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Research article

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Gigasanalis, a new genus of the tribe Achilini with the description of a new species from China (Hemiptera, Fulgoromorpha, Achilidae)

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Abstract. A new planthopper genus, *Gigasanalis* Long & Chen gen. nov. (Hemiptera, Fulgoromorpha, Achilidae, Achilinae, Achilini) is established from South China (Hainan Province). A new species, *Gigasanalis jianfenglingensis* Long & Chen sp. nov., is described and illustrated.

Keywords. Achilidae, distribution, Fulgoroidea, new taxa, planthopper.

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Introduction

The Achilidae Stål, 1866 is a moderate-sized families of planthoppers (Hemiptera: Fulgoromorpha), which is divided into 3 subfamilies (Achilinae Stål, 1866, Apatesoninae Metcalf, 1938 and Myconinae Fennah, 1950), 13 tribes (11 extant and 2 extinct tribes), 162 genera and 515 species (including 14 fossil species from 11 genera) in recent years (Brysz & Szwedo 2017; Bartlett *et al*. 2018; Bourgoin 2022). Achilidae is distributed worldwide apart from Antarctic and Arctic regions, and with a higher diversity in the tropical and subtropical northern hemisphere (Brysz & Szwedo 2019; Bourgoin 2022). Currently, we know very little about the biology of this family. The feeding habits of immatures and adults are quite different. Their immatures, associated with rotting wood, are easily detected under the bark of dead wood, and possibly feed on fungal hyphae (O'Brien 1971; Asche 2015); for example, *Cixidia confinis* (Zetterstedt, 1828) has been reported to live under the bark of fallen pine trees (Gnezdilov *et al*. 2019). Adults feed on the phloem of woody plants, thus belong to phytophagous insects.

The planthopper tribe Achilini was established by Fennah (1950), consists of the subtribes Achilina Fennah, 1950, Cixidiina Emeljanov, 1992, and Elidipterina Fennah, 1950 (Emeljanov 1992). This tribe belongs to the subfamily Achilinae (Hemiptera: Achilidae) (Bartlett *et al*. 2018). The tribe is readily distinguished from other known tribes in Achilidae by the hindwing with the peculiar characteristic of anastomosis between the first and second anal veins (Emeljanov 1992). To date, Achilini contain 32 genera (26 extant and 6 extinct) and 96 species (87 extant and 9 extinct) (Bourgoin 2022; Brysz *et al*. 2022). Among these, the Chinese Achilini contain three genera (*Catonidia* Uhler, 1896, *Cixidia* Fieber, 1866 and *Paracatonidia* Long, Yang & Chen, 2015) (Long *et al.* 2015).

In this paper, a new genus and species of the tribe Achilini from Hainan, China, are established described and illustrated.

Material and methods

Material

The type material is deposited in the Institute of Entomology, Guizhou University, Guiyang, Guizhou Province China (IEGU).

Preparations and illustration

The color photographs were taken with a Keyence VHX-6000 system. External morphology was observed under an Olympus SZX7 stereoscopic microscope. Measurements were made with the aid of an eyepiece micrometer. The genital segments of the examined specimens were macerated in 10% KOH, then transferred to glycerol for examination. Drawings and external morphology were done with the aid of a Leica MZ 12.5 stereo microscope. Illustrations were scanned by a Canon CanoScan LiDE100 and imported into Adobe Photoshop CS5 for labeling and plate composition.

Measurements and abbreviations

Body length	=	length of specimen from apex of vertex to fore wing apex (in dorsal view)
A/B	=	width of vertex at posterior margin / length of vertex at midline
C/D	=	length of frons at midline / maximum width of frons
D/E	=	maximum width of frons / width of frons at apex
F/C	=	length of postclypeus at midline / length of frons at midline
G/H	=	length of apical / length of subapical
I/B	=	length of pronotum at midline / length of vertex at midline
J/I	=	length of mesonotum at midline / length of pronotum at midline
J/B+I	=	length of mesonotum at midline / cumulative length of vertex and pronotum at midline
K/L	=	length of fore wing from the base to the apical margin in median portion / width of fore wing at the widest part
M/N	=	length of hind wing from the base to the apical margin in median portion / width of hind wing at the widest part

Terminology

The momenclature of the wing veins follows the interpretation proposed by Asche (2015) and Bourgoin *et al*. (2015). The morphological terminology and measurements used in this study follow Chen *et al*. (1989), Yang & Chang (2000), Asche (2015) and Bourgoin (1993) for the female.

