



## Revision of the New Guinean genus *Zophiuma* (Hemiptera, Lophopidae)

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### Abstract

The lophopid genus *Zophiuma* Fennah, 1955 is revised with two new species described, *Z. gitauae* **sp. nov.** and *Z. torricelli* **sp. nov.** and *Z. doreyensis* (Distant, 1906) is placed in synonymy with *Z. pupillata* (Stål, 1863). A key to the species for the genus, distribution map and the male genitalia illustrations are provided.

**Key words:** Auchenorrhyncha, Fulgoromorpha, Papua New Guinea, Indonesia

### Introduction

Nine genera of Lophopidae are present on the New Guinea Island and to several small closely located islands. Most of them, like *Zophiuma* Fennah, 1955, are restricted to those islands, *Acarina* Stål, 1863, *Jugoda* Melichar, 1915, *Kasserota* Distant, 1906, *Maana* Soulier-Perkins, 1998, *Megacarna* Baker, 1925, *Onycta* Fennah, 1955 and *Panegu* Soulier-Perkins & Stroinski, 2016 (Soulier-Perkins 2000; Soulier-Perkins & Stroinski 2016). Only one genus is cosmopolitan, *Lophops* Spinola, 1839, represented by one species in Papua New Guinea, *Lophops fusca* Melichar, 1915.

The Lophopidae feed from phloem tissue and have a restricted number of host plant belonging essentially to the Palmaceae and Poaceae (Soulier-Perkins *et al.* 2007), which is the case for *Zophiuma* found essentially on palms. It is also one of the rare lophopid genera for which a species is involved in crop damage (Smith 1980), *Z. butawengi* (Heller, 1966). This species is also known as the Finschhafen planthopper. The Finschhafen disorder is characterised by a yellow-bronzing of fronds. It begins from the tips and progresses towards the petiole. Advanced symptoms appear as chlorosis of the leaflets followed by necrosis and finally death of the entire frond. It affects both young and old palms. The disorder is not systemic but due to direct feeding effect. The chlorotic symptoms are most likely caused by destruction of tissues during the feeding process or perhaps, a possible toxin in the insect's saliva (Gitau *et al.* 2011b) but no evidence were detected of a presence of phytoplasmas or bacteria-like organisms. According to Smith (1980) around 1/3 of coconut palms that are affected may be lost. The current management is based on repeated application of systemic organophosphate insecticides throughout a targeted trunk injection, with well-known undesirable adverse effects on the environment (Guerrieri *et al.* 2011). However, some alternative strategies are explored. The first is the use of biological control since two autochthonous Hymenoptera natural enemies were found, described and studied (Guerrieri *et al.* 2011; Gitau *et al.* 2011c). The second is the use of an entomopathogenic fungi discovered during a field survey that seems a promising candidate for further investigations as a potential inundative entomopathogenic agent (Woruba *et al.* 2014). When Gitau *et al.* (2011a) revised the genus, they had access to numerous specimens of *Z. butawengi* and what they called *Z. pupillata* (Stål 1863), both from Papua New Guinea. Here we had access to specimens of *Zophiuma* collected in Papua New Guinea but as well from the provinces of Papua and West Papua in Indonesia. This allowed us to review the genus with a different range of geographic areas represented.

## Materials and methods

The abdomen of each specimen examined was cut off and cleared for 20 minutes in warm (80°C) 10% KOH. Dissections and cleaning of genital structures were performed in distilled water. If needed, a few drops of blue paragon (rather than Chlorazol black now forbidden) for dyeing the ectodermic genital ducts were added for a few minutes. Final observations were made in glycerol using a Leica microscope (MZ16). The habitus photos were taken using Canon EOS 6 D with a Macro lens Canon EF 100 mm f/2.8, view command on the computer with the software Canon and then assembly with the software Helicon focus 6. SimpleMappr (Shorthouse 2010) was used to produce the background of distribution map.

Terms used follow Bourgoïn (1988) and Soulier-Perkins (1998, 2001) for the genitalia and Bourgoïn *et al.* (2015) for the forewing venation.

### Abbreviations:

FSCA	Florida State Collection of Arthropods, Gainesville, Florida, USA
BMNH	Natural History Museum, London, UK
BPBM	Bernice Pauahi Bishop Museum, Hawaii, USA
MNHN	Muséum national d'Histoire naturelle, Paris, France
UQIC	Department of Entomology, University of Queensland, Brisbane, Australia
AdpP	Antero-dorsal part of periandrium
PvaA	Antero-ventral process of aedeagus
PvpA	Postero-ventral process of aedeagus
PvfP	Postero-ventral folds of periandrium
Cu	cubital
R	Radial

## Taxonomy

### Suborder Fulgoromorpha Evans, 1946

### Superfamily Fulgoroidea Latreille, 1807

### Family Lophopidae Stål, 1866

### Genus *Zophiuma* Fennah, 1955

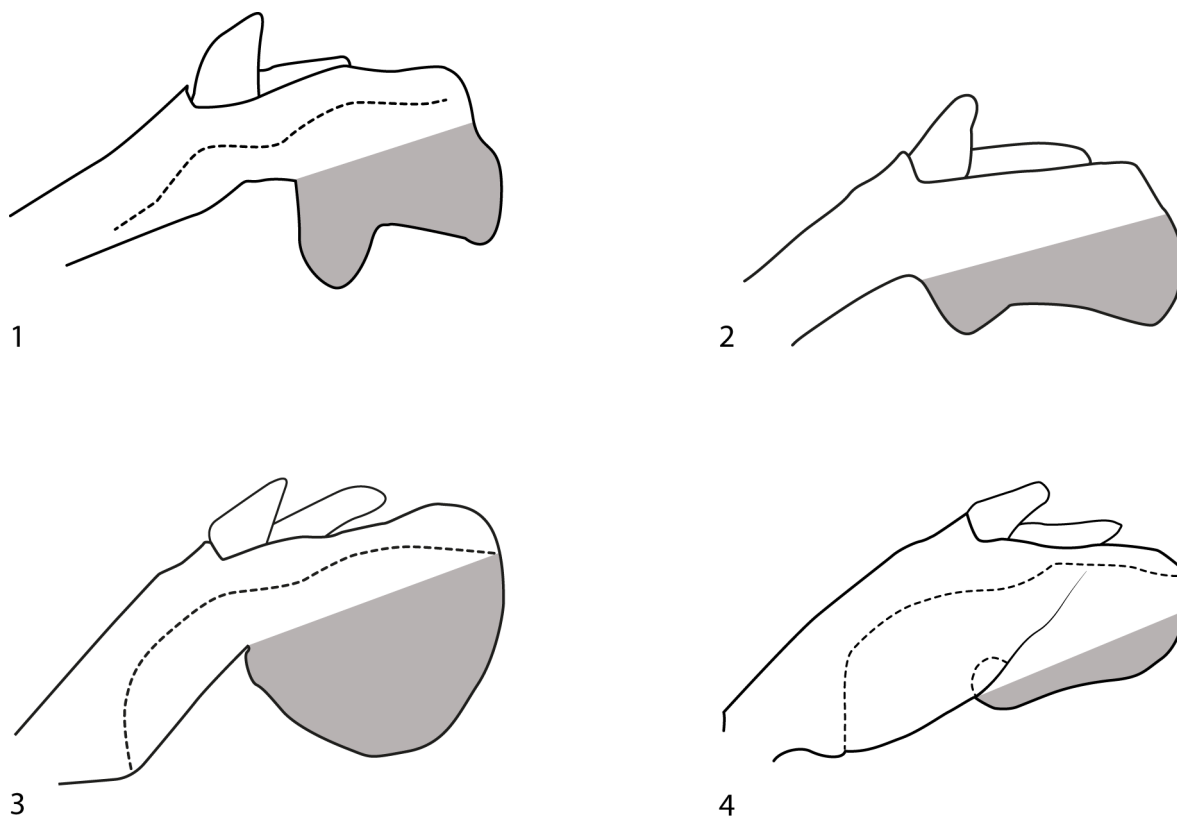
*Zophiuma* Fennah 1955: 170. Type species: *Acarna pupillata* Stål, 1863 by original designation.

