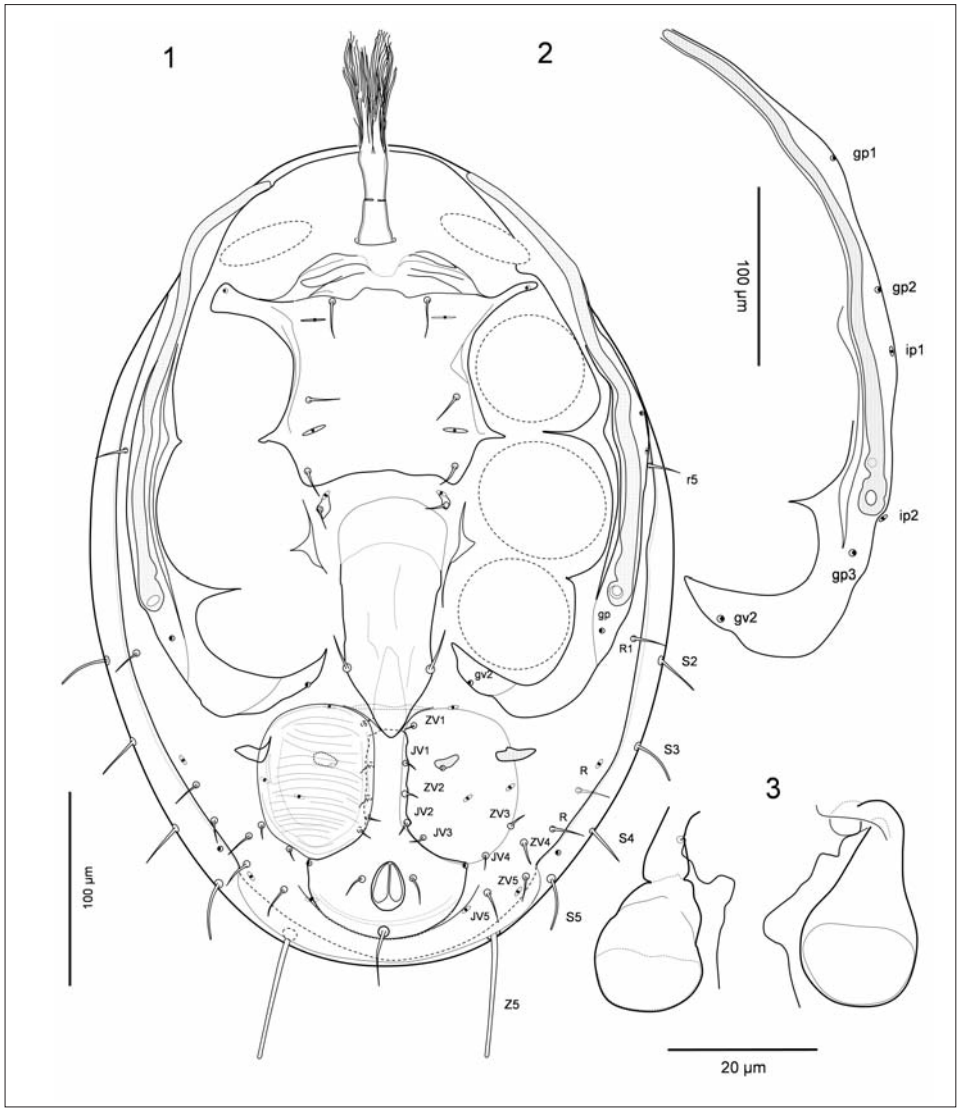

Figure II – *Discoseius perplexus* n. sp., adult female.
1. Idiosoma, ventral aspect; 2. Peritrematal shield with poroids; 3. Details of spermatheca.

lateral surfaces basal to the digits; fixed digit with tiny pilus dentilis and row of several teeth along masticatory surface; movable cheliceral digit bidentate; arthrodial envelope margin smooth. Deutosternum with eight transverse rows of denticles of similar width (Fig. IV, 3, 4), rows multidenticulate, all rows connected. Corniculi normal in form, convergent apically (Fig. IV, 3); internal malae smooth, longer than corniculi. Subcapitular setae smooth, not strongly dissimilar in lengths. Palpi with normal setation as described for Gamasina by Evans (1964); palpfemoral seta *al* and palpgenual setae *al-1* and *al-2* more or less spatulate; palptarsal apotele two-tined, with spatulate tips (Fig. IV, 1).

Legs. Legs I to IV with pretarsi bearing paired small claws with basal swelling, short paradactyli and rounded pulvillae (Fig. V, 6). Legs I (Fig. V, 1, 7, 8) longer than other legs (Fig. V, 2, 3, 4), legs II to IV with tarsus (excluding pretarsus) about 2.0 to 2.5 times as long as tibia. Distal margins of coxae I-IV without prominent serrations or spur-like processes. Tarsus I without markedly elongated setae apically (Fig. V, 7), and with sensilla *s* inconspicuous, rigid, pointed rather than lanceolate (Fig. V, 8). Tarsi II-IV with apical setal processes *ad-1*, *pd-1* shorter then pretarsi, and with acutely triangular apical process ventrally (Fig. V, 5, 6). Complement of setae on segments of legs I-II-III-IV mostly normal for tribe Blattisociini as presented by LINDQUIST & EVANS (1965) (=subfamily Blattisociinae sensu LINDQUIST *et al.*, 2009): coxae, 2-2-2-1; trochanters, 6-5-5-5; femora, 12 (2 2/1 3/2 2) - 11 (1 2/1 3/2 2) - 6 (1 2/1 1/0 1) - 6 (1 2/1 1/0 1); genua, 13 (2 3/1 3/2 2) – 10 (2 3/1 2/1 1) – 9 (2 2/1 2/1 1) – 9 (2 2/1 3/0 1); tibiae, 13 (2 3/1 3/2 2) – 9 (2 2/1 2/1 1) – 8 (2 1/1 2/1 1) – 9 (2 1/1 3/1 1), but genu II and tibia II lacking *pl-2* (Fig. V, 2), tibia IV lacking *pl-2*, and with *pd-3* in nearly an *ad-2* position (Fig. V, 4). Leg setae collectively smooth.

