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Two New Species of Chigger Mites in the Genus *Gahrliepia* (Acari: Trombiculidae) from China

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Abstract.- This paper describes two new species of chigger mites, *Gahrliepia eothenomydis*, n. sp. and *Gahrliepia gengmaensis*, n. sp., that live on two species of rodents found in the Yunnan province of southwest China. Specifically, the specimens were collected from *Eothenomys miletus* (Thomas 1914) and *Rattus sladeni* (Linnaeus 1758). The leg segmentations of the two new species are 7.6.6. The length of their scutum is longer than its breadth and neither species has an anteromedian projection nor an anteromedian seta (AM). On the scutum, there are no inter medial setae between the sensilla. The formula of the palpotarsus (fT) for the two new species are both 4B (B=branched), and fp (formula of palpal seta) = B/N/N/N/B (N=naked). The former new species (*Gahrliepia eothenomydis*, n. sp.) has two sensillae clavates with barbs on their shafts. There are 19 scutal setae on the scutum. The fDS (formula of d**or**sal setation) = 2.2.4.10.10.8.2.4 = 42, VS (number of ventral setae) = 60, and PPLs (posterior posterolateral setaes) = 15. In the later new species (*Gahrliepia gengmaensis*, n. sp.), two sensilla clavates were lost. There are 23 scutal setae on its scutum. The fDS = 2.2.2.4.2.6.8.4, VS = 44, and PPLs = 19. These two new species increase the number of *Gahrliepia* species in China to 39 species.

Key words: Chigger mite, Trombiculidae, *Gahrliepia*.

INTRODUCTION

Chigger mites are a group of small arachnids (class Arachnida), belonging to the families Trombiculidae and Leeuwenhoekiidae in the subclass Acari. There are seven stages in the life cycle of chigger mites, which include the egg, deutovum (or prelarva), larva, nymphochrysalis, nymph, imagochrysalis and adult (male and female). Of the seven stages, only the larvae are parasitic, whereas the other six stages are free living. Small mammals, especially rodents, are the most common hosts of chigger mite larvae. The larvae of chigger mites are the vector of tsutsugamushi disease (scrub typhus), which is easily transmitted to humans from their rodent hosts (Li *et al*., 1997; Daniel and Stekolnikov, 2003, 2009; Guo *et al*., 2006). As a result, the taxonomic identification of chigger mites is mainly based on the larvae. To date more than 3,000 species of chigger mites have been recorded globally, and more than 400 species have been reported in China (Li *et al*., 1997).

Ewing (1944) was the first to determine that there are two families of chigger mites (Trombiculidae and Leeuwenhoekiidae) under the superfamily Trombiculidae Ewing (Li *et al*., 1997). In China, the family Trombiculidae consists of the subfamilies Trombiculinae Ewing 1929 and Gahrliepiinae 1952, whereas the Leeuwenhoekiidae consists of the subfamilies Leeuwenhoekiinae Womersley 1944 and Apoloniinae Wharton 1947. The subfamily Gahrliepiinae includes the genera *Walchia* Ewing 1931, *Schoengastiella* Hirst 1915, *Gahrliepia* Oudemans 1912, *Intermedialia* Yu *et al*., 1979 and *Wuella* Wang 1997 (Wang, 1997). Under the genus *Gahrliepia*, 37 species have been recorded in China. This paper describes two new species of *Gahrliepia*, *G. eothenomydis*, n. sp. and *G. gengmaensis*, n. sp. The specimens of these new species were collected from rodents in Yunnan Province, southwest China. These two new species increases the number of *Gahrliepia* species in China to 39.

MATERIALS AND METHOS

The specimens of two new species of chigger mites were collected from two species of rodents

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(order Rodentia), the Yunnan red-backed vole (also called the Yunnan Chinese vole or the large oriental vole), *Eothenomys miletus* (Thomas, 1914) (Andrew and Xie, 2009) in the family Cricetidae, and the sladeni rat, *Rattus sladeni* (Linnaeus, 1758) in the family Muridae. These two species, were trapped using Golden Cat traps (Guixi Mousetrap Apparatus Factory, Guixi, Jiangxi, China) in the Yunnan Province of southwest China in 2010. The Yunnan red-backed vole was captured from bush habitats of Cangshan Mountains, whereas *Rattus sladeni* was captured from a farm in Gengma County. The trapped small mammals were conventionally anesthetized and they were finally identified to species on the basis of morphological characteristics or postmortem examinations of skull characteristics (Andrew and Xie, 2009). The capture of small mammals was approved by the local wildlife service authority in Yunnan Province, China. All research was approved by the Institute of Pathogens and Vectors, Dali University.