Results

Class Insecta Linnaeus, 1758
Order Hemiptera Linnaeus, 1758
Suborder Fulgoromorpha Evans, 1946
Superfamily Fulgoroidae Latreille, 1810
Family Achilidae Stål, 1866
Subfamily Achilinae Stål, 1866
Tribe Achilini Stål, 1866
Subtribe Achilina Stål, 1866

Key to genera of the subtribe Achilina Stål, 1866 (based on Guglielmino et al. 2010)

1. Pronotum anterior margin of disk roundly concave. Stem MP forked in front of claval apex. Tegmen with wavy branches of MP and CuA ..... ***Gigasanalis*** Long & Chen gen. nov.
– Pronotum anterior margin of convex. Stem MP forked apicad of claval apex. Tegmen with not wavy branches of MP and CuA 2

2. Upper part of frons distinctly concave. Sides of frons subparallel. All veins of pterostigma directed anterodistally ..... ***Ouwea*** Distant, 1907 (= *Spendon* Jacobi, 1928)
– Upper part of frons shallowly tectiform. Sides of frons divergent downwards to clypeus. Proximal veins of pterostigma (one or two) directed transversally 3

3. Penultimate segment of rostrum reaching fore margins of hind coxae. Branches of MP and CuA 1 of fore wings without anastomosis .....***Achilus*** Kirby, 1818
– Penultimate segment of rostrum reaching hind margins of hind coxae. Branches of MP and CuA 1 of fore wings with anastomosis ..... ***Olmiana*** Guglielmino, Bückle & Emeljanov, 2010

Taxonomic account

Genus ***Gigasanalis*** Long & Chen gen. nov.
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Type species

Gigasanalis jianfenglingensis Long & Chen gen. et sp. nov., here designated.

Diagnosis

The new genus differs from other taxa of Achilina Stål, 1866 by the following characters: 1) the genus is readily distinguished from other known genera in the tribe Achilini by disc of pronotum with anterior margin roundly concave; 2) stem MP forked in front of claval apex (Stem MP forked apicad of claval apex in *Achilus* Kirby, 1818, *Olmiana* Guglielmino, Bückle & Emeljanov, 2010 and *Ouwea* Distant, 1907); 3) tegmen with wavy branches of MP and CuA.

Etymology

The genus name, which is masculine, is a combination of ‘gigas’ and ‘analis’, indicates the new genus has a large anal segment in Achilini.

Description

Head. Width of head with eyes less than ⅔ of width of pronotum. Vertex flat, the anterior margins obvious, posterior margins carinate, lateral carina present and straight, median carina stronger and thicker (Fig. 5). Frons median carina in lateral view (Fig. 6), upper margin subtruncate, median carina

complete, lateral margins carinate, sinuously diverging to below level of antennae thence gradually incurved to suture (Fig. 7). Clypeus with median carina weak, surface concave, fronto-clypeal cuneate, posterior margin at border of lora is strengthened, converging and not passing to clypeus, but lora and clypeus not fused (Fig. 7). Rostrum long, just exceeding metacoxae, with apical segment shorter than subapical segment, about 0.6 × as long as subapical segment. Antenna setaceous, scapus short, pedicel truncately subglobose, flagellum degradation or absent (Fig. 6). Ocelli separated from eyes (Fig. 5). Pronotum slightly shielding eyes in dorsal view (Fig. 5).

Thorax. Pronotum in mid line shorter than vertex; anterior margin of disk roundly concave, posterior margin elevated, with an incision angle of 145 degrees, median carina distinct, lateral carinae roundly convex towards eyes, not reaching hind margin; anterior margin of pronotal disc is placed between compound eyes at about half (Fig. 5). Mesonotum with scutellum nearly diamond, median area flat, lateral sections slope down, three carinae weak, median and lateral carinae nearly parallel, lateral carinae reaching posterior margin, median carina passing to mesoscutellum, mesoscutellum with transverse stripes (Fig. 5).

Wings. Fore wing with costal margin slightly convex; apical margin roundly convex; posterior margin with an angle of 155 degrees at apex of clavus; postcostal cell with one crossvein slightly basad of ScP+R forking; costal field with bent recurrent secondary veins; longitudinal veins ScP+R and MP arising as short common stem from basal cell, about ⅓ of length of ScP+R; stem ScP+R approximately ²/₅ of length of tegmina (Fig. 8). Vein ScP+RA with fork clearly before RP fork, ending on costal margin with 7–8 terminals; vein RP with fork plainly after MP fork, ending on costal margin with 5–6 terminals; vein MP with fork plainly after CuA fork, before apex of clavus, with 6–7 terminals; veins MP and CuA with wavy branches, cell C4 with many cross veins; CuA with the first fork distinctly before ScP+RA fork, with 2–3 terminals; clavus terminating at middle of forewing, Pcu with 2–3 false transverse veins (Fig. 8). Hind wing with simple ScP+RA, reaching margin based of apex, branch RP vein with 1–2 terminals, stem MP with 2 terminals (MP_{1+2} and MP_{3+4} not branched), vein CuA with 4 terminals, vein A2 with blind branches (Fig. 9).

Legs. Post-tibiae with a lateral spine at basal ²/₅. Metatibia with 7–8 apical teeth, rightmost apical teeth obviously larger, arrangement in slanting; basimetatarsomere with row of 13 apical teeth, each tooth with platellae except for marginal ones; midmetatarsomere with 14–15 apical teeth, arrangement in arcuate, each tooth with platellae except for marginal ones, internal spines; metatibio-tarsal formula 7(8)–13–14(15) (Figs 22–23).

