

Redescription of male and female genitalia of *Tipula* (*Emodotipula*) *holoteles* (Diptera), with notes on the structure of the semen pump in the subgenus *Emodotipula*

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Abstract: The original description of male hypopygium of *Tipula* (*Emodotipula*) *holoteles* Alexander, 1924 is expanded with additional morphological characters and detailed illustrations. The additional morphological descriptions of the female ovipositor along with detailed drawings are provided. The male semen pump and the female vaginal apodeme as well as the spermatheca are also described and illustrated for the first time, representing the first report of these structures of *Tipula* (*Emodotipula*) *holoteles*. Additionally, the taxonomic potential of the semen pump in the subgenus *Emodotipula* is analyzed and discussed. The new specific name *Tipula* (*Emodotipula*) *yangi* nom. nov. is proposed as a replacement name for junior homonym *Tipula* (*Emodotipula*) *alexanderi* Men, 2017. A worldwide checklist and a key to Chinese species of the subgenus *Emodotipula* are provided.

Key words: Nematocera; crane flies; ovipositor; vaginal apodeme; *Tipula* (*Emodotipula*) *yangi*; key

全斑喜马大蚊 *Tipula* (*Emodotipula*) *holoteles* 雌性和雄性生殖器的重新描述及喜马大蚊亚属 *Emodotipula* 物种精子泵结构研究 (双翅目)

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摘要: 对全斑喜马大蚊 *Tipula* (*Emodotipula*) *holoteles* Alexander, 1924 的尾节构造特征进行了补充描述, 并提供了详尽的插图。对雌虫的产卵器构造特征进行了重新描述并首次提供了详尽的插图。首次对该物种的雄性精子泵、雌性阴道内突以及受精囊构造进行了描述, 并提供了插图。另外, 对精子泵结构在喜马大蚊亚属 *Emodotipula* 物种分类中的作用进行了分析和讨论。为次同名亚氏喜马大蚊 *Tipula* (*Emodotipula*) *alexanderi* Men, 2017 另起新名为杨氏喜马大蚊 *Tipula* (*Emodotipula*) *yangi* nom. nov.。还提供了该亚属的物种名录和中国种类检索表。

关键词: 长角亚目; 大蚊; 产卵器; 阴道内突; 杨氏喜马大蚊; 检索表

Introduction

The subgenus *Emodotipula* Alexander, 1966 is a small group of species in *Tipula*

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Linnaeus, 1758, established with the type species *Tipula marmoratipennis* Brunetti, 1912 from India by original designation. This subgenus includes 23 known species mainly distributed in the Palearctic and Oriental Regions (Oosterbroek 2018).

Tipula (Emodotipula) holoteles was firstly described by Alexander (1924) based on one male and one female which were collected on Akagi Mountain, Japan. Although the original description of external morphology of this species was detailed, but the description of the genitalia was general and illustrations were lacking. Subsequently, Alexander (1971) provided an illustration of the median lobes of male tergite nine based on the type specimen, but this simple drawing was still inadequate for identification. And there have been no illustrations of the female genitalia.

In this study, we expand the original description of the male hypopygium of *Tipula (Emodotipula) holoteles* by providing additional morphological characters and detailed illustrations based on the type specimen and other specimens. We also provide a morphological description of the female ovipositor, including detailed drawings of each part. The male semen pump and the female vaginal apodeme as well as the spermatheca are also described for the first time. The taxonomic potential of the semen pump is discussed by comparing this structure across 13 congeneric species. A worldwide checklist and a key to Chinese species of *Tipula (Emodotipula)* are provided.

Material and methods

The hypopygium and ovipositor were removed and macerated in 10% NaOH for one hour in a 50°C water bath, then observed in glycerin and illustrated under an Olympus SMZ 10 stereomicroscope (Olympus, Japan), and finally preserved in glycerin jelly in 0.20 ml centrifuge tubes. Photographs of the body parts of adults were obtained using same stereomicroscope with a Cannon EOS 80D camera (Cannon, Japan). All measurements are given in millimeters (mm) and made with the aid of an eyepiece scale. The terminology and methods of description and illustration follow Alexander and Byers (1981) and Frommer (1963).