ETYMOLOGY – The name of the genus is a Latinized combination of the term *discus*, meaning a flat, circular plate or shape, and *seius* or *sejus*, a Roman surname commonly used by authors to form names for genera of mesostigmatic mites. The name is masculine in gender, and alludes to the form of the peculiar pair of structures on the opisthosomatic venter of these mites.

DISTRIBUTION AND HABITATS – This genus is based on

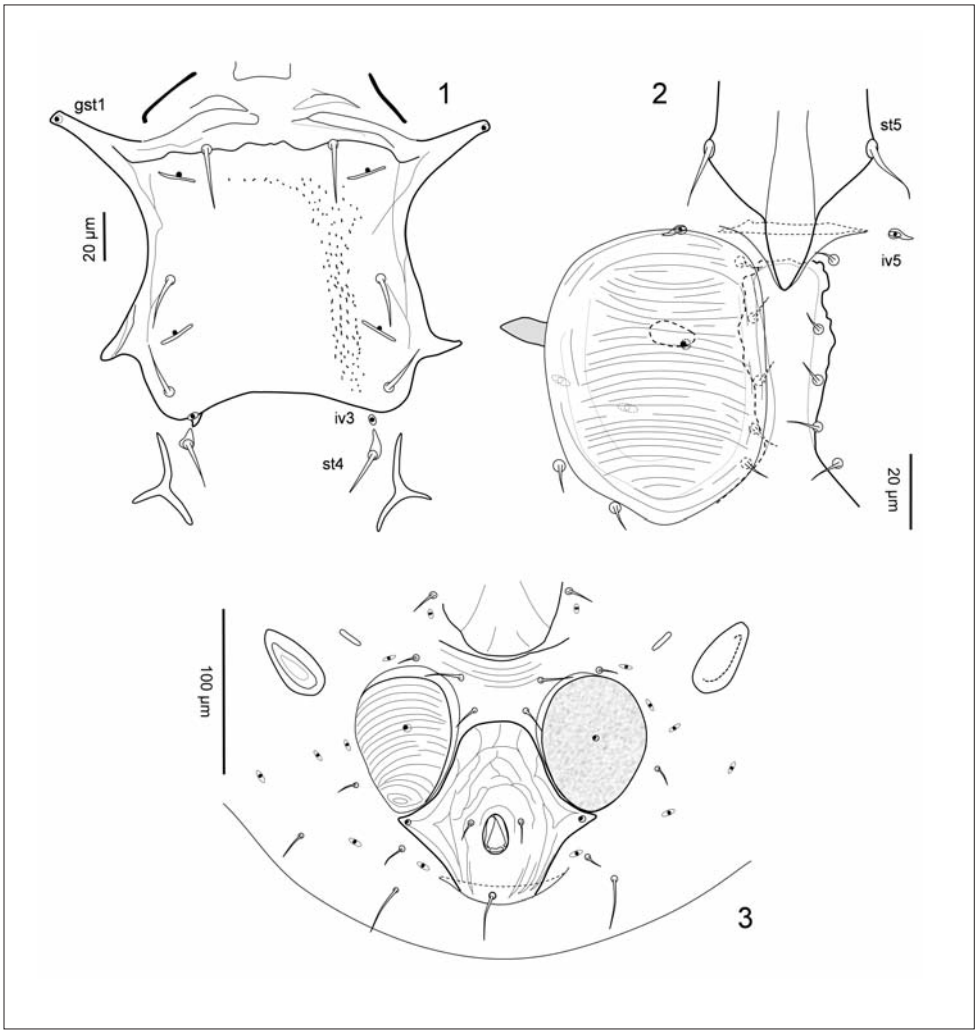

Figure III – *Discoseius perplexus* n. sp. and *Canestriniphis megalodacne* Potter & Johnston, adult female. 1. (*D. perplexus*) Detail of sternal shield, fused to exopodal strips between legs II-III and III-IV, metasternal platelets and poroids *iv3*; 2. (*D. perplexus*) Detail of posterior region of epigynal shield and cuticular ventral structures. 3. (*C. megalodacne*) Detail of posterior region of epigynal shield, cuticular ventral structures and anal shield.

material extracted from just one sample of perennial fungal growth on a decaying log in coastal lowland rainforest of Costa Rica. Although associated with a diversity of mesostigmatans collected from this sample of fungi, these mites were not found with the others in various (at least ten) other samples of fungi taken elsewhere in that vicinity. We wonder, therefore, whether they were perhaps phoretic on an arthropod that happened to be present on that fungal patch, but not on the others sampled. Unfortunately, access to a residual sample of unmounted material in ethanol is not practical (if existent).