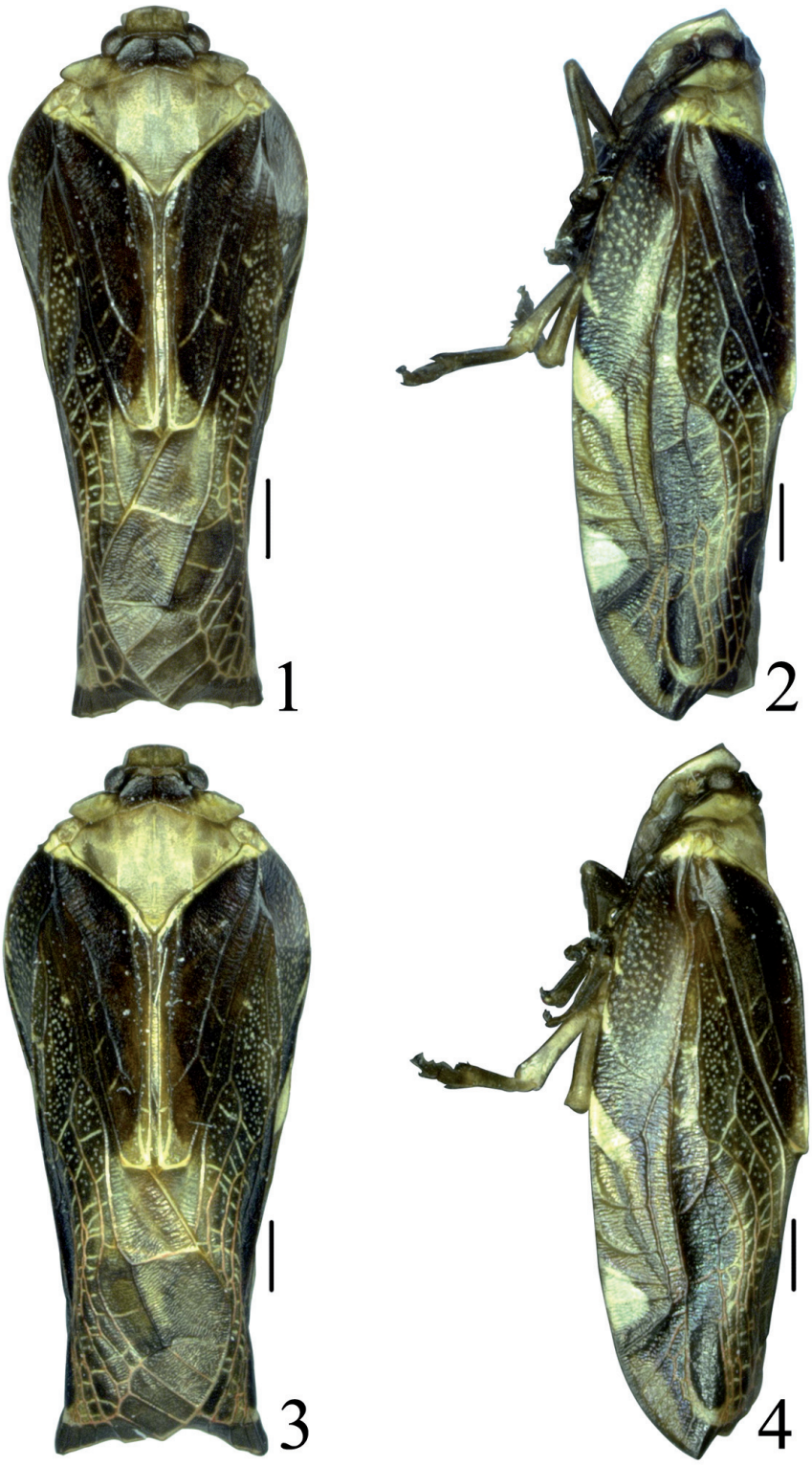
Male terminalia. Pygofer in lateral view with dorsal margin distinctly shorter than ventral margin (Fig. 11), ventral view with median bifurcate process (Fig. 12). Aedeagal complex distally with a sheath-shaped 4-lobate periandrial part and a rather elongate basal part – mainly formed by the inner penis. Periaodrium distally with paired lateral lobes, ventral lobes and dorsally with an unpaired, base half connected together, protruding cephalad into body cavity (Figs 14–16). Genital lamina obsolete (Fig. 15). Sheath developed, arm-shaped, with apical ⅓ dorsally bent, then with apex directed basally (Fig. 15). Inner penis rods reflexed and elongate, basally fused, distally rod-like, devoid of lateral branches. Anal segment relatively larger in dorsal view; anal style tongue-shaped, wide, bristles vestigial or absent, distinctly covering abdominal end (Fig. 10). Genital style with two tortuous ear-like processes rising from apical third (Fig. 13). Phallobasal conjunctival processes bilaterally symmetrical, exceeding apical margin of phallobase (Figs 12–13). Connective relatively stout and short (Fig. 15).

Host plant

Unknown.

Diversity and distribution

The genus is monotypic and contains a single species from South China (Hainan Province) (Fig. 24)**.**



Figs 1–4. *Gigasanalis jianfenglingensis* Long & Chen sp. nov. **1–2**. Paratype, ♂ (IEGU). **1**. Habitus, dorsal view. **2**. Habitus, lateral view. **3–4**. Paratype, ♀ (IEGU). **3**. Habitus, dorsal view. **4**. Habitus, lateral view. Scale bars = 1 mm.