The chigger mites on the rodents were conventionally collected (Li *et al*., 1997). Chigger mites were preserved in vials of 70% ethyl alcohol and mounted individually on microscope slides in Hoyer's medium (Huang *et al.*, 2013). All measurements are given in micrometres (μm). Terminology and nomenclature used in the morphological descriptions follows Goff *et al.* (1982), Wen and Gui (2000) and Sabyan et, al. (2014). Type specimens (holotypes and paratypes) of the mites and their representative rodent hosts were deposited in the specimen repository of Institute of Pathogens and Vectors.

Gahrliepia eothenomydis, new species (Fig. 1)

Diagnosis

Legis 7-segmented. Legs and are 6-segmented. All coxae have 1 branched seta (1B). The length of scutum is longer than its breadth and it neither has an anteromedian projection nor an anteromedian seta. Two sensillae clavates have barbs on their shafts. On the scutum, there are no inter medial setae between the sensilla. The shape of scutum is like a horse face, with an almost straight posterior margin. The formula of the palpotarsus (fT) are branched (fT=4B), and fp (formula of palpal seta) = B/N/N/N/B (N=naked). Two sensillae clavates have barbs on their shafts. There are 19 scutal setae on the scutum. The fDS (formula of dorsal setation) = 2.2.4.10.10.8.2.4 = 42, VS (number of ventral setae) = 60, and PPLs (posterior posterolateral setaes) = 15. IP (index of poda) =1530-1820μm.

Idiosoma (Fig. 1A,B)

Medium sized (285×205μm), oval shaped, color unknown. The dorsal scutum is located in the upper position of the body. A pair of ocelli (eyes) lies on both sides of the upper part of dorsal scutum. There is a pair of humeral setae (length 43-45μm) below the ocelli. Approximately 40 dorsal setae (length 35-38μm) are arranged in irregular rows. Two pairs of sternal setae are 42-44μm in length. The formula for the sternal setae (fst) is 2.2. The formula of dorsal setation (fDS) = 2.6.8.10.8.6, with a length of 39-41μm. There are 60 ventral setae (VS) with a length of 22-24μm each. The total number of idiosomal setae equals to 100.

Gnathosoma (Fig. 1C)

Palps are 6-segmented including the coxa, trochanter, femur, genu, tibia and palpotarsus. The formula of palpal setae (fp) = B/N/N/N/B. The formula of palpotarsus (fT) = 4B. The palpal claw (13μm in length) has three prongs. The gnathobase is punctuated, bearing 1 barbed seta. The chelostyle (39μm in length) has a broad base, with a serrated tricuspid cap.

Scutum (Fig. 1D)

The scutum is broad and its shape is like a horse-face, with an almost straight posterior margin. The scutum length is longer than the width. It neither has an anteromedian projection nor anteromedian seta. The two sensillae clavates have barbs on their shafts. On the scutum, there are no inter medial setae between the sensillae. Long thick scutum setae are uniformly arranged on the scutum with SD/PW=137μm /82 μm =1.67. The middle part of the scutum is obviously protruded. PPLs = 15 in numbers. SB is near mid-point of AP; PL AL. The scutal measurements of the holotype are: AW (53μm); PW (82μm); SB (50μm); ASB (20μm); PSB (117μm); AP (36μm); AL (37μm); PL (46μm);

