Lasiohelea tianmushana Yu & Yang (Diptera: Ceratopogonidae), a New Species from Western Tianmu Mountain, Zhejiang, China[1]

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Abstract A new species of a hematophagous midge, *Lasiohelea tianmushana* Yu & Yang (Diptera: Ceratopogonidae), is described based on morphological features. Specimens were collected in April 2016 with light traps at Western Tianmu Mountain in the Lin'an area in Zhejiang province, China. There are now 67 known species of *Lasiohelea* from the Palearctic and Oriental regions in China and, to our knowledge, this is the first record of the genus at Western Tianmu Mountain.

Key Words biting midge, *Lasiohelea*, new species, light trap, Western Tianmu Mountain

In the family Ceratopogonidae (Borkent 2005), particularly the genus *Culicoides*, 96% of the species are hematophagous, with more than 1,300 species worldwide (Temmam et al. 2016). In the subfamily Forcipomyiinae, vertebrate hematophagy is restricted only to the genus *Lasiohelea* (Edwards 1926) and, according to the catalogue of world species of biting midges (Borkent 2016), the total number of known *Lasiohelea* species in China is 73 (including 14 from Taiwan) (Yu 2006). In China, approximately 70% of *Lasiohelea* species are distributed mainly in the Palearctic region and are predominantly found in the humid areas of South China, except for a few species scattered at the geographic border of Hubei and Guangxi provinces (N 30–40°) (Yu 2003, 2006).

Zhejiang province, located in the Yangtze River delta along the coast of the East China Sea, has a typical subtropical monsoon climate, characterized by four seasons, abundant sunshine, and rainfall averaging 160.4 cm annually, which is optimal for the survival and reproduction of midges in these mountainous terrains and alluvial plains. Although there are 3 subfamilies, 9 genera, and 65 species of Ceratopogonidae in Zhejiang province, there are few reports of hematophagous midges in the genus *Lasiohelea*. Exceptions are *Lasiohelea taiwana* Shiraki (Health Department of General Logistics Department of the Chinese People's Liberation Army 1979) and *Lasiohelea lushana* Yu & Wang (Han et al. 2016). Thus, our

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objective was to conduct a survey for *Lasiohelea* species at Western Tianmu Mountain.

Materials and Methods

In our survey, we captured one male and three females of hematophagous midge using light traps (Jiexing Co. Ltd., Wuhan, China) operated at Western Tianmu Mountain in the Lin'an area in Zhejiang province, China. The four adults were anaesthetized with chloroform and placed in 75**%** ethanol. Specimens, including female and male genitalia, were mounted on microscope slides and sealed with Canada balsam according to methods of Yu (2006). Identifications were performed with a SteREO Discovery V12 microscope (Carl Zeiss MicroImaging GmbH, Göttingen, Germany), using the taxonomic keys of Debenham (1983), Yu and Wirth (1997), and Yu (2006).

Results

Descriptions. *Lasiohelea* (*Lasiohelea*) *tianmushana* Yu & Yang 2017, new species (Figs. 1, 2).

Diagnosis. Female and male adults: The three features that distinguish *L. tianmushana* from other extant *Lasiohelea* species in the Palearctic and Oriental regions are: (a) female cibarium with 15 arrow-like teeth in a row, (b) female wing with dense macrotrichia along costa and radial veins, and (c) aedeagus of male genitalia subdivided into two long aigrette-like projections at the bend and outer gonostylus tapered to narrow constriction on 1/3 apex.