Gigasanalis jianfenglingensis Long & Chen sp. nov.
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Figs 1–21

Diagnosis

The salient features of this new species following: 1) aedeagus with phallobase bilaterally symmetrical, dorsal periandrial lobe shovel-shaped with apex broadly concave (Fig. 14); 2) each paired inner penis rod with apex rod like and with three dorsal spines located at subapical (Figs 14–16); 3) anal segment in dorsal view (Fig. 10) approximatively oblong-shaped, epiproct distinctly exceeding apical margin of anal segment, anal style with slightly exceeding apical margin of epiproct; 4) genital style with lobes tortuous and irregular, apical margin almost rounded (Figs 11–13).

Etymology

The species name refers to the type locality, Jianfengling National Natural Reserve, Hainan Province, China.

Type material

Holotype

CHINA • ♂; Hainan Province, Jianfengling National Natural Reserve; 18°43′ N, 108°52′ E; 23 Apr. 2014; H.-Y. Sun leg.; sweeping; IEGU.

Paratypes

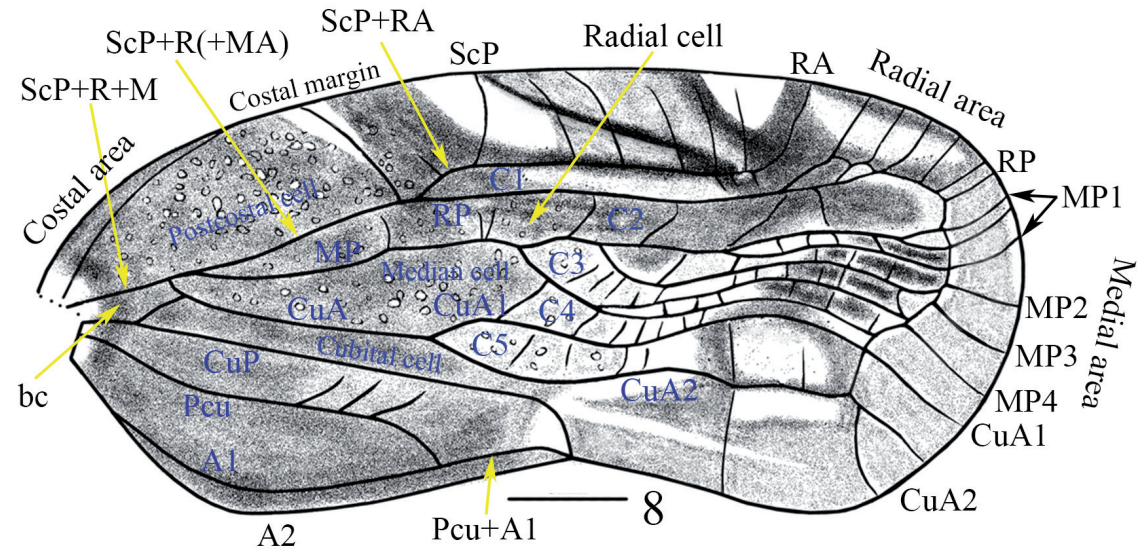
CHINA • 1 ♂, 1 ♀; same collection data as for holotype; 22 Apr. 2014; F.-L. Xu leg.; sweeping; IEGU • 1 ♀; same collection data as for holotype; 22 Apr. 2014; J.-K. Long leg.; light trap; IEGU • 1 ♀; same collection data as for holotype; W.-C. Yang leg.; IEGU • 1 ♀; same collection data as for holotype; 22 Apr. 2017; Y.-S. Ding leg.; IEGU.