REMARKS – Family placement of *Discoseius* in Blattisociidae is challenged by two of its attributes. A position of the third pair of sternal lyrifissures on the posterior edge of the sternal shield in females is considered to be an apomorphic state peculiar to the Ascidae, in distinction to Blattisociidae and other podospermous families of Gamasina. While the location of *iv3* on the sternal shield in *Discoseius* is retained in some specimens, leaving setae *st4* alone on poorly sclerotized metasternal platelets, in others this retention is asymmetrical or *iv3* may be narrowly isolated on soft cuticle or with *st4* on weak platelets. The bluntly pointed form of the epigynal shield's posterior margin of *Discoseius* differs from that of other blattisociids. However, this attribute is subject to much homoplasy among speciose genera of related families, e.g., the bluntly pointed form among a few species of the ascid genus *Antennoseius* e.g., (*A. dungeri* Karg, 1965).

The genus *Discoseius* is based on its adult females having several apomorphies, some of which appear to be unique among the known taxa of Blattisociidae: (1) a pair of ribbed, soft cuticular, disc-like opisthogastric structures; (2) form of ventrianal shield, with narrow anteromedial extension between cuticular disc-like structures; (3) epigynal shield with bluntly pointed posterior margin; (4) deep postgenital and postanal furrows; (5) genu and tibia of leg II lacking seta *pl-2*; (6) tibia of leg IV lacking seta *pl-2*. Attributes (1), (2), (3), and (5?) appear to be unique to this genus. Attribute (4) is shared with members of the genus *Fungiseius*, one species of which is sometimes coexistent with *Discoseius perplexus*. Attribute (6) is otherwise typical only of the genus *Arrhenoseius* among blattisociids.

Adult females of the eviphidid genus *Canestriniphis*

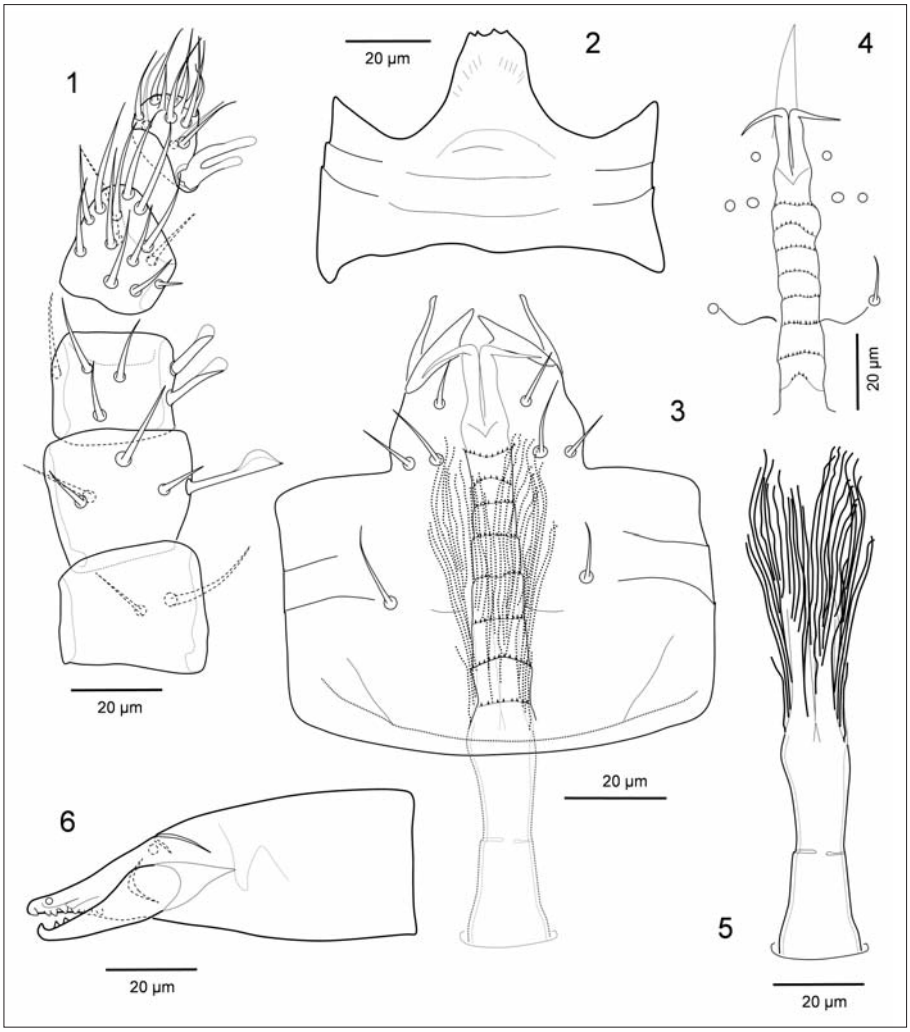

Figure IV – *Discoseius perplexus* n. sp., adult female.
1. Palpus, dorsolateral view; 2. Gnathotectum; 3. Subcapitulum; 4. Detail of deutosternum with rows of denticles; 5. Tritosternum, showing denticle at base of laciniae; 6. Chelicera, lateral view.

