

A taxonomic treatment of *Synopeas* Förster (Platygastridae, Platygastrinae) from the island of New Guinea

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Abstract

Synopeas from New Guinea is revised, including 16 new species and four previously named species. The concepts for these species were developed in conjunction with a CO1 analysis that includes 16 New Guinean species and 3 *Synopeas* species from other regions. The molecular analysis determined that the New Guinea fauna does not form a clade, indicating multiple migrations. The following species are described and keyed: *S. amandae* Awad, **sp. nov.**; *S. anunu* Awad, **sp. nov.**; *S. butterilli* Buhl; *S. codex* Awad, **sp. nov.**; *S. csozi* Buhl; *S. kalubia* Awad, **sp. nov.**; *S. kiki* Awad, **sp. nov.**; *S. kira* Awad, **sp. nov.**; *S. klingunculum* Awad, **sp. nov.**; *S. luli* Awad, **sp. nov.**; *S. occultum* Awad, **sp. nov.**; *S. pattiae* Awad, **sp. nov.**; *S. psychotriae* Buhl; *S. pterocarpi* Buhl; *S. pulupulu* Awad, **sp. nov.**; *S. roncavei* Awad, **sp. nov.**; *S. sanga* Awad, **sp. nov.**; *S. toto* Awad, **sp. nov.**; *S. valavala* Awad, **sp. nov.**; *S. zhangi* Awad, **sp. nov.** *Leptacis pleuralis* (Buhl), **comb. nov.** is transferred from *Synopeas*. Images of 56 holotypes of *Synopeas* are made publicly available online.

Keywords

Cecidomyiidae, CO1 barcoding, galls, Papua New Guinea, parasitoid wasps, Platygastroidea, taxonomy

Introduction

Synopeas Förster, 1856, is one of the largest genera in Platygasteridae (sensu Masner and Huggert 1989; Talamas et al. 2019) with 378 described species (Hymenoptera Online 2019). It is found worldwide and is commonly collected in all habitats where platygasterids are present. However, *Synopeas* has never been revised and the existing keys to species are few in number and limited in scope. Past taxonomic work was often based upon simple measurements of one or few specimens, and most descriptions lack thorough illustrations. Thus, there is a need for imaging and redescription of type specimens for the worldwide fauna. Additionally, molecular data is unavailable for most *Synopeas* species. The BOLD database has records for only four identified species of *Synopeas*. Ecological data is also rare, as most species have been described from adult specimens caught by net or trap and host or plant associations are available for only 42 species. Species of *Synopeas*, like other Platygasterinae, are known to be obligate primary endoparasitoids of gall midges (Diptera: Cecidomyiidae). Female wasps oviposit in eggs or early first instars of the host. The parasitoid development is delayed until later host instars, at which point it proceeds rapidly (Abram et al. 2012).

The previously described *Synopeas* species of Papua New Guinea can be traced to three collecting events: the voyage of the *Noona Dan* in 1961–1962 (Wolff 1963; Buhl 1997); a visit to Mt. Wilhelm by the Hungarian acarologist János Balogh in 1968 (Dózsa-Farkas 2003; Buhl 2004); and the extensive rearing work of Philip Butterill in 2010–2012. Of these, only Balogh and Butterill sampled the island of New Guinea.

The *Noona Dan* expedition was sponsored by the University of Copenhagen with a mission to collect natural history specimens and data from several Indo-Australian island groups. The Papuan *Synopeas* specimens described from the voyage were collected from the Bismarck Archipelago, off the island of New Britain. The *Noona Dan* expedition also collected *Synopeas* specimens from the Philippines and the Solomon Islands, which we examined and photographed.

Synopeas reared from galls collected in Papua New Guinea provided the basis for our study, which seeks to elevate the standard of taxonomy for Platygasteridae through the integration of morphological, molecular, and ecological data. We examined primary types of *Synopeas* described from the Philippines, Australia, New Zealand, Papua New Guinea, and Indonesia to be as thorough as possible and to avoid redescription of species that may be widespread. Images of these types are made publicly available to facilitate future work in the Australasian fauna of the genus.

The present work describes 20 species of *Synopeas* from the island of New Guinea. These include 16 new species of *Synopeas* from the Butterill collection and four previously described species from the Butterill and Balogh collections: *S. butterilli* Buhl, *S. csoszi* Buhl, *S. psychotriae* Buhl, and *S. pterocarpi* Buhl. An illustrated key to the *Synopeas* species of New Guinea is provided.

Materials and methods

Collections

This work is based on specimens deposited in the following repositories with abbreviations used in the text:

FSCA	Florida State Collection of Arthropods, Gainesville, USA
HNHM	Hungarian National History Museum, Budapest, Hungary
NHMUK	Natural History Museum, London, UK
NMINH	National Museum of Ireland – Natural History, Dublin, Ireland
RMNH	Naturalis Biodiversity Center, Leiden, Netherlands
SAMA	South Australian Museum, Adelaide, Australia
SMNS	State Museum of Natural History, Stuttgart, Germany
USNM	National Museum of Natural History, Smithsonian Institution, Washington, DC, USA
ZMUC	Natural History Museum of Denmark, Copenhagen, Denmark

Specimens

Wasps were reared as a part of two community ecology projects focused on gall-forming insects in Papua New Guinea. Sampling occurred from 2010 to 2012 in the lowland rainforests of Madang (Butterill and Novotny 2015) and in the montane rainforests of the Finisterre Mountains, Morobe Province (Butterill, unpublished data). All parasitoid specimens were reared from galls formed by Cecidomyiidae and stored in 95% ethanol. In total, we examined 249 *Synopeas* specimens (Table 1) reared from 21 plant species in 14 genera.