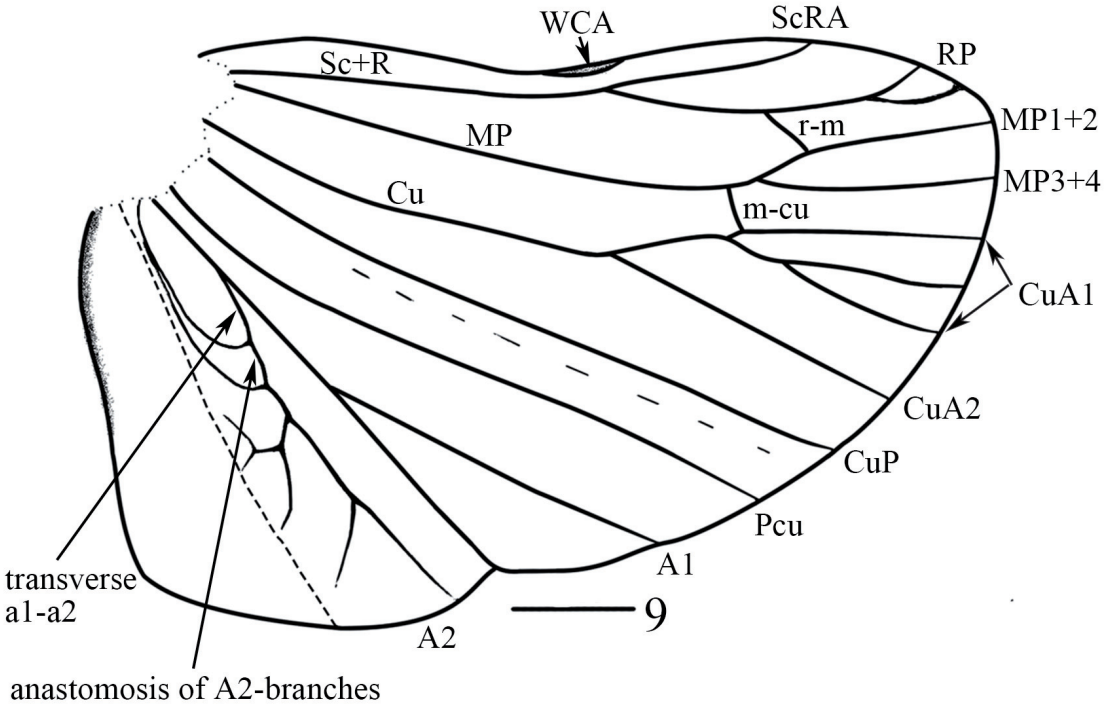
Description

Size. Body length (from apex of vertex to fore wing apex): male 10.0–10.3 mm (n = 2), female 10.6–11.6 mm (n = 4); fore wing length: male 8.8–8.9 mm (n = 2), female 9.4–10.1 mm (n = 4).

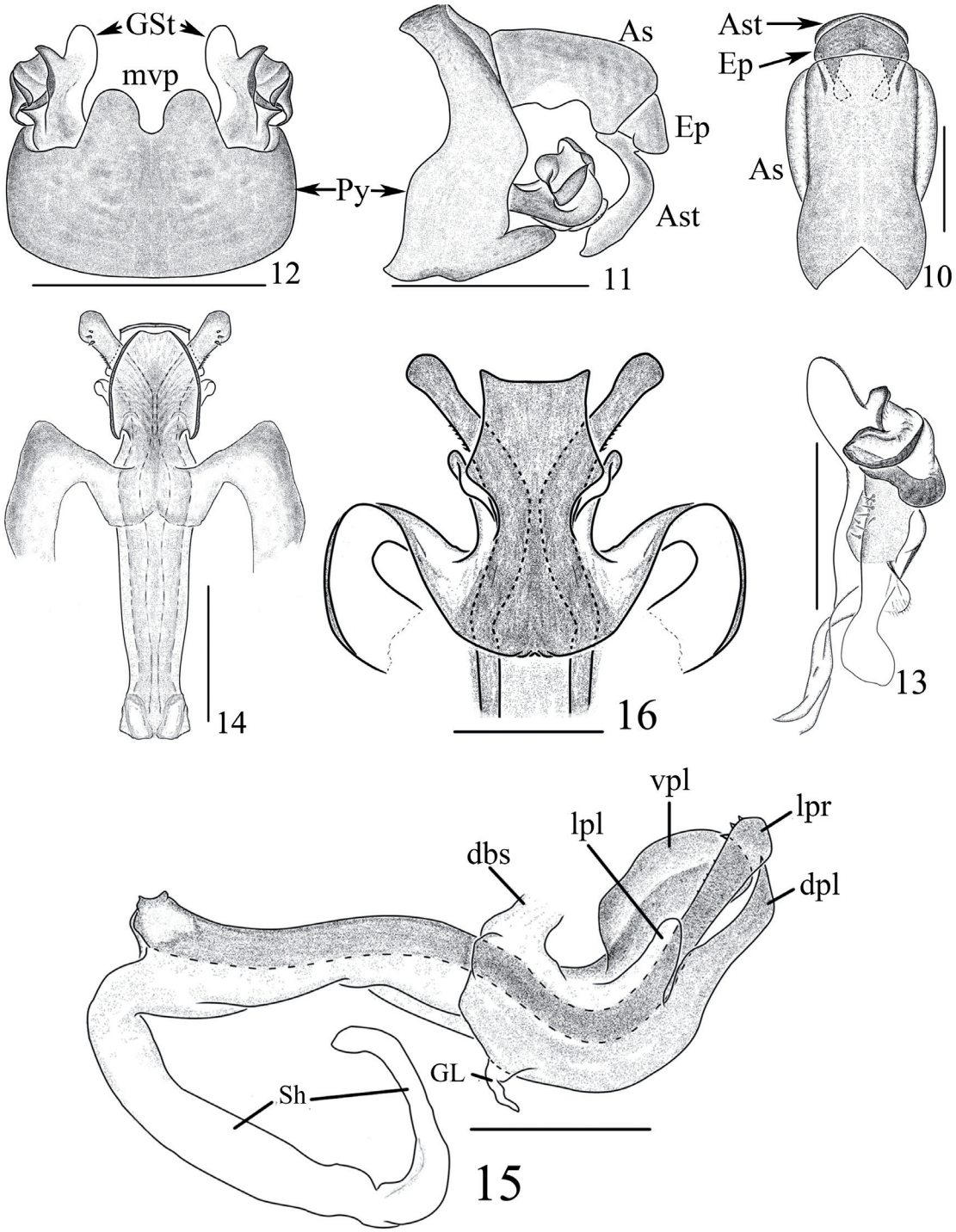
Coloration. Yellowish white to dark brown (Figs 1–4). Vertex yellowish brown (Figs 1, 3, 5). Frons brown, area along lateral margin with a broad longitudinal yellowish white stripe from upper margin to

Figs 5–7. *Gigasanalis jianfenglingensis* Long & Chen sp. nov., paratype, ♂ (IEGU). **5**. Head and thorax, dorsal view. **6**. Head, lateral view. **7**. Face. Scale bars = 0.5 mm..