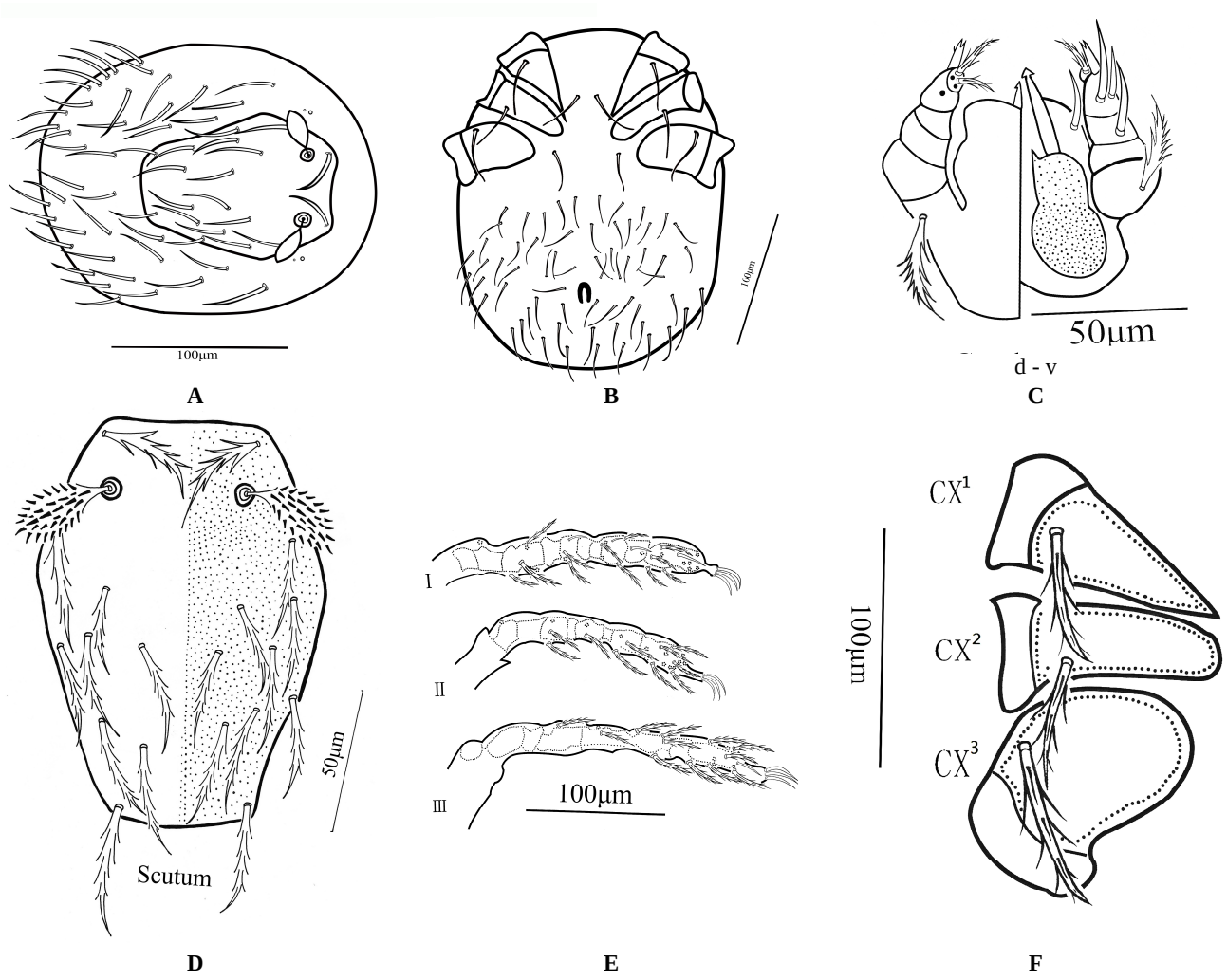

Fig.1. Larva of *Gahrliepia eothenomydis* new species; A, dorsal idiosoma; B, ventral idiosoma; C, the gnathosoma (Gn); d, dorsal view; v, ventral view); D, the scutum (dorsal shield); E, the distal leg segments of *Gahrliepia eothenomydis* n. sp. (Larva Ⅰ, Ⅱ and III distal segments of leg 1, leg 2 and leg 3); F, he leg coxae of *Gahrliepia eothenomydis* n. sp. and *Gahrliepia gengmaensis* n. sp. (Larva. Cx1-Cx2-Cx3: the coxa 1, coxa 2 and coxa 3 of the legs).

sensilla (5+28×12μm). Here, SD, scutum distance; PW, posterolateral seta width; SB, sensillary base distance; AP = distance between anterolateral seta and posterolateral seta; PL, posterolateral seta; AL, anterolateral seta; AW, anterolateral seta width; ASB, antero-sensillary base distance; PSB, postero-sensillary base distance. The mean measurements of the holotype and six paratypes are shown in Table I.