Abbreviations for institutional collections used herein: VU—Vilnius University, Vilnius, Lithuania; USNM—United States National Museum of Natural History, Washington, D. C., USA; AQNU—Anqing Normal University, Anhui, China.

Taxonomy

Specimens examined. *Tipula (Emodotipula) holoteles* Alexander, 1924: (Holotype) **Japan**, Akagi, Kotsuke-no-kuni, ♂, 29-VII-1923, T. Esaki. **Russia**, Kunashir Island, 1♂, VIII-1989, collector unknown. **Russia**, Sakhalin Island, 1♀, 08-IV-1989, collector unknown. (VU); *Tipula (Emodotipula) breviscapa* Alexander, 1953: (Holotype) **Japan**, Mt. Tsurugi, Awa, Nagoro, ♂, 02-VI-1950, I. Ito. (USNM); *Tipula (Emodotipula) fabriciana* Alexander, 1966: (Holotype) **India**, Chateng, Sikkim, ♂, 22-V-1959, F. Schmid. (USNM); *Tipula (Emodotipula) goetghebuerana* Alexander, 1970: (Holotype) **India**, Shergaon, Kameng, North East Frontier Agency, Assam, ♂, 09-V-1961, F. Schmid. (USNM); *Tipula (Emodotipula)*

hintoniana Alexander, 1968: (Holotype) **India**, Nyukmadong, Kameng, North East Frontier Agency, Assam, ♂, 23-IV-April 1961, F. Schmid. (USNM); *Tipula (Emodotipula) multibarbata* Alexander, 1935: (Holotype) **Korea**, Shorei, ♂, 09-VII-1923, J. Masaki. (USNM); *Tipula (Emodotipula) naviculifer* Alexander, 1920: (Holotype) **Japan**, Saitama, ♂, 29-V-1919, R. Takahashi. (USNM); *Tipula (Emodotipula) shogun* Alexander, 1921: (Metatype) **Russia**, Kunashir, Tretiakovo, ♂, 06-VII-1968, E. N. Savchenko. (USNM); *Tipula (Emodotipula) submarmoratipennis* Alexander, 1936: (Paratype) **India**, Lower Pulwar Nullah, Kashmir, 1♂, 12-X-1934, V. Hutchinson. (USNM); *Tipula (Emodotipula) tenuiloba* Alexander, 1971: (Holotype) **Japan**, Mount Amakazari, Echigo, Honshu, 03-VI-1955, K. Baba. (USNM); *Tipula (Emodotipula) vaillantiana* Alexander, 1964: (Holotype) **India**, Chattrik, Manipur, Assam, ♂, 21-VII-1960, F. Schmid. (USNM); *Tipula (Emodotipula) yangi* Men, 2019, nom. nov.: (Holotype) **China**, Yaoluoping National Nature Reserve, Yaoluoping Village, Anhui Province, ♂, 26-VIII-2016, Qiulei MEN (Paratype) 1♀, same data as holotype. (AQNU); *Tipula (Emodotipula) yaoluopingensis* Men, 2015: (Holotype) **China**, Yaoluoping National Nature Reserve, Anhui Province, ♂, 15-VIII-2013, Qiulei MEN (paratypes) 2♀, same data as holotype. 1♂, Anhui, Yaoluoping National Nature Reserve, Yaoluoping Village, 24-VIII-2016, Qiulei MEN (AQNU).

Tipula (Emodotipula) yangi Men, 2019, nom. nov.

Tipula (Emodotipula) alexanderi Men, 2017, as junior homonym of and preoccupied by *Tipula (Schummelia) alexanderi* Joseph, 1974.

Etymology. The new nomination is named after Prof. Ding YANG (China Agricultural University, Beijing, China) for his great contribution to the studies of Chinese crane fly.

The worldwide checklist of the subgenus *Emodotipula* in the genus *Tipula*

Tipula (E.) breviscapa Alexander, 1953 — Japan (Shikoku).

Tipula (E.) fabriciana Alexander, 1966 — India (Sikkim).