Figs 8–9. *Gigasanalis jianfenglingensis* Long & Chen sp. nov., paratype, ♂ (IEGU). **8**. Fore wing. **9**. Hind wing. Abbreviations: A1 = First anal vein; A2 = Second anal vein; bc = Basal cell; C1 = Cell C1; C2 = Cell C2; C3 = Cell C3; C4 = Cell C4; C5 = Cell C5; Cu= Cubitus; CuA = Cubitus anterior; CuP = Cubitus posterior; m-cu = Transverse veinlet between media and cubitus; MP = Media posterior; Pcu + A1 = Postcubitus + First anal vein; Pcu = Postcubitus; r-m = Transverse veinlet between radius posterior and media; RA = Radius anterior; RP = Radius posterior; Sc + R = Subcosta + Radius; ScP + R (+ MA) = Subcosta posterior + Radius (+ Media anterior); ScP + R + M = Subcosta posterior + Radius + Media; ScP + RA = Subcosta posterior + Radius anterior; ScP = Subcosta posterior; ScRA = Subcosta + Radius anterior; WCA = Wing coupling apparatus. Scale bars: = 1 mm.

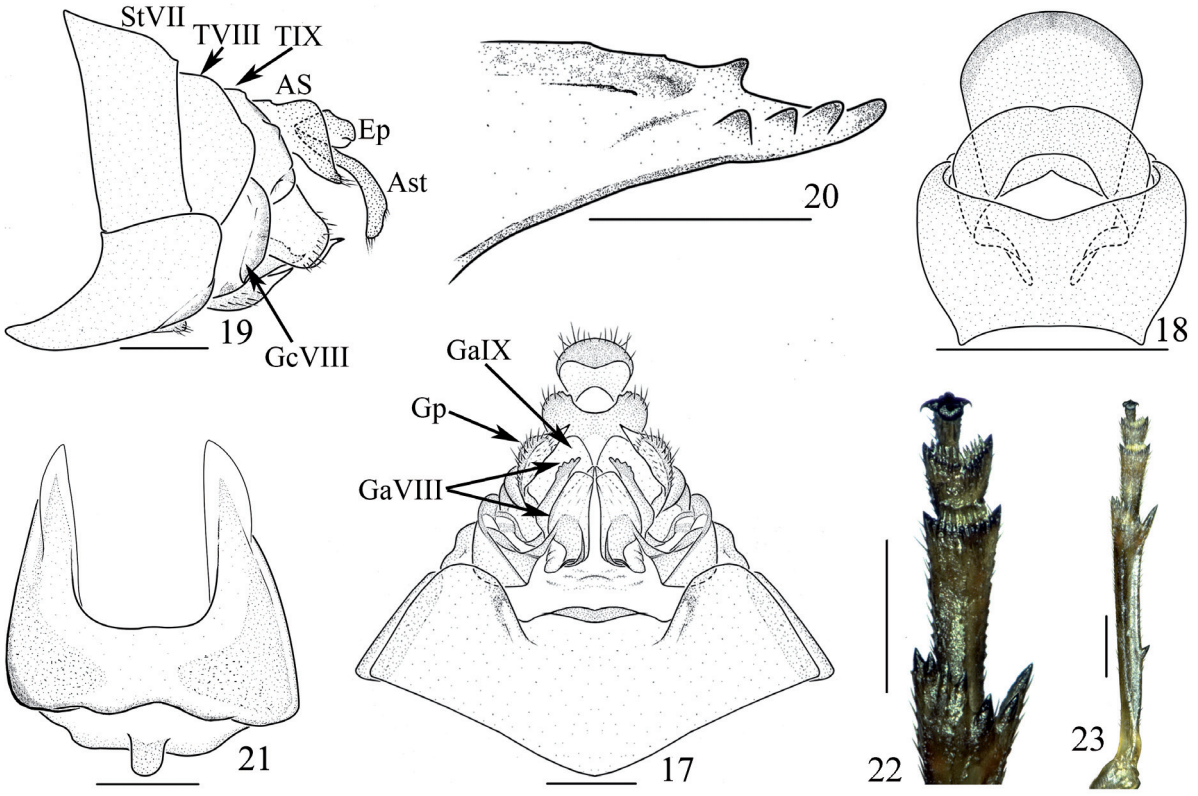


Figs 10–16. *Gigasanalis jianfenglingensis* Long & Chen sp. nov., paratype, ♂ (IEGU). **10**. Anal segment of male, dorsal view. **11**. Male genitalia, lateral view. **12**. Male genitalia, ventral view. **13**. Left genital style, dorsal view. **14**. Aedeagus, dorsal view. **15**. Aedeagus, lateral view. **16**. Aedeagus, ventral view. Abbreviations: As = anal segment (segment X); Ast = anal style (paraproct, segment XI); dbs = dorsobasal suspensorium; dpl = dorsal periandrial lobe; Ep = epiproct (segment XI); GL = genital lamina; GSt = genital style; lpl = lateral periandrial lobe(s); lpr = paired inner penis rods; mvp = medioventral projection of pygofer; Py = pygofer; Sh = sheath; vpl = ventral periandrial lobe. Scale bars = 0.5 mm.

