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Redefinition of the genus *Scarabacariphis* Mašán and new morphological data for *S. geotrupes* comb. nov. (Ishikawa) (Acari: Mesostigmata: Eviphididae)

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ABSTRACT — Herein, *Alliphis geotrupes* Ishikawa, 1979 is transferred to the genus *Scarabacariphis* Mašán, 1994 because of its free peritrematal shield (*i.e.* separated from the dorsal shield). The genus *Scarabacariphis* is redefined, and a key to the species of *Scarabacariphis* is provided, as well as additional morphological information for *Scarabacariphis geotrupes* **comb. nov.**

KEYWORDS — Eviphidoidea; *Alliphis*; new combination; Scarabaeoidea

INTRODUCTION

Predatory mesostigmatic mites of the family Eviphididae include about 130 described species under 20 genera that occur in soil, litter, and decomposing organic materials like vertebrate dung, carrion and nest of birds and mammals (Berlese 1910; Evans and Till 1979; Halliday 2008, 2010; Karg 1963, 1976, 1993; Kazemi and Rajaei 2013; Kazemi *et al.* 2008; Mašán 1994; Mašán and Halliday 2009, 2010; Ryke and Meyer 1957). Before publishing this paper, the genus *Scarabacariphis* Mašán, 1994 was a monotypic genus known only from Slovakia and Armenia (Arutunian, 1992; Mašán, 1994; Mašán and Halliday, 2010).

Ishikawa (1979) described *Alliphis geotrupes* based on specimens associated with *Geotrupes laevistriatus* (Matschulsky) collected in Japan. Based on the original description and illustrations of

the species, its peritrematal shields are less developed and free from the dorsal shield anteriorly. These character states define the genus *Scarabacariphis*. The purposes of this paper are to transfer *Alliphis geotrupes* to *Scarabacariphis*, present new morphological information for the species, redefine *Scarabacariphis* and prepare a key to the current members of the genus.

MATERIALS AND METHODS

The mite specimens used for this study were slides of one female paratype specimen of *Alliphis geotrupes* ex *Geotrupes laevistriatus* collected in Japan (Ishikawa 1979), and also three paratypes of *Scarabacariphis ankavani* (Arutunian, 1992) ex *Onthophagus fracticornis* (Preyssler) collected in Slovakia.

Morphological observations, measurements and illustrations were made using a compound microscope equipped with differential interference contrast and phase contrast optical systems, and a drawing tube. Measurements were made in micrometres (μm). Some measurements have been given in range when left and right side characters of the body differed in size. Dorsal and sternal shield lengths and widths were respectively taken from the anterior to posterior shield margins along the midline, and from the lateral margins at the broadest level between setae j6-J1 and at the level of setae st2. The length of the epigynal shield was taken from the anterior margin of the hyaline extension to the posterior margin of the shield along the midline; the shield width was taken at the level of setae st5. Anal shield length and width were measured along the midline from the anterior to posterior margin, including the cribrum, and at the broadest point, respectively. Leg lengths were taken from the base of the coxa to the apex of the tarsus, without the ambulacrum (stalk, claws and pulvillus). The length of the second cheliceral segment was measured from the base to the apex of the fixed digit, and the width at the broadest point. The length of the fixed cheliceral digit was taken from the dorsal poroid to the apex, and that of the movable digit from the base to apex.

The notation for idiosomal setae follows Lindquist & Evans (1965) adapted by Mašán and Halliday (2010); idiosomal pore-like structures, *i.e.* gland pores and poroids, follows mostly Athias-Henriot (1971, 1975), adapted by Kazemi *et al.* (2014).

Genus *Scarabacariphis* Mašán, 1994

Scarabacariphis Mašán, 1994: 6.

Type species *Scarabacariphis grandisternalis* Mašán, 1994 (= *Alliphis ankavani* Arutunian, 1992), by original designation.

Diagnosis — Idiosoma completely or partly covered by dorsal shield. Dorsal shield almost flattened, sub-oval, entire, finely reticulated over entire surface, free from peritrematal shields, usually bearing 29-30 pairs of mostly needle-like and short

setae, with 22 pairs of pore-like structures, including six pairs of gland pores (gd1-2, gd4, gd6, gd8-9). Weakly sclerotized presternal platelets present or absent. Sternal shield entire, almost as long as wide, with three pairs of simple narrow setae and two pairs of poroids, iv1 slit-like, oriented obliquely, iv2 ovoid. Endopodal platelets between coxae II-III completely fused to sternal shield; endopodals between coxae III-IV not enlarged, free. Metasternal setae and poroids iv3 on soft integument or situated on minute metasternal platelets. Epigynal shield inconspicuously reticulated, anterior hyaline margin of shield rounded, setae st5 on lateral marginal of shield or in soft integument; postgenital platelets absent. Anal shield subtriangular or pear-shaped, bearing simple and slender subequal circumanal setae. Exopodal platelets between coxae III-IV always present, those between coxae I-III present or absent; parapodal platelets narrow, free. Metapodal platelets small, narrow. Peritrematal shields finely developed along peritremes, free, post stigmatic section tapered, not extending beyond posterior level of coxae IV, with three pairs of poroids and two pairs of gland pores. Peritremes extending to anterior level of coxae I to II. Dorsolateral and ventral integument simply striated, in female with 10 pairs of simple setae (excluding st5), in male with eight setae. Sternogenital shield of male well separated from anal shield. Deutosternal groove with five rows of denticles, each with 2-13 teeth. Movable digit of female chelicera with one large tooth. Palpgenu with six setae. Palptarsus with one sickle-like seta and two-tined apotele. Epistome with long median projection, and wing-like lateral elements. Complement of leg chaetotaxy as: coxae 2-2-2-1; trochanter 6-5-5-5; femora 13-11-6-6; genua 11-11-8-7; tibiae 11-10-7-7. Male legs without spurs.

