# A Checklist of Chigger Mites (Acari: Trombiculidae and Leeuwenhökiidae) From Taiwan, With Descriptions of Three New Species

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**ABSTRACT** Scrub typhus is a lethal human disease transmitted by larval trombiculid mites (i.e., chiggers) that have been infected with the rickettsia *Orientia tsutsugamushi*. In total, 21 chigger species are known from Taiwan. We update the checklist of chiggers of Taiwan based on an intensive survey of shrew and rodent hosts in grasslands and agricultural fields in lowland Taiwan, coupled with surveys of forests in one mountainous site and an opportunistic examination of submitted host specimens. Three new species of chiggers, *Gahrliepia* (*Gateria*) *lieni* sp. n., *Gahrliepia* (*Gateria*) *minuta* sp. n., and *Gahrliepia* (*Gateria*) *yilanensis* sp. n., as well as 23 newly recorded chigger species, were discovered. Accordingly, recorded chigger species of Taiwan more than doubled from 21 to 47 species. Two new species and nine newly recorded chigger species were discovered in forests in one mountainous site in northeastern Taiwan, suggesting that many more chigger species may be uncovered, particularly in mountainous Taiwan. Further studies should also investigate *O. tsutsugamushi* infection in different chigger species to assess its risks to human health.

**KEY WORDS** *Gahrliepia*, *Gateria*, trombiculid, taxonomy, checklist

Scrub typhus is a deadly human disease transmitted by larval trombiculid mites (i.e., chiggers) infected with the rickettsia *Orientia tsutsugamushi*. Although scrub typhus has been endemic in Taiwan for around 100 yr (Hatori 1919), information on the chigger vectors remains limited. Checklists of chiggers from Taiwan have been previously reported (Maa and Kuo 1966, Tseng 1982). Several chigger species were identified from a series of field surveys (Lien et al. 1967, 1974; Gale et al. 1974; Hasegawa et al. 1990). Li et al. (1997) listed species of chiggers from Taiwan, and Wen (2000) reported a new species, *Gateria taiwanensis* (Wen), from Natou County, Taiwan. Eight species of chiggers were identified in a field investigation for vectors and pathogens of scrub typhus in Kinmen County (Wang et al. 2004). The occurrence of *Leptotrombidium imphalum* Vercammen-Grandjean & Langston, *Leptotrombidium deliense* (Walch), *Gahrliepia* spp., and *Walchia* spp. was documented in Hualien County, eastern Taiwan: *L. imphalum* was the most abundant chigger species (Kuo et al. 2011a,b, 2012). In total, 21 chigger species of nine genera in two families are recognized in Taiwan, based on these previous studies.

Knowledge of chigger species is essential to elucidate disease dynamics of scrub typhus. Based on our extensive field surveys of chiggers in Taiwan, we identified many newly recorded species and three new species. Here, we update the checklist of chigger species in Taiwan, provide detailed morphological descriptions and illustrations of newly discovered species, and revise the key to *Gahrliepia* species. In total, we have identified three new species and 23 newly recorded species, more than doubling the number of chigger species in Taiwan from 21 to 47 species.

## Materials and Methods

Chiggers were collected from >100 sites on the mainland and outlying islets (Penghu, Kinmen, Lienchiang, Green Island, and Orchid Island) of Taiwan during previous studies of field shrews and rodents (Wang et al. 2004; Kuo et al. 2011c, 2015) from 1999 to 2015. This collection was supplemented with host specimens occasionally being submitted for examination because of chigger infestations. Trapping of shrews and rodents was implemented in grasslands or agricultural fields (cultivated and abandoned) but not inside or near human habitations because scrub typhus mainly prevails in rural areas and occurs outside of houses (Traub and Wisseman 1974). Additionally, we focused on lowland areas (<200 m in elevation) because these

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areas are where most people in Taiwan live; thus, any chiggers therein have a higher chance of being encountered. One exception is Szuyuan Wukou, which is mainly forested and located close to 2,000 m in elevation in Yilan County, northeastern Taiwan.

Once they were collected from vertebrate hosts, chiggers were preserved in 70% alcohol and mounted with Berlese fluids. Specimens were identified following published keys (Vercammen-Grandjean and Langston 1975, Wen 1984e, Wang and Zhong 1992, Li et al. 1997) and measured with an Olympus BX51 system microscope (Olympus Optical Co., Ltd., Tokyo, Japan). All measurements are given in micrometers, rounded off to the nearest integer. Goff et al. (1982) was followed for the abbreviations and terminology used in this study, with some alterations: DS (m), medial setae of first posthumeral row in dorsal idiosoma; SB/PL, bases of sensillae above those of PLs; SN, sensillae; ST, sternal setae; SW, width of hexagonal scutum in genus *Gahrliepia*; VS (pre), medial ventral setae of first poststernal row; and VS (post), medial ventral setae of first postanal row.

The holotypes and paratypes were deposited in the Centers for Research, Diagnostic and Vaccine Development, Centers for Disease Control, Ministry of Health and Welfare, Taiwan. Accession numbers for specimens are provided in parentheses.

## Nomenclature

This article and the nomenclatural acts it contains have been registered in Zoobank (www.zoobank.com), the official register of the International Commission on Zoological Nomenclature. The LSID (Life Science Identifier) number of the publication is: urn:lsid:zoobank.org:pub:67683A3B-BBA0-48F4-A8CE-F2A0B4082D5E

## Results

In total, 9,071 chiggers were identified from a sample of 3,387 shrews and rodents, one carnivore (*Herpestes urva*), two birds (*Otus lettia*), and one reptile (*Sphenomorphus indicus*). We have successfully identified 38 chigger species, including 3 new species, 23 newly recorded species, and 12 known species (9 of 21 known species were not found in this study). Combined with species previously known to Taiwan, there are at least 47 chigger species belonging to 13 genera in two families.

All three new species belong to the genus *Gahrliepia* Oudemans, 1912 (*Gahrliepia lieni*, *Gahrliepia minuta*, and *Gahrliepia yilanensis*); therefore, revised keys to *Gahrliepia* species in Taiwan are provided, in addition to detailed morphological descriptions and illustrations of each new species. Finally, a checklist of the 47 chigger species in Taiwan is provided.

## Key to the Species of the Genus *Gahrliepia* in Taiwan

1. Scutum significantly smaller than other congeners (PW ≤90 μm; SD ≤145 μm; SW ≤105 μm); idiosomal setae shorter (HS <45 μm; DS (m) <40 μm; VS (pre) ≤25 μm; VS (post) ≤30 μm; Ip ≤720 μm; NDV ≤100 ... *G.* (*Gat.*) *minuta* sp. n.
   Scutum larger (PW > 90 μm; SD > 145 μm; SW > 105 μm); idiosomal setae longer (HS > 45 μm; DS (m) > 40 μm; VS (pre) > 25 μm; VS (post) > 30 μm); Ip > 720 μm; NDV > 100 ..... 2
2. Scutal setae ≥25 in number; posterior margin of scutum curved outward ..... 3
   Scutal setae <23 in number; posterior margin of scutum near straight ..... 4
3. DS 45–48 in number; NDV = 118–121 ..... *G.* (*Gat.*) *linguipelta* (new record)
   DS 60 in number; NDV = 132 ..... *G.* (*Gat.*) *taiwanensis*
4. DS 46–49 in number; NDV = 108–119 ..... *G.* (*Gat.*) *longipedalis* (new record)
   DS >50 in number; NDV = 118–141 ..... 5
5. DS 50–53 in number; second row of DS consists of two sets of three setae that are closely aligned; ventral fomorala on leg III branched ..... *G.* (*Gat.*) *yilanensis* sp. n.
   DS 61–66 in number; second row of DS evenly situated; ventral fomorala on leg III nude ..... *G.* (*Gat.*) *lieni* sp. n.