Gitau *et al.* (2011a) made the most recent revision of the genus. They retained only three valid species *Zophiuma pupillata* (Stål, 1863), *Z. butawengi* (Heller, 1966) and *Z. doreyensis* (Heller, 1966). Based on molecular characters, they could make a clear difference between the specimens they identified as *Z. pupillata* and *Z. butawengi*. As an addition and to distinguish the male genitalia, and which parts belong to the aedeagus and periandrium, we performed some dissection of male genitalia for all the species we were able to examine. Gitau *et al.* (2011a) also provided a key to the species. We provide here a key based on male characters in order to include the 2 new species here described and to take into consideration the new synonymy we have proposed.

### Key to the species of male *Zophiuma*

- 1 Postero-ventral margin of male anal segment barely produced (Fig. 4) ..... *Z. torricelli* sp. nov.
- Postero-ventral margin of male anal segment broadly produced in a lobe .....
- 2 Lobe regularly and broadly rounded (Fig. 3) ..... *Z. pupillata*

- Lobe with a clear cut-out in middle ..... 3
- 3 Anterior part of lobe clearly smaller and not as long as posterior part (Fig. 2) ..... *Z. gitauae* **sp. nov.**
- Anterior part of lobe slightly smaller but as long as posterior part (Fig. 1). ..... *Z. butawengi*



FIGURES 1–4. Schematic patterns of *Zophiuma*’ male anal tube. 1. *Z. butawengi*. 2. *Z. gitauae*. 3. *Z. pupillata*. 4. *Z. torricelli*.

### Note on the females *Zophiuma*

It is often difficult to identify the species when only the female is collected. However, for the species *Z. butawengi*, the females have brown tegmina and never reach 2 cm long as total length. All the females observed for the 3 other species were always clearly longer than 2cm. Generally their tegmina bear some red but for *Z. gitauae* **sp. nov.** and *Z. torricelli* **sp. nov.** a hyaline lunula is observed between the anterior reddish part and the brownish apex of tegmen. For *Z. pupillata*, this hyaline lunula is absent.

### *Zophiuma butawengi* (Heller, 1966)

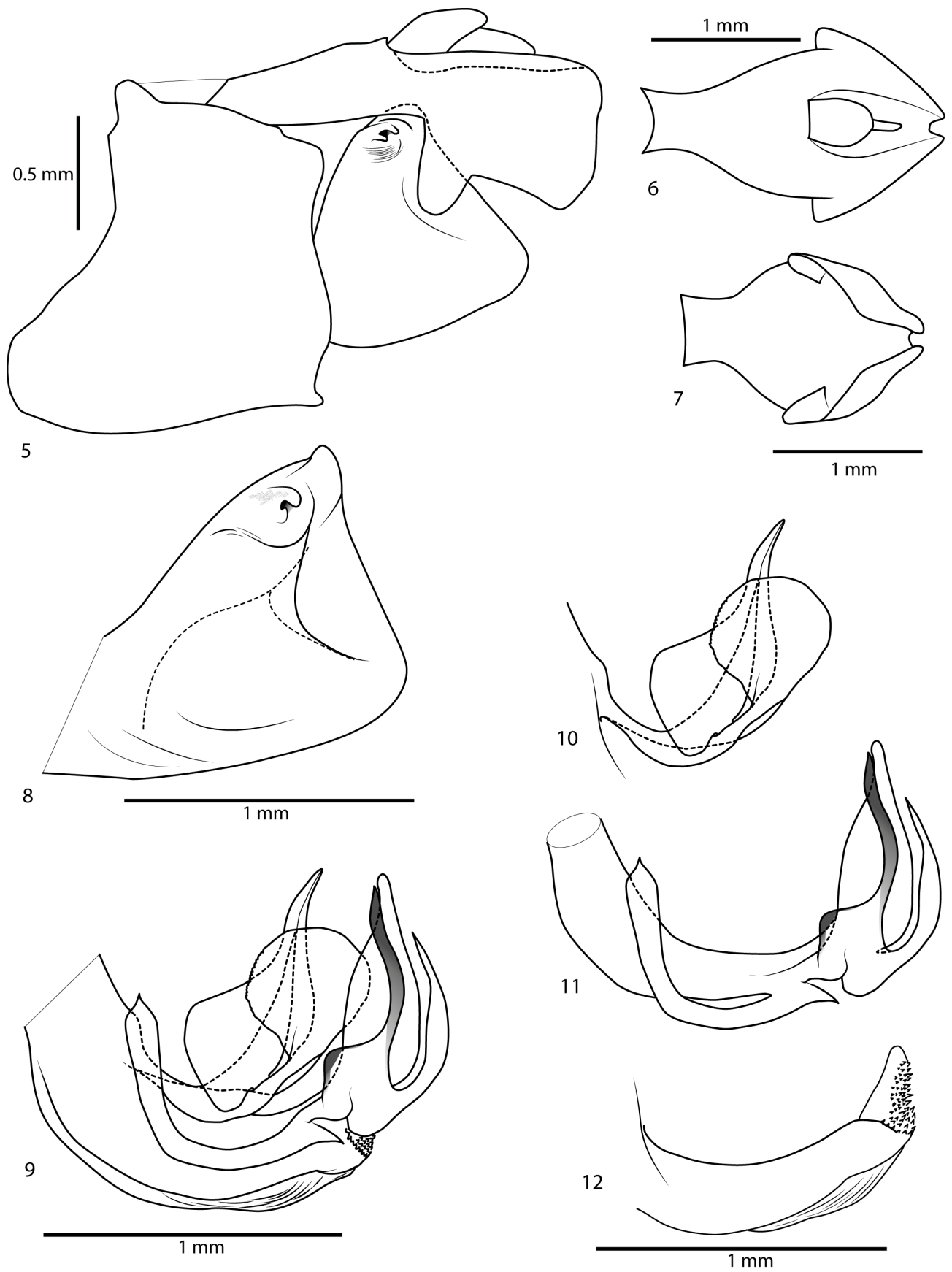
(Figs 5–12)

