

An annotated catalogue of the genus *Paragavialidium* Zheng (Orthoptera: Tetrigoidea) with the first description of male *Paragavialidium hainanensis*

Lei XIN, Weian DENG^①

School of Chemistry and Bioengineering, Hechi University, Yizhou, Guangxi 546300, China

Abstract: Total fourteen species of the genus *Paragavialidium* Zheng are systematically reviewed. Male *Paragavialidium hainanensis*, newly discovered in Wuzhishan, Hainan Province, is described and given taxonomic notes. An annotated list of the species, a redescription and a key to species of the genus *Paragavialidium* are provided.

Key words: Caelifera; Pygmy locust; taxonomy

伴蚬蚱属名录及海南伴蚬蚱雄性的首次发现（直翅目：蚬蚱总科）

辛磊，邓维安^①

河池学院 化学与生物工程学院，广西 宜州 546300

摘要：本文对伴蚬蚱属昆虫进行了系统研究。首次报道采自海南五指山的海南伴蚬蚱 *Paragavialidium hainanensis* 雄性并给予描述和分类学讨论。文章给出了该属种类名录及分布、分种检索表，并对属征作了重新记述。

关键词：蝗亚目；蚬；分类学

Introduction

The genus *Paragavialidium* (Orthoptera: Tetrigoidea) was established by Zheng in 1994 with *Paragavialidium curvispinum* from Jiangxi as type species (Zheng 1994). The genus currently comprised 14 known species which are all distributed in southern China (Deng *et al.* 2012; Wei *et al.* 2018). *Paragavialidium* can easily be distinguished from other genera of the subfamily Scelimeninae by: anterior margin of pronotum has a short cylindrical or triangular projection in the middle above the occiput, fore edge of the pronotum with a distinct obtuse projection below the eyes, humeral angles significantly angled and projected, and upper or lower margins of fore and middle femora armed with large teeth.

In this report, we introduce male *Paragavialidium hainanensis* (Zheng & Liang) for the first time. At the same time, we list the species, redescribe the generic character and give a species key for the genus *Paragavialidium*.

Material and methods

Grasshopper specimens were examined using a Motic-SMZ-168 stereomicroscope and photographed using an Olympus digital camera with the program CombineZM 1.0.0 (Hadley 2014). All images were processed with Adobe Photoshop CS 11.0.

Morphological terminology and the measurement landmarks method followed those used by Zheng (2005) and Deng *et al.* (2007). Measurements are given in millimetres.

The specimens examined in this study, including all holotypes and paratypes, have been deposited in the Entomological Museum of Hechi University, Yizhou, China (EMHU); Institute of Zoology, Shaanxi Normal University, Xi'an, China (ZSNU); Biology Museum of Sun Yat-sen University, Guangzhou, China (BMSYU); Specimen Room of School of Life Sciences, Huaibei Normal University, Huaibei, Anhui, China (SSHNU); College of Life Science and Chemistry, Dali University (CLCDU).

Taxonomy

Paragavialidium Zheng, 1994

Paragavialidium Zheng, 1994: 1; Jiang & Zheng, 1998: 286; Liang & Zheng, 1998: 70; Zheng, 2005: 73; Deng, Zheng & Wei, 2007: 62; Zheng & Cao, 2011: 742; Deng *et al.*, 2012: 52; Zha *et al.*, 2016: 44; Deng, 2016: 66; Wei, Xin & Deng, 2019: 50.

Type species: *Paragavialidium curvispinum* Zheng, 1994.