Notes on the genus — Ishikawa (1979) described an eviphidid species with most typical characters of the genus *Alliphis*, *A. geotrupes*, but he illustrated its peritrematal shields free from the dorsal shield. I confirmed this observation in the paratype specimen. The only genera of Eviphididae that bear free peritrematal shields from the dorsal shield are *Rafaphis* Skorupski & Błaszak, 1997 and *Scarabacariphis*, so the placement of *A. geotrupes* is not ac-

ceptable. Comparing these genera with free peritrematal shields, *Raphafis* is unrelated to *A. geotrupes* because of its unique character states for the Eviphididae, such as the dorsal shield extending ventrally and capturing three pairs of opisthogastric setae, reduced and sub-oval sternal shield, atypical leg chaetotaxy and also epistome. Although *Scarabacariphis* shares several characters with *A. geotrupes*, there are some morphological differences between the type species of this monotypic genus and *A. geotrupes*, including the absence of larval setae J2 in the latter species (present in *S. ankavani*), setae st5 off the epigynal shield (on the shield in *S. ankavani*), and exopodal platelets between coxae I–III present and small (absent in *S. ankavani*). Currently, the only eviphidid genus without setae J2 is *Podoniphis* Joharchi *et al.*, 2014, but they can be easily separated by the rudimentary peritrematal shields fused to the dorsal shield in *Podoniphis*, most dorsal shield setae in *Podoniphis* relatively elongated, except J5 minute and strongly reduced (setae J5 in *Scarabacariphis* and *Alliphis* not reduced, other setae not elongated) and also presence of a robust spine-like ventral setae in femur II of the female (absent in females of *Scarabacariphis* and *Alliphis*). The insertion of setae st5 off the epigynal shield can be seen in *Scarabaspis* Womersley, 1956 and some species of *Thinoseius* Halbert, 1920, and also with intraspecific variation in *Podoniphis persicus* Joharchi *et al.*, 2014 (on or off the shield but near its border). Moreover, although all of these mites have peritrematal shields fused to the dorsal shield, the members of *Scarabaspis* bear two sickle-like sensory setae on palptarsus (in contrast one in *Scarabacariphis* and *Alliphis*) and also flattened oval-shaped disc setae on coxae I–II (simple setae in *Scarabacariphis* and *Alliphis*); *Thinoseius* has some meaningful different characters that mostly seem to be autapomorphic attributes within Eviphididae, including presence of five setae on the palpgenu (six setae in other eviphidids), female dorsal shield with 11–17 pairs of setae showing considerable sexual dimorphism and also female sternal shield absent, reduced or fragmented into sclerotized platelets. So, based on these observations I propose to transfer *Alliphis geotrupes* to *Scarabacariphis* (see more in discussion).

***Scarabacariphis geotrupes* comb. nov.
(Ishikawa, 1979)**

Figures 1,2

Alliphis geotrupes Ishikawa, 1979: 117.

Diagnosis (adult female) — Dorsal shield usually with 29 pairs of subequal setae, setae s6, S1, S5 may be asymmetrically absent, J2 always absent, z1 shortest, Z5/J5 = 1.7. Presternal platelets absent. Anterior margin of sternal shield straight. Metasternal setae and poroids iv3 free on soft integument. Epigynal setae in soft integument. Exopodal platelets between coxae I–III present. Peritremes extending to anterior level of coxae II. Each row in deutosternal groove with 8–13 denticles.

Additions to original description

Dorsal idiosoma (Figure 1a) — Length of dorsal shield setae: j1 20 – 23, j2 22, j3 25 – 26, j4 24 – 29, j5 21 – 22, j6 23, J1 19 – 22, J3 18, J5 16 – 18, z1 10 – 11, z2–z4 25 – 26, z5 21 – 22, Z1 27, Z3 24, Z4 24 – 25, Z5 29 – 30, s2 21 – 22, s4 27 – 28, s5 28 – 29, s6 25, S1 22 – 25, S3 24 – 25, S4 26 – 28, S5 28. Lateral soft integument bears three pairs of short, needle-like setae, 18 – 23 long.

