

A new genus and species record for Mongolia and Republic of Korea, *Alliphis necrophilus* Christie, 1983 (Parasitiformes: Eviphididae)

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Associations of wingless mites with winged arthropods highlight important life history strategies and ecological interactions. Here we report a mesostigmatan mite species association with an earth-boring dung beetle. Mite specimens were collected from the soil of organic apple orchards in the Province of Gyeongsangbuk-do, Republic of Korea, and cattle dung was collected from grassland in Mongolia. The species was identified as *Alliphis necrophilus* Christie, 1983 (Acari: Eviphididae). This is the first report of any species in the genus *Alliphis* in Korea. Some descriptive details and ecological remarks are also provided.

Keywords: association, *Chromogeotrupes auratus*, dung beetle, *Geotrupes amoenus*, Geotrupidae, phoresy

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INTRODUCTION

Mites in the superfamily Eviphidoidea are primarily humus and litter-inhabiting predators. Many mites in the Eviphidoidea have adapted to transient habitats such as dung and carrion. These species form phoretic relationships with a variety of arthropods (Lindquist *et al.*, 2009).

The family Eviphididae mites body size is a small to medium-sized free-living mesostigmatid mite group with a cosmopolitan distribution (Halliday, 2010). Eviphididae mites are abundant in various habitats, including stable and continuous microhabitats in soil and leaf litter, as well as temporally and spatially isolated patches of resources such as dung and carrion (Mašán and Halliday, 2010). The family includes insecticolous species that have intimate associations with scarab beetles that inhabit the subelytral cavity of their hosts and breed in their subterranean nesting chambers. Phoresy enables these mites continued existence on ephemeral and scattered habitats such as animal excretion (Mašán and Halliday, 2010). *Alliphis* is one of the largest genera within

the Eviphididae. It currently includes about 20 species mostly associated with scarab beetles and is primarily distributed in the Palearctic region, although some species are found in Africa and Australia (Mašán and Halliday, 2010).

In addition to scarab beetles, eviphidid mites also form associations with beetles in the families Geotrupidae and Silphidae species of which are strongly associated with animal dung or carrion (Mašán and Halliday, 2010). Mašán and Halliday (2010) reported *Alliphis halleri*, *A. kargi*, *A. phoreticus*, *Alloseius pratensis* species that form associations with the family Geotrupidae beetles.

Two species in the family Eviphididae have been reported in Korea; *Copriphs hastatellus* Berlese, 1910 and *Holostaspella scatophila* Evans and Hyatt, 1963. These species are associated with *Copris* dung beetles (Coleoptera: Scarabaeidae). This paper reports the observation of *Alliphis necrophilus* Christie, 1983 in the family Eviphididae. This is the first report of this genus and species in Korea. We provide some detailed descriptions relative to those of Christie (1983), Mašán (1994) and Mašán and Halliday (2010).

MATERIALS AND METHODS

We collected soil samples from organic apple orchards in Punggi, Province of Gyeongsangbuk-do, Republic of Korea (36°50' N, 128°28' E) during 2012. Mite specimens were extracted using a modified Berless-Tullgren funnel (30W, 72h) and preserved in 70% ethyl alcohol. Additional specimens of the species were collected from cattle dung beetles (*Geotrupes amoenus* (Coleoptera: Geotrupidae)) and associated soil from grassland in Mongolia (48°15' N, 106°50' E). Mite specimens were removed from insects using an entomological pin. Mites were cleared in lactophenol solution and mounted on slide glass using polyvinyl alcohol mounting medium (PVA medium) (Downs, 1943). Morphological features of adult female and setal measurements were conducted under the compound phase contrast microscope (Olympus JP/BX51) equipped with a drawing tube. New record species are deposited in Insect Ecology Lab, Department of Plant Medicine, Andong National University (ANU), Andong, Korea and also in NIBR (ZIIYIV 0000754963).

RESULTS AND DISCUSSION

Family Eviphididae Berlese
Eviphididae Berlese, 1913: 11.

Genus *Alliphis* Halbert
Alliphis Halbert, 1923: 369. Type species *Gamasus halleri* G. & R. Canestrini, 1881, by monotype.