Potter & Johnston (1976) are remarkably similar to those of *Discoseius* in having a pair of nearly identical, transversally-ribbed, pliable, disc-like structures on the opisthogaster (Fig. III, 2, 3). Other similarities include a dorsal shield with lateral margins extending ventrally, somewhat tortoise-like, absences of paravertical setae *z1* and of one of the posterolateral pairs of *S*-setae on the dorsal shield, a gnathotectum with a strongly convex anterior margin, a robust, bushy tritosternum, and a bidentate movable cheliceral digit. Known only from a few specimens phoretic on adult erotylid beetles, these mites probably live in association with their carriers in bracket fungi. It is tempting, therefore, to consider *Canestriniphis* and *Discoseius* as sister taxa, based especially on the unique presence and form of the disc-like structures, along with living in similar substrates. However, other differences between the two taxa, above all, the plesiomorphic laelapoid-type form of the sperm access system in *Canestriniphis*, argue against this. Unlike *Discoseius*, female *Canestriniphis* are characterized by the following attributes: fixed cheliceral digit reduced to a hyaline appendage (apomorphy); setae *j2* similarly developed as others of *j*-series (plesiomorphy); sternal region lacking setae *st4* (apomorphy), and with lyrifissure *iv3* on soft cuticle well removed from posterior margin of sternal shield (plesiomorphy); endopodal strips between coxae II and III free from sternal shield (homoplasy); opisthogaster with anal shield (homoplasy); and a series of apomorphic leg setal deficiencies - femur II with 9 setae, lacking *pd-3*, *pl-2;* genu I and tibia I with 8 setae, each lacking *al-2*, *ad-3*, *pd-3*, *pl-2*, *v-3;* genu II with 7 setae, lacking *al-2*, *ad-3*, *pl-2*, *av-1;* genua III and IV with 7 setae, lacking *al-2*, *pv-1;* tibia II with 7 setae, lacking *al-2*, *ad-2*, *pl-2;* tibia III with 7 setae, lacking *al-2;* tibia IV with 7 setae, lacking *al-2*, *pd-3*, *pl-2* (loss of *pl-2* shared with *Discoseius*).

Although the dorsal shield setation of *Canestriniphis* is somewhat reduced, the *J*-series of five setae is retained, and not typical of most other genera of Eviphididae. Setae *r3*, *r5*, and *R1* were overlooked in the original description, but we observed them present on soft cuticle in the type series. Based on the different complex of sperm access systems between these two taxa, we conclude that the shared similarity of the soft, pliable disc-like structures is a remarkable example of convergence.

Discoseius perplexus new species
(Figs. I-V)

DIAGNOSIS – With attributes of the genus. In addition, dorsal shield entirely ornamented with elongate jigsaw-like reticula, with setae *j2* vestigial or minute, *J1-J5* very short, and *z4*, *s4*, *Z1-Z5* moderately long, blunt-tipped, *Z5* the longest; tritosternum with prominent, bushy laciniae.

DESCRIPTION – Adult female - Dorsal shield 383-400 long, 270-299 at its greatest width at level of setae *s6*; shield ornamented with elongate, jigsaw-like reticula over entire surface (Fig. I, 1, 4); shield with 28 pairs of smooth setae, the longest ones with blunt tips. Dorsal setae of dissimilar lengths; *j1* (15-17), *j2* vestigial (with a setal nubbin) or minute (2) (Fig. I, 2), *j3* (25-32), *j4-5* (9-10), *j6* (15-23), *z2* (23-27), *z4* (42-45), *z5* (10-13), *s1-s2* (5-10), *s4* (45-50), *r3* also short (11-12); *J1-J5* (5-8), *Z1-Z4* (42-50), *S2-S3* (22-25), *S5* (27-30), *Z5* (60-64) longest (Fig. I, 1, 3). Lateral soft cuticle usually with four pairs of simple setae *r5* and *R1, R4, R5* (13-15). Peritrematal plates uniting with dorsal shield anteriorly at level of setae *s1* (Fig. II, 1); peritremes long, apices reaching anteriorly slightly beyond level of setae *s1* where concealed from dorsal view (Fig. I, 1; Fig. II, 1).

Tritosternum (Fig. IV, 5) with base longer (15-20) than wide (12-15) at base, with laciniae peculiarly thick, bushy in form, free for about 0.6 to 0.8 of total length (78-85 excluding base), their fused area smooth. Presternal area ornamented with pair of weakly sclerotized platelets consolidated with sternal shield (Fig. II, 1; Fig. III, 1). Sternal shield length from anterior margin at level between setae *st1* to posterior margin 80-85, narrowest width between legs II 82-87, finely punctate over nearly entire surface and lineate along lateral margins (Fig. III, 1), posterior margin slightly concave; shield with strong endopodal extensions between coxae I-II which bear poroid *gst1* distally, and with well developed extensions between coxae II-III. Sternal setae *st1* (17-20) slightly longer than *st2-st3* (15-18), *st4* (13-17) on poorly sclerotized small metasternal plates, sometimes accompanied by poroids *iv3* on anterior edge of the plates, or *iv3* barely attached to posterior margin of sternal shield or free on soft cuticle. Endopodal strips moderately developed between coxae III and IV. Epigynal shield 110-120 long, 41-47 wide at level of genital setae, ornamented with one elongate cell on posterodistal region, axe-shaped, straight-sided, with bluntly pointed posterior margin; genital setae *st5* (15-18) subequal in length to *st2-st3*. Paragenital poroids *iv5* on soft cuticle well removed from posterolateral margins of epigynal shield. Ventrianal shield unornamented, axe-shaped, with narrow anterior projection (width 15-18) and broadly rounded posterior margin, midlength (93-108) greater than greatest width (74-78) at level of paranal glandular pores; three pairs of short (7-8) opisthogastric setae (*JV1*, *ZV2*, *JV3*) on lateral margins of narrow ventrianal extension, paranal setae (10-13) about half as long as postanal seta (21-27). Soft cuticle with seven pairs of short opisthogastric setae, *ZV1*, *JV3*, *JV4*, *ZV3* (5-8), *JV5, ZV4, ZV5* (13-16). Peritrematal shield consolidated with exopodal strip curving behind coxa IV and bearing poroids *ip1* (*ip2* off the shield), and gland pores *gp1*, *gp2*, *gp3*, *gv2* (Fig. II, 2). Metapodal plate length 7-8, width 17-21. Spermathecal apparatus with small (ca 20), thinly sclerotized, vasiform calyx, and fine minor duct emanating from hardly discernible embolus (Fig. II, 3).