*Hellerides butawengi* Heller, 1966: 1

*Zophiuma butawengi* (Heller), Liang 1995: 163

*Zophiuma lobulata* Ghauri 1967: 557, Syn. in Gitau *et al.* 2011a: 88

**Examined material.** 1♂ [KBMission Milne, Bay New Guinea, 1–14 Apr1944, K. V. Krombein], [ExColln, K.V. Krombein], [*Zophiuma lobulata* Ghauri, Kramer 1969], 1♂ [KBMission Milne, Bay New Guinea, 18 Apr1944, K. V. Krombein], [ExColln, K.V. Krombein], 2♀ [Figscklefen, New Guinea, V-9-69] [ex yellowing coconut] [Bianchi Ruthenberg colls] [2] (FSCA). 2♀ [Tibulum PTn. Nr., Finschhafen, Morobe Distr., New Guinea, 15 II 1966] [On fronds of *Coco nucifera*, coll. John Datas] (UQIC). 1♀ [P. N. guinea: Gadaisu, June 1919, J. T. Zimmer leg.] [Compared with type *Zophiuma lobulata* Ghauri], MNHN(EH)24619, 1♂ [P. N. guinea: Gadaisu, June 1919, J. T. Zimmer leg.] MNHN(EH)24620, (MNHN).



**FIGURES 5–12.** *Zophiuma butawengi* terminalia. **5.** Anal tube, pygofer and gonostylus, lateral view. **6.** Anal tube, dorsal view. **7.** Anal tube, ventral view. **8.** Gonostylus, lateral view. **9.** Phallic complex, lateral view. **10.** Dorsal part of periandrium, lateral view. **11.** Aedeagus, lateral view. **12.** Ventral part of periandrium, lateral view.

**Distribution.** West New Britain Province and on the mainland for the provinces Morobe, Oro and Milne Bay (Papua New Guinea)

**Host plants.** Areaceae (Ghauri 1967, Soulier-Perkins *et al.* 2007). According to Gitau *et al.* (2011a), the major crop species include the Coconut (*Cocos nucifera* L.), Oil palms (*Elaeis guineensis* Jacq.) and Betel nut (*Areca catechu* L.).

***Zophiuma gitauae* Soulier-Perkins & Le Cesne sp. nov.**

(Figs 13–26)

*Zophiuma pupillata* (Stål) [sic]: Gitau *et al.* 2011a: 88 (Figs 6–8)

**Type material.** Male holotype: [Papouasie Nelle Guinée, province de Madang, Wanang 3, 180 m, 5°13'40''S 145°4'47''E] [Museum Paris, PL camp, 29-XI-21012, A. Soulier-Perkins] MNHN(EH) 24524 (MNHN). Paratypes: [Papouasie Nelle Guinée, province de Madang, Wanang 3, 180 m, 5°13'40''S 145°4'47''E], PL camp, A. Soulier-Perkins, 1♂: 1-XII-2012, MNHN(EH) 24526; 2♂: 2-XII-21012, MNHN(EH) 24527–24528; 1♀: 14-XI-2012, MNHN(EH) 24525 and 1♀: 24-XI-2012, MNHN(EH)24529 (MNHN).

**Examined material.** 1♂ [New Guinea NE Madang 5m, Oct. 28, 1958] [Palm] [J. L. Gressitt collector] [*Zophiuma doreyensis* Dist. Det. Fennah] (BPBM). 1♀ [New Guinea NE. Madang, Oct. 28, 1958], [Palm], [J. L. Gressitt collector] (BPBM)

**Distribution.** Madang Province (Papua New Guinea)

**Diagnosis.** The male anal tube, presenting a cut out in apical lobes and the female colouration of tegmina, reddish at base and brownish toward apex with a hyaline lunula in between are characteristic for this species.

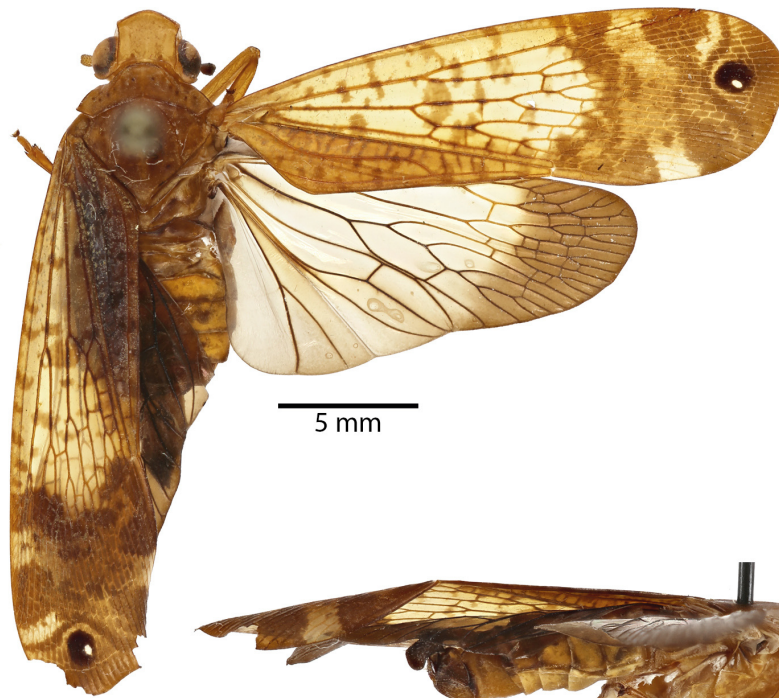
**Description.** Total length of male holotype: 2.11 cm (incl. tegmina).

