



Contribution to the aphaenopsian trechine beetle from Nanling region, South China (Coleoptera: Carabidae: Trechini)

RAN LI¹, ZI-JUN LIU² & SUN-BIN HUANG^{1,3,*}¹Department of Entomology, College of Plant Protection, South China Agricultural University, 483 Wushan Road, 510642 Guangzhou, China✉ liran2022scau@163.com; <https://orcid.org/0009-0007-3442-9162>²College of Forestry, Northeast Forestry University, 26 Hexing Road, 150040 Harbin, China✉ lzj114514@nefu.edu.cn; <https://orcid.org/0009-0001-2611-0158>³Guangdong Provincial Key Laboratory of Utilization and Conservation of Food and Medicinal Resources in Northern Region, Shaoguan University, 288 Daxue Road, 512005 Shaoguan, China*Corresponding author: ✉ huangsunbin@163.com; <https://orcid.org/0000-0001-8357-6651>

Abstract

Despite previous reports of several aphaenopsian trechine genera from various regions of South China, Guilin has remained unrecorded until now. This study lists the first report of an aphaenopsian trechine *Yinaphaenops guilinensis* **gen. nov., sp. nov.** from Guilin, expanding the known diversity of this group in Nanling region. Additionally, the male of *Sinaphaenopoides zhaoyiae* Tian, Huang & Jia, 2023 is reported and described for the first time.

Key words: taxonomy, Guangxi, Hunan, subterranean, cavernicolous, troglobite

Introduction

The subterranean biodiversity in China, particularly the cave Trechini ground beetles, is an area of rich and ongoing discovery. Approximately 197 species of subterranean trechines are identified within 75 genera (Tian *et al.* 2023b), a number continually expanding. The Nanling Priority Area for Biodiversity Conservation is notable for its karst landscapes, which are home to several species of Trechini ground beetles in southern Hunan and north-eastern Guangxi (Fig. 1). Known species discovered in those regions include *Sidulemus solidus* Tian & Yin, 2013 from the cave Bidongfeiyuan (Hunan: Chenzhou: Guidong) (Tian & Yin 2013), *Oodinotrechus (Pingleotrechus) yinae* Sun & Tian, 2015 from the cave Chaotian Yan (Guangxi: Guilin: Pingle) (Sun & Tian 2015), *Wanhuaphaenops zhangii* Tian & Wang, 2016 from the cave Songjia Dong (Hunan: Chenzhou: Beihu) (Tian *et al.* 2016), and *Sinaphaenopoides zhaoyiae* Tian, Huang & Jia, 2023 from the cave Zhongguo Dong (Hunan: Chenzhou: Suxian) (Tian *et al.* 2023a).

In 2023 and 2024, extensive surveys were conducted in Chenzhou and Yongzhou (Hunan), Shaoguan and Qingyuan (Guangdong), as well as Guilin (Guangxi). These surveys have led to the rediscovery of all the above mentioned species, except *Wanhuaphaenops zhangii* from the abandoned show cave Songjia Dong. Besides, new findings, a new genus and species of aphaenopsian ground beetle from Guilin as well as the male of *Sinaphaenopoides zhaoyiae* from the type locality, were also recorded in the conservation areas. However, there is still no record from Guangdong in the karst region to the south of the Nanling Mountains. These expeditions have broadened our understanding of the biodiversity of subterranean Trechini within these karst regions in Nanling Mountains. This paper reports new findings from the karst areas of Nanling Priority Area for Biodiversity Conservation by presenting a new trechine genus and species from Guilin and the male of *Sinaphaenopoides zhaoyiae* from Chenzhou.

Material and Methods

The blind beetles were collected with an aspirator inside the cave, killed using ethyl acetate in the lab and later kept in 50% ethanol before study. All type material is deposited in the insect collection of South China Agricultural University, Guangzhou, China (SCAU).

Dissections and observations were made using Motic SMZ-171 microscope (Hong Kong, China). Dissected genital pieces, including the median lobe and parameres of the aedeagus, were glued or included in a drop of dimethyl hydantoin formaldehyde (DMHF; details see Steedman 1958) on small transparent plastic cards and pinned under the specimen. Habitus pictures were taken using a Keyence VHX-5000 digital microscope (Osaka, Japan). Genitalia pictures were taken using a Canon PowerShot G9 camera (Tokyo, Japan) connected to a Motic BA210 microscope (Hong Kong, China), and then stacked and processed with Helicon Focus 8 (Helicon Soft Limited, Kharkiv, Ukraine) and Adobe Photoshop CC (Adobe System Incorporated, California, USA).