Ventral idiosoma (Figure 2a) — Base of tritosternum columnar, 32 long, 19 wide anteriorly, 33 wide posteriorly, laciniae sparsely plumose, 75 – 77 long. Presternal platelets absent. Sternal shield finely reticulate, 103 long, 105 wide, anterior margin of shield almost straight, posterior margin concave, with three pairs of smooth setae st1 (30 – 31), st2 (24), st3 (25) and two pairs of poroids, iv1 slit-like and oblique, iv2 ovoid. Metasternal setae (23 – 24) and iv3 in soft integument and flanked by subtriangular endopodal platelets between coxae III–IV. Epigynal shield tongue-shaped, 127 long, 63 wide, anterior hyaline margin of shield rounded, reaching to level of setae st4. Genital setae st5 inserted in soft integument, 25 – 27 long. Anal shield pear-shaped, as long as wide (86), finely reticulated, anal opening in middle of shield, para-anal setae (30 – 31) inserted almost at mid-level of anal opening, post anal seta (29) slightly shorter, cribrum well developed, without para-anal extensions. Exopodal platelets between coxae I–IV present, small; parapodal platelets narrow; metapodal platelets small,

FIGURE 1: *Scarabacariphis* spp. adult female: a – Dorsal idiosoma, *S. geotrupes* **comb. nov.**; b – Palp (palpfemur-palptarsus), *S. geotrupes* **comb. nov.**; c – Subcapitulum, *S. geotrupes* **comb. nov.**; d – Subcapitulum, *S. ankavani*.

FIGURE 2: *Scarabacariphis geotrupes* **comb. nov.**, adult female: a – Ventral idiosoma; b – Epistome; c – Chelicera.

narrow. Peritrematal shields developed along peritremes, anterior and posterior extensions of shields free, with two pairs of gland pores and three pairs of poroids. Peritremes 156 long, reaching to anterior margin of coxae II. Opisthogasteric membrane with eight pairs of smooth setae, including st5, 20 – 30 long, and six pairs of poroids including iv5.

Gnathosoma (Figures 1b-c, 2b-c) — Epistome with long median process, sparsely denticulate on 2/3 of base and plumose at apical 1/3, with one pair of lateral shorter projections apically dentate (Figure 2b). Internal malae with paired knife-like laciniae, conspicuously longer than corniculi; labrum bladeli-like, longer than internal malae; corniculi horn-like, 27 – 28 long. Hypostomal setae smooth, h3 (23) > h1 (19) > h2 (11) = pc (11). Deutosternal groove with five denticulate rows and one anterior and one posterior smooth rows; denticulate rows each with 8-13 denticles (Figure 1c). Second segment of chelicera 149 long, 41 wide; fixed and movable digits unidentate, 39 and 45 long, respectively; dorsal seta 13 long; small round hyaline process present behind movable digit (Figure 2c).

Legs — Legs with short and slender setae, leg chaetotaxy as genus standard. Lengths of legs I-IV 380 – 395, 340 – 368, 332 – 349 and 402 – 405, respectively.

Key to females of known species of *Scarabacariphis* Mašán

1. Dorsal shield bears 30 pairs of setae, J2 present; posterior dorsomarginal setae S1, S3-5, Z1, Z3-5 considerably longer than J series setae; peritremes long, reaching to anterior level of coxae I; epigynal setae on lateral margin of shield *S. ankavani* (Arutunia, 1992)

— Dorsal shield bears 29 pairs of setae, J2 absent; dorsal shield setae subequal in length; peritremes shorter, reaching to anterior level of coxae II; epigynal setae on soft integument *S. geotrupes* (Ishikawa, 1979) **comb. nov.**

DISCUSSION

The genus *Scarabacariphis* was erected by Mašán (1994) and diagnosed from the related genera *Alliphis* Halbert, 1923 and *Pelethiphis* Berlese, 1911 by the length of dorsal shield setae ("very short and approximately of equal length" in *Alliphis* and "very long and setae Z5 are usually more than 10-times shorter than the other marginal setae" in *Pelethiphis*) and size of the peritrematal shields and the shape of iv2 ("rounded in *Scarabacariphis*, slot-like in *Alliphis*"). Mašán and Halliday (2010) focused on the reduced peritrematal shields in *Scarabacariphis* in comparison to the genus *Alliphis*, but in the same work and in the key for the genera of European Eviphididae they also mentioned several other character states: the subventral position of setae j1 and z1 in *Scarabacariphis* and dorsal position of these setae in *Alliphis*; the subequal or moderately varying length of posterior dorsal shield setae in *Alliphis* compared with the conspicuously longer postero-marginal dorsal shield setae in *Scarabacariphis*; and the presence of exopodal platelets between coxae I-III in *Alliphis* and absence of them in *Scarabacariphis*. I have examined several species of *Alliphis* collected from Europe (*A. kargi* Arutunian, 1991, *A. halleri* (G. and R. Canestrini, 1881), *A. phoreticus* Mašán, 1994) and Iran (*A. halleri*, *A. scarabaeorum* Ogandzhanyan, 1969, and also undescribed species), and found the position of setae j1 and z1 in mounted specimens differs and is related to mounting of the specimens. Also, the length of the postero-marginal setae in *A. scarabaeorum* are up to five times longer than the shorter J series setae. So, it seems the free peritrematal shield in *Scarabacariphis* can be the only and main morphological differential diagnostic character between the genera *Alliphis* and *Scarabacariphis*.

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