Female adult. Head: Compound eyes bare (Fig. 1A); antennae generally with 13 flagellomeres; 8 proximal flagellomeres much shorter than 5 distal flagellomeres (as in Figs. 1A, 2A); ultimate antennal segment with a terminal papilla; length of flagellar segments in proportion of 12:7:7:7:7:7:7:10:26:26:27:27:36; antennal ratio (AR) 2.22. Maxillary palpus with 5 segments and relative lengths (RL–P) of 8:13:15:9:13; third segment stout and swollen, without a shallow sensory pore, maximum width just above center, 1/2–2/3 subapically inner surface containing several capitate sensilla (Fig. 2B). Cibarial armature with 15 arrow-like teeth in a single row (Fig. 2C); mandible with about 15 teeth; 5 distal minute spines. Clypeus squarish or somewhat wider than long with 9 bristles, 3 setae on the front edge, 2 scattered along each lateral side or anterior margin (Fig. 2D). **Thorax** (Fig. 2E): Uniformly brown, without scales; scutellum with line of 9 strong bristles on front margin. **Wing:** Wing length 0.91 mm, width 0.38 mm; macrotrichia developed and rather densely distributed on the whole wing, especially along costa and radial veins; costa and 2Rs cell extending well beyond half of the wing length (Fig. 1B). **Legs:** Pale brown legs, without scales; hind tibia with 7 distal bristles and 13 comb teeth; tarsal ratio about 1.70 in foreleg and midleg, 1.96 in hind leg; femur, tibia, and tarsi of all legs as in Table 1. **Abdomen:** As brown as thorax, but abdominal sterna paler than terga. **Genitalia** (Figs. 1C, 2F): Spermatheca oval, weakly sclerotized, single functional seminal capsule present, tapering to slender opening without elongate neck, circular aperture with diameter approximately 1/4 that of spermatheca.

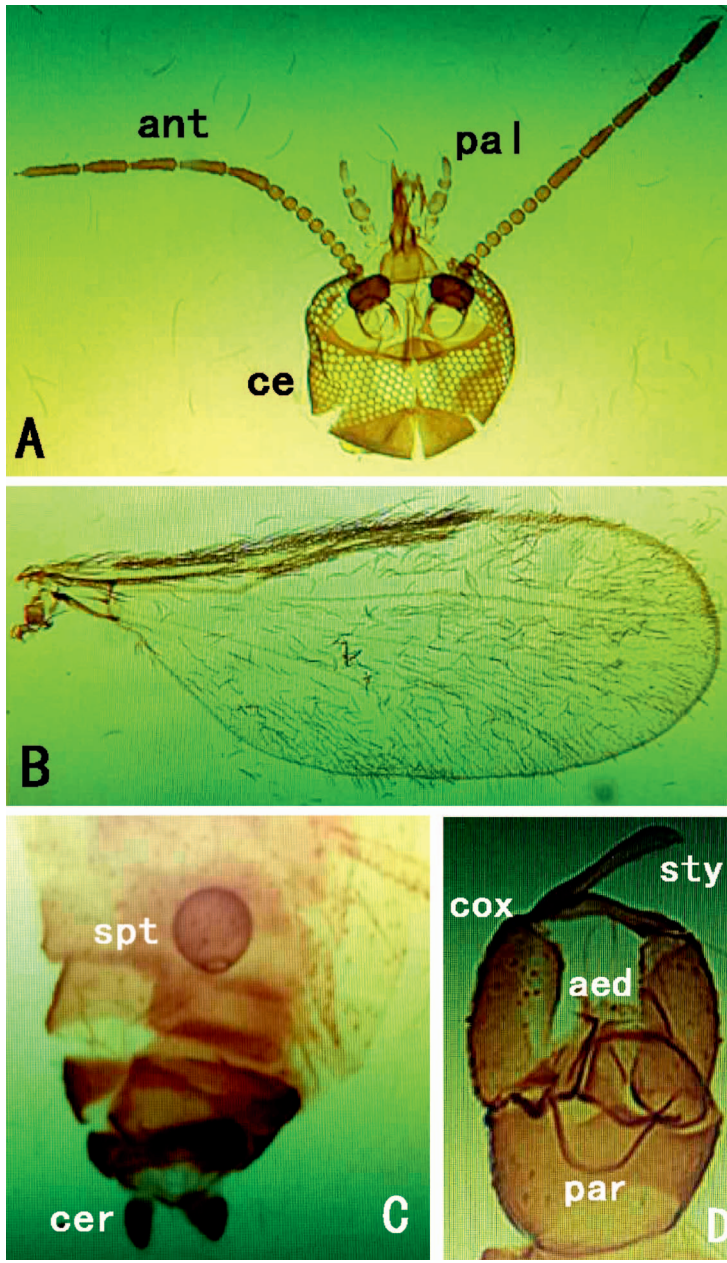

Fig. 1. Morphology of *L. tianmushana* with dorsal view of (A) head, (B) wing, (C) ventral aspect of female abdomen, and (D) male genitalia. aed, aedeagus; ant, antenna; ce, compound eye; cer, cerci; cox, gonocoxite; pal, maxillary palpus; par, paramere; spt, spermatheca; sty, gonostyle.