The length of the body was measured from the apex of the left mandible to the end of the elytra, and from apical margin of labrum to elytral apex; the width of the body was taken at the maximum width of the elytra.

Abbreviations for morphological terms:

HLm = length of head including mandibles, from apex of right mandible to occipital suture

HLl = length of head excluding mandibles, from front of labrum to occipital suture

HW = maximum width of head, along the widest point

PL = length of pronotum, from apical margin to basal margin along the median line

PW = maximum width of pronotum, along the widest point

EL = length of elytra, from base of scutellum to elytral apex

EW = maximum width of combined elytra, along the widest point

Taxonomy

Yinaphaenops gen. nov.

Chinese common name: 隐盲步甲属

Type species: *Yinaphaenops guilinensis* sp. nov. (Guizai Dong, Guilin, Guangxi)

Generic characteristics. Large sized cave trechine, apterous, depigmented, eyes completely absent, aphaenopsian type, with body and appendages thin and very elongate; both dorsal and ventral body surfaces largely glabrous, except surface of whole thorax sparsely covered with microscopic hairs. Head elongate, gradually narrowing backward from first supraorbital pore; frontal furrows not complete; two pairs of supraorbital setae present; mandibles thin and elongated, falcate though straight in proximal parts, longer than width of head; labial suture clear, mentum 2-setose, submentum multisetose; both labial palpomere and maxillary palpomere glabrous; antennae very long, extending over apical margin of elytra. Prothorax strongly tumid and convex. Pronotum elongated, distinctly longer than wide, somewhat barrel-shaped, slightly constricted to base and front, sparsely pubescent; median line clear and fine; marginal setae absent; hind angles subrectangular and blunt; front angles faintly marked and blunt. Propleura largely visible from above. Scutellum large and subtriangular. Elytra strongly convex, subovate, narrowed anteriorly and dilated posteriorly; shoulder erased; lateral sides smooth, not ciliate; striae unobtrusive, equipped with traceable punctuation; apical carina not present; three setiferous pores present; marginal umbilicate pores not aggregated. Legs fairly long, tibiae straight, wholly pubescent, without longitudinal sulcus. Ventrites III–IV not completely confused, suture traceable; ventrites V–VI each with four pairs of paramedial setae; ventrite VII 2-setose apically in male, 4-setose in female. Male genitalia moderately sclerotized, small, abruptly bent dorsally in its apical part; inner sac moderately sclerotized, simple; parameres well developed, each with 4 setae.

Remarks. Among subterranean trechine genera from China and South East Asia, the new genus *Yinaphaenops* gen. nov. seems morphologically similar to the aphaenopsian genus *Dongodytes* Deuve, 1993, *Sinaphaenops* Uéno & Wang, 1991, *Lanxangaphaenops* Deuve, 2012 and *Sinaphaenopoides* Tian, Huang & Jia, 2023 at the first impression by sharing the following characteristics: aphaenopsian trechine, elongated body, antennae and legs; body surfaces glabrous; frontal furrows not complete; mandibles stoutly prolonged; prothorax clearly tumid; propleura visible from above; elytra subovate, narrowed at base then dilated posteriorly.

Among those genera, *Yinaphaenops* **gen. nov.** morphologically shows a close resemblance to *Dongaphaenops* Deuve & Tian, 2014, presently treated as a subgenus of *Sinaphaenops* Uéno & Wang, 1991, the first recorded aphaenopsian genus in China with three subgenera and 13 species (Deuve & Tian 2014; Ma *et al.* 2020; Magrini *et al.* 1997; Uéno 2002; Uéno & Kishimoto 2002; Uéno & Wang 1991); as well as the genus *Lanxangaphaenops* Deuve, 2012, with two species and three subspecies (Deuve 2012; Deuve 2017). However, *Yinaphaenops* **gen. nov.** can be clearly distinguished from the two above mentioned genera by the following combination of characters: 2 pair of supraorbital pores with two pairs of additional pores present (only two pairs of supraorbital pores present in *Dongaphaenops*, and two pairs of supraorbital pores plus additional multisetose pores present in *Lanxangaphaenops*); prothoracic marginal setae absent (both two pairs of marginal setae in *Dongaphaenops* and *Lanxangaphaenops*, the latter with a few additional ones); 1st pore of marginal umbilicate pore series in elytra not shifted inwardly and distance to 2nd pore long (1st pore highly shifted inwardly and backwardly, and the position behind the 2nd and 3rd pores in *Dongaphaenops*, 1st slightly shifted inwardly but not behind the 2nd and 3rd pores in *Lanxangaphaenops*); elytral shoulder erased (both *Dongaphaenops* and *Lanxangaphaenops* with notable shoulders).