## Three New Chigger Species in Taiwan

### *Gahrliepia* (*Gateria*) Ewing 1938

*Gateria* Ewing, 1938: 291, 295; 1944b: 348; 1946b: 436; Radford, 1942: 67; 1946: 247; 1954: 270; Fuller, 1952: 216.
*Jiapiania* Wen, 1984c: 19.
*Gahrliepia* (*Gateria*) Li et al., 1997: 482.

**Diagnosis.** Medium-to-large mite; scutum hexagonal; lack of AM; with two ALs and two PLs, and multiple pairs of PPLs. SN usually clavate with tiny spikes on surface. Palpal tarsus with 4B. Legs 7-6-6 segmented; leg III without tibiala.

**Comments.** *Gateria* Ewing, 1938 resembles another subgenus *Gahrliepia* (Oudemans, 1912) in overall appearance but differs in the palpal tarsus: species of the subgenus *Gateria* bear 4B, and those of the subgenus *Gahrliepia* bear 5B.

### 1. *Gahrliepia* (*Gateria*) *lieni* sp. n.

(Fig. 1; Table 1)
(urn:lsid:zoobank.org:act:87A395A8-D7D9-434E-A02D-D8C1515E2AD7)

**Diagnosis of Larva.** SIF = 4B-N-3-2110.0000. fPp = B/B/NNN/4B; scutum long, hexagonal. Scutal setae 19–23, with 2 ALs, 2 PLs, and 15–19 PPLs; PPLs arranged in 4 (3, 5), 5 (4, 6), 4 (3, 5), 2 (1, 3), 2 (0). SN claviform with spikes on surface. Scutal and idiosomal setae branched and tapering to apex. DS 61–66 in number (including HS), arranged in 2 (3–4), 4 (5–6), 6 (7) ...; posterior DS arranged disorderly. VS 67–77. NDV = 128–141.

**Larva.** ($n = 10$) Live larva oval. Measurements of body length and width are as follows (in μm): Semiengorged body length 314–465, width 260–374 and

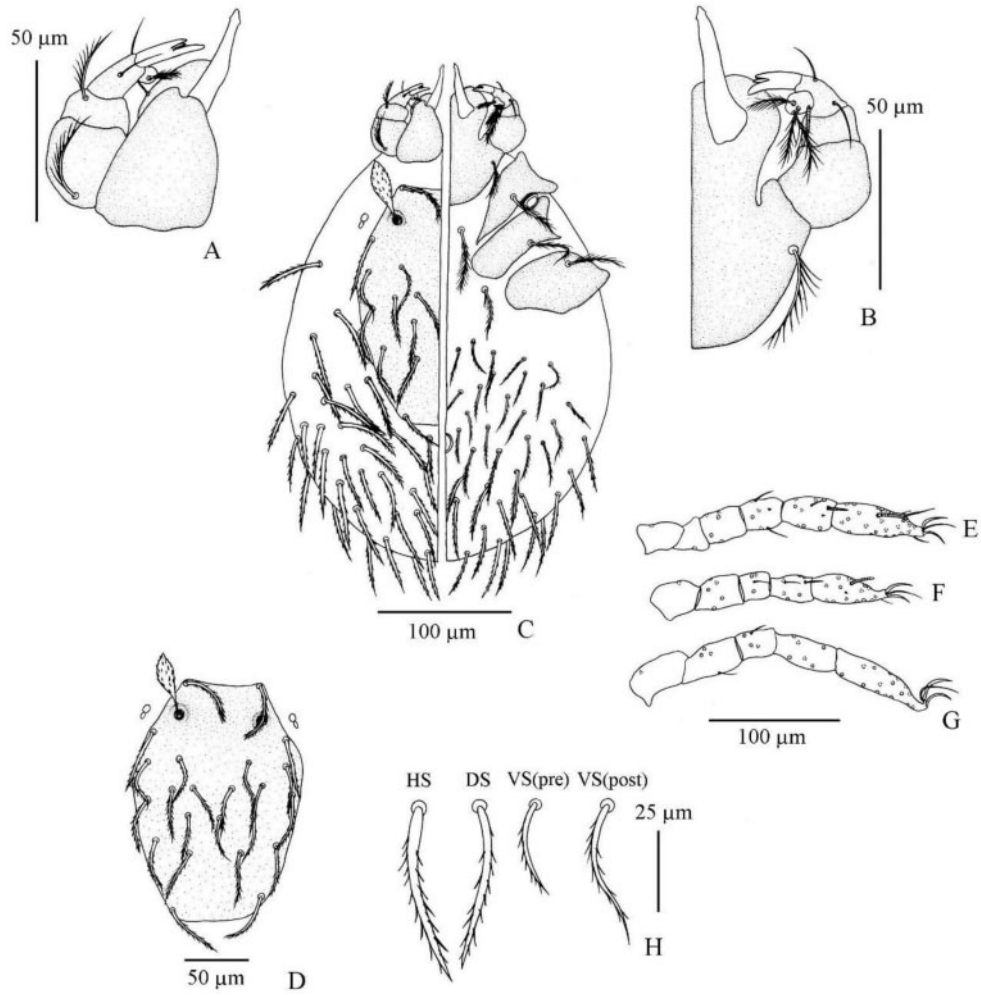


**Fig. 1.** *G.* (*Gat.*) *lieni*, sp. n. larva. (A) Dorsal view of the gnathosoma. (B) Ventral view of the gnathosoma. (C) Dorsal and ventral view of the larva. (D) Scutum. (E–G) Leg I, II, and III. (H) Idiosomal setae.

**Table 1. Standard measurements (in μm) of *G.* (*Gat.*) *lieni* sp. n. larva**

| | AW | PW | SB | ASB | PSB | SD | SW | AP | AL | PL |
|---|---|---|---|---|---|---|---|---|---|---|
| Holotype | 59 | 106 | 66 | 27 | 161 | 189 | 131 | 47 | 52 | 54 |
| Mean | 62 | 102 | 61 | 27 | 151 | 178 | 127 | 45 | 53 | 50 |
| Min. | 59 | 97 | 59 | 25 | 146 | 172 | 119 | 40 | 48 | 45 |
| Max. | 66 | 109 | 66 | 30 | 161 | 189 | 134 | 49 | 58 | 54 |

| SN | PS | HS | DS(m) | VS(pre) | VS(post) | pa | pm | pp | Ip |
|---|---|---|---|---|---|---|---|---|---|
| 50 by 15 | 25 | 58 | 56 | 32 | 48 | 324 | 280 | 337 | 941 |
| 47 by 14 | 26 | 57 | 53 | 31 | 43 | 304 | 260 | 318 | 882 |
| 45 by 14 | 22 | 53 | 50 | 28 | 41 | 287 | 243 | 304 | 846 |
| 50 by 15 | 29 | 64 | 56 | 32 | 48 | 324 | 280 | 337 | 941 |

engorged body length 530–572, width 470–507. Eyes 2 + 2, located by scutum; anterior pair larger; posterior pair long, elliptical.

*Gnathosoma.* Gnathosomal base round, evenly punctate, with a pair of pectinate setae; cheliceral base evenly punctate; cheliceral blade with tricuspid cap. Galeal setae nude; fPp = B/B/NNN/4B, with a blunt solenidion; palpal claw three-pronged.

*Scutum.* Long, hexagonal; anterior margin nearly straight; posterior margin slightly convex. Scutum evenly punctate. PW/AP = 2.06–2.45; PW/SD = 0.54–0.62. SB/PL. Scutal setae branched, 19–23, with 2 ALs, 2 PLs, and 15–19 PPLs that are more slender than the ALs and the PLs, arranged in 4 (3, 5), 5 (4, 6), 4 (3, 5), 2 (1, 3), 2 (0). SN claviform with short spikes on surface. Standard measurements of scutum are presented in Table 1.

