**Spatulaphorus geotruporum** (Acari: Pygmephoridae) a new record for mites fauna of Asia, with some notes on the genus

Sarina Seyedein, Vahid Rahiminejad* and Ahmad Nadimi

Department of Plant Protection, Faculty of Plant Production, Gorgan University of Agricultural Science and Natural Resource, Golestan, Iran.

**ABSTRACT.** During a comprehensive survey of the heterostigmatic mites associated with dung beetles in the hyrcanian forests, northern Iran, several colonies of the pygmephoroid mites including four species of the genus *Spatulaphorus* Rack, 1993, *S. copridis* Khaustov, 2007, *S. gorganica* Rahiminejad & Hajiqanbar, 2011, *S. vladimiri* Khaustov, 2005 and *S. geotruporum* Khaustov, 2005 phoretic on *Geotrupes spiniger* (Marsham, 1802) were found. This is the first record of *S. geotruporum* from Asia. Furthermore, this is the first record of phoresy of *S. geotruporum* on *G. spiniger*.

**Key words:** Heterostigmatina, Dung beetles, Phoresy, Host preference, Iran

**Introduction**

Dung beetles are considered as a perceptible component of the diversity of insects in tropical rain forests (Halffter & Matthews, 1966) which have received proportionate attention from entomologists because of their remarkable adaptations in decomposing vertebrate dung pads (Bornemissza, 1960; Villalba et al., 2002). They are utilized by many phoretic mites for dispersal purposes (Peck & Forsyth, 1982). Mites of the family Pygmephoridae Cross, 1965 consist primarily of free-living and generally fungivorous species, which are described based only on adult females (Kaliszewski et al., 1995; Krantz & Walter, 2009); the pygmephorid family is the second largest family in the superfamily Pygmephorioidea and include 31 genera and more than 300 species (Khaustov & Trach, 2018). Some mites of all four families of Pygmephorioidea, Pygmephoridae Cross, 1965, Neopygmephoridae Cross, 1965, Microdispidae Cross, 1965 and Scutacaridae Oudemans, 1916, can establish close interaction with geotrupid beetles (Khaustov & Frolov, 2018). Furthermore, representatives of five genera of this family utilize dung beetles for phoretic dispersal: *Pediculaster* Vitzthum, 1927; *Geotrupophorus* Mahunka, 1970; *Pygmephorellus* Cross and Moser, 1971; *Spatulaphorus* Rack, 1993 and *Pseudopygmephorellus* Khaustov, 2008.
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(Khaustov & Trach, 2012). The genus *Spatulaphorus* Rack, 1993 is comprised of 14 described species and known to have phoretic relationships with different dung beetles from the families Geotrupidae and Scarabaeidae (Rahiminejad et al., 2011; Khaustov & Trach, 2012; Khaustov & Forolov, 2018). Heretofore four species of the genus *Spatulaphorus* have been described and recorded from Iran: *S. gorganica* Rahiminejad and Hajiqanbar, 2011, *S. copridis* Khaustov, 2007, *S. vladimiri* Khaustov, 2005 and *S. gymnopleuri* Sobhi and Hajiqanbar, 2017, which were collected from geotrupid beetles, *Geotrupes spiniger* Marsham, 1802 (Rahiminejad et al., 2011, 2013; Katlav et al., 2015) except *S. gymnopleuri* that found on Scarabaeid beetle, *Gymnopleurus flagellates* (F.) (Sobhi et al., 2017).

Following a comprehensive study upon heterostigmatic mites associated with coprophagous beetles in hyrcanian forests of northern Iran, several colonies of aforementioned species as well as *S. geotruporum* as a new record for acarine fauna of Asia were found. In the current work, we are aiming to report some species of *Spatulaphorus*, also some notes on leg chaetotaxy, distributions and host range of this genus.

**Material and methods**

The host beetles were collected as a result of several samples from Golestan province (Naharkhoran, Alangdareh, Toshan and Ghorogh Forests and Hezarpich Region), northern Iran in 2018. All the mite species were detached from *Geotrupes spiniger* (Col.: Geotrupidae). Host beetles were captured by a light trap or direct sampling from Oak forests.