Among other genera or subgenera from the geographical areas located in the northern karst areas of Nanling Mountains, *Sidulemus*, *Pingleotrechus*, *Wanhuaphaenops* and *Sinaphaenopoides*, *Yinaphaenops* **gen. nov.** is more related to *Sinaphaenopoides* (Sun & Tian 2015; Tian *et al.* 2016; Tian *et al.* 2023b; Tian & Yin 2013). But it can be clearly distinguished from *Sinaphaenopoides* by the followings: head and prothorax more narrowed and elongate (head and prothorax more tumid in *Sinaphaenopoides*); frontal furrows parallel-sided, two pairs of supraorbital setiferous pores present plus two pairs of additional pores (frontal furrows not parallel-sided, three pairs of supraorbital setiferous pores present in *Sinaphaenopoides*); mentum and submentum not fused, submentum 12-setose or 13-setose (mentum and submentum fused, submentum 8-setose or 9-setose in *Sinaphaenopoides*); marginal setae absent in pronotum (two pairs of marginal setae in *Sinaphaenopoides*); elytral shoulder and stria erased, 1st pore of marginal umbilicate pore series not shifted inwardly (shoulders and stria notably marked, 1st pore clearly shifted inwardly). Geographically, the Nanling Mountains may act as a significant barrier, as Trechini species have not yet been reported from the southern part of this region.

Most aphaenopsian species of Asian Trechini share a similar convergent habitus, exhibiting highly specialized troglomorphic adaptations. These morphological adaptations, while distinct, make it challenging to precisely determine their lineage solely based on physical characteristics. Therefore, preliminary molecular analyses based on the nuclear markers were conducted to resolve the phylogenetic relationships of *Yinaphaenops* **gen. nov.**, confirming an alliance of the new genus and aforementioned two genera, *Dongaphaenops* and *Lanxangaphaenops*.

Etymology. The genus name derives from “Yin” (hidden/elusive in Chinese) and “Aphaenops” (aphaenopsian trechine beetle genus from Europe, Pyrenees), indicating the mysterious and troglomorphic appearance of this new ground beetle.

Range. China: Guangxi (Fig. 1).

Yinaphaenops guilinensis sp. nov.

Chinese common name: 桂林隱盲步甲
(Figs 1–6)

Type material. HOLOTYPE: CHINA: male, cave Guizai Dong, Lingchuan, Guilin, Guangxi, China, 26-IV-2024, leg. Sun-Bin Huang, Ming-Zhi Zhao, Ran Li & Rong Chen (SCAU, sample ID: C240426D01GX). **PARATYPES: CHINA:** 1 female, same locality, 3-VIII-2023, leg. Hao-Fei Fan (SCAU).

Description. Body length 6.7–7.5 mm (from apical margin of labrum to elytral apex), 7.6–8.3 mm (including mandibles); width 1.9–1.95 mm. Forebody elongated, head slightly narrower and longer than prothorax, elytra rather prolonged, longer than forebody. Legs and antennae thin and rather long. Body surface light brown (holotype) or dark brown (paratype); apical of antennae and tarsi of legs yellow brown. Body seemingly glabrous on dorsal surface though sparsely covered with extremely minute hairs on pronotum. Microsculpture of dorsum finely impressed, mesh pattern varying on different parts of dorsum surface; disk of head and pronotum with transverse meshes, isodiametric meshes on elytra; microsculpture rather shallow on ventral surface. Habitus as in Fig. 2.