Gnathotectum with anterior margin strongly convex, smooth or slightly serrated (Fig. IV, 2). Cheliceral shaft, excluding basal section, 60-65 long, with moderately small digits (Fig. IV, 6); dorsal face of fixed digit with short blunt dorsal seta; fixed digit with minute pilus dentilis, with row of six-seven small teeth along apical half of masticatory surface and one offset subapical tooth; movable digit (24-25) bidentate. Corniculi short (18-21), with medial edges and pointed apices strongly convergent (Fig. IV, 3); internal malae slender, tapered, folded laterally, much longer (32) than corniculi, and with smooth lateral margins. Deutosternum usually with eight rows of denticles sparsely multidenticulate (6-10 teeth), slightly widening from apical to basal row (Fig. IV, 4). Subcapitulum with setae *hp1* as short as *hp2* (10-12), these shorter than *hp3* (14-15) and *pc* (16-19). Palpi (85-90) nearly straight; palptrochanter with inner seta curved, longer (17-19) than outer seta (12-13); palpfemoral seta *al* (19) with spatulate, pointed tip (Fig. IV, 1); palpgenual setae *al-1* and *al-2* slightly spatulate, both with rounded tips; palptarsal claw with two tines spatulate with rounded tips (Fig. IV, 1).

Legs II-IV of similar lengths and thickness, shorter than dorsal shield length; legs I slightly longest (410-449, excluding distal peduncle (14-16) and pretarsus), slightly longer than dorsal shield; other leg lengths, excluding pretarsi: II 282-314, III 285-313, IV 325-365. Legs II to IV with tarsus about 2.2-2.4 times as long as tibia. Tarsi II-IV with pair of apical setal processes *ad-1, pd-1* moderately short (8-14), less than half as long as length of pretarsus to base of claws (25-30); tarsi II-IV with apical ventral process well developed (9-10), acutely triangular, 0.4 as long as length of pretarsus to base of claws (Fig. V, 5, 6). Leg I segment length ratios, femur: genu: tibia: tarsus, about 1.0: 0.8-0.9: 0.9: 1.7-1.8; tarsus (125-137) about 1.7-1.8 longer than femur (68-75), which slightly longer than genu (58-62) and tibia (62-70); length of pretarsus I to base of claws (15-17). Coxae I-IV lineated on ventral surface (Fig. V, 1, 2, 3, 4); coxal setae simple, moderately long (9-19). Legs I to IV with chaetotactic formulae of segments as described for genus. Legs without notably modified setae (Fig. V, 1, 2, 3, 4, 5, 7). Paired claws on tarsi I-IV with small basal swelling (Fig. V, 6).

TYPE MATERIAL – All specimens, holotype and three paratypes, adult females, collected from one sample: La Selva Biological Station, Heredia Province, Costa Rica (10º 26' 1" N, 84º 1' 2" W, elevation 50-150 m), Arboleda area, ex Hongo, 28 March 1995, coll. ALAS.

The holotype is deposited in the Instituto Nacional de Biodiversidad (INBio) of Costa Rica, Santo Domingo de Heredia; two paratypes are deposited in the Canadian National Collection of Insects and Arachnids (CNCI), Research Branch, Agriculture & Agri-Food Canada, Ottawa, and one paratype is deposited in the Museo de Zoología, Universidad de Navarra (MZUNAV), Pamplona, Spain.

ETYMOLOGY. The specific epithet, *perplexus*, derives from the Latin word meaning "puzzling" or "involved", and is intended to refer to conjectural aspects such as the peculiar structures of the female opisthosomatic venter and function of its disc-like structures, and the taxonomic placement of the genus.

REMARKS. Athough recovered from just one of many samples of mites found associated with bracket fungi in the lowland rainforest area of La Selva, *Discoseius perplexus* coexisted with a remarkable variety of other blattisociid mites, including the bizarrely stilt-legged *Opilioseius grallator* Lindquist & Moraza (2010), stout-legged forms of *Fungiseius armatus* Moraza & Lindquist (2011) and one or two species of *Hoploseius*, and at least three species of *Lasioseius* and two of *Cheiroseius*.