below level of antennae (Fig. 7). Clypeus, rostrum and antennae brown. Genae yellowish white with area beneath antennae brown (Figs 2, 4, 6). Eyes and ocellus generally reddish brown (Fig. 6). Pronotum with area between lateral carinae (containing median and lateral carinae) dark brown, lateral lobes yellowish white, and ventral lobes brown (Figs 1–7). Mesonotum and tegula yellowish white (Figs 1, 3, 5). Fore wing dark brown to yellowish white, area at base yellowish white, costal margin with one small sharp triangle yellowish white marking and one large yellowish white stripe, and with another large triangle yellowish white marking at costal cell, area from base of postcostal cell to radial cell, median cell and base of C5 with numerous, small, yellowish white spots, main veins brown with branches pale brown to reddish brown, and short cross veins yellow to yellowish brown (Figs 1–4, 8). Hind wing pale brown, veins brown (Fig. 9). Legs and abdomen brown to dark brown.

Head. Vertex: A/B = 2.3. Frons: C/D = 1.2; D/E = 1.3; F/C = 0.6. Rostrum: G/H = 0.6.

Thorax. Pronotum: I/B = 0.9. Mesonotum: J/I = 5.1; J/B+I = 2.5. Fore wing: K/L = 2.3. Hind wing: M/N = 1.6.



Figs 17–23. *Gigasanalis jianfenglingensis* Long & Chen sp. nov. **17–21**. Paratype, ♀ (IEGU). **22–23**. Paratype, ♂ (IEGU). **17**. Female genitalia, ventral view. **18**. Anal segment of female, dorsal view. **19**. Female genitalia, lateral view. **20**. Left valvula I, from inside. **21**. Valvula II, ventral view. **22**. Spinal formula. **23**. Post tibiae. Abbreviations: As = anal segment (segment X); Ast = anal style (paraproct, segment XI); Ep = epiproct (segment XI); GaVIII = gonapophysis VIII ("*valvula I*"); GaIX = gonapophysis IX ("*valvula II*"); GcVIII = gonocoxa VIII ("*valvifer VIII*"); Gp = gonapophysis ("*valvula III*"); StVII = sternite VII; TVIII = tergite VIII; TIX = tergite IX. Scale bars: 17–19, 22–23 = 0.5 mm; 20–21 = 0.2 mm.

Male terminalia. Pygofer in lateral view (Fig. 11) with posterior margin broadly convex in the middle, medioventral process (Fig. 12) with apical ½ divided into two large branches, each with apical margin roundly convex. Aedeagus with phallobase bilaterally symmetrical (Figs 14, 16), dorsal periandrial lobe shovel-shaped with apex broadly concave (Fig. 14); lateral periandrial lobe in lateral view (Fig. 15) large finger-like with apical margin roundly convex; ventral periandrial lobe in ventral view (Fig. 16) with basal ⅓ neck-shaped, apical ⅔ subquadrangular with two basal horn-shaped processes large, directed laterally, with two apical horn-shaped processes small and acuate, directed apically. Dorsobasal suspensorium broad and flaky (Figs 14, 16). Each paired inner penis rod with apex rod like and with three dorsal spines located at subapical (Figs 14–16). Connective with basal ⅓ relatively stout and apical ⅔ finger-like (Fig. 15). Anal segment in dorsal view (Fig. 10) approximatively oblong-shaped, with ratio of length to maximum width 1.6, with basal margin with a reentrant angle of about 90 degrees in midline, epiproct tongue-shaped, distinctly exceeding apical margin of anal segment, anal style with apical margin broadly convex and slightly exceeding apical margin of epiproct; in lateral view (Fig. 11) anal segment with ventral margin with two dumpy processes, apical margin subtruncate, anal style approximatively banana-shaped, hanging at the apex of anal segment ventrad, with length nearly as long as anal segment. Genital style with lobes tortuous and irregular, apical margin almost rounded (Figs 11–13).