Diagnosis. Dorsal idiosoma. Idiosoma dorso-ventrally flattened. Dorsal shield entire, suboval, almost completely covering dorsal idiosoma, never expanded ventrally, with simple rounded vertex, with fine reticulation at least on marginal area of shield. Dorsal shield with 30 pairs of subequal, uniform, needle-like setae, only *j*₁ sometimes slightly thickened, lanceolate; *j*₁ and *z*₁ in dorsal position on vertex. Sexual dimorphism of dorsal chaetotaxy absent. Some dorsal pore-like structures conspicuous hypertrophied, elongate.

Ventral idiosoma. Presternal platelets present, small, paired, weakly sclerotised and transversely striate. Ventral shield with weak sculptural ornamentation on surface. Sternal shield well sclerotised, with three pairs of setae and two pairs of lyrifissures, first pair small, oriented obliquely to longitudinal axis. Anal shield usually subtriangular, with three subequal circum-anal setae. Gnathosoma. Palptarsus without paired macroeupathidia. Epistome with elongate central projection and wing-like lateral elements usually densely serrated on distal margin.

Alliphis necrophilus Christie, 1983

Alliphis necrophilus Christie, 1983: 232; Mašán, 1994: 7; Takaku *et al.*, 1994: 306; Ma, 1996: 54; Schwarz *et al.*, 1998: 162; Makarova, 1998: 115; Mašán, 1999: 517.

Alliphis yinchuanensis Gu & Bai, 1997: 249 (synonymy by Mašán and Halliday, 2010: 30).

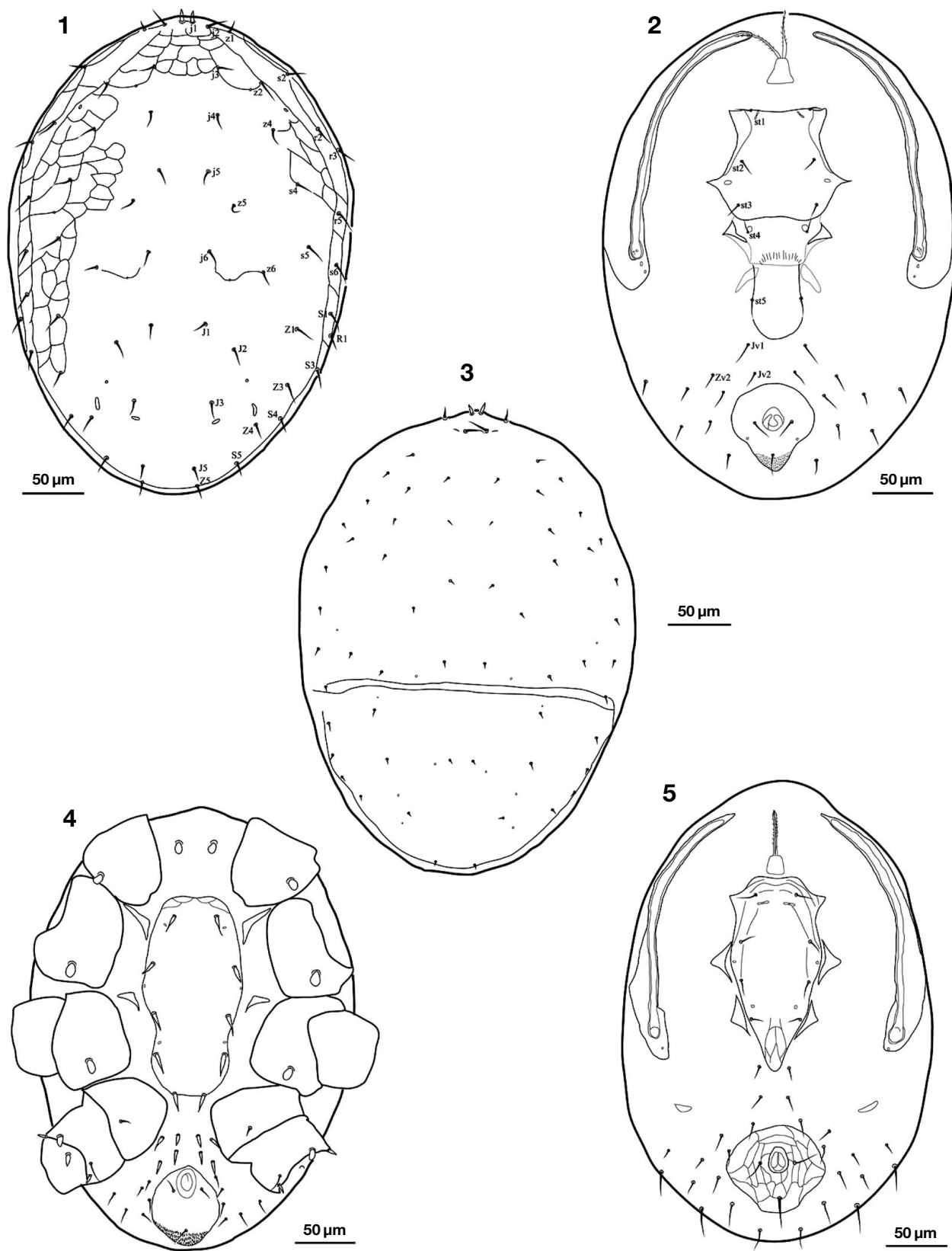
Alliphis brevisternalis Ma & Wang, 1998: 12 (synonymy by Mašán and Halliday, 2010: 30).