Head in dorsal view, vertex 1.16 larger than long in midline, lateral margins parallel, anterior and posterior margins regularly curved, vertex surface flat without median carina (Fig. 13). In frontal view, frons 1.14 wider across widest part than long in midline, fronto-vertex margin slightly rounded and convex followed by lateral margins slightly diverging on half their length then sharply curved and reaching a frontoclypeal suture concave and slightly v-shaped, frons tree carinate, sublateral carinae joining dorsally and delineating an ovoid disc in middle, median carina straight and clearly visible (Fig. 15). In lateral view, ocellus present, located below compound eye and anteriorly to antenna. Ocellar carina present and genal carina absent (Fig. 14). Prothorax larger than head, 4.65 larger than long in midline, mesothorax bearing 1 double median carina and 2 sublateral, strongly curved anteriorly. Tegmen 3.6 longer than wide, ScP+R(+MA) and MP forking almost at same level, then CuA, all forking before end of clavus, presence of anastomosis between CuA1 and MP(3+4). Metatibiae bearing 3 lateral spines and 9 apical spines organised in a v shaped line, first metatarsal segment bearing a series of 11 apical spines organised in a triangular area, longer than cumulative length of second and third metatarsal segment, second segment reduced to a lobe without any spine (Fig. 15).

Male terminalia. In lateral view, first half-length of anal tube narrower than second half due to apical lobes development, lobe with cut out in middle (Fig. 21). Pygofer with dorsal margin having a clear step down in middle, ventral margin very regular, almost straight like posterior margin. Gonostylus with dorsal margin regular up to dorsal process oriented antero-dorsally, ventral and posterior margins curving regularly (Fig. 22). Dorsal periandrium developed in a dorsal extension rounded apically, followed laterally by a process with sharp tip and a structure covering partially the two other structures and with its apex duck head shaped (Figs 23–24). Ventral periandrium developed dorsally into a narrowing shape bearing a series of small teeth posteriorly, most posterior part of periandrium membranous (Fig. 26). Aedeagus bearing only a ventral process, PvaA long regularly curved, oriented anteriorly and with a pointed apically. Apex of aedeagus developed in an ovoid structure and a two teeth sclerified structure partially covering ovoid structure along its anterior and posterior margins (Fig. 25).

Colour. Males and females are of different colours. Male (Figs 13–15), mostly light yellowish, darker brownish zones can be observed on thorax in dorsal view and on tegmina, tips of spines on metatibia and first metatarsal segment are dark brown, a white dot surrounded by a roundish dark brown area is located at tip of tegmina. Female (Figs 17–19), mostly reddish, lighter colorations can be observed on vertex, frons and rostrum, over half of tegmina is red then a hyaline lunula can be observed followed by different pattern of brownish colour in which a white dot within a black circle can be observed at apex (Fig. 17).





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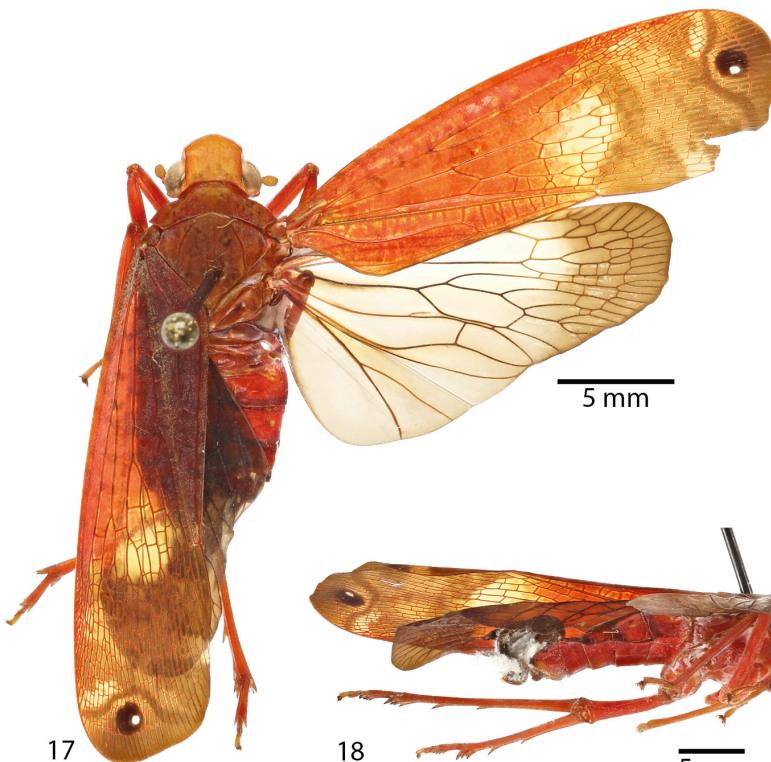


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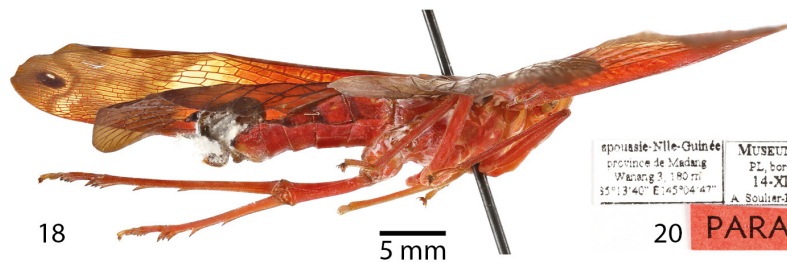
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Province de Madang	PL, camp	MONH/347
Warang 3, 180 m	29-XI-2012	24524
85°13'40" E 145°04'47" S	A. Soulier-Perkins Rec.	