Legs (Figs. 1E,F)

Leg is 7-segmented. Legs and are 6-segmented, terminating with a claw. Coxae, and have 1 branched seta (1B). Leg is 285-295μm in length and 19-22μm in width. Leg is 245-255μm in length and 19-22μm in width. Leg is 295-305 μm in length and 20-23μm in width. SIF, 4B-N-3-2110-0000; fP, B/N/N/N/B; IP, 1670 -1690 μm. Fsp, 7.6.6; Oc, 2/2; fcx, 1.1.1; fst, 2.2; fDS, 40; fSc: 2AL+2PL+15PPL, 19; NDV, 102. Here, IP, index of poda; SIF, synthetic identification formula; fP, formula of poda; fsp, formula of segmented poda; Oc, ocellus; fcx, formula of coxa; fst, formula of

Table I.- Measurements (means) of a holotype and six paratypes of *Gahrliepia eothenomydis*, n. sp. (μm)

No.	AW	PW	fT	SB	ASB	PSB	SD	AP	AL	PL	PPL	Sensilla
H	51	81	13	47	21	117	138	35	36	48	38	6+28×13
P1	51	97	13	57	25	135	140	40	48	47	46	×
P2	52	85	14	51	25	123	148	40	47	46	41	5+26×16
P3	52	87	13	53	24	129	153	42	37	48	38	7+30×14
P4	48	85	14	49	25	124	149	39	38	45	40	4+32×14
P5	52	86	12.5	51	25	126	151	32	36	48	37	×
P6	51	88	14	52	22	125	147	39	36	46	40	×

sternal seta; fDS, formula of dorsal setation; fSc, formula of scutum setation; P, poda; NDV, numbers of dorsal and ventral setae.

Types

Holotype: one Larva was collected from Yunnan red-backed vole, *Eothenomys miletus* (Thomas 1914) in the Cangshan Moutains (100°07' E, 25°42' N, 2,127 m) of Yunnan Province, southwest China on April 6, 2010. Paratypes: 6 larvae with the same data as the holotype. The collector of the new species is unknown.

Remarks

The new species is named after its host, *Eothenomys miletus*. The color of a living larva is not known. Idiosoma is subrotund. Scutum is obviously seen in the dorsal view. The pinnae of AL and PL are sparse. PPLs have thin and sharp-tipped barbs. Two sensillae clavates have barbs on their shafts. Ocellus (Oc) is small. fP = B/N/N/N/B. The chelostyle has an usual tricuspid cap, dorsal and ventral teeth. Leg solenidiontaxy is normal. The new species, *Gahrliepia eothenomydis*, n. sp., is similar to *Gahrliepia agrariusia* (Li *et al*., 1997), but with some prominent differences listed below (Table II).

Gahrliepia gengmaensis, new species
(Fig. 2)

Diagnosis

Leg is 7 segmented. Legs and are 6 segmented. All the coxae have 1 branched seta (1B). The length of scutum is longer than its breadth, with no anteromedian projection and no anteromedian seta. There are only two sensillary bases on the scutum and two sensilla clavates were lost. There are no inter medial setae between the two sensillary bases. The fT, 4B, and fp, B/N/N/N/B. There are 23 scutal setae on its scutum. The fDS, 2.2.2.8.8.6.2, VS, 44, and PPLs, 19. IP = 1410μm.

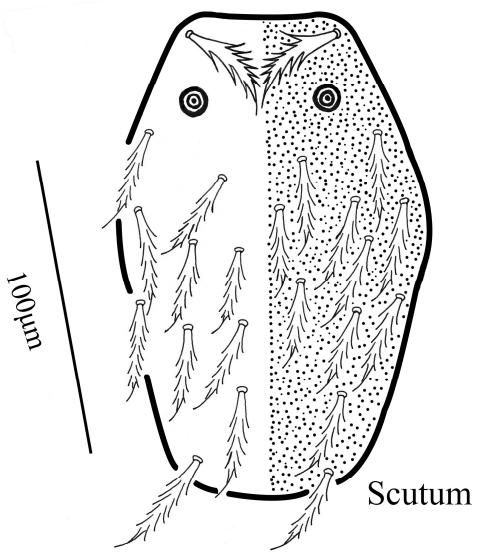

Fig. 2. The scutum (dorsal shield) of *Gahrliepia gengmaensis* n. sp. (Larva)

Idiosoma

Medium size, 275×215μm, oval shape, color unknown. The dorsal scutum is located in the upper position of the body. A pair of ocelli (eye) lies on both sides of the upper part of the dorsal scutum. A pair of humeral setae (length 37μm) is below the ocelli. Approximately 30 dorsal setae (length 33-37μm) are arranged in irregular rows. There are 2 pairs of sternal setae (length 31μm). The formula of sternal setae (fst) = 2.2.