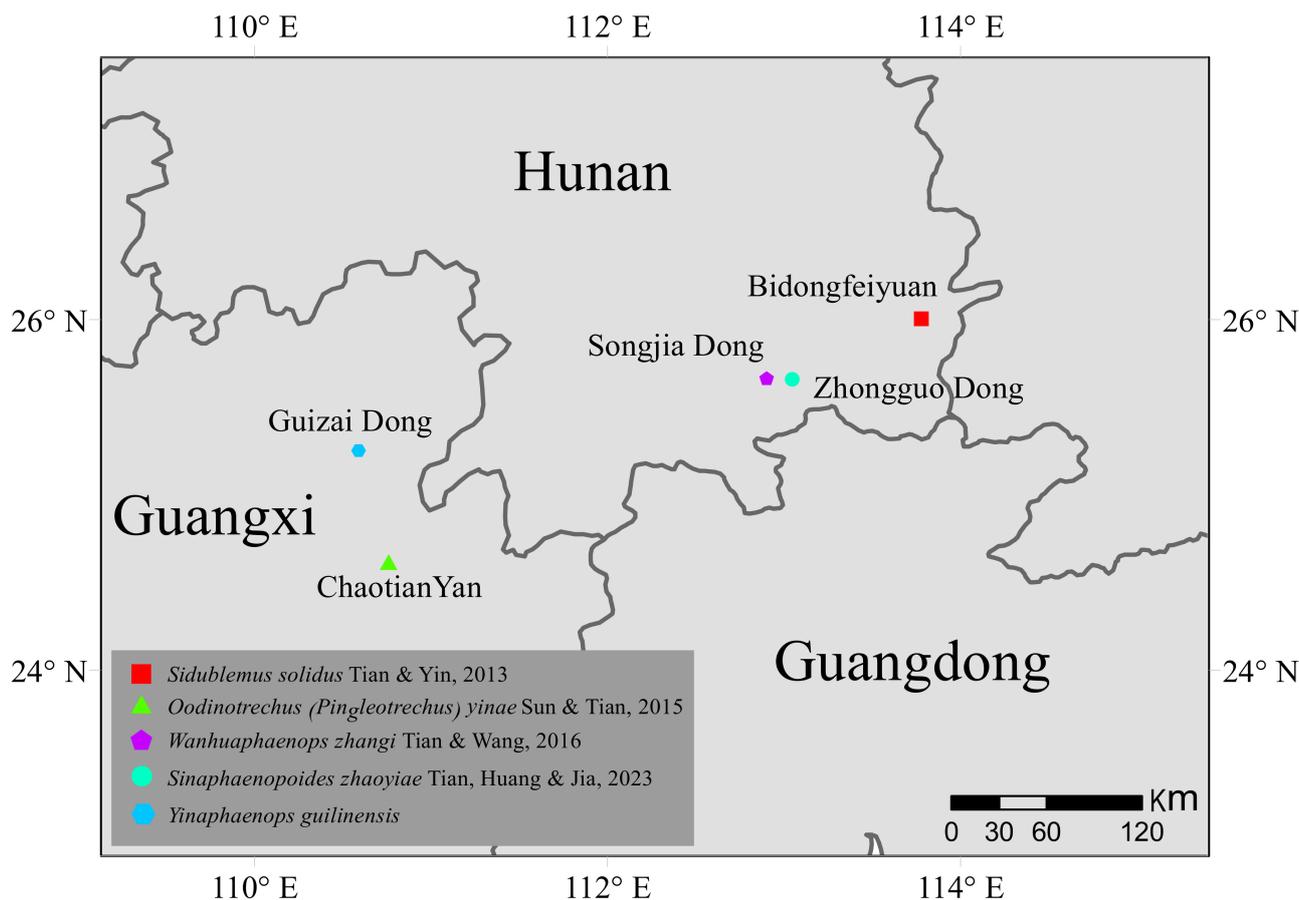


FIGURE 1. Distribution map of cave trechine beetle from Nanling region, South China.

Head elongate, much longer than wide ($HLm/HW = 2.96\text{--}3.01$, $HLl/HW = 1.83\text{--}1.97$), widest at level of anterior supraorbital pores, and gradually narrowed posteriad towards neck constriction, neck constriction visible, a little more than half width of head; frons and supraorbital areas moderately convex; frontal furrows parallel-sided; two pair of supraorbital setae present, distant from each, with two irregular additional smaller setae (Fig. 3A); eyes completely absent; labrum nearly rectangular, slightly protruding at apex, with 6-setose apically; mandibles slender and elongated, falcate and tridentate in male holotype but not clearly dentated in female paratype (Fig. 3B, C); labial suture clear, mentum 2-setose on either side of tooth, base largely concave with two non-setiferous pores present; tooth long, humped, non-bifid; submentum 13-setose in male holotype, 12-setose in female paratype; ligula thick and short, adnated to paraglossae, 10-setose at apex, two of them bigger than others at center; paraglossae narrow and incurved, extending well beyond ligula; 2nd labial palpomere 2 times as long as 3rd, both glabrous; 2nd maxillary palpomere as long as 3rd maxillary palpomere, which almost 2 times longer than 4th, all palpomeres glabrous; genae sparsely covered with several hairs in apical and middle parts. Antennae long and slender, extending to elytral apices; antennomere 3 longest, 4–11 decreasing in length towards terminal antennomere, antennomere 10 as long as antennomere 11.