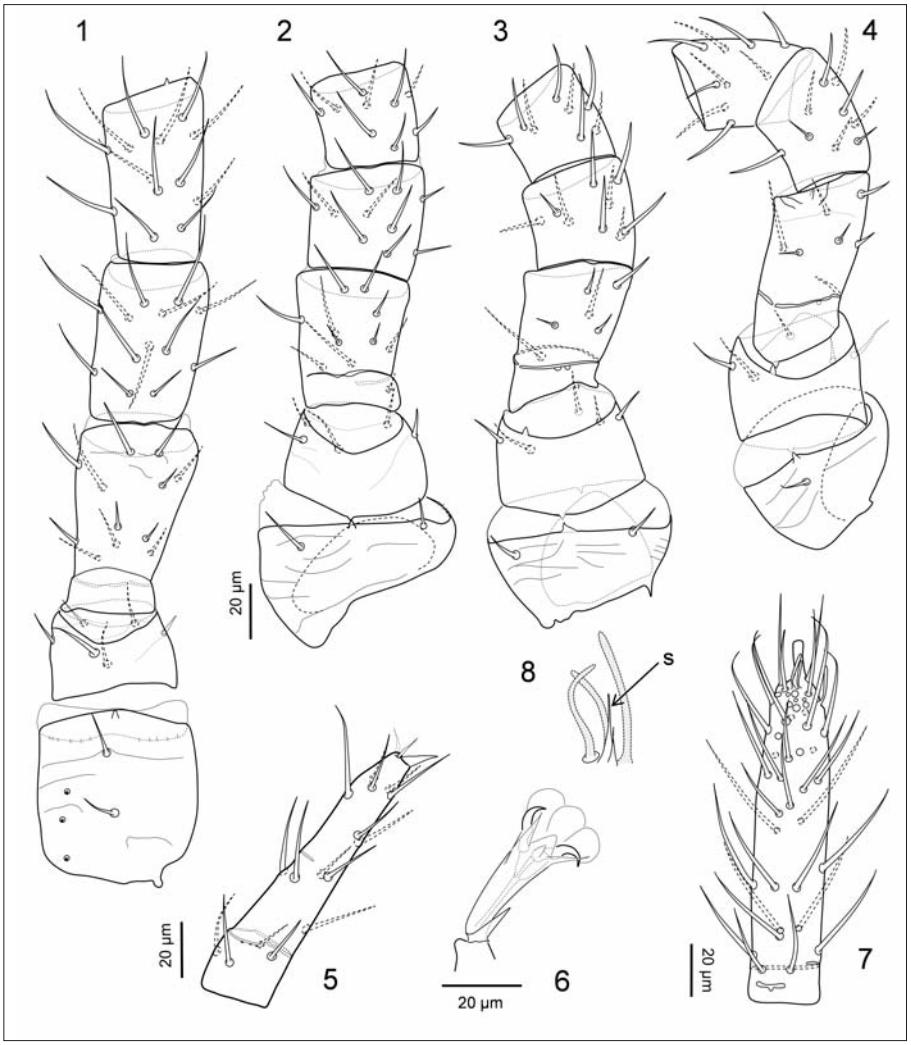

Figure V – *Discoseius perplexus* n. sp., adult female.
Discoseius perplexus n. sp., adult female.- 1-4, legs I-IV, excepting tarsi, coxae I-IV ventral view: 1. Leg I excluding tarsus, dorsal view; 2. Leg II, anterolateral view; 3. Leg III, anterolateral view; 4. Leg IV, anterolateral view; 5. Tarsus IV, lateral view; 6. Detail of pretarsus IV; 7. Tarsus I, dorsal view; 8. Detail of tarsal seta "s" and other sensorial setae.

DISCUSSION

STRUCTURE OF THE OPISTHOGASTRIC DISCS – At first glance, the form of the disc-like structures in female *Discoseius* and *Canestriniphis* may suggest an adhesive function, like those found among adult Heterozerconidae and Discozerconidae. While those of the latter families are quite evidently sucker-like, adhesive and present on adults of both sexes (TRÄGÅRDH, 1911; DOMROW, 1956; BAKER *et al.*, 1987; EVANS, 1992; GERDEMAN & ALBERTI, 2007), the structures in *Discoseius* and *Canestriniphis* do not convincingly indicate adhesion and may suggest another function. Females of *Canestriniphis* were not found to be "attached" to their beetle hosts by means of these structures (POTTER & JOHNSTON, 1976). In living form and when preserved in alcohol, these structures in *Discoseius* and *Canestriniphis* bulge outward from the surrounding surfaces. While one may think that some dorsoventral muscles could contract that bulging surface, causing a sucker-like adhesion, there appear to be two surfaces to these discs – an outer, bulging, finely transversely-striated one, and an inner, flat, unstriated one (seeming plain in *Discoseius* but granular in *Canestriniphis*, Fig. III, 2, 3). The outer surface does not appear to have any glandular pores or lyrifissures, and it covers the inner surface which does bear a lyrifissure and what appears to be a glandular pore associated with the inner pair of small metapodal platelets. When flattened from slide-mounting, the somewhat collapsed outer surface also overlaps one or two other lyrifissures, the inside edge of the lateral pair of small metapodal platelets, the insertions of setae *Jv1-Jv3* and *Zv1-Zv2*, and the narrowed lateral margins of the ventrianal shield (Fig. III, 2). These details, if perceived correctly, cast doubt on an adhesive function: there is no evidence of dorsoventral sigillae or muscular bundles other than those represented by the small metapodal plates, and the inner pair of these plates is separated from the striated soft cuticle of the outside surface of the discs; also, there is no sclerotized rim edging the disc, such as found among discozerconid and heterozerconid adults. Instead, these details lead conjecture to an entirely different function of these structures, perhaps as sacs capable of being filled with a liquid or gaseous sub-