Tipula (E.) goetghebueraana Alexander, 1970 — India (Assam).

Tipula (E.) gomina Dufour, 2003 — France (Alpes Maritimes, Savoie).

Tipula (E.) hemmingseni Alexander, 1968 — India (Assam).

Tipula (E.) hintoniana Alexander, 1968 — India (Assam).

Tipula (E.) holoteles Alexander, 1924 — Japan (Honshu); Russia (Kunashir Island, Sakhalin Island).

Tipula (E.) leo Dufour, 1991 — Spain (Cadiz, Granada); Morocco (Rif).

Tipula (E.) lishanensis Young, 2014 — China (Taiwan).

Tipula (E.) marmoratipennis Brunetti, 1912 — India (Uttarakhand, W Bengal).

Tipula (E.) multibarbata Alexander, 1935 — Korean Peninsula.

Tipula (E.) multisetosa Alexander, 1935 — China (Sichuan).

Tipula (E.) naviculifer Alexander, 1920 — Russia (Sakhalin Island, Kuril Island); Japan (Hokkaido, Honshu).

Tipula (E.) obscuriventris Strobl, 1900 — Andorra; Austria; Bulgaria; Czech Rep.; Denmark; Finland; France; Germany; Greece; Italy; Liechtenstein; Luxembourg; Macedonia; Montenegro; Poland; Romania; Serbia; Slovakia; Slovenia; Spain; Sweden; Switzerland; Ukraine; Russia; Armenia; Turkey; Iran.

Tipula (E.) yangi Men, 2019, nom. nov. — China (Anhui).

Tipula (E.) saginata Bergroth, 1891 — Austria, France (Alpes Maritimes); Italy (Aosta, Piemonte); Switzerland.

Tipula (E.) shogun Alexander, 1921 — Russia (Kuril Island); Japan (Hokkaido).

Tipula (E.) stylostena Alexander, 1961 — India (Arunachal Pradesh, Uttarakhand); Pakistan.

Tipula (E.) submarmoratipennis Alexander, 1936 — Uzbekistan; Tajikistan; Kyrgyzstan; Afghanistan; India.

Tipula (E.) tenuiloba Alexander, 1971 — Japan (Honshu).

Tipula (E.) thailandica Young, 2014 — Thailand.

Tipula (E.) vaillantiana Alexander, 1964 — India (Assam).