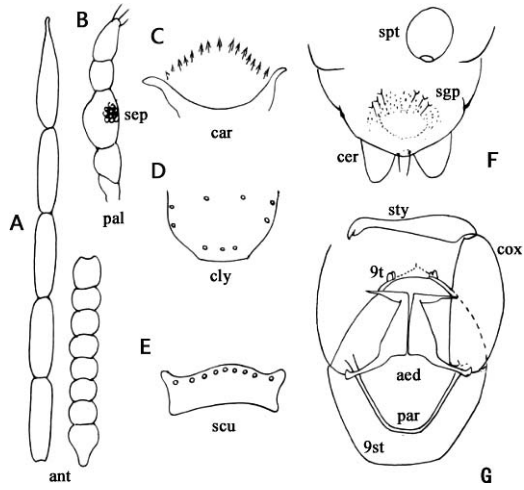

Fig. 2. Structure of *L. tianmushana*. A–F, female; G, male. (A) antenna (ant); (B) maxillary palpus (pal) and sensory pit (sep); (C) cibarium (car); (D) clypeus (cly); (E) scutellum (scu); (F) ventral view of female genitalia (spt, spermatheca; cer, cerci; sgp, subgenital plate); (G) ventral view of male genitalia (aed, aedeagus; par, paramere; cox, gonocoxite; sty, gonostyle; 9t, 9th tergum; 9 st, 9th sternum).

Male adult. General color and structure as in female, with usual sexual differences. Males distinguished from females based on following morphological features. **Head:** Distal 4 antennal segments elongate; segments 3–15 in proportion of 25:15:15:15:14:12:12:12:12:25:34:28:33; RL–P 7:13:15:7:16; AR 1.1. **Genitalia:** Male abdominal genitalia as in Fig. 1D and Fig. 2G. Gonocoxite broad, subcylindrical, without lobes, approximately as long as gonostylus; ventral gonostylus arising at the apex of gonocoxite, evenly tapering to a constriction on 1/3 apex, apical part distinctly narrower than subbasal part. Apex of aedeagal plate distinctly curved outwards as long aigrette-like proboscis, lateral lobes elongated, with slender basal arm curved, ventrad to triangular tip; paramere deeply arcuate and wide U-shaped.

Immature stages. Unknown.

Table 1. Mensural parameters of the legs of female *L. tianmushana*.

Leg	TR*	F–T**
Foreleg	1.70	145:146:73:43:31:21:19
Midleg	1.70	151:171:73:43:33:21:19
Hind leg	1.96	165:162:102:52:40:25:20

* Tarsal ratio.

** Femur, tibia, and tarsi.

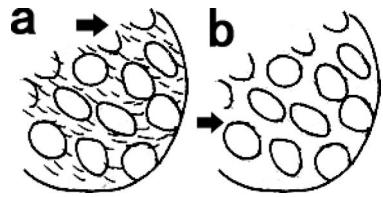

Fig. 3. Compound eye of (a) *L. lushana* and (b) *Lasiohelea* sp.

Distribution and bionomics. *Lasiohelea tianmushana* is known only from the type locality. Few adults were collected at the edges of Western Tianmu Mountain, Lin'an city, Zhejiang province, China, where the adults live mainly in moist habitats around the river, rice fields, drainage ditches, and bamboo forests at elevations of 300–500 m. No adults were captured near the temple Lion's Mouth Pass (Kaishan Old Hall) at the top of the mountain (elevation approximately 1,500 m), irrespective of whether ultraviolet light traps or aerial net bags were used for sampling. Very little is known of the life history or breeding habitats of the species. Moreover, intense sampling from top to bottom of Western Tianmu Mountain has failed to find any immature stages of this new species in the genus *Lasiohelea*.