The mites were cleared in lactophenol and mounted in Hoyer’s medium. A light microscope with phase contrast (Olympus BX51) was used for morphological study of the mites. The taxonomic system of Pygmephoroidea follows Khaustov (2004, 2008); the terminology of idiosoma and legs follows that of Lindquest (1986); the nomenclature of subcapitular setae and the designation of cheliceral setae follow that of Grandjean (1944, 1947), respectively. With using a global positioning system (GPS smart phone device), details of geographical position have been recorded.

**Results**

In this study four species of *Spatulaphorus* Rack, 1993 identified.

**Family Pygmephoridae Cross, 1965**

**Genus Spatulaphorus Rack, 1993**

**Type species:** *Spatulaphorus camerikae* Dastych and Rack, 1993, by original designation.

**Spatulaphorus geotruporum** Khaustov, 2005

**Material examined.** Six specimens of adult females were obtained in bottom of a vial containing twelve of *Geotrupes spiniger* (Col.: Scarabaeoidea: Geotrupidae). The host beetles were collected with direct sampling in Toshan Forest, 36.46° N, 54.25° E, 203 m a.s.l., 12.IX.2018, leg., V. Rahiminejad.

**Diagnosis.** *Spatulaphorus geotruporum* can be identified by the reduced apodemes 4 and the subequal setae c₁ and c₂.

**Remarks.** This species is recorded from Iran for the first time. Moreover, the association between this mite and *G. spiniger* is new (see Table 2). This species was described from Ukraine (Khaustov, 2005) associated with *G. stercorarius* L..

**Spatulaphorus vladimiri** Khaustov, 2005

**Material examined.** Five large colonies of adult females were obtained under the elytra of *G. spiniger*. The host beetles were collected by light trap in Naharkhoran forest, 36.46° N, 54.27° E, 450 m a.s.l., 12.IX.2018 and Hezarpich region, Golestan province, northern Iran, 36.46° N, 54.24° E,
Diagnosis. The species can be simply identified by short and foliate setae of $sc_2$, $c_2$, $d$, $f$, $h_2$.

*Spatulaphorus copridis* Khaustov, 2007

**Material examined.** Two females obtained in bottom of two vials containing *G. spiniger*, submerged in ethyl alcohol 75%. The host beetle was collected with light trap from Oak trees in Alangdareh forest, 36.46° N, 54.26° E, 311 m a.s.l., 9.VIII.2018, leg., V. Rahiminejad and S. Seyedein.

Diagnosis. *Spatulaphorus copridis*, clearly distinguished from all known species of *Spatulaphorus* by having only one seta ($l'$) on genu I.

*Spatulaphorus gorganica* Rahiminejad & Hajiqanbar, 2012

**Material examined.** Nine large colonies of females obtained under the elytra of *G. spiniger*. The host beetles were collected with light trap from Oak trees in Naharkhoran forest, 36.46° N, 54.27° E, 409 m a.s.l., 5.VII.2018; Alangdareh forest, 36.46° N, 54.26° E, 317 m a.s.l., 18.VII.2018 and Toshan Forest, 36.46°N, 54.25°E, 206 m a.s.l., 21.VIII.2018, leg., V. Rahiminejad and S. Seyedein.

Diagnosis. *Spatulaphorus gorganica*, can be identified by having modified and spine-like setae $tc'$, $pl''$ (on tarsus III) and $pl''$ (on tarsus IV) are another evidences that indicate various speciation paths in this genus (Table 1).

Discussion

It is worth to be noted the state of possessing only one seta on genu I (absence of $l'$) is a unique autapomorphic character for *S. copridis* that may implies this to be considered as the most derivative species within the genus; In the other hand, modified (Spine or Foliate -like) setae $tc'$, $pl''$ (on tarsus III) and $pl''$ (on tarsus IV) are another evidences that indicate various speciation paths in this genus (Table 1).