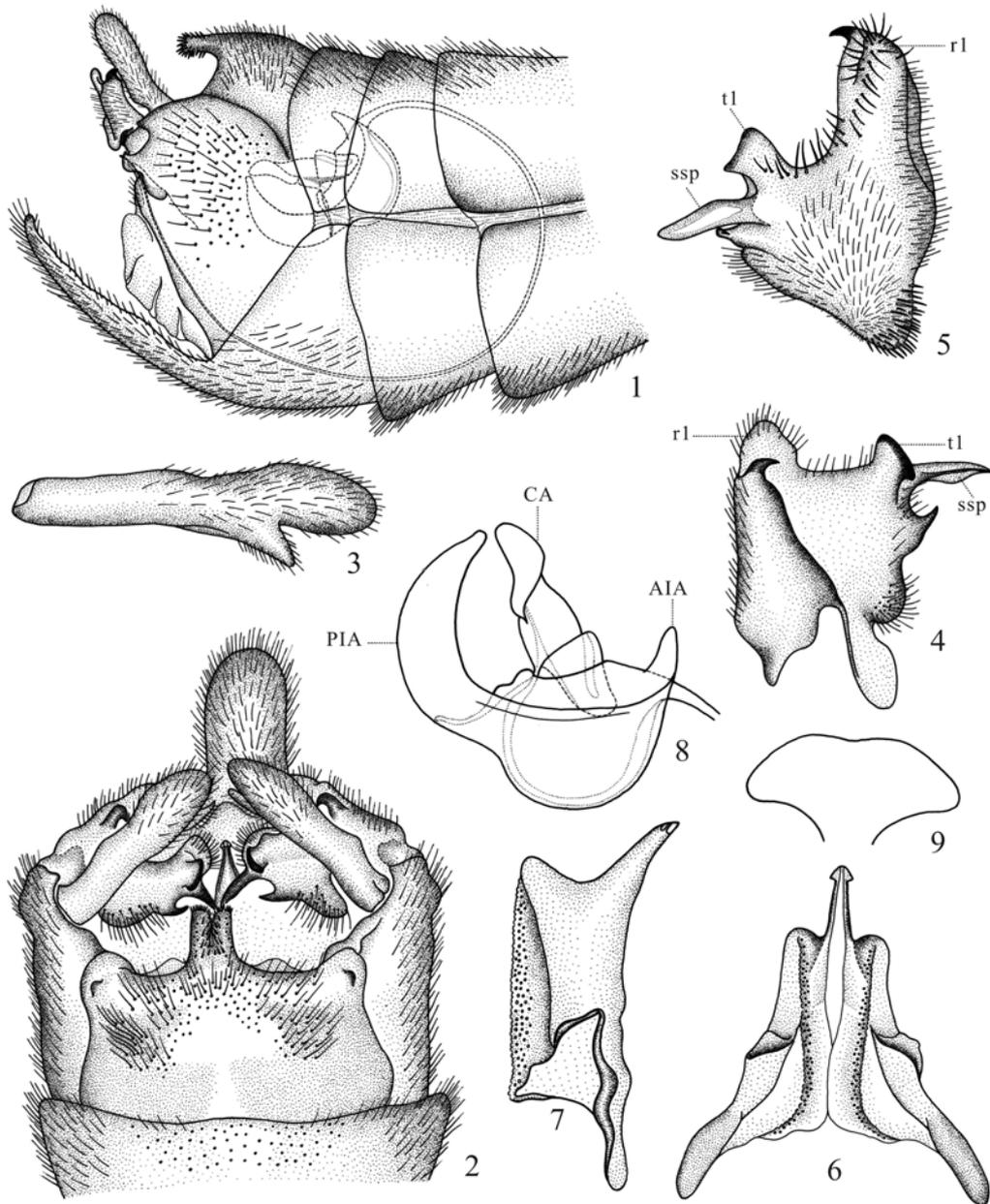
Tipula (E.) yaoluopingensis Men, 2015 — China (Anhui).

Key to species of the subgenus *Emodotipula* from China (male)

1. Tergite nine produced into two black lobes, between them a rounded lobe *Tipula (Emodotipula) multisetosa*
- Tergite nine with two or four lobes 2
2. Tergite nine with four lobes at posterior margin, gonocoxite strongly elongated *Tipula (Emodotipula) yangi*, nom. nov.
- Tergite nine with two lobes, gonocoxite not elongated 3
3. Sternite eight with two strong processes at posterior margin *Tipula (Emodotipula) lishanensis*
- Sternite eight without processes at posterior margin *Tipula (Emodotipula) yaoluopingensis*