*Idiosomal setae.* DS 61–66, arranged in 2 (3–4), 4 (5–6), 6 (7) . . . ; posterior DS arranged disorderly. HS and DS similar to PL, branched and tapering to apex. ST 2-2 and finely branched; posterior pair conspicuously farther apart than the first pair. VS 67–77, with preanal setae 41–51 and postanal setae 24–29. NDV = 128–141. Measurements of idiosomal setae are presented in Table 1.

*Legs.* fsp 7-6-6, all with a pair of claws and a slender empodium. Coxae I-III unisetose, evenly punctate. All

segments with various numbers of branched setae (B). *Leg I*: coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, two genualae and one microgenuala; tibia 8B, two tibialae (the distal one is similar to the tarsala and thicker than the proximal one) and one microtibiala; tarsus 23B, one central tarsala; one microtarsala, pretarsala, nude subterminala and parasubterminala. *Leg II*: coxa 1B; trochanter 1B; femur 5B; genu 3B, with one genuala; tibia 6B, with two tibialae (the distal one is slightly thicker than the proximal one); tarsus 15B, with one central tarsala; one microtarsala and pretarsala. *Leg III*: coxa 1B; trochanter 1B; femur 4B, one nude ventral femorala; genu 3B, with one genuala; tibia 6B; tarsus 16B.

**Type Material.** HOLOTYPE: one larva (IW0048-14-3), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *Niviventer coninga*, female. PARATYPES: seven larvae (IW0047-2-3, IW0047-3-1∼2, IW0047-4-1, IW0047-5-1∼3), same locality, date, and collector, ex *Apodemus semotus*, male; two larvae (IW0048-10-2, IW0048-14-2), same locality, date, and collector, ex *N. coninga*, female.

**Distribution.** This species was only found in the forest of Szuyuan Wukou, Yilan County, Taiwan, close to 2,000 m in elevation. Rain mainly falls between July and October. The mean annual temperature is 11.8°C, with mean minimum and maximum temperatures of 5.4 and 16.8°C.

**Remarks.** Among its congeners, *G.* (*Gat.*) *lieni* most closely resembles *G.* (*Gat.*) *taiwanensis* (Wen, 2000) in Taiwan, but it can be distinguished from the latter by the following features (*G.* (*Gat.*) *taiwanensis* in parentheses): PPLs 15–19 (22); scutum without sharp posterolateral angles inserted by PPL (scutum with sharp posterolateral angles inserted by PPL); ventral femorala of leg III nude (branched) (Wen 2000).

*Gahrliepia* (*Gat.*) *lieni* also resembles the new species *G.* (*Gat.*) *yilanensis* and can be distinguished from the latter by the following features (*G.* (*Gat.*) *yilanensis* in parentheses): DS 61–66 (DS 50–53); setae of second row of DS evenly spaced (second row of DS consists of two sets of three setae closely aligned); ventral femorala of leg III nude (branched).

**Biology.** Recorded hosts of *G.* (*Gat.*) *lieni* include *A. semotus* and *N. coninga* which are both endemic rodents in Taiwan and are found primarily in mountainous areas.

**Etymology.** The species is named after Prof. Jih-Ching Lien, an authoritative researcher in medical entomology, and the first scholar to initiate chigger studies in Taiwan.

### 2. *Gahrliepia* (*Gateria*) *minuta* sp. n.

(Fig. 2; Table 2)

(urn:lsid:zoobank.org:act:2D9667C6-8E79-4B28-A12C-399EAF002235)

**Diagnosis of Larva.** SIF = 4B-N-3-2110.0000. fPp = B/B/NNN/4B; scutum long hexagonal. Scutal setae 16, with 2 ALs, 2 PLs, and 12 PPLs; PPLs arranged in 2, 4 (3), 2 (3), 2, 2. SN claviform with spikes on surface. Scutum conspicuously smaller than those of other congeners in Taiwan. DS 42–43 (including HS), arranged in 2, 4, 6 (8), 9 . . . ; posterior DS arranged disorderly. VS 54–55. NDV = 97.

**Larva.** ($n = 2$) Live larva oval. Measurements of body length and width are as follows (in μm): Semi-engorged body length 342–460, width 219–374. Eyes 2 + 2, located by scutum; anterior pair larger; posterior pair long, elliptical.

*Gnathosoma.* Gnathosomal base round, evenly punctate, with a pair of pectinate setae; cheliceral base sparsely punctate; cheliceral blade with tricuspid cap. Galeal setae nude; fPp = B/B/NNN/4B, with a blunt solenidion; palpal claw three-pronged.

*Scutum.* Long, hexagonal; conspicuously smaller than those of other congeners in Taiwan. Anterior margin slightly concave and posterior margin gently convex. Scutum evenly punctate. PW/AP = 1.99–2.40; PW/SD = 0.60. SB/PL. Scutal setae branched, 16, with 2 ALs, 2 PLs, and 12 PPLs, which are more slender than the ALs and the PLs, and arranged in 2, 4 (3), 2 (3), 2, 2. SN claviform with spikes on surface. Standard measurements of the scutum are presented in Table 2.

*Idiosomal setae.* DS 42–43, arranged in 2, 4, 6 (8), 9 . . . ; posterior DS arranged disorderly. HS and DS similar to PL, branched and tapering to apex. ST 2-2 and finely branched. VS 54–55, with preanal setae 34–35 and postanal setae 19–21. NDV = 97. Idiosomal setae shorter than other congeners in Taiwan. Measurements of idiosomal setae are presented in Table 2.

*Legs.* fsp 7-6-6, all with a pair of claws and a slender empodium. Coxae I-III unisetose, evenly punctate. All segments with various numbers of branched setae (B). *Leg I*: coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, two genualae and one microgenuala; tibia 8B, two tibialae (the distal one is similar to the tarsala and thicker than the proximal one) and one microtibiala; tarsus 23B, one central tarsala; one microtarsala, pretarsala, nude subterminala, and parasubterminala. *Leg II*: coxa 1B; trochanter 1B; femur 5B; genu 3B, with one genuala; tibia 6B, with two tibialae (the distal one is slightly thicker than the proximal one); tarsus 15B, with one central tarsala; one microtarsala and pretarsala. *Leg III*: coxa 1B; trochanter 1B; femur 4B, one nude ventral femorala; genu 3B, with one genuala; tibia 6B; tarsus 16B.

**Type Material.** HOLOTYPE: one larva (7955-2-1), Hualien County, Fuli, Tungli, 1-V-2001, Coll. H. C. Wang, ex *Bandicota indica*, female. PARATYPE: one larva (7919-1-1), same locality, 28-II-2001, Coll. H. C. Wang, ex *Rattus losea*, male.

**Distribution.** This species has only been collected in abandoned agricultural fields in Tungli Village, Hualien County, eastern Taiwan.

**Remarks.** Compared with other congeners from Taiwan, *G.* (*Gat.*) *minuta* has a smaller scutum and shorter idiosomal setae. *G.* (*Gat.*) *minuta* most closely resembles *G.* (*Gat.*) *kiangsiensis* Hsu et al., 1965 in China, but it can be distinguished from the latter by the following features (*G.* (*Gat.*) *kiangsiensis* in parentheses): scutal setae 16 (14); DS 42–43 (28).

**Biology.** The known hosts of *G.* (*Gat.*) *minuta* are rodents common in lowland in Taiwan, including *B. indica* and *R. losea*.