HOLOTYPE

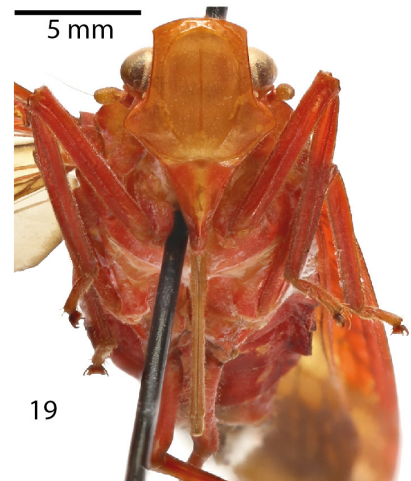
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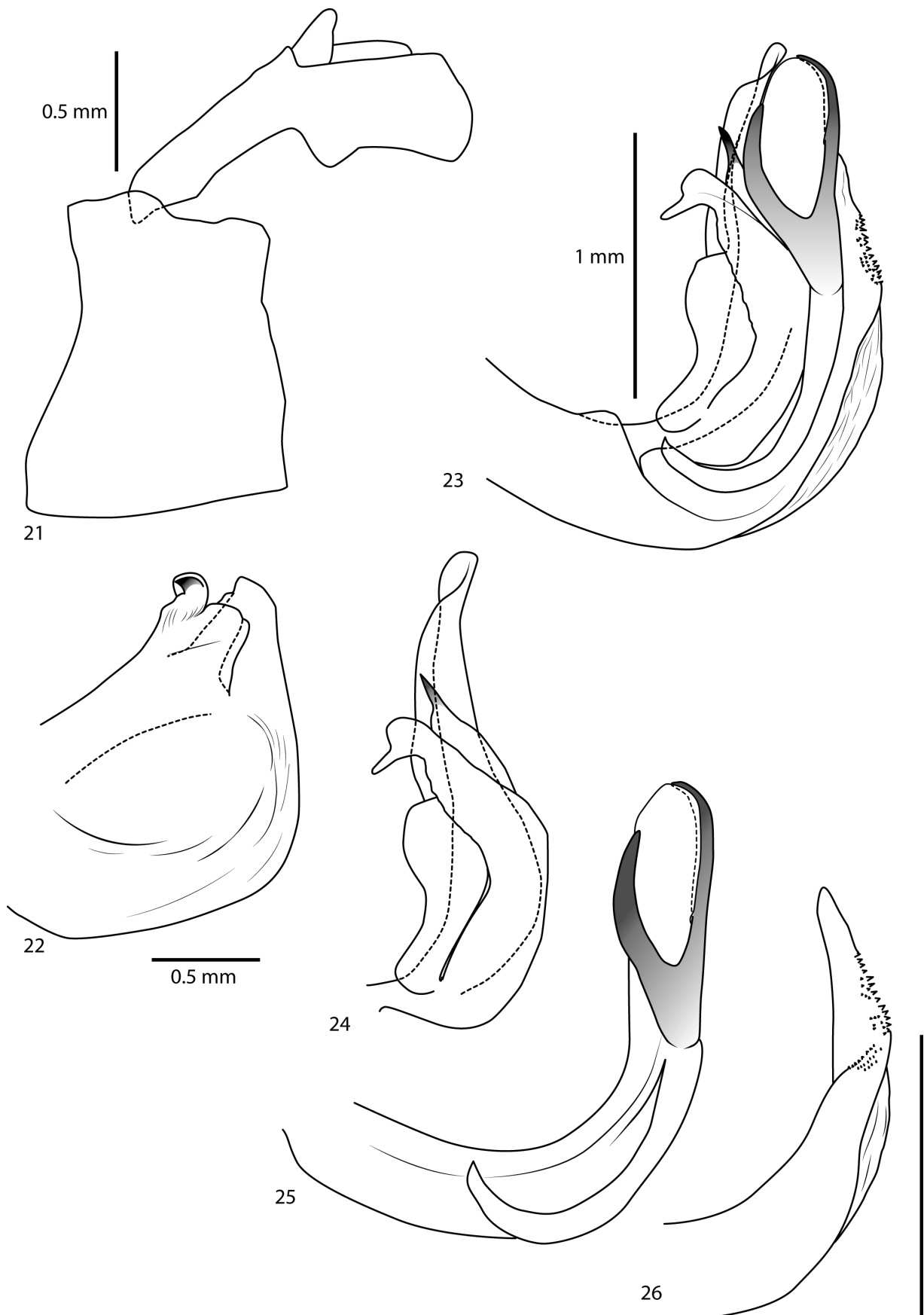
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Papouasie-Nlle-Guinée	MUSEUM PARIS	Museum Paris
Province de Madang	PL, bord mière	MONH/347
Warang 3, 180 m	14-XI-2012	24525
85°13'40" E 145°04'47" S	A. Soulier-Perkins Rec.	

PARATYPE

20

FIGURES 13–20. *Zophiuma gitauae* sp. nov., holotype male (13–16) paratype female (17–20). 13. Habitus, dorsal view. 14. Habitus, lateral view. 15. Frons and clypeus, anterior view. 16. Labels. 17. Habitus, dorsal view. 18. Habitus, lateral view. 19. Frons and clypeus, anterior view. 20. Labels.



**FIGURES 21–26.** *Zophiuma gitauae* **sp. nov.**, holotype male terminalia. **21.** Anal tube and pygofer, lateral view. **22.** Gonostylus, lateral view. **23.** Phallic complex, lateral view. **24.** Dorsal part of periandrium, lateral view. **25.** Aedeagus, lateral view. **26.** Ventral part of periandrium, lateral view.

**Etymology.** The species is named for Catherine Gitau who first took some images and made drawings of the genitalia for this species.

***Zophiuma pupillata* (Stål, 1863)**

(Figs 27–32)

*Acarua pupillata* Stål, 1863: 586

*Kasserota pupillata* (Stål), Distant 1906: 350

*Zophiuma pupillata* (Stål), Fennah 1955: 171

*Zophiuma guineae* (Lallemand), Liang 1995: 163

*Hellerides guineae* Lallemand, 1962: 3, Syn. in Gitau *et al.* 2011a: 88

*Zophiuma doreyensis* (Distant), Fennah 1955: 171, Gitau *et al.* 2011a: 90

*Kasserota doreyensis* Distant, 1906: 350, **new synonym**

**Examined material.** 1♂, [New Guinea, Doromena], [II-28-45 SG Jewett] (FSCA). 1♀ and 2♂ [New Guinea (Neth.) rain forest behind dock V, 20m, Hollandia, VII-14-1957] [D. Elmo Hardy collector] [fronds of coconut palm] (BPBM). 1♀ [New Guinea (Neth.), Hollandia 100m, Aug. 24, 1965] [J.L. Gressitt collector] [*Zophiuma pupillata* (Stål) det. Fennah] (BPBM). 1♀ [New Guinea Neth. Genjam, 40km W of Hollandia, 100–200m, 1–10-III-1960] [T.C. Maa collector] (BPBM). 7♂ [New Guinea (Neth.): Hollandia area, Hamadi, 50 m. July 13., 1957] ], [coconut fronds], [D. Elmo Hardy collector] (BPBM). 1♀, 3♂ [New Guinea: Neth. Biak I.: StrandVI-24-1959] [T.C. Maa collector] (BPBM). 1♀, 1♂ [New Guinea (Neth.): Hollandia area, Hamadi, 50 m. July 13, 1957], [coconut fronds], [D. Elmo Hardy collector] MNHN(EH)24621–24622 (MNHN).

Examination of type material *Acarua pupillata* Stål, 1863 and *Kasserota doreyensis* Distant, 1906 was made by Mr M. Webb according to the requests of the authors. Type material being very fragile, a loan was not possible. Mr M. Webb provided as well images of the material (Figs 27–28).