Prothorax fairly tumid and elongate with prolonged apical part, slightly wider than head, much longer than wide, widest at about basal third, much more gradually narrower towards apex than base; propleura strongly convex, largely visible from above, gradually convergent anteriorly, nearly reaching apical fifth. Pronotum narrow and elongated, shorter than head ($PL/PW = 1.39\text{--}1.5$), about as wide as head, widest at about two fifth from base, obviously more gradually narrowed toward apex than toward base; lateral margins entire and fine, slightly and largely sinuate ventrad to base and front from widest level of pronotum; marginal setae not traced; hind angles subrectangular, thick and blunt; front angle obtuse; disc convex, sparsely pubescent, median line distinct and fine, meeting apical transverse impression and basal transverse impression, which clearly impressed; basal foveae marked but shallow.



FIGURE 2. Habitus of *Yinaphaenops guilinensis* gen. nov., sp. nov., holotype, male.

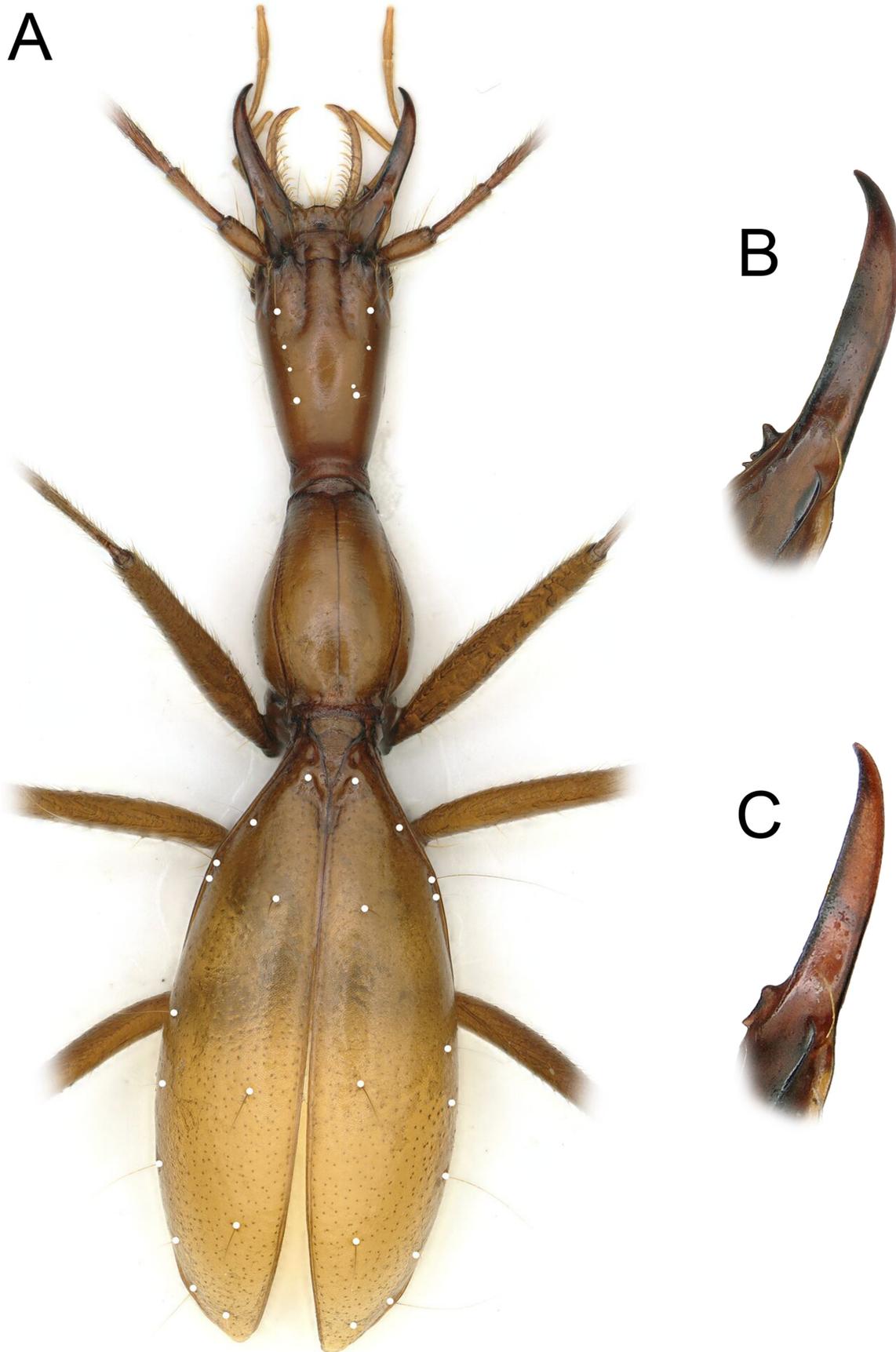


FIGURE 3. *Yinaphaenops guilinensis* gen. nov., sp. nov.: **A**, chaetotaxy; **B**, right mandible, holotype, male; **C**, right mandible, paratype, female.



FIGURE 4. Male genitalia of *Yinaphaenops guilinensis* gen. nov., sp. nov.

Elytra elongate ovate, very narrow at base, posteriorly dilated, wider than prothorax, obviously longer than wide, about 2 times as long as wide ($EL/EW = 2.06\text{--}2.2$), widest well after middle, at level of preapical dorsal pore, rather gradually narrowed towards apices; disk well convex, stria barely recognizable, punctuation traceable; apical carina not marked; shoulder rather erased; lateral sides smooth, not ciliate, finely bordered throughout. Chaetotaxy: basal pore closer to elytral suture than to marginal gutter; three setiferous pores positioned adjacently along interval 3, evenly distributed on elytra; marginal umbilicate pores not aggregated, distance from 1st to 2nd much longer than that from 2nd to 3rd; 2nd and 3rd close to marginal gutter; 4th pore widely distant from previous three, reaching about half of elytra; middle group and apical group arranged; apical pore at subequal distance from elytral suture to marginal gutter (Fig. 3A).