Among the pygmephorid mites associated to Coleoptera, females of *Geotrupophorus* and *Spatulaphorus* have most association with geotrupid beetles, and several species of *Elattoma* and *Pygmephorellus* are associated with a variety of subcortical and dung-inhabiting beetles (*Krantz & Walter, 2009*). All members of the genus *Spaulaphorus* have been recorded to be exclusively phoretic on coprophagous beetles belonging to the families Geotrupidae and Scarabaeidae (*Geotrupes* (Col.: Geotrupidae), *Copris*, *Onitis*, *Catharsius* (Col.: Scarabaeidae: Coprinae) and *Gymnopleurus* (Col.: Scarabaeidae: Gymnopleurini)) (Table 2). Heretofore the four species of the genus *Spatulaphorus*, *S. gorganica*, *S. copridis*, *S. vladimiri* and *S. geotruporum* have been described and recorded from Iran and Ukraine and all of them were collected from the dung beetle *Geotrupes spiniger*. This may corroborate the status of the beetles of the family Geotrupidae as a preferential host for these mites. However more investigations are required to ascertain whatever potential dung inhabiting host families they have phoretic relationship with.

Acknowledgments

The study was supported by the Gorgan University of Agricultural Science and Natural Resource.

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.
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Table 1. Leg setation difference among species of the genus Spatulaphorus (females).

<table>
<thead>
<tr>
<th>Species</th>
<th>S. geotrupi</th>
<th>S. foliates</th>
<th>S. langi</th>
<th>S. camerikae</th>
<th>S. luriei</th>
<th>S. geotruporum</th>
<th>S. vladimiri</th>
<th>S. copris</th>
<th>S. gorganica</th>
<th>S. tenue</th>
<th>S. emplutoriporum</th>
<th>S. Altaicus</th>
<th>S. brasiliensis</th>
<th>S. gymnopileuri</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seta l” on Genu I</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Seta u' on Tarsus II</td>
<td>+</td>
<td>-</td>
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<td>+</td>
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<td>+</td>
</tr>
<tr>
<td>Spine-like seta on Tarsus II</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
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</tr>
<tr>
<td>Spine-like seta pII on Tarsus III</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
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</tbody>
</table>

Table 2. Information about hosts, locality and reference of all known species of the genus Spatulaphorus.

<table>
<thead>
<tr>
<th>Species</th>
<th>Host</th>
<th>Locality</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. geotrupi</td>
<td>Geotrupes sp. (Geotrupidae)</td>
<td>Hungry Ukraine</td>
<td>Mahunka, 1970 Khaustov, 2005</td>
</tr>
<tr>
<td>S. foliates</td>
<td>Onitis sp. (Scarabaeeidae)</td>
<td>Botswana</td>
<td>Dastych &amp; Rack, 1993</td>
</tr>
<tr>
<td>S. langi</td>
<td>Catharsius sp. (Scarabaeeidae)</td>
<td>Vietnam</td>
<td>Dastych &amp; Rack, 1993</td>
</tr>
<tr>
<td>S. camerikae</td>
<td>Catharsius ulysses (Boheman) (Scarabaeeidae)</td>
<td>Botswana</td>
<td>Dastych &amp; Rack, 1993</td>
</tr>
<tr>
<td>S. luriei</td>
<td>Scarab beetles (Scarabaeeidae)</td>
<td>South Africa</td>
<td>Dastych et al., 1997</td>
</tr>
<tr>
<td>S. geotruporum</td>
<td>Geotrupes stercorarius L. (Geotrupidae)</td>
<td>Ukraine Iran</td>
<td>Khaustov, 2005 Present study</td>
</tr>
<tr>
<td>S. vladimiri</td>
<td>Geotrupes stercorarius (Geotrupidae)</td>
<td>Ukraine Iran</td>
<td>Khaustov, 2005 Katlav et al., 2015</td>
</tr>
<tr>
<td>S. copris</td>
<td>Copris lunaris (Mueller) (Scarabaeeidae)</td>
<td>Ukraine Iran</td>
<td>Khaustov, 2007 Rahiminejad et al., 2013</td>
</tr>
</tbody>
</table>
Table 2. Continued.