Taxonomic discussion. General taxonomic comparison: See the key to species of the genus *Lasiohelea* (Figs. 3–8). One male and three females were collected together, using light traps in the same location at Western Tianmu Mountain; both male and females of this species showed a common pigmentation pattern, with the exception of another three species, *L. humilavolita* Yu & Liu, *L. interceda* Yu (Yu and Wirth 1997), and *L. lushana*, captured at Western Tianmu Mountain at the same time. This species is a current member of the subfamily Forcipomyiinae, with the typical morphology of armed cibarium, hairy marcotrichia, single spermatheca lacking a neck, and aedeagus with elaborated apical hooklike projection, which significantly resembles *L. oxypenis* in Malaysia in the form of male genitalia (Fig. 8). This species is also linked to *L. brevisicae* Debenham in the form of accessorial shape and hooklike process at the terminal of aedeagus (Fig. 7), in New South Wales, Australia (Debenham 1983), but sensory organs of *L. tianmushana* are densely arrayed near the center of the third segment of the maxillary palpus, whereas *L. brevisicae* possesses scattered sensilla group on

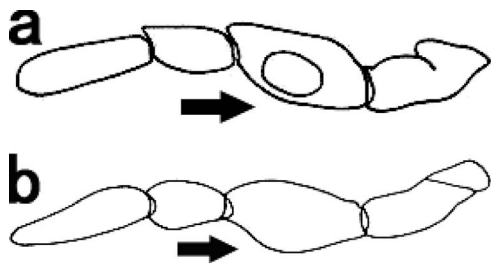

Fig. 4. Sensory pit on the maxillary palp of (a) *L. humilavolita* and (b) *L. forficula*.

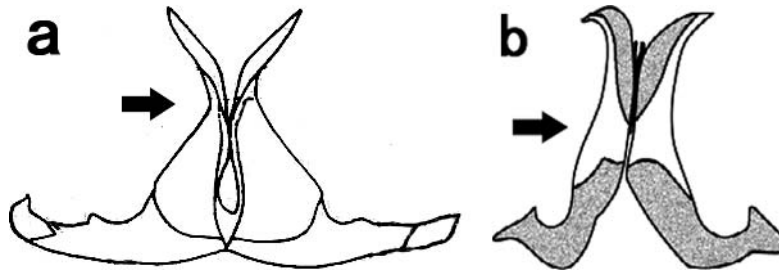

Fig. 5. Male aedeagus of (a) *L. interceda* and (b) *L. humilavolita*.

apical 1/2 (Fig. 6). Moreover, the structure of the cibarial armature is a useful taxonomic characteristic for differentiating adult females of *L. tianmushana* from those of *L. forficula*.

Key to Species of the Genus *Lasiohelea*

1. Eyes hairy (Fig. 3a). Female, 9th sternite with a butterfly-like chitinized thickening, subgenital plate symmetrical with footlike structure. Male, apical process of aedeagal sclerites slender and sharp ..... *L. lushana*
- Eyesbare (Fig. 3b) 2
2. Palpal 3rd segment with clearly defined sensory pit (Fig. 4a)..... 3
- Palpal3rd segment without distinct sensory pit (Fig. 4b) 4
3. Male, apex of aedeagal each lateral plate band-like and slight outward, with distinctive acromion (Fig. 5a). Scutellum with more than 10 stout setae ... . *L. interceda*