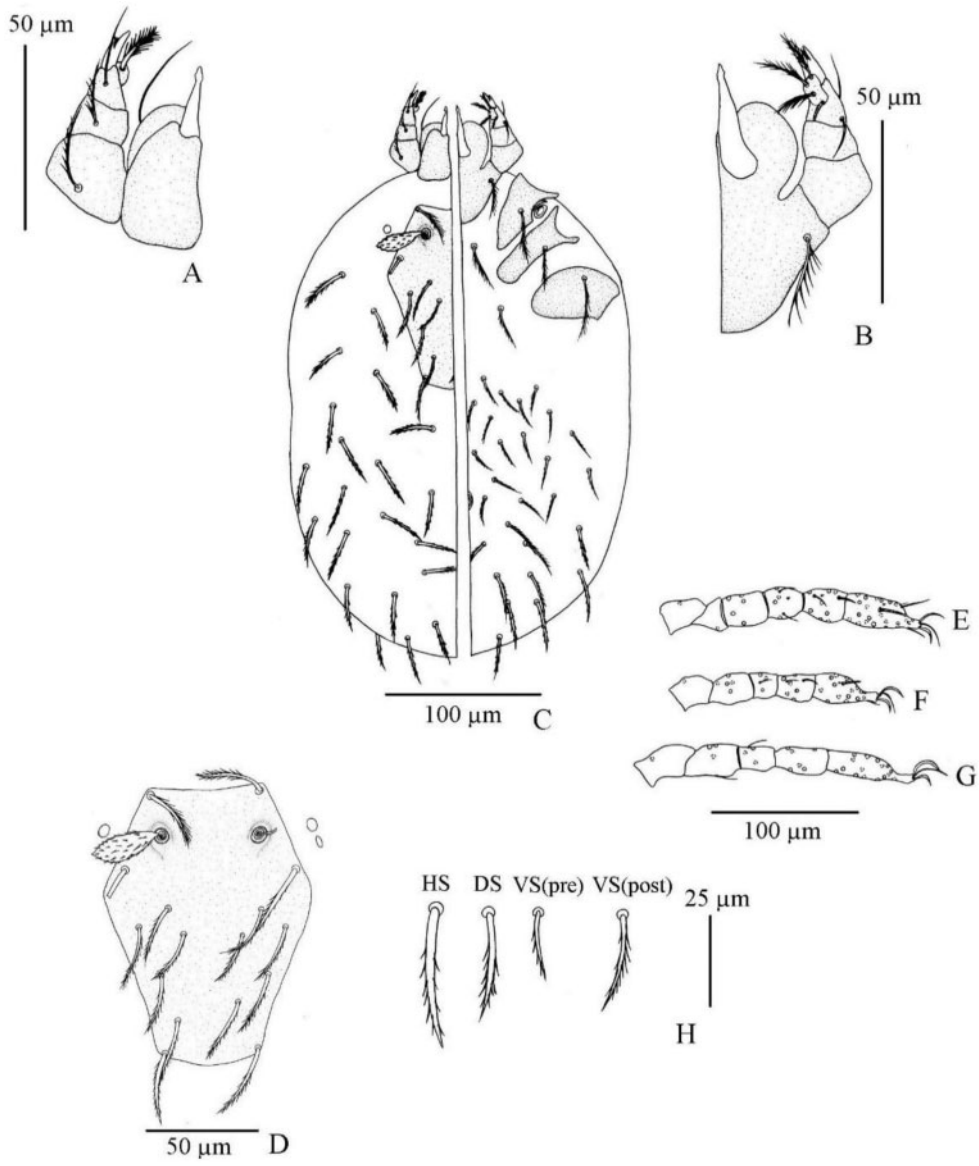


**Fig. 2.** *G.* (*Gat.*) *minuta*, sp. n. larva. (A) Dorsal view of the gnathosoma. (B) Ventral view of the gnathosoma. (C) Dorsal and ventral view of the larva. (D) Scutum. (E–G) Leg I, II, and III. (H) Idiosomal setae.

**Table 2. Standard measurements (in µm) of *G.* (*Gat.*) *minuta* sp. n. larva**

| | AW | PW | SB | ASB | PSB | SD | SW | AP | AL | PL |
|---|---|---|---|---|---|---|---|---|---|---|
| Holotype | 51 | 79 | 47 | 23 | 109 | 132 | 96 | 40 | 32 | 35 |
| Paratype | 51 | 86 | 48 | 22 | 121 | 144 | 101 | 36 | 37 | 41 |
| Mean | 51 | 82 | 47 | 23 | 115 | 138 | 99 | 38 | 34 | 38 |

| SN | PS | HS | DS(m) | VS(pre) | VS(post) | pa | pm | pp | Ip |
|---|---|---|---|---|---|---|---|---|---|
| 34 by 12[a] | 22 | 40 | 31 | 20 | 27 | 243 | 210 | 248 | 700 |
| — | 22 | 41 | 35 | 22 | 30 | 251 | 215 | 250 | 717 |
| — | 22 | 40 | 33 | 21 | 28 | 247 | 213 | 249 | 708 |

[a] Data from one specimen.

**Etymology.** The specific name is derived from the particularly small scutum and shorter idiosomal setae of the species. The word 'minuta' means small.

### 3. *Gahrliepia* (*Gateria*) *yilanensis* sp. n.

(Fig. 3; Table 3)
(urn:lsid:zoobank.org:act:FA67C721-51F1-4212-9AA5-8701BF5A81D6)

**Diagnosis of Larva.** SIF = 4B-N-3-2110.0000. fPp = B/B/NNN/4B; scutum long, hexagonal. Scutal setae 19–22 in number, with 2 ALs, 2 PLs, and 15–18 PPLs;

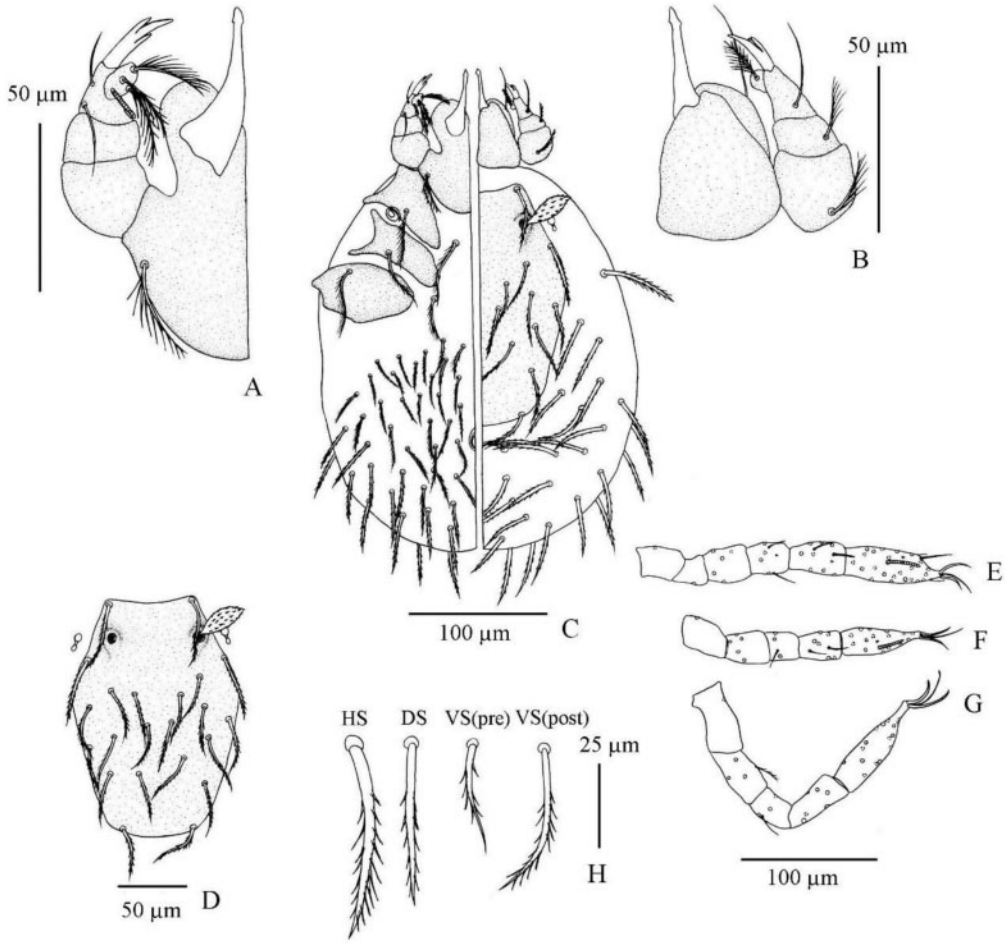


**Fig. 3.** *G.* (*Gat.*) *yilanensis*, sp. n. larva. (A) Ventral view of the gnathosoma. (B) Dorsal view of the gnathosoma. (C) Dorsal and ventral view of the larva. (D) Scutum. (E–G) Leg I, II, and III. (H) Idiosomal setae.