Specimens examined. three females, Punggi, Yeongju, Province of Gyeongsangbuk-do, Republic of Korea, 36° 50' N, 128°28' E, alt. 542 m, 27 April 2012, E. Keum coll., from soil of organic apple orchard; two females, three males, 27 deutonymph, Mongolia, 48°15' N, 106° 50' E, alt. 68 m, 21 Jun 2015, J. Kim and C. Jung coll., from *Geotrupes amoenus* (Geotrupidae).

Diagnosis. Dorsal idiosoma. Dorsal shield suboval, relatively wide, 410-525 µm long and 280-380 µm wide in females, 340-500 µm long and 230-305 µm wide in males, distinctly reticulated only in marginal areas. Dorsal setae relatively short, subequal in length in females.

Ventral idiosoma. Presternal platelets present. Sternal shield approximately as wide as long, 98-124 µm long and 90-120 µm wide, smooth; first pair of sternal pores slit-like, oriented obliquely. Epigynal shield 47-72 µm wide. Post-genital sclerites absent. Anal shield slightly wider than long, 63-89 µm long and 76-101 µm wide, subtriangular, with rounded anterior margin and smooth surface. Epistome with elongated central projections; lateral wing-like elements poorly developed, sloping, densely serrated on anterior margin.

Remarks. *Alliphis necrophilus* is a necrophilous species specifically associated with burying beetles (Coleoptera: Silphidae) and cadavers of small mammals attacked by burying beetles. Among the burying beetles, *Nicrophorus* burying beetles seem to be preferred: *N. humator* and *N. vespillo* in Slovakia, Poland and China (Mašán, 1994; Ma, 1996; Haitlinger, 2004), *N. vespilloides* in Scotland (Christie, 1983), *N. maculifrons* and *N. quadripunctatus* in Japan (Takaku *et al.*, 1994), and *N. japonicus* in China (Gu and Bai, 1997). Haitlinger (2004) reported an association of *A. necrophilus* with other beetles: *Oiceoptoma thoracica*, *Silpha obscura* (Silphidae) and *Trichodes apiarius* (Cleridae). In our study, *A. necrophilus* were collected from the earth-boring dung beetle *Geotrupes amoenus* (Coleoptera: Geotrupidae) in Mongolia. In Korea *Chromogeotrupes auratus* in the family Geotrupidae, can be found in mountain and grassland habitats (Kwang *et al.*, 2011). Thus this species could occur in association with *Ch. auratus* in Korea as well. Mites collected from the soil of organic apple orchards may also be associated with burying beetles. Kim (2016) reported a higher abundance of ground beetles in organic apple



Figs. 1-5. *Alliphis necrophilus*, female, 1, dorsal idiosoma; 2, ventral idiosoma; male, 3, dorsal idiosoma; 4, ventral idiosoma; deutonymph, 5, ventral idiosoma.

orchards than in conventional orchards. Also higher input of organic materials in organic apple orchards than conventional orchards for nutritional management and weed management could help inhabit those ground beetles as well as the associated mites. To date, there have been two species of Eviphididae reported in Korea; *Copriphus hastatellus* Berlese, 1910 and *Holostaspella scatophila* Evans and Hyatt, 1963. This study adds the species *Alliphis necrophilus* Christie, 1983 to Korean fauna record. Further study of the phoretic mites associated with beetles could reveal their ecological interactions.