Ventrite IV 6-setose, ventrites V–VI 8-setose, ventrite VII 2-setose apically in male, 4-setose in female. Legs long and slender, wholly pubescent; protibiae straight, gradually dilated towards apices, without externally grooved; tarsi long and thin, protarsomere 1–2 not dilated.

Male genitalia small; aedeagus slender, tubular, bent ventrad toward apex; basal orifice broadly opening; basal blade present, large, round, and moderately sclerotized; inner sac simply armed with a large copulatory piece, which fairly sclerotized at basal part, and largely covered with minute scales on surface; apical orifice open at about distal 1/3 with a broad apical lobe; parameres stout on both sides, both bearing four long apical setae (Fig. 4).

Etymology. The species name is derived from the locality of Guilin, a city renowned worldwide for its spectacular karst landscape and unique geological formations.

Distribution. China (Guangxi: Guilin). Known only from Cave Guizai Dong, the type locality (Fig. 1).

The entrance of the cave Guizai Dong is situated approximately halfway up the mountain. It has a total length of 524.7 meters, with two main passage bifurcated after the biggest hall of the cave. Speleothems, including stalagmites, calcium carbonate waterfall, rimstone dam, are adorned in different part of the cave. The cave, with its high humidity and scattered small water pools, provides an ideal habitat for cave-dwelling creatures. Beetles were discovered under a rock near a small water pool (Figs 5, 6).

Remarks. The new species *Yinaphaenops guilinensis* exhibits differences in the dentation of the mandibles. Specifically, the holotype (male) possesses a tridentate tooth structure, whereas the paratype (female) does not display a clearly dentate mandible (Fig. 3B, C). The cause of this discrepancy remains unidentified at present. It could be sexual dimorphism or simply polymorphism, which may results in dental wear and less distinct morphological features. To better understand this phenomenon, collection of additional individuals and further examination are necessary.