Female terminalia. Sternite VII with posterior margin distinctly concave as U-shaped, anterior margin obtuse angle-shaped producing basad (Fig. 17). Anal segment (Figs 18–19) in dorsal view suborbicular, basal margin broadly concave, apical margin incised in the middle; epiproct with apical margin incised in the middle, exceeding apex of anal segment; anal style with apical margin roundly convex and distinctly exceeding apical margin of epiproct. Gonapophysis VIII with spines at the outer and inner lateral margins respectively 4 and 1 (Fig. 20). Gonapophysis IX with two lateral lobes incompletely symmetrical, narrowing and sharp apically (Fig. 21). Sternite IX with outer surface shagreen (Figs 17,

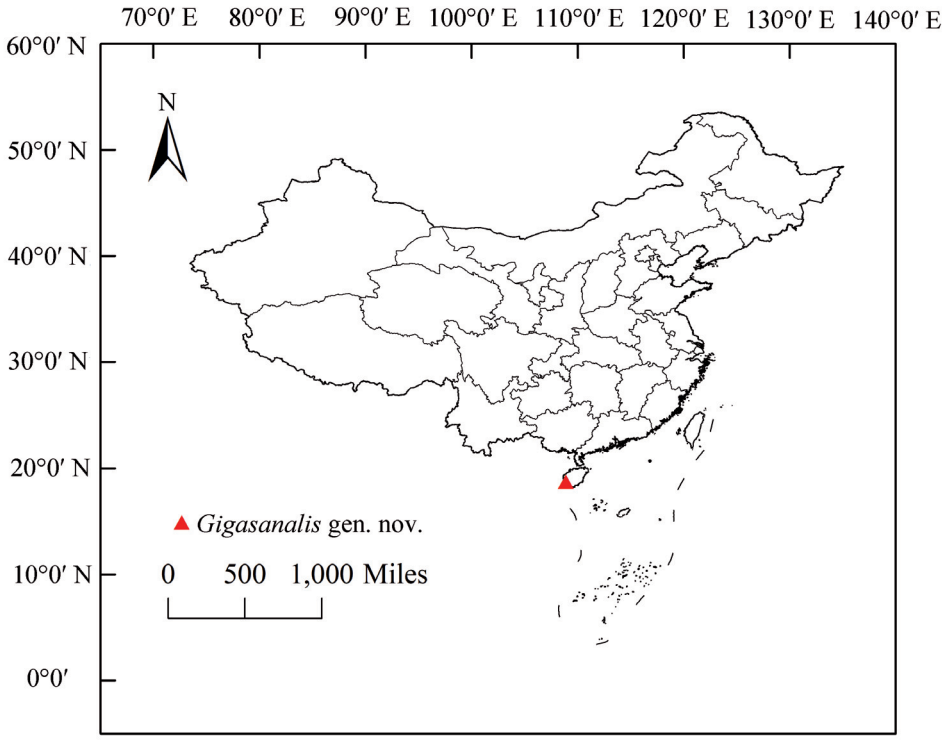


Fig. 24. Geographic distribution of *Gigasanalis* Long & Chen gen. nov.

19), in lateral view (Fig. 19) apical margin roundly convex, with an angulate process ventrally, directed inwards.

Distribution and habitat

Jianfengling National Natural Reserve, Hainan Province, China; so far only known from the type locality in the central part of the protection zone. The type series was collected in primitive forest, in the of 2014 April.

Discussion

Achilini constitutes a well-defined tribe in Achilidae: Achilinae, easily recognized by the following characteristics: width of head with eyes less than two-thirds width of pronotum, post-tibiae with a lateral spine and costal area with reversing transverse vein (Emeljanov 1992; Bartlett *et al*. 2018). *Gigasanalis* gen. nov. here is attributed to the subtribe Achilina (Achilidae: Achilinae: Achilini), mainly based on the following characters: 1) peculiar anastomosis between first and second anal veins of hind wings; 2) blind branches in anal system of hind wing and 3) location of A_1 branch of hind wing and no median fold. *Gigasanalis* clearly differs from the other genera of Achilina, by the combination of characters of the pronotum and details of the tegmen venation. In some respect, the fore wing of *Gigasanalis* resembles that of *Elidiptera* Spinola, 1839 and *Metaphradmon* Fennah, 1950, with apical branches of CuA2 directed obliquely backward or transverse, but clearly differs by the presence of cell C4 and C5 with many cross veins.

Currently Achilini is divided into 3 subtribe (Achilina, Cixidiina and Elidipterina) according to Emeljanov (1992). In contrast to the study of Emeljanov (1992), Brysz *et al*. (2022) suggests that the current subdivision of Achilini into subtribes should be discarded, and only two lineages should be recognised. In the morphological phylogenetic analysis of Brysz *et al*. (2022), *Flatachilus* Fennah, 1950 is located at the basal position of the phylogenetic tree, clearly separated from the other Achilini. However, relationships in the Achilini tribe need further investigation.

As of now, Achilini are known to feed on 14 plant species: *Arctostaphylos* sp., *Argyrodendron actinophyllum* (F.Muell.) Edlin, *Citrus aurantium* L., *Eriobotrya japonica* (Thunb.) Lindl., *Olea europaea* L., *Olea* sp., *Pinus pinaster* Aiton, *Pinus* sp., *Pinus sylvestris* L., *Prunus persica* (L.) Batsch, *Quercus cerris* L., *Quercus ilex* L., *Quercus pubescens* Willd., *Quercus* sp. (Bourgoin 2022). Although the host of the new genus and species in this paper are unknown, the specimens examined are assuredly collected in primitive forest of Jianfengling, Hainan Province, China. The genus has the habit of phototaxis at night (some examined specimens collected by light trap).

Acknowledgements

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