**Distribution.** West Papua and Papua provinces of Indonesia.



**FIGURES 27–28.** Types specimens in BMNH. **27.** *Acarua pupillata* Stål, 1863 holotype female with labels; below *Z. pupillata* female specimen from the same locality. **28.** *Kasserota doreyensis* Distant, 1906 holotype male with labels.

As mentioned by Gitau *et al.* (2011a) the type specimen for *Z. pupillata* is a female described by Stål (1863), which he believed to be a male at that time. The label of the locality for this specimen is typewritten “Dory” (Fig. 27), which corresponds to the locality Dorey now known as Manokwari in West Papua. In the BMNH, along with the type of *Z. pupillata* a second specimen can be found bearing a typewritten label “Wallace” and a handwritten label “Dor.” (Fig. 27) which correspond as well to the village Dorey, locality in West Papua where Alfred Russel Wallace spent some time in 1858. It is also a female like the *Z. pupillata* type (Fig. 27). Distant type of *Z. doreyensis* is a male known only by the type (Gitau *et al.* 2011a) in the BMNH (Fig. 28). This specimen bears a typewritten label “Wallace” and a handwritten label “Dor.”, just like the red specimen alongside Stål *Z. pupillata* type. After examining further material collected in the island of Biak (4 males) and within the close vicinity of Jayapura (3 females and 9 males), all the males have similar genitalia as *Z. doreyensis* and the females are red and with on the



tegmina an absence of a hyaline lunula like *Z. pupillata*. For these reasons we consider that *Z. doreyensis* should be placed in synonymy with *Z. pupillata*. The synonymy made by Gitau *et al.* for the species *Hellerides guineae* Lallemand, 1962 remains valid since in the image of the female type specimen provided by those authors (Gitau *et al.*: 90), we can see clearly the absence of hyaline lunula on tegmina, characteristic of *Z. pupillata*. In the original description, it is written that the specimen was collected in New Guinea, but no mention of a more accurate locality is given. However, the collector mentioned Ludeking who was a director of health in the Dutch army and most likely collected in provinces of West Papua and Papua, which were a Dutch colony at the time. This seems congruent with the actual known distribution of *Z. pupillata* (Fig. 44).

### ***Zophiuma torricelli* Soulier-Perkins & Le Cesne sp. nov.**

(Figs 33–43)

**Type material.** Male holotype: [New Guinea: NE. Torricelli Mts. Siaute, sea lev. XI-9–17-1958], [W.W. Brandt Collector], [*Zophiuma doreyensis* (Dist.) det. R.G. Fennah] (BPBM). Paratypes: 1♀ [New Guinea: NE. Torricelli Mts., Nengian vill., XI-17–24-1958] [W.W. Brandt collector] (BPBM). 1♀ [New Guinea: NE. Torricelli Mts., Sugoiteis vill. 900 m. II-10–28-1959] [W.W. Brandt collector Bishop] MNHN(EH)24623 (MNHN), 5♂, 1♀ [New Guinea, Torecella Mts., Afua village, 16.iii.–3.iv.1939], [G.P. Moore, B.M. 1939–479], [NHMUK 013589025–013589029] and [NHMUK 013589030] (BMNH).

**Distribution.** Mount Torricelli in Sandaun Province (Papua New Guinea)

**Diagnosis.** The shape of male anal tube is characteristic. In lateral view, apical lobe is far less developed than for the three other species, its width is not greater than width measured just before epiproct insertion (Fig. 38).

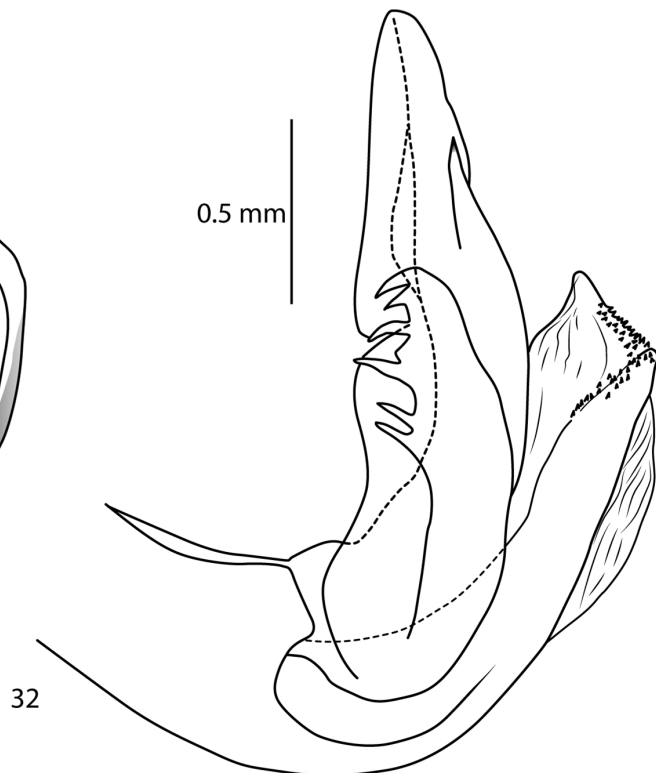
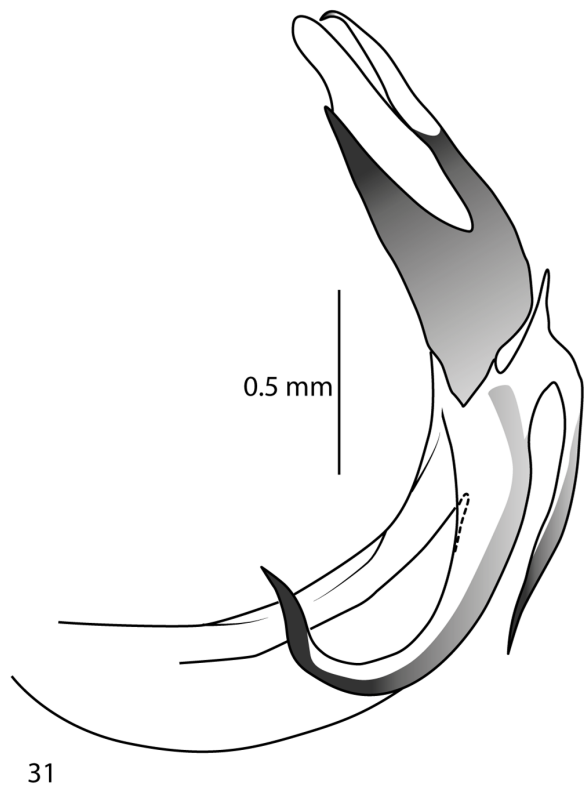
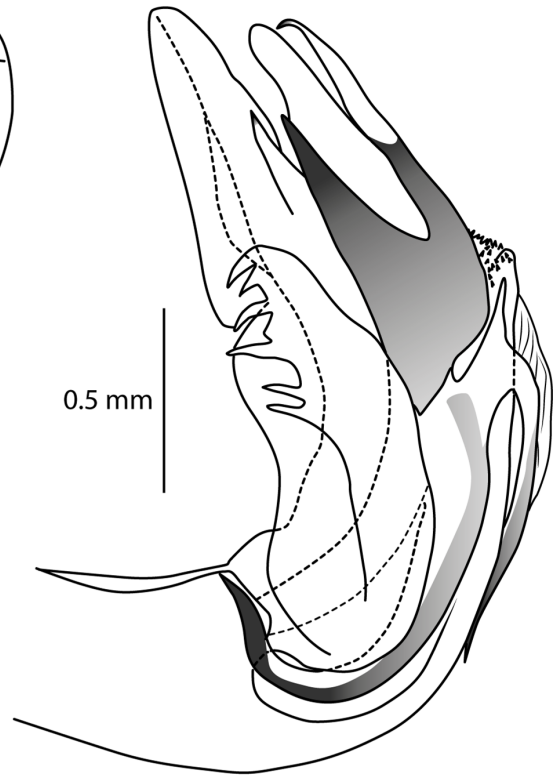
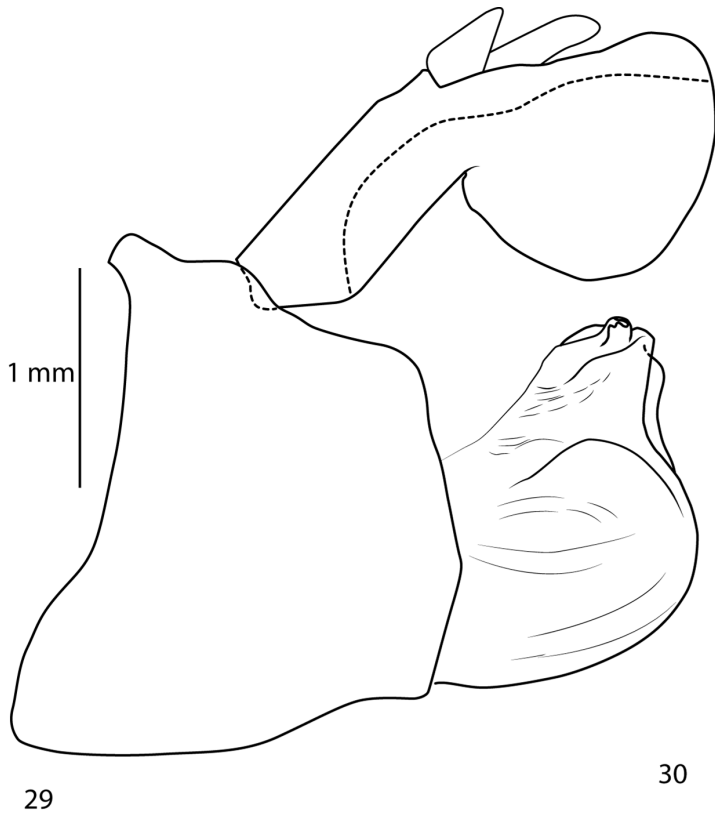
**Description.** Total length of male holotype: 2.15 cm (incl. tegmina).