Redescription. Body size medium to large, elongated and slender. Vertex distinctly wider than one eye, fastigium of vertex not surpassing anterior margin of eyes, lateral margin distinctly folded upwards; frontal costa archedly protruding between antennae. Antennae filiform, inserted below lower margin of eyes. Eyes globose, not exerted over pronotal surface. Disc of pronotum with numerous coarse protuberances, median carina of pronotum inconspicuous or entire, anterior margin of pronotum with a cylindrical or triangular projection in the middle above the occiput, fore edge of the pronotum with a distinct obtuse projection below eyes, humeral angles obtuse or acute and significantly projected, posterior angle of lateral lobe of pronotum produced into a sharp spine which is straight laterally or curved forwards, hind pronotal process extending far beyond apex of hind femora. Visible part of tegmina elongate, ovate. Hind wings developed, not reaching or reaching apex of hind process of pronotum. Upper and lower carinae of fore and middle femora with two or three large teeth each, hind femora with a row of tubercles on median keel of lower side. First segment of posterior tarsi longer than third.

Composition and distribution. Altogether 16 species are assigned to the genus *Paragavialidium* according to the OSF (Orthoptera Species File) (Cigliano *et al.* 2020), but *P. tridentatum* Zheng, 1994 syn. nov. and *P. platynotum* Zheng & Xu, 2010 syn. nov. were synonymized with *P. hainanensis* (Zheng & Liang, 1985) by Adžić *et al.* (2020). In fact, only 14 species are now assigned to the genus *Paragavialidium* and only found in China and the species are distributed mainly in Southern China.

Key to the species of *Paragavialidium* Zheng, 1994

Modified from Wei *et al.* (2019), *P. tridentatum* Zheng, 1994 syn. nov. and *P. platynotum* Zheng & Xu, 2010 syn. nov. were synonymized with *P. hainanensis* (Zheng & Liang, 1985) by

Adžić *et al.* (2020). Therefore, these two species are omitted from the identification key.

1. Lateral spines of pronotum directed distinctly transverse 2
- Lateral spines of pronotum curved forward 3
2. Width of vertex 1.9 times width of one eye; median carina of pronotum entire; with a pair of abbreviated carinae between shoulders; lower carinae of middle femora with three large teeth
..... *P. emeiensis* Zheng & Cao
- Width of vertex 1.5 times width of one eye; median carina of pronotum visible only in prozona; without a pair of abbreviated carinae between shoulders; lower carinae of middle femora with two large teeth
..... *P. orthacantum* Zheng
3. Middle of anterior margin of pronotum with a cylindrical projection 4
- Middle of anterior margin of pronotum with a triangular projection 5
4. Width of vertex 1.5 times width of one eye; median carina of pronotum entire before the middle and not conspicuous behind the middle; pronotum reaching apex of hind tibia; hind wings not reaching apex of posterior process of pronotum *P. tenuifemora* Deng
- Width of vertex 2.0 times width of one eye; median carina of pronotum entire; pronotum reaching middle of hind tibia; hind wings reaching apex of posterior process of pronotum *P. serrifemura* Zheng & Cao
5. Width of vertex 1.3 times width of one eye; lower carinae of fore femora with one large tooth or two indistinct small gibbositities *P. longzhouensis* Zheng & Jiang
- Width of vertex 1.6–2.5 times width of one eye; lower carinae of fore femora with two or three large teeth .. 6
6. Upper carinae of hind femora finely serrated; pronotum reaching two-thirds of hind tibia; lower carinae of fore femora with two large teeth *P. curvispinum* Zheng
- Upper carinae of hind femora finely serrated before the middle and after the middle with three to five distinct large teeth 7
7. Upper carinae of fore femora with four teeth and lower carinae with two large and one small tooth in female; pronotum surpassing apex of hind tibia *P. dolichonotum* Deng
- Upper carinae of fore femora with two or three teeth in female 8
8. Middle of anterior margin of pronotum with prominent obtuse angle; lower carinae of middle femora with three large teeth *P. prominemarginatum* Zha & Ding
- Anterior margin of pronotum straight; lower carinae of middle femora with two large teeth 9
9. Upper carinae of fore femora with two teeth; three pulvilli of first segment of posterior tarsus equal in length *P. sichuanensis* Zheng, Wang & Shi
- Upper carinae of fore femora with three teeth; third pulvillus of first segment of posterior tarsus longer than first and second 10
10. Width of vertex 2.3 times width of one eye in female; pronotum reaching middle of hind tibia
..... *P. anhuiensis* Zha, Deng & Zheng
- Width of vertex 1.8–2.0 times width of one eye in female; pronotum reaching or surpassing apex of hind tibia 11
11. Lower carinae of fore femora with three large teeth; pronotum reaching apex of hind tibia
..... *P. islandium* Zha & Wen
- Lower carinae of fore femora with two large teeth; pronotum surpassing apex of hind tibia 12
12. Apex of pronotum truncate; hind wings reaching apex of posterior process of pronotum
..... *P. hainanensis* (Zheng & Liang)
- Apex of pronotum slightly concave; hind wings not reaching apex of posterior process of pronotum 13
13. Lateral margins of pronotum with one or two pair of large teeth and serrulate behind humeral angles; outer side of hind femora with 1–2 indistinct large tubercules *P. serrimarginis* Deng & Zheng