**Table 3. Standard measurements (in μm) of *G.* (*Gat.*) *yilanensis* sp. n. larva**

| | AW | PW | SB | ASB | PSB | SD | SW | AP | AL | PL |
|---|---|---|---|---|---|---|---|---|---|---|
| Holotype | 59 | 104 | 64 | 29 | 152 | 181 | 124 | 46 | 58 | 52 |
| Mean | 59 | 105 | 65 | 27 | 147 | 177 | 128 | 46 | 56 | 50 |
| Min. | 56 | 101 | 63 | 26 | 139 | 166 | 124 | 45 | 53 | 45 |
| Max. | 62 | 110 | 68 | 29 | 152 | 181 | 134 | 48 | 59 | 52 |

| SN | PS | HS | DS(m) | VS(pre) | VS(post) | pa | pm | pp | Ip |
|---|---|---|---|---|---|---|---|---|---|
| 46 by 15 | 25 | 54 | 51 | 31 | 42 | 297 | 267 | 314 | 879 |
| 47 by 15 | 25 | 58 | 52 | 30 | 43 | 303 | 262 | 317 | 882 |
| 45 by 14 | 22 | 54 | 48 | 28 | 42 | 295 | 255 | 309 | 864 |
| 50 by 15 | 27 | 61 | 56 | 32 | 44 | 309 | 270 | 327 | 906 |

PPLs arranged in (1), 4 (5–6), 6 (4–5), 4 (3, 5), 2 (1, 3–4), 2 (0). SN claviform with spikes on surface. Second row of DS (separated medially by scutum) consists of two sets of setae, each includes three closely aligned setae (some specimens with four setae on one side). DS 50–53 (including HS), arranged in 2 (3), 6 (7), 7 . . . ; posterior DS arranged disorderly. VS 69–84. NDV = 118–135.

**Larva.** ($n = 6$) Live larva oval. Measurements of body length and width are as follows (in μm): Unengorged body length 250–295, width 183–230. Eyes 2 + 2, located by scutum; anterior pair larger.

*Gnathosoma.* Gnathosomal base round, evenly punctate, with a pair of pectinate setae; cheliceral base evenly punctate; cheliceral blade with tricuspid cap. Galeal setae nude; fPp = B/B/NNN/4B, with a blunt solenidion; three-pronged palpal claw.

*Scutum.* Long, hexagonal; anterior margin slightly concave; posterior margin slightly convex. Scutum evenly punctate. PW/AP = 2.20–2.36; PW/SD = 0.58–0.62. SB/PL. Scutal setae branched, 19–22, with 2 ALs, 2 PLs, and 15–18 PPLs, which are more slender than the ALs and the PLs and are arranged in (1), 4 (5–6), 6 (4–5), 4 (3, 5), 2 (1, 3–4), 2 (0). SN claviform with short spikes on surface. Standard measurements of scutum are presented in Table 3.

*Idiosomal setae.* DS 50–53 in number, arranged in 2 (3), 6 (7), 7 . . . ; posterior DS arranged disorderly.

Second row of DS (medially separated by scutum) consists of two sets of setae, each set includes three setae that are closely aligned (some specimens with four setae on one side). HS and DS similar to PL, branched and tapering to apex. ST 2-2 and finely branched. VS 69–84, with preanal setae 41–54, similar to ST but shorter, and postanal setae 21–32, similar to posterior DS. NDV = 118–135. Measurements of idiosomal setae are presented in Table 3.

*Legs.* fsp 7-6-6, all with a pair of claws and a slender empodium. Coxae I-III unisetose, evenly punctate. All segments with various numbers of branched setae (B). *Leg I*: coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, two genualae and one microgenuala; tibia 8B, two tibialae (the distal one is similar to the tarsala and thicker than the proximal one) and one microtibiala; tarsus 23B, one central tarsala; one microtarsala, pretarsala, nude subterminala, and parasubterminala. *Leg II*: coxa 1B; trochanter 1B; femur 5B; genu 3B, with one genuala; tibia 6B, with two tibialae (the distal one is slightly thicker than the proximal one); tarsus 15B, with one central tarsala; one microtarsala and pretarsala. *Leg III*: coxa 1B; trochanter 1B; femur 4B, one branched ventral femorala; genu 3B, with one genuala; tibia 6B; tarsus 16B.

**Type Material.** HOLOTYPE: one larva (IW0048-8-1), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, female. PARATYPES: one larva (IW0047-2-4), same locality, date, and collector, ex *A. semotus*, male; four larvae (IW0054-1-2∼3, IW0054-2-1∼2), same locality, 13-VIII-2008, Coll. C. C. Kuo, ex *N. culturatus*, female.

**Distribution.** Similar to *G.* (*Gat.*) *lieni*, this species has been collected in forests of Szuyuan Wukou, Yilan County, Taiwan, at nearly 2,000 m in elevation. Rain mainly falls between July and October. The mean annual temperature is 11.8°C, with mean minimum and maximum temperatures of 5.4 and 16.8°C.

**Remarks.** *Gahrliepia* (*Gat.*) *yilanensis* most closely resembles the new species *G.* (*Gat.*) *lieni* and can be distinguished from this species using the following features (*G.* (*Gat.*) *lieni* in parentheses): DS 50–53 (DS 61–66); second row of DS consists of two sets of three setae closely aligned (setae of second row of DS evenly arranged); ventral femorala of leg III branched (nude).

**Biology.** *Gahrliepia* (*Gat.*) *yilanensis* was collected from rodents living mainly in the mountains: *A. semotus*, *N. coninga*, and *N. culturatus*, which are all endemic to Taiwan.

**Etymology.** The species is named after the County 'Yilan' of Taiwan where the specimens were collected.

## Checklist of Chigger Species of Taiwan

### Family Leeuwenhökiidae Womersley, 1944
### Subfamily Leeuwenhökiinae Womersley, 1944

#### Genus *Odontacarus* Ewing, 1929

***Odontacarus majesticus* (Chen & Hsu, 1955)**

Localities: Kinmen County (Hsiaokukang, Lake Hou).

Hosts: Rodents (*R. losea*, *R. tanezumi*).

### Family Trombiculidae Ewing, 1944a
### Subfamily Gahrliepiinae Womersley, 1952

#### Genus *Gahrliepia* Oudemans, 1912
#### Subgenus *Gateria* Ewing, 1938

***Gahrliepia* (*Gateria*) *lieni*, sp. n.**

Localities: Yilan County (Szuyuan Wukou).

Hosts: Rodents (*A. semotus*, *N. coninga*).

***Gahrliepia* (*Gateria*) *linguipelta* Jeu et al., 1983 (new record)**

Localities: Yilan County (Szuyuan Wukou).

Hosts: Rodents (*A. semotus*, *N. culturatus*).