Head. In dorsal view, vertex 1.33 larger than long in midline, lateral margins parallel, anterior and posterior margins regularly curved, vertex surface flat without median carina (Fig. 33). In frontal view, frons 1.14 wider across widest part than long in midline, fronto-vertex margin slightly rounded and convex followed by lateral margins almost parallel on half their length then sharply curved and reaching a frontoclypeal suture concave and slightly v shaped, frons tree carinate, sublateral carinae joining dorsally and delineating an ovoid disc in middle, median carina clearly visible (Fig. 35). In lateral view, ocellus present and located below compound eye and anteriorly to antennae. Ocellar carina present and genal carina absent (Fig. 34). Prothorax larger than head and 4.6 larger than long in midline. Tegmen 3.6 longer than wide, ScP+R(+MA) and MP forking almost at same level, then CuA, all forking before end of clavus, presence of an anastomosis between CuA1 and MP(3+4) (Fig. 34). Metatibiae bearing 3 lateral spines and 9 apical spines organised in a v shaped line, first metatarsal segment bearing 11 apical spines organised in a triangular area, longer than cumulative length of second and third metatarsal segment, second segment reduced to a lobe without any spine.

Male terminalia. In lateral view, anal tube thick, 2.6 times longer than its biggest thickness measured just before epiproct insertion, apical lobes not clearly developed (Fig. 38). Dorsal and ventral margins of pygofer converging posteriorly, posterior margin convex. Gonostylus with dorsal margin irregular bearing a process oriented anterodorsally close to it, ventral and posterior margins roughly straight and perpendicular to each other. Dorsal periandrium developed in a dorsal extension bilobate apically, followed posteriorly by a process with a blunt tip and laterally by a structure wing shaped covering partially the two other structures, its most anterior margin developed anteriorly into two teeth (Figs 41, 43). Ventral periandrium not strongly developed but with its most posterior half partially membranous which allows the structure to inflate (Figs 37, 43). Aedeagus bearing two ventral processes, PvaA long regularly curved, oriented anteriorly and blunt at tip, PvpA short, slender with a sharp apex. Apex of aedeagus developed in a bifid structure and a small tooth on side (Figs 41–42).

Colour. Mostly light yellowish (Figs 33–35), darker brownish zones can be observed on thorax in dorsal view and on tegmen, tips of spines on metatibia and on first metatarsal segment are dark brown. A white dot surrounded by a roundish dark brown area is located in apical area of tegmen.

**Etymology.** The species was collected on Mount Torricelli in the Northwest of Papua New Guinea. The species is named after this mount.



**FIGURES 29–32.** *Zophiuma pupillata* terminalia. **29.** Anal tube, pygofer and gonostylus, lateral view. **30.** Phallic complex, lateral view. **31.** Aedeagus, lateral view. **32.** Periandrium, lateral view.