-. Lateral margins of pronotum with fine teeth behind humeral angles; outer side of hind femora without indistinct large tubercle *P. fujianensis* Deng

1. *Paragavialidium emeiensis* Zheng & Cao, 2011

Paragavialidium emeiensis Zheng & Cao, 2011: 744 (Type depository: IZSNU).
Distribution: China (Sichuan).

2. *Paragavialidium orthacanam* Zheng, 1994

Paragavialidium orthacanam Zheng, 1994: 3 (Type depository: IZSNU).
Distribution: China (Zhejiang).

3. *Paragavialidium tenuifemora* Deng, 2019

Paragavialidium tenuifemora Deng, In: Wei, Xin & Deng, 2019: 455 (Type depository: EMHU).
Distribution: China (Jiangxi, Hubei).

4. *Paragavialidium serrifemura* Zheng & Cao, 2011

Paragavialidium serrifemura Zheng & Cao, 2011: 743 (Type depository: IZSNU).
Distribution: China (Guangdong).

5. *Paragavialidium longzhouensis* Zheng & Jiang, 1994

Paragavialidium longzhouensis Zheng & Jiang, 1994: 33 (Type depository: IZSNU).
Distribution: China (Guangxi).

6. *Paragavialidium curvispinum* Zheng, 1994

Paragavialidium curvispinum Zheng, 1994: 2 (Type depository: IZSNU).
Distribution: China (Anhui, Fujian, Hunan).

7. *Paragavialidium dolichonotum* Deng, 2019

Paragavialidium dolichonotum Deng, In: Wei, Xin & Deng, 2019: 560 (Type depository: EMHU).
Distribution: China (Guangxi).

8. *Paragavialidium prominemarginatum* Zha & Ding, 2017

Paragavialidium prominemarginatum Zha & Ding, In: Ding, Wen, Wu, Boonmee, Eungwanichayapant & Zha, 2017: 749 (Type depository: SSHNU).
Distribution: China (Guizhou).

9. *Paragavialidium sichuanensis* Zheng, Wang & Shi, 2007

Paragavialidium sichuanensis Zheng, Wang & Shi, 2007: 926 (Type depository: IZSNU).
Distribution: China (Sichuan).

10. *Paragavialidium anhuiensis* Zha, Deng & Zheng, 2014

Paragavialidium anhuiensis Zha, Deng & Zheng, In: Zha, Deng, Zheng & Li, 2014: 429 (Type depository: SSHNU)
Distribution: China (Anhui).

11. *Paragavialidium islandium* Zha & Wen, 2016

Paragavialidium islandium Zha & Wen, In: Zha, Wen, Pan & Hyde, 2016: 47 (Type depository: SSHNU).
Distribution: China (Zhejiang).

12. *Paragavialidium hainanensis* (Zheng & Liang, 1985)

Scelimena hainanensis Zheng & Liang, 1985: 52–53 (Type depository: BMSYU).