Specimens examined: one larva (IW0047-2-5), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *A. semotus*, male; one larva (IW0054-1-1), same locality, 13-VIII-2008, Coll. C. C. Kuo, ex *N. culturatus*, female.

***Gahrliepia* (*Gateria*) *longipedalis* Yu & Yang, 1986 (new record)**

Localities: Nantou County (Luku); Yilan County (Szuyuan Wukou).

Hosts: Shrew (*Crocidura attenuata*); Rodents (*N. coninga*, *N. culturatus*).

Specimens examined: five larvae (IW0048-9-6, IW0048-10-1, IW0048-10-3, IW0048-12-1, IW0048-14-1), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, female; one larva (IW0054-2-3), same locality, 13-VIII-2008, Coll. C. C. Kuo, ex *N. culturatus*, female.

***Gahrliepia* (*Gateria*) *minuta*, sp. n.**

Localities: Hualien County (Tungli).

Hosts: Rodents (*B. indica*, *R. losea*).

***Gahrliepia* (*Gateria*) *taiwanensis* (Wen, 2000)**

Localities: Nantou County (Wushe).

Hosts: Rodent (*Microtus kikuchii*).

***Gahrliepia* (*Gateria*) *yilanensis*, sp. n.**

Localities: Yilan County (Szuyuan Wukou).

Hosts: Rodents (*A. semotus*, *N. coninga*, *N. culturatus*).

#### Genus *Walchia* Ewing, 1931
#### Subgenus *Walchia* Ewing, 1931

***Walchia* (*Walchia*) *acugastia* Wen et al., 1984 (new record)**

Localities: Hualien County (Hokang).

Hosts: Rodent (*B. indica*).

Specimens examined: one larva (7810-3-4), Hualien County, Juisui, Hokang, 19-X-2000, Coll. H. C. Wang, ex *B. indica*, male.

***Walchia* (*Walchia*) *chinensis* (Chen & Hsu, 1955)**

Localities: Kinmen County (Chengyi, Hsiaokukang, Lake Hou, Shangchi, Tayang).

Hosts: Shrew (*Suncus murinus*); Rodents (*R. losea*, *R. norvegicus*, *R. tanezumi*).

***Walchia* (*Walchia*) *fragilis* Schluger, 1955 (new record)**

Localities: Yilan County (Szuyuan Wukou).

Hosts: Rodent (*N. coninga*).

Specimens examined: one larva (IW0048-14-4), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, female; seven larvae (IW0053-7-3, IW0053-9-3∼4, IW0053-11-1∼2, IW0053-12-3∼4), same locality, 13 VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, male.

***Walchia* (*Walchia*) *jiangxiensis* Wang & Song, 1981 (new record)**

Localities: Hualien County (Hokang).

Hosts: Rodents (*B. indica*, *R. losea*).

Specimens examined: six larvae (7785-1-2∼3, 7785-2-1∼2, 7785-3-1∼2), Hualien County, Juisui, Hokang, 17-VIII-2000, Coll. H. C. Wang, ex *R. losea*, male; eight larvae (7810-1-1∼3, 7810-2-1, 7810-3-1∼3, 5), same locality, 19-X-2000, Coll. H. C. Wang, ex *B. indica*, male.

***Walchia* (*Walchia*) *kritochaeta* (Traub & Evans, 1957) (new record)**

Localities: Pingtung County (Kaomei Bridge); Hualien County (Kauliao, Tungli).

Hosts: Rodents (*B. indica*, *N. coninga*, *R. losea*).

Specimens examined: five larvae (IW0035-1-1∼2, IW0035-3-2, IW0035-4-1∼2), Pingtung County, Kaoshu, Kaomei Bridge, 20-VI-2008, Coll. C. C. Kuo, ex *B. indica*, male; one larva (7778-6-1), Hualien County, Fuli, Tungli, 15-VIII-2000, Coll. H. C. Wang, ex *N. coninga*, male; one larva (7779-4-1), Hualien County, Yuli, Kauliao, 16-VIII-2000, Coll. H. C. Wang, ex *B. indica*, male; one larva (7804-2-1), same locality, 18-X-2000, Coll. H. C. Wang, ex *R. losea*, female; four larvae (7807-1-1∼2, 7807-3-1, 7807-5-1), same locality, date, and collector, ex *B. indica*, male.

***Walchia* (*Walchia*) *pacifica* (Chen & Hsu, 1955) (new record)**

Localities: Hsinchu County (Chiale); Nantou County (Chingshin, Neipu, Peikang); Tainan City (Kuantien); Hualien County (Kauliao, Tungli).

Hosts: Rodents (*B. indica*, *N. coninga*, *R. exulans*, *R. losea*).

Specimens examined: two larvae (IW0038-3-1, IW0038-4-1), Hsinchu County, Chienshih, Chiale, 15-VII-2008, Coll. C. C. Kuo, ex *B. indica*, male; one larva (8078-1-1), Nantou County, Puli, Neipu, 30-VIII-2001, Coll. H. C. Wang, ex *B. indica*, male; two larvae (8086-1-1, 8086-3-1), Nantou County, Puli, Chingshin, 17-X-2001, Coll. H. C. Wang, ex *B. indica*, female; one larva (8080-1-1), Nantou County, Kuohsing, Peikang, 30-VIII-2001, Coll. H. C. Wang, ex *B. indica*, male; four larvae (IW0013-2-1, IW0013-3-1, IW0013-4-3, IW0013-6-2), Tainan City, Kuantien, 17-VI-2007, Coll. C. C. Kuo, ex *R. losea*, female; one larva (7808-1-1), Hualien County, Yuli, Kaoliao, 18-X-2000, Coll. H. C. Wang, ex *B. indica*, female; one larva (8038-2-1), same locality, 13-VI-2001, Coll. H. C. Wang, ex *B. indica*, male; two larvae (7955-3-1, 7955-5-1), Hualien County, Fuli, Tungli, 5-I-2001, Coll. H. C. Wang, ex *B. indica*, female.

***Walchia* (*Walchia*) *parapacifica* (Chen et al., 1956) (new record)**

Localities: Pingtung County (Kaomei Bridge); Yilan County (Szuyuan Wukou); Hualien County (Hokang, Kauliao, Tungli).

Hosts: Rodents (*A. semotus*, *B. indica*, *N. coninga*, *R. losea*).

Specimens examined: four larvae (IW0035-2-1, IW0035-3-1, IW0035-4-3, IW0035-6-1), Pingtung County, Kaoshu, Kaomei Bridge, 20-VI-2008, Coll. C. C. Kuo, ex *B. indica*, male; two larvae (7778-1-1, 7778-4-1), Hualien County, Fuli, Tungli, 15-VIII-2000, Coll. H. C. Wang, ex *N. coninga*, male; one larva (7785-1-1), Hualien County, Juisui, Hokang, 17-VIII-2000, Coll. H. C. Wang, ex *R. losea*, male; four larvae (7804-1-1, 7804-3-1, 7804-4-1∼2), same locality, 18-X-2000, Coll. H. C. Wang, ex *R. losea*, female; one larva (7807-3-1), same locality, date, and collector, ex *B. indica*, male; one larva (7854-1-1), same locality, 21-XII-2000, Coll. H. C. Wang, ex *R. losea*, male; one larva (7834-4-1), Hualien County, Yuli, Kauliao, 20-XII-2000, Coll. H. C. Wang, ex *R. losea*, male; two larvae (7995-1-1, 7995-5-1), same locality, 2-V-2001, Coll. H. C. Wang, ex *R. losea*, female.

***Walchia* (*Walchia*) *xishaensis* Zhao et al., 1986 (new record)**

Localities: Hualien County (Kauliao, Tungli); Taitung County (Pinlang, Tungching).

Hosts: Rodents (*N. coninga*, *R. losea*).