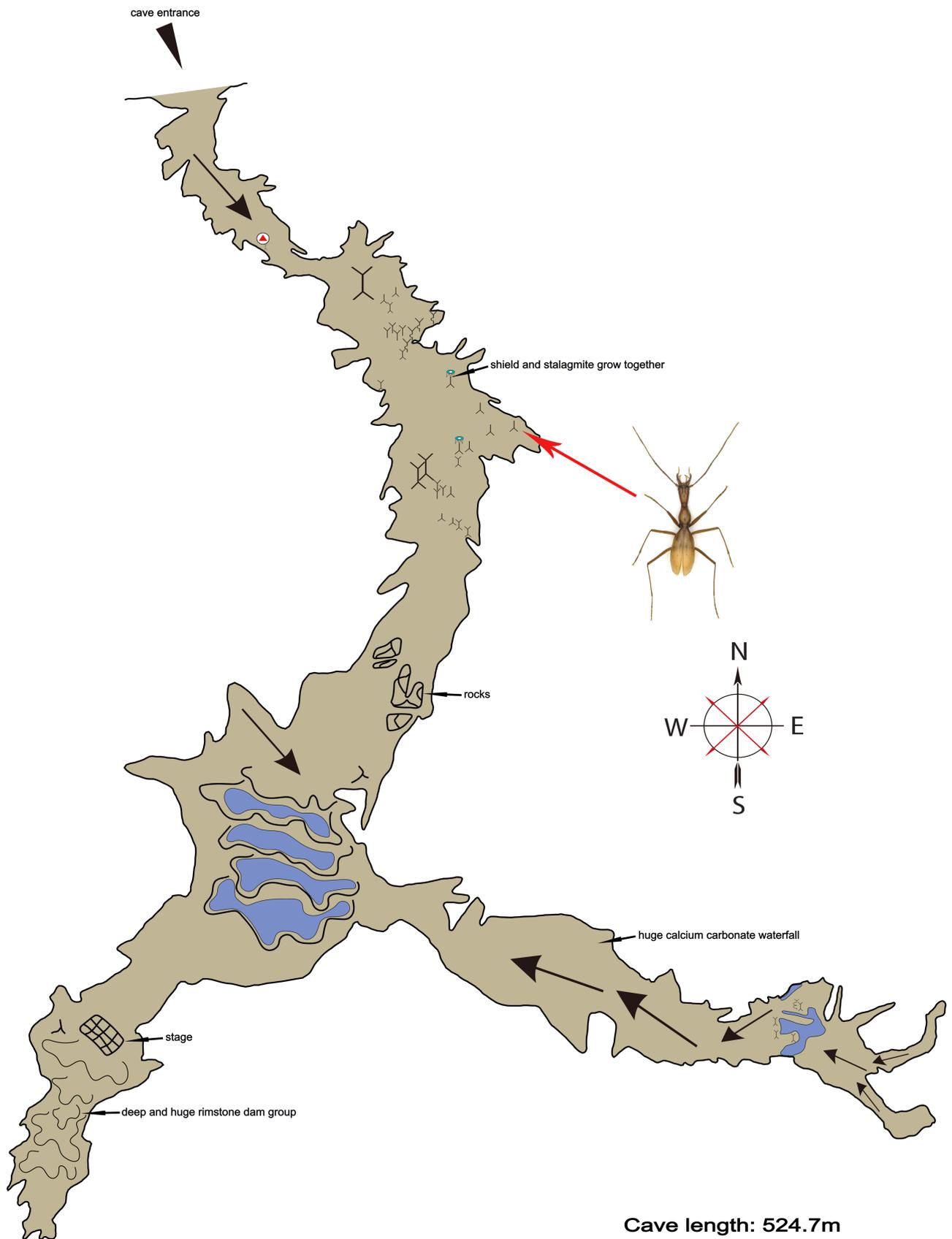


FIGURE 5. Map of the cave Guizai Dong, type locality of *Yinaphaenops guilinensis* gen. nov., sp. nov. (red arrow indicating where the beetles were collected).



FIGURE 6. Guizai Dong: A, Entrance; B, *Yinaphaenops guilinensis* gen. nov., sp. nov.