stance. If the pore-like structure associated with the inner metapodal plate is glandular, this could be a conduit for liquid or gaseous substances from the opisthosomatic hemolymph. But if this is so, what would be the function of the substance in these sacs – defence or attraction or adhesion? And if so, for any of those, how is the substance expulsed, when no external glandular outlet is discernible?

In the absence of males, we have little notion of whether they may bear these disc-like structures. If indeed adhesive and used for phoresy, we would anticipate their absence on males, which are generally not known to be phoretic among the taxa of Blattisociidae [adult males of *Krantzoseius walteri* Seeman being exceptional (SEEMAN, 2012)]. But if present on males, this may be further evidence of a function other than adhesion.

PHORETIC ASSOCIATIONS AMONG ARTHROPODS INHABITING BRACKET FUNGI – The diversity of blattisociid mites that frequently coexist in bracket fungi in tropical lowland rainforest areas such as La Selva also reflects the diversity of forms of insects and other arthropods that occupy the same habitats. Blattisociid mites generally depend on a phoretic behavior of their adult females to disperse from one temporary habitat resource to another (WALTER & LINDQUIST, 1995). While the choice or preference of carrier may be fairly specific, as with females of *Hoploseius* known to be phoretic only on drosophilid flies (LINDQUIST, 1975) and those of some species of *Cheiroseius* phoretic on nematocerous flies (WHITSEL & SCHOEPPNER, 1973), we have scant notion about which other kinds of insects, especially beetles, may serve as carriers. As erotylid beetles have been found to carry adult female *Canestriniphis* in temperate regions (POTTER & JOHNSTON, 1976), these fungus-dwelling beetles should be among those examined for harbouring blattisociids in tropical regions.

Key to the world genera and subgenera of the subfamily Blattisociinae

Rationale for the synonymy of several subgeneric concepts of *Lasioseius* sensu Christian & Karg was presented by Moraza & Lindquist (2011).

1. Leg II of female usually much thicker than other legs; leg II with strong spine-like setae either on ventral faces of several segments or on dorsal and lateral faces of tarsus 2
- Leg II of female not thickened, lacking strong spine-like setae on ventral faces of several segments or on dorsal face of tarsus 3

2. Dorsal shield with lateral margins lacking a delineated strip that bears some of *s-S* or *r-R* setae; female with expansive ventrianal shield; leg II with strong, opposable spine-like setae on ventral faces of femur, genu, tibia and tarsus, but lacking strong clawlike setae on dorsal face of tarsus; leg I genu and tibia each with maximum of 11 setae (*pd-3*, *av-2* absent) ..... *Hoploseius* Berlese 1914
- Dorsal shield with lateral margins bearing a delineated strip that bears some of *r*-marginal setae anteriorly and the series of *S*- lateral setae posteriorly; female with small ventrianal shield or anal shield; leg II of female without strong opposable spine-like setae on ventral faces of femur and genu, but with two or more strong, clawlike setae dorsally on tarsus; leg I genu and tibia each with minimum of 12 setae (*pd-3* present, *av-2* present or absent) ..... *Fungiseius* Moraza & Lindquist 2011

3. Female opisthogaster with a pair of prominent disc-like structures on soft cuticle flanking narrow anterior extension of a ventrianal shield ..... *Discoseius* n. gen.
- Female opisthogaster lacking disc-like structures on soft cuticle, and with anal shield or broad, expansive ventrianal shield 4

4. Dorsal shield of adults with only 15 pairs of setae, 10 podonotal (*j2* absent) and 5 opisthonotal (*S*-series absent); stigmata lacking peritrematal extensions; palptrochanter with one seta ..... *Krantzoseius* Seeman 2012
- Dorsal shield of adults with at least 18 pairs of setae, minimally 11 podonotal (including *j2*) and 7 opisthonotal (including at least two of *S*-series); stigmata with well-developed peritremes; palptrochanter with two setae 5

5. Corniculi narrowly separated, usually slender; anterior margin of gnathotectum convex, smooth; fixed digit of chelicera with few or no teeth; peritrematal shield slender, barely wider than stigma at level of stigma; female with humeral seta *r3* usually on soft cuticle beside dorsal shield; protonymph with 2 setae on palptrochanter 6
- Corniculi well separated, stout; anterior margin of gnathotectum convex or triramous, smooth or denticulate; fixed digit of chelicera usually with many teeth; peritrematal shield clearly wider than diameter of stigma at level of stigma; female with humeral seta *r3* on dorsal shield; protonymph with usually 1 seta on palptrochanter 7