Specimens examined: one larva (7776-2-1), Hualien County, Fuli, Tungli, 15-VIII-2000, Coll. H. C. Wang, ex *R. losea*, male; five larvae (7778-1-2, 7778-2-1, 7778-3-1, 7778-4-2, 7778-5-1), same locality, date, and collector, ex *N. coninga*, male; two larvae (7784-1-1, 7784-2-1), Hualien County, Yuli, Kauliao, 16-VIII-2000, Coll. H. C. Wang, ex *R. losea*, male; one larva (8537-38-1-1), Taitung County, Orchid Island, Tungching, 6-IX-2006, Coll. H. C. Wang, ex *R. losea*, female; four larvae (9286-87-1-1, 9286087-2-1, 9286-87-5-1∼2), Taitung County, Peinan, Pinlang, 11-VI-2009, Coll. H. C. Wang, ex *R. losea*, female; one larva (9292-2-1), same locality, date, and collector, ex *R. losea*, male.

## Subfamily Trombiculinae Ewing, 1929
## Genus *Ascoschöngastia* Ewing, 1946a

***Ascoschöngastia indica* (Hirst, 1915)**

Localities: Kinmen County (Hsiaokukang, Lake Hou).

Hosts: Rodents (*R. norvegicus*, *R. tanezumi*).

***Ascoschöngastia paishaensis* (Chen et al., 1958) (new record)**

Localities: Yilan County (Szuyuan Wukou).
Hosts: Rodent (*N. coninga*).
Specimens examined: six larvae (IW0053-7-1, IW0053-8-1, IW0053-9-1∼2, IW0053-10-1, IW0053-12-1), Yilan County, Tatung, Szuyuan Wukou, 13-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, male.

***Ascoschöngastia rattinorvegici* Wen, 1984a (new record)**

Localities: Yilan County (Szuyuan Wukou).
Hosts: Rodent (*N. coninga*).
Specimens examined: 21 larvae (IW0048-2-1, IW0048-5-1, IW0048-6-1, IW0048-9-1∼ IW0048-9-5, IW0048-10-1∼2, IW0048-11-1∼3, IW0048-12-1∼5, IW0048-13-1∼3), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, female; one larva (IW0053-12-2), same locality, 13-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, male.

## Genus *Eutrombicula* Ewing, 1938

***Eutrombicula ablephara* (Womersley, 1952)**

Localities: Nantou County.
Hosts: Reptile (*Sp. indicus*).

***Eutrombicula isshikii* (Sugimoto, 1938)**

Localities: Taiwan (detailed locality not reported).
Hosts: Birds (*Capella hardwickii*, *Centropus bengalensis lignator*); Rodents (*R. norvegicus*, *R. tanezumi*).

***Eutrombicula wichmanni* (Oudemans, 1905)**

Localities: Taitung County (Langtao, Tungching), Penghu County.
Hosts: Birds (*Centropus bengalensis lignator*, *Gallus domesticus*, *Monticola solitarius*); Domestic goat (*Capra aegagrus hircus*); Human (*Homo sapiens*); Rodents (*R. losea*, *R. norvegicus*, *R. tanezumi*).

## Genus *Helenicula* Audy, 1954

***Helenicula kohlsi* (Philip & Woodward, 1946) (new record)**

Localities: Kinmen County (Lake Hou).
Hosts: Rodent (*R. tanezumi*).
Specimens examined: two larvae (7157-1-1, 7157-3-1), Kinmen County, Kinning, Lake Hou, 4-XI-1999, Coll. H. C. Wang, ex *R. tanezumi*, female.

## Genus *Herpetacarus* Vercammen-Grandjean, 1960

### Subgenus *Herpetacarus* Vercammen-Grandjean, 1960

***Herpetacarus* (*Herpetacarus*) *longdongensis* (Mo et al., 1990) (new record)**

Localities: Hualien County (Hokang).
Hosts: Rodent (*R. losea*).
Specimens examined: one larva (8008-2-1), Hualien County, Juisui, Hokang, 5-III-2001, Coll. H. C. Wang, ex *R. losea*, female.

## Genus *Leptotrombidium* Nagayo et al., 1916

### Subgenus *Leptotrombidium* Nagayo et al., 1916

***Leptotrombidium* (*Leptotrombidium*) *akamushi* (Brumpt, 1910)**

Localities: Hualien County (Fenglin, Hokang)
Hosts: Rodents (*A. agrarius*, *B. indica*, *R. losea*).

***Leptotrombidium* (*Leptotrombidium*) *apodemi* Wen & Sun, 1984 (new record)**

Localities: Yilan County (Szuyuan Wukou).
Hosts: Rodent (*N. coninga*).
Specimens examined: two larvae (IW0053-7-2, IW0053-10-2), Yilan County, Tatung, Szuyuan Wukou, 13-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, male.

***Leptotrombidium* (*Leptotrombidium*) *asanumai* Takada, 1977**

Localities: Chiayi County (Alishan).
Hosts: Rodent (*A. semotus*).

***Leptotrombidium* (*Leptotrombidium*) *cangjiangense* Yu et al., 1981 (new record)**

Localities: Yilan County (Szuyuan Wukou).
Hosts: Rodent (*N. coninga*).
Specimens examined: three larvae (IW0048-1-1, IW0048-11-4∼5), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *N. coninga*, female.

***Leptotrombidium* (*Leptotrombidium*) *deliense* (Walch, 1922)**

Localities: Nantou County (Peikang, Pingho); Tainan City (Kuantien, Shanshang); Yilan County (Tungkang, Wuwei Port); Hualien County (Fenglin, Hokang, Kauliao, Tungli, Shoufeng); Taitung County (Chungliao, Kungkuan, Langtao, Nanliao, Nantzuhu, Pinlang, Shihlang); Penghu County (Chienliao, Chihtung, Huhsi, Nanliao, Tachih); Kinmen (Hsiaoching, Hsiaokukang, Lake Hou, Tayang); Lienchiang County (Chinsha, Chulo).
Hosts: Birds (*Centropus bengalensis lignator*, *G. domesticus*, *Phasianus colchicus formosanus*, *Turnix sylvatica*); Carnivores (*Canis familiaris*, *Felis domesticus*); Domestic goat (*Capra aegagrus hircus*); Shrews

(*Cr. attenuata*, *Cr. suaveolens*, *Su. murinus*); Human (*Ho. sapiens*); Domestic rabbit (*Oryctolagus cuniculus*); Rodents (*A. agrarius*, *B. indica*, *Mus caroli*, *Mu. musculus*, *R. exulans*, *R. norvegicus*, *R. losea*, *R. tanezumi*).

***Leptotrombidium* (*Leptotrombidium*) *fujianense* Liao & Wang, 1983 (new record)**

Localities: Kaohsiung City (Shanping).
Hosts: Carnivore (*He. urva*).
Specimens examined: one larva (20150127C03-4), Kaohsiung City, Liukuei, Shanping, 27-I-2015, Coll. C. C. Chen, ex *He. urva*, gender unknown.

***Leptotrombidium* (*Leptotrombidium*) *imphalum* Vercammen-Grandjean & Langston, 1975**

Localities: Hualien County (Fenglin, Hokang, Kaoliao, Tungli, Shoufeng); Kinmen County (Tayang).
Hosts: Shrews (*Cr. attenuata*, *Cr. suaveolens*, *Su. murinus*); Rodents (*A. agrarius*, *B. indica*, *Mu. caroli*, *Mu. musculus*, *R. exulans*, *R. losea*).

***Leptotrombidium* (*Leptotrombidium*) *kawamurai* (Fukuzumi & Obata, 1953)**

Localities: Lienchiang County (Chinsha, Chulo, Jenai, Szuwei).
Hosts: Shrew (*Su. murinus*).