Redescription of male and female genitalia

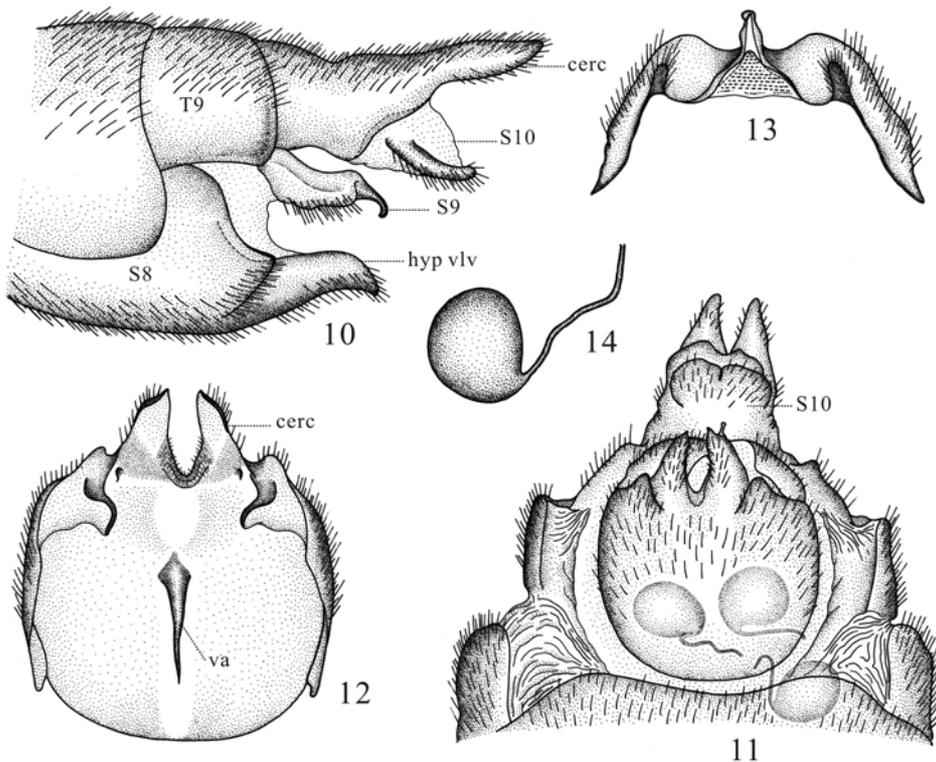
Hypopygium. Sternite eight widened at base, abruptly produced caudad into a long lobe, which is broad basally and narrow apically, apex directed dorsad in lateral view (Fig. 1); the terminal of sternite eight rounded, parallel laterally in dorsal view (Figs. 1, 2); whole surface of sternite eight densely covered with long and fulvous setae (Figs. 1, 2). Sternite nine and tergite nine almost fused, forming an indistinct suture (Figs. 1, 2); tergite nine rounded at lateral corner, nearby with a small nodule (Fig. 2); posterior margin of tergite nine transverse, its median area produced into a pair of black finger-shaped processes, densely covered with black and spinous teeth on apical and inner sides (Fig. 2). Sternite nine broader than tergite nine, deeply concave at the base of outer gonostylus, with an expanded membranous area on the caudal side (Fig. 1). Outer gonostylus narrow and long, with basal half straight and parallel laterally, slightly curved in the middle area, and then gradually broadened to a rounded terminal, a cone-shaped process generated from lateral margin (Figs. 1–3). Inner gonostylus complicated in shape with many processes as follows: a rounded lobe (rl) at left anterior corner, sparsely covered with thick and long setae; nearby the rounded lobe with a black horn-shaped process; a truncated lobe (tl) at right anterior corner, expanded apically and blackened at apex; beside truncated lobe with an elongated sword-shaped process (ssp), acute apically and broadened medially; a horn-shaped process connected to the sword-shaped process, forming a deep and rounded incision between them; right posterior corner expanded, densely covered with thick and short setae (Figs. 4, 5). Adminiculum with apex arrowhead-shaped, lateral margins straight and parallel in lateral view, the lower margin densely covered with small rounded punctations (Figs. 6, 7).



Figures 1–9. Male genitalia of *Tipula (Emodotipula) holoteles*. 1. Hypopygium, lateral view; 2. Hypopygium, dorsal view; 3. Outer gonostylus, lateral view; 4. Inner gonostylus, lateral view; 5. Inner gonostylus, dorsal view; 6. Adminiculum, dorsal view; 7. Adminiculum, lateral view; 8. Semen pump, lateral view; 9. Compressor apodeme, dorsal view. Abbreviations: AIA – anterior immovable apodeme; CA – compressor apodeme; PIA – posterior immovable apodeme; rl – rounded lobe; ssp – sword-shaped process; tl – truncated lobe.

Semen pump and aedeagus. Posterior immovable apodeme elongated, sword-shaped, narrow at base, and then slightly broad, gradually tapered to terminus, curved dorsad in lateral view (Fig. 8). Compressor apodeme fan-shaped in dorsal view, slightly concave in the middle (Fig. 9). Anterior immovable apodeme short in lateral view, slightly expanded in dorsal view (Fig. 8). Aedeagus elongated, at least seven times longer than semen pump, thick at base, gradually narrowed to apex, the thickest region five times wider than the thinnest region (Fig. 1).