<table>
<thead>
<tr>
<th>Species</th>
<th>Host</th>
<th>Locality</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. gorganica</td>
<td>Geotrupes spiniger (Geotrupidae)</td>
<td>Iran</td>
<td>Rahiminejad et al., 2011</td>
</tr>
<tr>
<td></td>
<td>Geotrupes stercorarius (Geotrupidae)</td>
<td></td>
<td>Khaustov &amp; Trach, 2012</td>
</tr>
<tr>
<td>S. venustus</td>
<td>Geotrupes mutator (Marsham, 1802)</td>
<td>Ukraine</td>
<td>Khaustov &amp; Trach, 2012</td>
</tr>
<tr>
<td>S. enoplotruporum</td>
<td>Enoplotrupes sp. (Geotrupidae)</td>
<td>Thailand</td>
<td>Khaustov &amp; Frolov, 2018</td>
</tr>
<tr>
<td>S. altaicus</td>
<td>Geotrupes baicalicus Reitter (Geotrupidae)</td>
<td>Russia,</td>
<td>Khaustov &amp; Trach, 2018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Altay Republic</td>
<td></td>
</tr>
<tr>
<td>S. brasiliensis</td>
<td>Dichotomius podalirius Felsche, 1901</td>
<td>Brazil,</td>
<td>Khaustov &amp; Frolov, 2017</td>
</tr>
<tr>
<td></td>
<td>(Scarabaeidae)</td>
<td>Amazonas</td>
<td></td>
</tr>
<tr>
<td>S. gymnopleuri</td>
<td>Gymnopleurus flagellatus (Fabricius, 1787)</td>
<td>Iran</td>
<td>Sobhi et al., 2017</td>
</tr>
<tr>
<td></td>
<td>(Scarabaeidae)</td>
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</tr>
</tbody>
</table>

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Acarological Conference, St. Petersburg. Zoological Institute of RAS, St. Petersburg, p. 137. [in Russian]


اولین گزارش برای فون (Acari: Pygmephoridae) Spatulaphorus geotruporum کنه‌های آسیا. همراه با بیان برخی نکات در مورد جنس

سارینا سیدین، وحید رحیمی نژاد و احمد ندیمی

گروه گیاهپزشکی، دانشکده تولید گیاهی، دانشگاه علوم کشاورزی و منابع طبیعی گلستان، ایران.

پست الکترونیکی نویسنده مسئول مکاتبه: vahidrahiminejad@gau.ac.ir

تاریخ دریافت: ۰۴ اردیبهشت ۱۳۹۸، تاریخ پذیرش: ۲۵ اردیبهشت ۱۳۹۸، تاریخ انتشار: ۳۱ اردیبهشت ۱۳۹۸

چکیده: در طول بررسی کنه‌های هترواستیگماتیکی مرتبط با سوسک‌های سرگین-غلطان در جنگل‌های هیرکانی شمال ایران، چندین کلنی از کنه‌های خانواده Spatulaphorus Rack, 1993 شامل چهار گونه از جنس Pygmephoridae نامهای ۲۰۰۷ S. gorganica Rahiminejad & S. copridis Khaustov, ۲۰۰۵ S. geotruporum و S. vladimiri Khaustov, ۲۰۰۵ Hajiqanbar, ۲۰۱۱ Geotrupes spiniger بصورت هم‌سفرد روی بدن سوسک Khaustov, ۲۰۰۵ بصورت هم‌سفرد روی بدن سوسک Marsham, ۱۸۰۲ (پیدا شد. این اولین گزارش هم‌سفردی که روی سوسک S. geotruporum همچنین، این مقاله اولین گزارش هم‌سفردی که روی سوسک است G. spiniger

واژگان کلیدی: هترواستیگماینی، سرسک‌غلطان، همسفر، ترجیح میزبانی، ایران