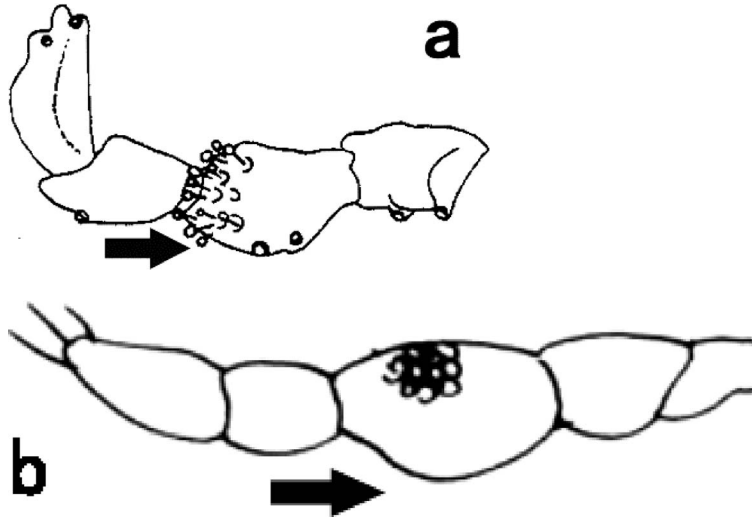

Fig. 6. Sensilla of (a) *L. brevisicae* and (b) *L. tianmushana.*

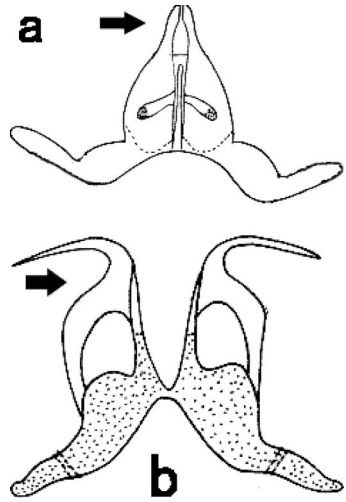

Fig. 7. Aedeagus of male genitalia of (a) *L. forficula* and (b) *L. oxypenis.*

- Maleapex of aedeagal each lateral plate banana leaf–shaped (Fig. 5b), paramere narrow and deeply arcuate. Scutellum with fewer than 10 stout setae. Female, diameter of circular aperture larger than 1/2 of the maximum width of spermatheca, subgenital plate with bat-like thickening … *L. humilavolita*

4. Female, apical 1/2 of 3rd palpal segment moderately swollen with approximately 12 scattered capitate sensilla (Fig. 6a). Thornlike cibarial spines in roughly 2 rows. Male aedeagal sclerites broad basally, outer apical margin with projecting triangular flange..... *L. brevisicae*

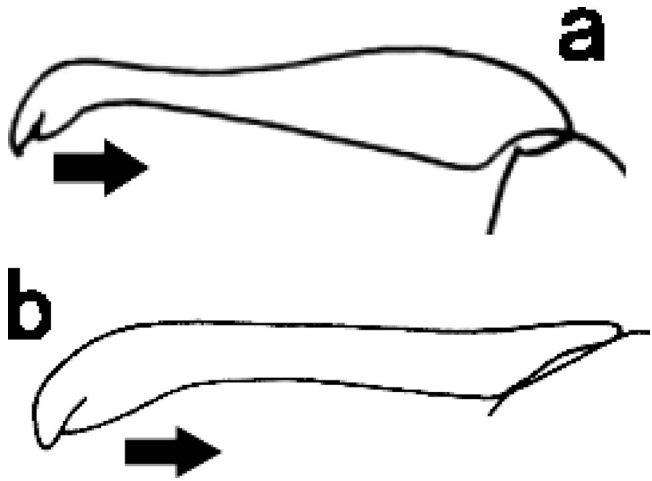

Fig. 8. Gonostylus of (a) *L. tianmushana* and (b) *L. oxypenis*.

- Female,3rd palpal segment elongate with obvious swollen near the center, with cluster of capitate sensilla together (Fig. 6b). Cibarial spines in 1 row .. 5
5. Male, apex of aedeagus each lateral plate straight and fingerlike (Fig. 7a). Female, spermatheca oval; cibarium with about 22 slender teeth, central 7 spines distinctly long; clypeus with 15 bristles ..... *L. forficula*
- Male,apex of aedeagus each lateral plate strongly curved outward (Fig. 7b) .. 6
6. Male, apex of aedeagal sclerites long aigrette-like projection; gonostylus tapered to narrow constriction on 1/3 apex (Fig. 8a). Scutellum with a row of 9 stout bristles. Tarsal ratio in foreleg less than 2.0. Female spermatheca oval; cibarial armature with about 15 arrow-like teeth in a row..... ..... *L. tianmushana* n. sp.
- Male, apex of aedeagal sclerites long slender spinelike; gonostylus without distinctive constriction on the apex (Fig. 8b). Scutellum with a row of 6 stout bristles. Tarsal ratio in foreleg more than 2.0 ..... *L. oxypenis*

Types. Holotype: one female; Allotype: one male; Paratypes: two females, 26 April 2016, from the fringe of forest, Western Tianmu Mountain, Lin'an city, Zhejiang province, CHINA (N 30°18′30″–30°24′55″, E 119°24′11″–119°28′21″). All these type specimens are deposited in the Museum of Medical Vectors, the Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing, China.

Derivation of specific epithet. The name *tianmushana* refers to the type locality of this species.

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