***Leptotrombidium* (*Leptotrombidium*) *pallidum* (Nagayo et al., 1919) (new record)**

Localities: Lienchiang County (Chinsha, Chulo, Jenai, Szuwei, Tangchi).
Hosts: Rodent (*R. losea*).
Specimens examined: three larvae (8633-2-1, 8634-2-1∼2), Lienchiang County, Peikan, Tangchi, 6-III-2007, Coll. H. C. Wang, ex *R. losea*, male; one larva (8654-3-1), Lienchiang County, Nankan, Szuwei, 7-III-2007, Coll. H. C. Wang, ex *R. losea*, female; one larva (8658-2-1), Lienchiang County, Nankan, Chulo, 7-III-2007, Coll. H. C. Wang, ex *R. losea*, female; four larvae (8663-1-1, 8664-1-1, 8664-2-1∼2), same locality, date, and collector, ex *R. losea*, male; two larvae (8673-1-1, 8673-2-1), Lienchiang County, Nankan, Jenai, 8-III-2007, Coll. H. C. Wang, ex *R. losea*, male; one larva (8679-2-1), Lienchiang County, Nankan, Chinsha, 8-III-2007, Coll. H. C. Wang, ex *R. losea*, female; four larvae (8682-1-1∼2, 8682-2-1∼2), same locality, date, and collector, ex *R. losea*, male.

***Leptotrombidium* (*Leptotrombidium*) *rubellum* Wang & Liao, 1984 (new record)**

Localities: Hualien County (Fenglin).
Hosts: Rodent (*R. losea*).
Specimens examined: two larvae (9155-56-4-1, 9165-66-9-1), Hualien County, Fenglin, 28-IV-2009, Coll. H. C. Wang, ex *R. losea*, female.

***Leptotrombidium* (*Leptotrombidium*) *scutellare* (Nagayo et al., 1921)**

Localities: Kinmen County (Chengyi, Chingchi, Hsiaoching, Hsiaokukang, Hsishan, Lake Hou, Tayang); Lienchiang County (Chinsha, Chulo).
Hosts: Shrew (*Su. murinus*); Rodents (*R. losea*, *R. norvegicus*).

***Leptotrombidium* (*Leptotrombidium*) *xianglinense* Wen, 1984d (new record)**

Localities: Lienchiang County (Panli).
Hosts: Rodent (*R. losea*).
Specimens examined: four larvae (8645-1-1∼4), Lienchiang County, Peikan, Panli, 6-III-2007, Coll. H. C. Wang, ex *R. losea*, male; three larvae (8648-1-1∼2, 8648-2-1), same locality, date, and collector, ex *R. losea*, female.

***Leptotrombidium* (*Leptotrombidium*) *yui* (Chen & Hsu, 1955)**

Localities: Nantou County (Peikang); Yilan County (Wuwei Port); Hualien County (Hokang); Kinmen County (Hsiaokukang, Lake Hou); Lienchiang County (Panli).
Hosts: Shrew (*Su. murinus*); Rodents (*B. indica*, *R. losea*, *R. norvegicus*).

## Genus *Neoschöngastia* Ewing, 1929

***Neoschöngastia americana* (Hirst, 1921)**

Localities: Penghu County.
Hosts: Birds (*G. domestics*, *Mo. solitarius*).

***Neoschöngastia gallinarum* (Hatori, 1920)**

Localities: Penghu County.
Hosts: Birds (*G. domestics*, *Mo. solitarius*, *Meleagris gallopavo*).

***Neoschöngastia monticola* Wharton & Hardcastle, 1946**

Localities: Penghu County.
Hosts: Bird (*Mo. solitarius*).

***Neoschöngastia posekanyi* Wharton & Hardcastle, 1946**

Localities: Nantou County (Jenai), Penghu County.
Hosts: Birds (*Ot. lettia*, *G. domestics*).

***Neoschöngastia solomonis* (Wharton & Hardcastle, 1946)**

Localities: Penghu County.
Hosts: Birds (*G. domestics*, *Mo. solitarius*).

### Genus *Schöngastia* Oudemans, 1910

#### *Schöngastia philipi* Womersley & Kohls, 1947

Localities: Penghu County.
Hosts: Reptile (lizards, species not reported).

### Genus *Toritrombicula* Sasa, 1954

#### *Toritrombicula corvi* (Hatori, 1920)

Localities: Taiwan.
Hosts: Birds (*Centropus bengalensis javanicus*, *Corvus macrorhynchos colonorum*, *G. domestics*).

#### *Toritrombicula densipiliata* (Walch, 1923) (new record)

Localities: Nantou County (Jenai).
Hosts: Bird (*Ot. lettia*).
Specimens examined: four larvae (990864-2∼5), Nantou County, Jenai, 26-VIII-2010, Coll. C. F. Tse, ex *Ot. lettia* ; one larva (990910-12), same locality, 9-IX-2010, Coll. C. F. Tse, ex *Ot. lettia*.

### Genus *Trombiculindus* Radford, 1948
### Subgenus *Trombiculindus* Radford, 1948

#### *Trombiculindus* (*Trombiculindus*) *hunanye* (Wen, 1984b) (new record)

Localities: Yilan County (Szuyuan Wukou).
Hosts: Rodents (*A. semotus*, *N. coninga*).
Specimens examined: two larvae (IW0043-1-1∼2), Yilan County, Tatung, Szuyuan Wukou, 12-VIII-2008, Coll. C. C. Kuo, ex *A. semotus*, female; four larvae (IW0045-1-1, IW0047-1-1, IW0047-1-1∼2), same locality, date, and collector, ex *A. semotus*, male; one larva (IW0048-13-1), same locality, date, and collector, ex *N. coninga*, female.

#### *Trombiculindus* (*Trombiculindus*) *spinifoliatus* (Wang et al., 1985) (new record)

Localities: Nantou County (Peikang).
Hosts: Rodent (*R. losea*).
Specimens examined: one larva (8090-1-1), Nantou County, Kuohsing, Peikang, 12-XII-2001, Coll. H. C. Wang, ex *R. losea*, male.

### Genus *Walchiella* Fuller, 1952

#### *Walchiella wuyiensis* Wang & Liao, 1981 (new record)

Localities: Kaohsiung City (Shanping).
Hosts: Carnivore (*He. urva*).
Specimens examined: one larva (20150127C03-4), Kaohsiung City, Liukuei, Shanping, 27-I-2015, Coll. C. C. Chen, ex *He. urva*, gender unknown.

## Discussion

In this study, we updated the chigger species of Taiwan based on our intensive surveys of field shrews and rodents in grasslands and cultivated and fallow fields in lowland Taiwan. Forests in mountainous Taiwan were also opportunistically studied. In total, three new species and 23 newly recorded species were identified, in addition to 21 known species. Accordingly, known chigger species in Taiwan more than doubled, from 21 to 47 species.

Most of our surveys focused on grasslands and fields in lowland areas. This is because scrub typhus is a rural disease (Traub and Wisseman 1974), and lowland areas are where the majority of Taiwanese people reside. The intensive study of similar habitats at low elevation has uncovered one new and 11 newly documented chigger species.

By stark contrast, after a two-night sampling of 21 rodents in forests of a single mountainous site, Szuyuan Wukou in Yilan County, we have discovered two new and nine newly recorded species. Such information suggests that many more chigger species are awaiting discovery in Taiwan, particularly in mountainous regions. New or newly documented chigger species are also likely to be uncovered from hosts other than shrews and rodents. This is exemplified by two newly recorded species collected from a mongoose (*He. urva*) host. Therefore, an extensive study of diverse host taxa across a broad range of altitudes in a variety of habitats is warranted for a more comprehensive knowledge of chigger species in Taiwan. The investigation of the etiologic agent of scrub typhus, *O. tsutsugamushi*, in different chigger species and their affinity for humans is equally important in order to assess their risks to human health.

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