33



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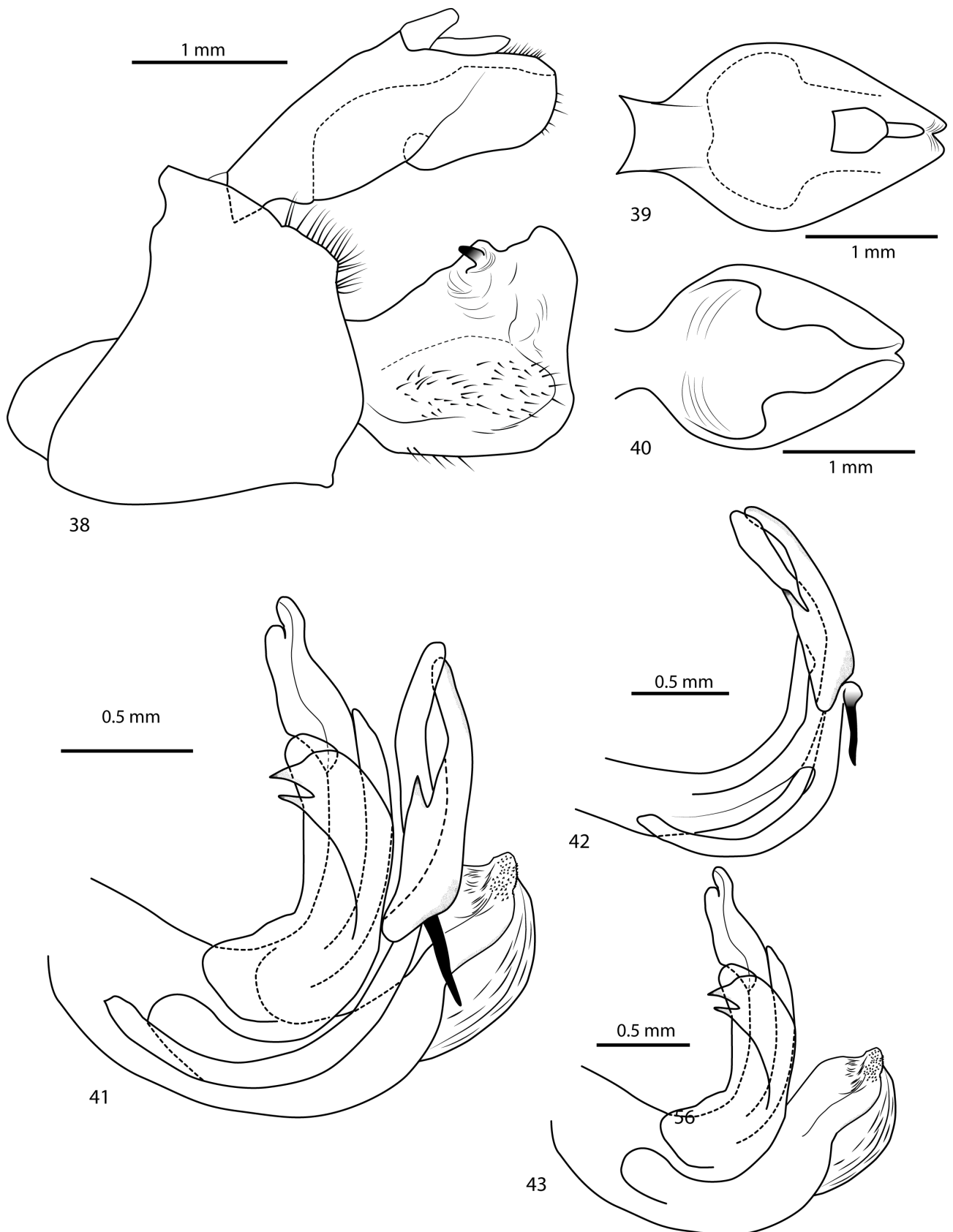
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1 mm



37

FIGURES 33–37. *Zophiuma torricelli* sp. nov. holotype. 33. Habitus, dorsal view. 34. Habitus, lateral view. 35. Frons and clypeus, anterior view. 36. Labels. 37. Aedeagus and periandrium, lateral view.



**FIGURES 38–43.** *Zophiuma torricelli* **sp. nov.** holotype terminalia. **38.** Anal tube, pygofer and gonostylus, lateral view. **39.** Anal tube, dorsal view. **40.** Anal tube, ventral view. **41.** Phallic complex, lateral view. **42.** Aedeagus, lateral view. **43.** Perianthrium, lateral view.



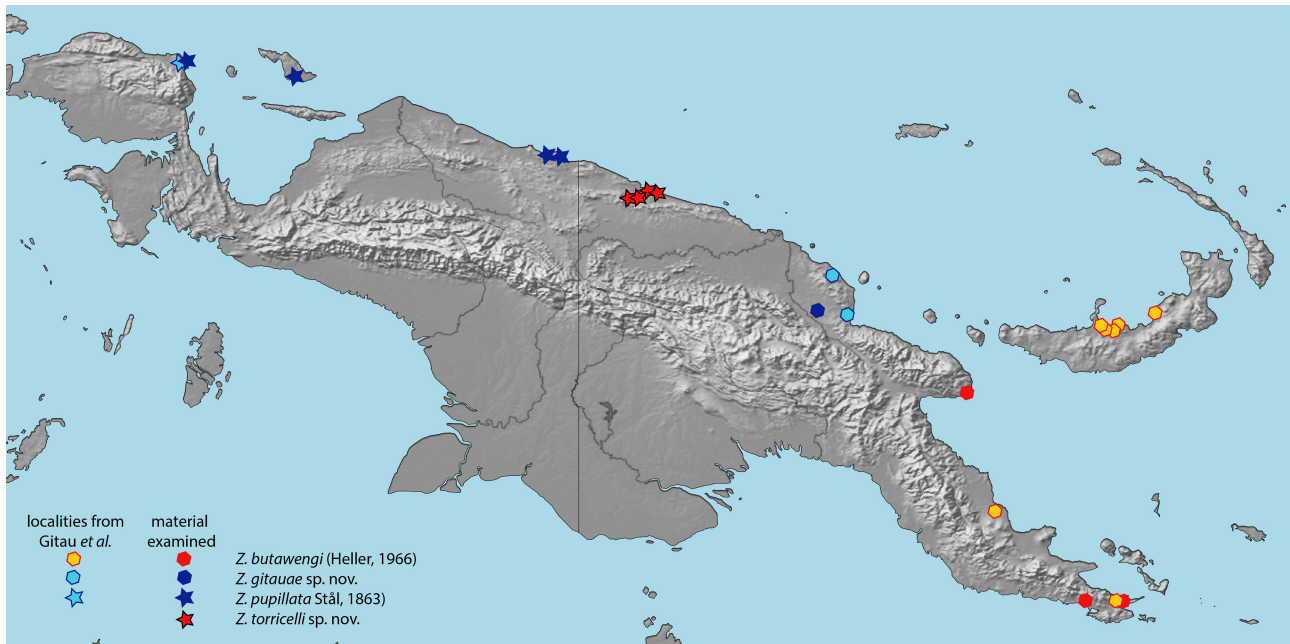


FIGURE 44. *Zophiuma* sp. distribution map.

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