Paragavialidium hainanensis (Zheng & Liang), In: Liang and Zheng, 1998: 72–73.

Distribution: China (Hainan).

Remarks Zheng & Liang (1985) described *Scelimena hainanensis* from Hainan, China based on only female specimens, they placed this species in *Scelimena* because the first segment of posterior tarsus is enlarged into a paddle. Subsequently, *Paragavialidium* was established by Zheng in 1994, and *Scelimena hainanensis* was transferred to *Paragavialidium* by Liang and Zheng (1998) based on a short triangular projection presented in the middle of anterior margin of pronotum.

Since the description of the new species at that time was based exclusively on one female, there was a lack of male relevant data and description. During a survey of Tetrigoidea insects conducted by teachers and students of Hechi University in Wuzhishan mountain, Hainan in 2017, 15♂ and 20♀ specimens of *Paragavialidium hainanensis* were collected. Herein we describe male *Paragavialidium hainanensis* for the first time.

Male of *Paragavialidium hainanensis* (Zheng & Liang) (Fig. 1)

Description. Body large-sized (body length = 12.2–12.5 mm, pronotum length = 19–19.2 mm), elongated and slender, slightly smaller than female. Head short and vertex not surpassing eyes, width of vertex 1.5 times width of an eye, middle of anterior margin of vertex slightly concave, median carina conspicuous; fossula deep; lateral margins of vertex produced upwards. In lateral view, vertex before eyes visible, frontal ridge archedly protruding archly between antennae, width of longitudinal furrow slightly wider than width of first antennal segment. Antenna filiform and 14-segmented, length of a middle segment about 9–10 times longer than its width, inserted far below lower margins of eyes. Eyes globose. Lateral ocelli located between lower margins of eyes.

Disc of pronotum broad and flat, with irregular tubercles and concavities, median carina of pronotum at the front of the shoulder and behind the shoulder each with a protuberance; five large tubercles presented on the postmedian part of pronotum; disc of pronotum slightly swollen behind humeral angles. Anterior margin of pronotum truncated, median carina of pronotum completed before the middle and not conspicuous behind the middle of pronotum; middle of anterior margin of pronotum with a triangular finger-shaped protuberance, fore edge of the pronotum with a small (indistinct) and a large (distinct) obtuse projection below eyes; lateral carinae of prozona slightly lamellar and parallel; humeral angles of pronotum prominent and acutely angled, with abbreviated carinae between shoulders; caudal end of pronotum narrow, long cone-shaped, apex truncate, surpassing apex of hind tibia, pronotum 2.0 times as long as its posterior part which surpasses hind femora. Posterior angles of lateral lobes of pronotum stickle-like, apex of spine curved forward, posterior margin of each lateral lobe of pronotum with ventral sinus and tegminal (upper) sinus. Visible part of tegmen long and ovate, apex sharply rounded. Hind wings developed, reaching apex of posterior process of pronotum. Width of fore femur a little wider than mid femur; upper carinae of fore femora with three to four large teeth and lower carinae with two large teeth. Upper carinae of middle femora with three teeth, lower carinae with two large teeth, width of middle femora and visible part of tegmina nearly equal; hind femur 3.5 times as long as wide, before the middle of upper

carinae finely serrated and the postmedian part of upper carinae with four distinct large teeth, antegenicular and genicular denticles acute, lower carinae with five to six teeth. Hind tibia slightly enlarged from proximal to distal part, outer side with seven to eight spines, inner side with eight to nine spines. First segment of posterior tarsi enlarged into a paddle; length of first segment of posterior tarsus longer than third, third pulvillus longer than first and second, apices of first and second acute, apex of third obtuse. Subgenital plate cone-shaped. Epiphallus saddle-shaped and dark yellow; anterior plate slender, apex curved inwards, bridge slightly broad, lower margins of anterior plate with twenty to twenty-four teeth.

