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

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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: Heterostigmata, Dung beetles, Phoresy, Host preference, Iran

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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 Pygmephoroidae and include 31 genera and more than 300 species (Khaustov & Trach, 2018). Some mites of all four families of Pygmephoroidae, 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 Hajiqaanbar, 2011, *S. copridis* Khaustov, 2007, *S. vladimiri* Khaustov, 2005 and *S. gymnopleuri* Sobhi and Hajiqaanbar, 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. geotruperum* 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

Pygmephoroida follows Khaustov (2004, 2008); the terminology of idiosoma and legs follows that of Lindquist (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 geotruperum 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 geotruperum* can be identified by the reduced apodemes 4 and the subequal setae c_1 and c_2 .

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,

360 m a.s.l., 9.VIII.2018, leg., V. Rahiminejad and S. Seyedein.

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., 21.IX.2018, leg., V. Rahiminejad,.

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 pl'' on tarsi II–IV; setiform setae sc_2 , c_2 , d , f and h_1 ; setae c_1 much longer than setae e and h_2 ; seta tc' on tarsus II setiform and very short and thin setae e and h_2 , versus long setae f and h_1 on the EF and H tergites.

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 *Spatulaphorus* 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.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Table 1. Leg setation difference among species of the genus *Spatulaphorus* (females).

	<i>S. geotrupi</i>	<i>S. foliatus</i>	<i>S. langi</i>	<i>S. camerikae</i>	<i>S. luriei</i>	<i>S. geotruporum</i>	<i>S. vladimiri</i>	<i>S. copridis</i>	<i>S. gorganica</i>	<i>S. venustus</i>	<i>S. enoplotruporum</i>	<i>S. altaicus</i>	<i>S. brasiliensis</i>	<i>S. gymnopteri</i>
Seta <i>l''</i> on Genu I	+	+	+	+	+	+	+	-	+	+	+	+	+	+
Seta <i>u'</i> on Tarsus II	+	-	+	+	+	+	+	+	+	+	-	+	+	+
spine-like seta on Tarsus II	-	+	+	-	-	-	+	-	+	+	-	+	-	-
spine-like seta <i>pl'</i> on Tarsus III	-	+	+	-	-	-	+	-	+	+	-	+	-	-

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

Species	Host	Locality	Reference
<i>S. geotrupi</i>	<i>Geotrupes</i> sp. (Geotrupidae)	Hungry Ukraine	Mahunka, 1970 Khaustov, 2005
<i>S. foliatus</i>	<i>Onitis</i> sp. (Scarabaeidae)	Botswana	Dastych & Rack, 1993
<i>S. langi</i>	<i>Catharsius</i> sp. (Scarabaeidae)	Vietnam	Dastych & Rack, 1993
<i>S. camerikae</i>	<i>Catharsius ulysses</i> (Boheman) (Scarabaeidae)	Botswana	Dastych & Rack, 1993
<i>S. luriei</i>	Scarab beetles (Scarabaeidae)	South Africa	Dastych et al., 1997
<i>S. geotruporum</i>	<i>Geotrupes stercorarius</i> L. (Geotrupidae) <i>Geotrupes spiniger</i> (Geotrupidae)	Ukraine Iran	Khaustov, 2005 Present study
<i>S. vladimiri</i>	<i>Geotrupes stercorarius</i> (Geotrupidae) <i>Geotrupes spiniger</i> (Geotrupidae)	Ukraine Iran	Khaustov, 2005 Katlav et al., 2015
<i>S. copridis</i>	<i>Copris lunaris</i> (Mueller) (Scarabaeidae) <i>Copris hispanus</i> (Scarabaeidae) <i>Geotrupes spiniger</i> (Geotrupidae)	Ukraine Iran	Khaustov, 2007 Rahiminejad et al., 2013

Table 2. Continued.

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

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

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

چکیده: در طول بررسی کنه‌های هترواستیگمای مرتبط با سوسک‌های سرگین-غلطان در جنگل‌های هیرکانی شمال ایران، چندین کلنی از کنه‌های خانواده Pygmephoridae شامل چهار گونه از جنس *Spatulaphorus* Rack, 1993، به نام‌های *S. gorganica* Rahiminejad & *S. copridis* Khaustov, 2007، *S. geotruperum* و *S. vladimiri* Khaustov, 2005، *Hajiqanbar*, 2011، *Khaustov*, 2005 بصورت هم‌سفر روی بدن سوسک *Geotrupes spiniger* (Marsham, 1802) پیدا شد. این اولین گزارش *S. geotruperum* از آسیا است. همچنین، این مقاله اولین گزارش هم‌سفری کنه *S. geotruperum* روی سوسک *G. spiniger* است.

واژگان کلیدی: هترواستیگماتینا، سرگین‌غلطان، همسفری، ترجیح میزبانی، ایران