Finding this species in the cave presented significant challenges. The first individual (paratype, female) was discovered serendipitously by the collector. Despite repeated visits to the location where the initial individual was discovered, our efforts to locate additional specimens were unsuccessful. It was only upon our final inspection of the site, just before concluding our fieldwork, that we succeeded in finding this elusive species again. This suggests that *Yinaphaenops guilinensis* **gen. nov., sp. nov.** is a hidden and elusive species, challenging to detect in its natural habitat, or a species inhabiting deep cracks of the karst, only rarely found in cave. The difficulty in locating this species could indicate a rare population, underscoring the importance of more exploration of the cave ecosystems in the cave and region. Unfortunately, during the preparation of the holotype, the elytra suture damaged and split during dissection. Additionally, antennomeres 10–11 of the left antenna and antennomere 11 of the right antenna were lost.

Sinaphaenopoides Tian, Huang & Jia, 2023

Chinese common name: 拟华盲步甲属

Type species: *Sinaphaenopoides zhaoyiae* Tian, Huang & Jia, 2023 (Zhongguo Dong, Chenzhou, Hunan)

Sinaphaenopoides zhaoyiae Tian, Huang & Jia, 2023

Chinese common name: 赵奕拟华盲步甲

(Figs 1, 7)

Type material examined. Holotype: female, Zhongguo Dong, Tianzidi Cun, Suxian Qu, Chenzhou Shi, 2019-XII-24, leg. Yi Zhao, in SCAU; paratype: 1 female, *ibid*; 2 females, 2020-X-28, same cave, leg. Wei-Xin Liu, Yi Zhao & Xin-Yang Jia.

Other material examined. China (Hunan): 1 male, cave Zhongguo Dong, Suxian, Chenzhou, Hunan, China, 5.VI.2024, leg. Sun-Bin Huang (SCAU, sample ID: C240605D01HN).

Male. Habitus same as in the original description of Tian *et al.* (2023a), except: protarsi with two basal segments dilated, inner denticle medium-sized in first tarsomere, small in second tarsomere; ventrite VII 2-setose apically. Male genitalia small; aedeagus slender, tubular, curved ventrad toward the apex; basal orifice medium; basal blade medium, round, and moderately sclerotized; apical orifice medium with a pointed and round apical lobe; inner sac medium, about 1/3 as long as aedeagus, armed with a medium copulatory piece, which is fairly sclerotized; parameres small and slender on both sides, both bearing two apical setae, which are fairly long (Fig. 7).



FIGURE 7. Male genitalia of *Sinaphaenopoides zhaoyiae* Tian, Huang & Jia, 2023.

Remarks. The conformation of the male genitalia of *Sinaphaenopoides zhaoyiae* does not align with that of most species of *Sinaphaenops*, suggesting maybe a different lineage. Instead, there are some morphological similarities to the geographically close new genus *Yinaphaenops* **gen. nov.** (sharing similar shape and structure, but varying in sagittal aileron, copulatory piece and parameres), which hints at a broader biogeographical relationship between the cave Trechini beetles of southern China and southeastern Asia. Notably, an examination of the elytral chaetotaxy of *Sinaphaenopoides zhaoyiae* reveals similarities to *Birmaphaenops* Deuve, 2017 (Deuve 2017). However, to fully understand these relationships and confirm these observations, a comprehensive molecular phylogenetic analysis is needed.

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南岭地区洞栖行步甲族Trechini研究新进展（鞘翅目：步甲科：行步甲族）

李冉¹, 刘子钧², 黄孙滨^{1,3,*}

¹华南农业大学植物保护学院昆虫学系, 五山路438号, 广州 510642, 广东, 中国

✉ liran2022scau@163.com; <https://orcid.org/0009-0007-3442-9162>

²东北林业大学林学院, 和兴路26号, 哈尔滨150040, 黑龙江, 中国

✉ lzj114514@nefu.edu.cn; <https://orcid.org/0009-0001-2611-0158>

³广东省粤北食药资源利用与保护重点实验室, 韶关学院, 大学路288号, 韶关512005, 广东, 中国

*通讯作者: ✉ huangsunbin@163.com; <https://orcid.org/0000-0001-8357-6651>

摘要: 中国南方喀斯特不同地区有报道过多个形态高度特化的洞栖行步甲已知属, 但目前桂林仍没有此类群的记录。本研究首次报道了产自桂林的高度特化洞栖行步甲—桂林隐盲步甲 *Yinaphaenops guilinensis* **gen. nov., sp. nov.**。此外还首次描述了赵奕拟华盲步甲 *Sinaphaenopoides zhaoyiaie* 的雄性外生殖器。

关键词: 分类; 广西; 湖南; 地下; 穴居; 真洞穴动物