Ovipositor. Ovipositor short in general. Tergite nine relatively broad, simple (Fig. 10). Cercus (cerc) slightly elongated, broad at basal, and then gradually narrowed to apex (Figs. 10, 12). Sternite ten rounded, separated into two parts by a small median incision (Fig. 11). Sternite nine broad basally, narrowed to terminals, curved caudad in lateral view, concave in a deeply V-shaped notch at anterior margin, shallowly emarginated at posterior margin, and extended cephalad forming two apodemes (Figs. 10, 11, 13). Sternite eight short and broad, rounded at anterior margin, with two angular lobes at the base of hypogynial valve (hyp vlv) (Figs. 11, 12). Hypogynial valve short, subequal in length to sternite nine, broad basally and gradually narrowed to apex in caudal view, slightly curved caudad in lateral view (Figs. 10, 11, 13). Vaginal apodeme nail-shaped, broad basally, gradually terminated into an acute apex (Fig. 12). Spermatheca black, irregularly oval (Figs. 11, 14).



Figures 10–14. Female genitalia of *Tipula (Emodotipula) holoteles*. 10. Ovipositor, lateral view; 11. Ovipositor, caudal view; 12. Sternite eight, hypogynial valve and vaginal apodeme, dorsal view; 13. Sternite nine, caudal view; 14. Spermatheca. Abbreviations: cerc – cercus; hyp vlv – hypogynial valve; S – sternite; T – tergite; va – vaginal apodeme.

Distribution. Japan; Russia.

Semen pump and aedeagus in the subgenus *Emodotipula*

After comparing the structure of the semen pump and aedeagus in 13 *Tipula* (*Emodotipula*) species, including *T. (E.) breviscapa*, *T. (E.) fabriciana*, *T. (E.) goetghebuerana*, *T. (E.) hintoniana*, *T. (E.) multibarbata*, *T. (E.) naviculifer*, *T. (E.) shogun*, *T. (E.) submarmoratipennis*, *T. (E.) tenuiloba*, *T. (E.) vaillantiana*, *T. (E.) alexanderi*, *T. (E.) yaoluopingensis* and *T. (E.) holoteles*, their semen pumps can be preliminarily characterized by the following characters: posterior immovable apodeme developed, sword-shaped, broadened medially and acute apically, curved dorsad in lateral view; compressor apodeme fan-shaped, slightly concave medially; aedeagus generally broad at base, gradually narrowed apically. Significant differences of morphological features among species were also observed, such as the shapes of the posterior immovable apodeme and compressor apodeme, and the length of aedeagus, which can be effectively used as means for distinguishing species in the subgenus *Emodotipula*.

Remarks. Dufour (1991) observed the sac-like sacculi laterales in some females of *Emodotipula* species, such as *T. leo*, *T. obscuriventris*, *T. saginata*, and *T. submarmoratipennis*. Tjeder (1979) mentioned the presence of sacculi laterales in an unidentified *Emodotipula* species. Young (2014) indicated the existence of this structure in both male and female of *T. lishanensis*, and also in the male of *T. thailandica*. In the present study, sacculi laterales are absent in the male and female of *T. holoteles*. Young (2014) and Tjeder (1979) assumed that the function of this structure relates to pheromones. However, the origin and function of this structure needs further research in the future.

The structure of the semen pump has received less attention than the structure of the hypopygium. Actually, we can find some structural patterns for the semen pump at subgeneric and generic levels. The semen pump of *Lunatipula* species generally has a very elongated posterior immovable apodeme. For *Platytipula* species, the semen pump looks very stubby with a short anterior immovable apodeme, posterior immovable apodeme and compressor apodeme. For *Pterelachisus* species, the semen pump is generally narrowed with an elongated posterior immovable apodeme which forms an obtuse angle between arms; the compressor apodeme has a deeply V-shaped notch in the middle in dorsal view. For *Nephrotoma* species, the semen pump generally has a very elongated compressor apodeme and distinctly expanded anterior immovable apodeme (unpublished data). In this study, a structural regularity of the semen pump in *Emodotipula* species was observed. However, there is still a need for more sampling and taxonomic work to be done in the future.

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