6. Dorsal shield without midlateral incisions; opisthonotal region of dorsal shield holotrichous, with 15 pairs of setae; fixed digit of chelicera well developed or reduced; female without isolated metasternal plates; leg IV of male without enlarged, spine-like setae ..... *Blattisocius* Keegan 1944 (including *Paragarmania* Nesbitt 1951, sensu Karg 1991)
- Dorsal shield with midlateral incisions; opisthonotal region of dorsal shield hypotrichous, with 12 pairs of setae (lacking a pair in each of *J*, *Z*, *S* series); fixed digit of chelicera well developed; female with isolated metasternal plates; leg IV of male with several enlarged, ventral spine-like setae ..... *Adhaerenseius* Loots & Theron 1992

7. Dorsal shield with 18 to 23 pairs of setae, lacking both podonotal setae *z3*, *z6*, *r2* and opisthonotal setae *J1-J3*, and *Z1* or *S1*; dorsal shield with humeral setae *r3* more or less erect, attenuated and undifferentiated in form from neighboring setae, simple or weakly barbed; genua of legs II and III with 10 and 8 setae, respectively, lacking *pv-1*; female ventrianal shield weakly sclerotized, unornamented, with 2 to 4 pairs of opisthogastric setae 8
- Dorsal shield with 23 to 38 pairs of setae, not lacking the above combination of setae and never lacking setae *J1*, *J2*, *Z1*; dorsal shield with humeral setae *r3* usually distinctively erect, its form (usually bushy or setulose or weakly to strongly tricarinate) more or less in contrast to inclined neighboring setae; genua of legs II and III usually with 11 and 9 setae, respectively, *pv-1* usually present; female ventrianal shield usually well sclerotized and ornamented, usually with 4 to 6 pairs of opisthogastric setae 9

8. Legs I to IV greatly elongated, I and IV two to three times as long as dorsal shield; legs II to IV with tarsi greatly elongated, over three times as long as the tibial segments; dorsal shield with 15 pairs of podonotal setae, *j1*, *s1*, *s2*, *s5* present; male with sternitigenital shield incised between sternal and genital regions, and not connected with endopodal fragments between coxae III-IV; male ventrianal shield small, its anterolateral margins remote from peritrematal/exopodal plates behind coxae IV; movable digit of female and nymphal chelicera multidentate, and with two grooves along paraxial surface ..... *Opilioseius* Lindquist & Moraza 2010
- Legs I to IV moderately elongated, I and IV at most 1.5 times as long as dorsal shield; legs II to IV with tarsi about 2.5 times as long as the tibial segments; dorsal shield with 11 pairs of podonotal setae, *j1*, *s1*, *s2*, *s5* absent; male with sternitigenital shield normally developed, not incised laterally, and fully integrated with endopodal strips alongside coxae III-IV; male ventrianal shield well developed, its anterolateral margins

abutting peritrematal/exopodal plates behind coxae IV; movable digit of female and nymphal chelicera quadridentate, lacking grooves along paraxial surface ..... *Aceodromus* Muma 1961

9. Adults with 3 to 10 pairs of marginal (*r-R*) and submarginal (*UR*) setae on soft lateral cuticle; female metapodal plates free on soft cuticle, female ventrianal shield with 6 or fewer pairs of setae in addition to circumanals; male usually with separate sternitigenital, ventrianal, and peritrematal-exopodal shields ..... *Lasioseius* Berlese 1916 10

- Adults with one pair of marginal setae (*R1*) on soft lateral cuticle; female metapodal plates incorporated into either ventrianal or peritrematal shields, female ventrianal shield with 7 pairs of setae in addition to circumanals; male with holoventral shield 11

10. Dorsal shield with humeral setae *r3* erect, usually tricarinate, and usually with some other (at least *j1*, *Z5*) or most setae tricarinate; gnathotectum variously shaped but without elongated median projection; movable cheliceral digit usually with 4 or less teeth; female with posterior margin of sternal shield straight or concave, and with slender endopodal plates beside coxae III and IV; male with separate sternitigenital, ventrianal, peritrematal-exopodal shields ..... *Lasioseius (Lasioseius)* Berlese 1916 (including *Borinquolaelaps* Fox 1946, *Crinidens* Karg, 1980, *Cuspiacus* Christian & Karg 2006, sensu Christian & Karg 2006)

- Dorsal shield with humeral setae *r3* not erect, and with nearly all setae simple, none tricarinate (*Z4* and/or *Z5* pencillate); gnathotectum with elongated, apically split median branch; movable cheliceral digit with 5 or more teeth; female with posterior margin of sternal shield convex, and with expansive endopodal plates beside coxae III and IV; male with holoventral shield ..... *Lasioseius (Endopodalius)* Christian & Karg 2006

11. Podonotal region of dorsal shield lacking setae *z1*, *s1*, *s2*; female with paragenital poroids on posterolateral corners of strongly widened epigynal shield, and with metapodal plates incorporated into anterolateral corners of ventrianal shield; male with 7 pairs of opisthogastric setae on ventrianal shield area; genu III with 10, tibia III with 9, and tibia IV with 10 setae (*pl-2* present on each) ..... *Zercoseius* Berlese 1916

- Podonotal region of dorsal shield holotrichous, setae *z1*, *s1*, *s2* present; female with paragenital poroids on soft cuticle abutting posterolateral corners of widened epigynal shield, and with metapodal plates incorporated into posterior margins of peritrematal shields; male with 4 pairs of opisthogastric setae on ventrianal shield area; genu III with 9, tibia III with 8, and tibia IV with 9 setae (each lacking *pl-2*) ..... *Arrhenoseius* Walter & Lindquist 2001

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