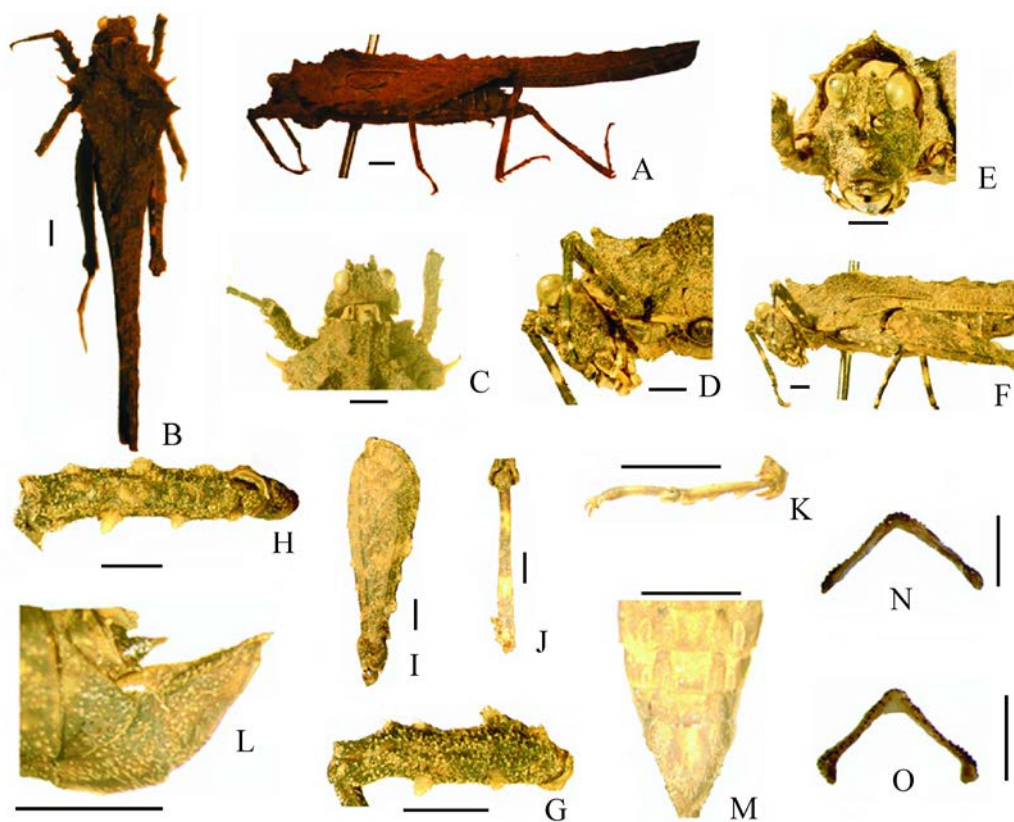


Figure 1. *Paragavialidium hainanensis* (♂). A. Body, lateral view; B. Body, dorsal view; C. Head, dorsal view; D. Head, lateral view; E. Head, frontal view; F. Head and pronotum, lateral view; G. Left fore femur, lateral view; H. Left mid femur, lateral view; I. Left hind femur, lateral view; J. Left hind tibia, dorsal view; K. Left posterior tarsi, lateral view; L. Subgenital plate, lateral view; M. Subgenital plate, ventral view; N. Epiphallus, dorsal view; O. Epiphallus, ventral view. Scale bars = 1 mm (Figs. A–M); 0.5 mm (Figs. N, O).

Body dark brown. Antenna and hind wings black. Fore and middle tibiae black, with light yellow ring in the middle. Hind femur dark brown; hind tibia dark brown, with two light rings in the middle.

Measurements (mm). Length of body ♂ 12.2–12.5; length of pronotum ♂ 19.0–19.2; length of hind femur ♂ 7.0–7.5.