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REFERENCES

- Berlese, A. 1913. *Acarotheca Italica* (Ricci, Firenze). 221p.
- Christie, J.E. 1983. A new species of *Alliphis* (Mesostigmata: Eviphididae) from Britain. *Acarologia* 24:231-242.
- Downs, W.G. 1943. Polyvinyl alcohol: a medium for mounting and clearing biological specimens. *Science* 97:539-540.
- Gu, Y.M. and X.L. Bai. 1997. A new species of *Alliphis* from China (Acari: Eviphididae). *Acta Zootaxonomica Sinica* 22:249-251.
- Haitlinger, R. 2004. Mites (Acari) occurring on some Coleoptera in Poland. *Polskie Pismo Entomologiczne* 73:3-24.
- Halbert, J.N. 1923. Notes on Acari, with descriptions of new species. *Journal of the Linnean Society, Zoology* 35:363-392.
- Halliday, R.B. 2010. Revision of the Australian Eviphididae (Acari: Mesostigmata). *Zootaxa* 2596:1-60.
- Kim, J.W. 2016. Comparison of arthropod diversity between organic and conventional apple orchards in Korea. Thesis of Andong National University, 1-169.
- Kwang, S.O., K.M. Hong, J.Y. Seok, W.R. Jae and Y.B. Cho. 2011. Study of beetles and butterflies in the area Dowon-valley, Mt. Masan, Gangwon province, Korea. *Journal of Korean Nature* 4(1):7-10.
- Lindquist, E.E., G.W. Krantz and D.E. Walter. 2009. Order Mesostigmata. In: G.W. Krantz and D.E. Walter (eds.), *A manual of Acarology* (Third Ed.), Texas Tech. Univ. Press. pp. 124-232.
- Ma, L.M. 1996. The discovery of *Alliphis necrophilus* in China (Acari: Eviphididae). *Acta Zootaxonomica Sinica* 21:54.
- Ma, L.M. and S.R. Wang. 1998. A new species of the genus *Alliphis* from China (Acari: Gamasina: Eviphididae). *Acta Arachnologica Sinica* 7:12-14.
- Makarova, O.L. 1998. A new eviphidid mite genus (Parasitiformes; Mesostigmata; Eviphididae) associated with the dung beetle *Scarabaeus transcaspicus* Stolfa (Coleoptera: Scarabaeidae) in Turkmenistan. *Acarologia* 39:115-122.
- Mašán, P. 1994. The eviphidid mites (Acarina: Mesostigmata: Eviphididae) associated with scarabaeid and carrion beetles (Coleoptera: Scarabaeidae, Silphidae) in Central Europe. *Acarologia* 35:3-19.
- Mašán, P. 1999. Mites (Acarina) associated with burying and carrion beetles (Coleoptera, Silphidae) and description of *Poecilochirus mrciaki* sp. nov. (Mesostigmata, Gamasina). *Biologia, Bratislava* 54:515-524.
- Mašán, P. and R.B. Halliday, 2010. Review of the European genera of Eviphididae (Acari: Mesostigmata) and the species occurring in Slovakia. *Zootaxa* 2585:1-122.
- Schwarz, H.H., M. Starrach and S. Koulianos. 1998. Host specificity and permanence of associations between mesostigmatic mites (Acari: Anactinotrichida) and burying beetles (Coleoptera: Silphidae: *Nicrophorus*). *Journal of Natural History* 32:159-172.
- Takaku, G., H. Katakura and N. Yoshida. 1994. Mesostigmatic mites (Acari) associated with ground, burying, roving carrion and dung beetles (Coleoptera) in Sapporo and Tomakomai, northern Japan. *Zoological Science* 11:305-311.

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