Table II.- The morphological differences between *Gahrliepia eothenomydis,* n. sp. and *Gahrliepia agrariusia.*

Morphological items	Morphological differences	
	***Gahrliepia eothenomydis*, n. sp.**	***Gahrliepia agrariusia***
Scutal setae	19	18
Number of dorsal setae	42	40
fDS	2.2.4.10.10.8.2.4	2.4.4.6.6.6.4.4.2.2
VS	60	46
AW	53	47
PW	82	77
SB	50	46
ASB	20	21
PSB	117	136
AP	36	36
AL	37	41
PL	46	43
Sens	5+28×12	? +37×10

Table III.- The morphological differences between *Gahrliepia gengmaensis,* n. sp. and *Gahrliepia miyi.*

Morphological items	Morphological differences	
	***Gahrliepia gengmaensis*, n. sp.**	***Gahrliepia miyi***
Scutal setae (number of setae on the scutum)	23	24
Number of dorsal setae	40	40
fDS (formula of dorsal setation)	2.2.2.4.2.6.8.4.	2.4.6.8.8.6.4.2
VS (number of ventral setae)	40+	66
AW	47μm	48
PW	79	78
SB	46	42
ASB	35	21
PSB	130	117
AP	36	34
AL	34	40
PL	34	37
Sens	×	38×13

Gnathosoma

The palpus was destroyed in the process of slide preparation. The chelostyle (length 32μm) has a broad base, with a serrated tricuspid cap.

Scutum (Fig. 2)

The scutum is broad, shaped like a horse face, with an almost straight posterior margin. The length of the scutum is longer than its width. It neither has an anteromedian projection nor an anteromedian seta. There are only two sensillary bases on the scutum and two sensilla clavates were lost. There are no inter medial setae between the two sensillary bases. Long thick scutum setae are uniformly arranged on the scutum. SD/PW, 165μm /79 μm, 2.01. PPLs, 19. SB is near mid-point of AP. The scutal measurements of the holotype are as follows: AW (47μm); PW (79μm); SB (46μm); ASB (35μm); PSB (130μm); AP (36μm); AL (34μm); PL (34μm). Here, SD, scutum distance; PW, posterolateral seta width; SB, sensillary base distance; AP, distance between anterolateral seta and posterolateral seta; PL, posterolateral seta; AL, anterolateral seta; AW, anterolateral seta width; ASB, antero-sensillary base distance; PSB, postero-sensillary base distance.

Legs

Leg is 7-segmented. Legs and are 6-segmented, terminating with a claw. The coxa has 1 branched seta (1B). Leg is 255-265μm long and 19-22μm wide. Leg is 202-218μm long and 18-22μm wide. Leg is 226-240μm long and 17-23μm wide. SIF, 4B-N-3-2110-0000; fP, B/N/N/N/B; IP, 1310-1510μm. Fsp, 7.6.6; Oc, 2/2; fcx, 1.1.1; fst, 2.2; fSc: 2AL+2PL+19PPL, 23.

Types

The holotype Larva was collected from Gengma couty (99°34' E, 23°41' N, 1,443m) in Yunnan Province of southwest China on December, 2010. No paratypes. The collector of the new species is unknown.

Remarks

The new species is named after the location where it was collected, type locality, Gengma country of Yunnan province. The color of a living larva is also unknown. Idiosoma is subrotund. Scutum is obviously seen in the dorsal view. The pinnae of AL and PL are sparse. The PPLs have thin and sharp-tipped barbs. Ocellus (Oc) is small. fP, B/N/N/N/B. The chelostyle has a usual tricuspid cap, dorsal and ventral teeth. Leg solenidiontaxy is

normal. The new species, *Gahrliepia eothenomydis*, n. sp., is similar to *Gahrliepia miyi* (Li *et al*., 1997), but with some prominent differences listed below (Table III).

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