Specimens examined. 15♂20♀, **China**, Hainan Prov., Wuzhishan (Wuzhishan National

Forest Park) (Fig. 2), 18°51.9674' N, 109°40.9319' E, 660 m alt., 25-VII-2017, collected by Weian DENG, Danni CHEN & Qin SHENG, EMHU.

Remarks. *P. hainanensis* (Zheng & Liang) is similar to *P. serrimarginis* Deng & Zheng, (Deng *et al.*, 2012), but the former: 1) with only one or two small teeth on lateral margin of pronotum behind humeral angles (one or two large teeth and saw-like in *P. serrimarginis*); 2) apex of hind pronotal process truncated (concave in *P. serrimarginis*); 3) hind wings reaching apex of hind pronotal process (not reaching in *P. serrimarginis*).

Collection locality. China (Hainan) (Fig. 2).

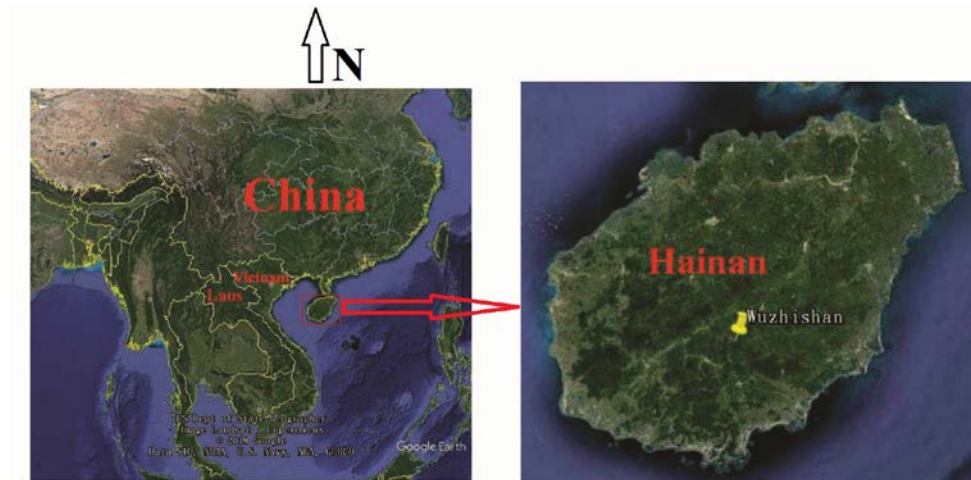


Figure 2. Collection localities from Wuzhishan.

Discussion

Paragavialidium hainanensis is semiaquatic, they often live in moist stony areas on borders of forest streams in tropical rainforests, they can swim well, they feed on mosses or humus and are important ecological indicators.

Notably, *Paragavialidium hainanensis* has not only the characteristic of *Paragavialidium*, (finger-like protrusion presented on anterior margin of pronotum), but also the characteristic of *Scelimena* (the first segment of the hind tarsi laterally enlarged into a paddle), so the species is taxonomically uncertain. A recent molecular phylogeny of Chinese genera of Scelimeninae, based on a combined database of *COI* and *16S rRNA* mitochondrial DNA and *18S rDNA* ribosomal RNA genes sequences, supported the placement of the species to be *Paragavialidium* (Chen *et al.* 2018). In other words, the characteristic that the finger-like protrusion on anterior margin of pronotum might be ancestral, while the characteristic that the first segment of the hind tarsi laterally enlarged into a paddle might be apomorphic.

13. *Paragavialidium serrimarginis* Deng & Zheng, 2012

Paragavialidium serrimarginis Deng & Zheng, *In*: Deng, Zheng, Wei & Lin, 2012: 53 (Type depository: IZSNU).

Distribution: China (Guangxi).

14. *Paragavialidium fujianensis* Deng, 2019

Paragavialidium fujianensis Deng, In: Wei, Xin & Deng, 2019: 464 (Type depository: EMHU).

Distribution: China (Fujian).

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