Holotypes of new species are deposited in USNM. Paratypes for species described here are deposited in USNM, FSCA, and SMNS (details in Suppl. material 1).

Morphological techniques

Specimens were examined with Leica M205C, Zeiss Discovery V8, and Wild M5A microscopes. Images were produced with a Macropod imaging system with a Canon EOS 6D Mark II camera, EF 70–200mm lens, and 10× and 20× M Plan APO Mitutoyo objective lenses. Microphotography software included EOS 6D Mark II camera utility and Helicon Focus Pro 6.8.0 for image stacking. Scanning electron micrographs were produced with a Phenom XL Desktop SEM using a eucentric sample holder and Phenom ProSuite software. Specimens were coated with gold-palladium using a Denton Vacuum Desk V sputter coater. Adobe Photoshop was used for addition of scale bars and post processing of both brightfield images and electron micrographs.

Table 1. Summary of *Synopeas* specimens by gall host plant identity.

Host plant family	Host plant species	Number of specimens
Actinidiaceae	<i>Saurauia conferta</i> Warb.	23
	<i>Saurauia schumanniana</i> Diels	2
Elaeocarpaceae	<i>Elaeocarpus dolichostylus</i> Schltr.	1
Euphorbiaceae	<i>Homalanthus nervosus</i> J.J.Sm.	1
	<i>Macaranga strigosa</i> Pax & K.Hoffm.	9
Loganiaceae	<i>Neuburgia corynocarpa</i> (A.Gray) Leenh.	22
Monimiaceae	<i>Palmeria</i> sp.	2
Moraceae	<i>Ficus adenosperma</i> Miq.	2
Myristicaceae	<i>Paramyristica</i> cf. <i>sepicana</i> (Foreman) W.J. de Wilde	2
Myrtaceae	<i>Syzygium decipiens</i> (Koord. and Valetton) Merr. and L.M.Perry	4
Piperaceae	<i>Piper amboinense</i> (Miq.) C.DC.	14
	<i>Piper celtidiforme</i> Opiz	3
	<i>Piper macropiper</i> Pennant	5
	<i>Piper</i> sp.	1
Rubiaceae	<i>Nauclea tenuiflora</i> (Havil.) Merr.	22
	<i>Nauclea</i> sp. 1	99
	<i>Psychotria ramuensis</i> Sohmer	2
Urticaceae	<i>Cypholophus friesianus</i> (K.Schum.) H.J.P.Winkl.	12
	<i>Cypholophus macrocephalus</i> (Blume) Wedd.	3
	<i>Cypholophus</i> sp. 1	18
	<i>Debregeasia longifolia</i> (Burm.f.) Wedd.	2
Total	14 genera	249

Molecular techniques

DNA extraction was performed using a non-destructive protocol adapted for microhymenoptera (Sabbatini Peverieri et al. 2018). DNA extracts were quantified with a NanoDrop 2000 spectrophotometer (Thermo Fisher Scientific, Waltham, MA) and PCRs had a target input of at least 20 ng of genomic DNA. PCRs were performed using a KAPA HiFi HotStart PCR Kit (Kapa Biosystems, Wilmington, MA). PCRs were 25 µL in total volume. The standard 5'-CO1 barcode region was targeted for each species using the primer pairs LCO1490/HCO2198 (Folmer et al. 1994) or LEPF1/LEPR1 (Hebert et al. 2004). Thermocycles were as follows: 1) initial denaturing at 95 °C for 2 min; 2) 98 °C for 30 sec; 3) 50 °C for 30 sec; 4) 72 °C for 40 sec [32 cycles of steps 2–4]; and 5) a final extension at 72 °C for 7 min. PCR amplicons were visualized on 1.5% agarose gels. Positive PCR amplicons were purified using the QIAGEN QIAquick PCR Purification Kit (QIAGEN Group, Hilden, Germany) and prepared for sequencing with BigDye Terminator v3.1 chemistry. Sequence chromatograms were trimmed and assembled in Sequencher 5.4.6 (2016). New CO1 barcodes were submitted to Genbank (Suppl. material 2).

CO1 gene sequences were aligned using the default settings of MUSCLE (Edgar 2004) as implemented in MEGA7 (Kumar et al. 2016). Specimens of *Inostemma* Haliday and *Platygaster* Latreille were selected as outgroups based on an unpublished phylogeny of the family. For geographic reference, the analysis included *Synopeas* specimens from Myanmar, the United Kingdom, and the United States. The resulting alignment included 75 terminal taxa (70 *Synopeas*) and was 655 bp in length. Neigh-

bor-joining trees were constructed using the K2P model (Kimura 1980) with partial deletion of missing data and a site coverage cutoff of 95%. Node support was assessed using 10,000 bootstrap replicates. The resulting tree topology was manipulated in FigTree v1.4.3 (Rambaut 2012) to aesthetically arrange nodes and collapse terminal clusters. The tree was further edited in Adobe Illustrator. CO1 barcodes were queried to the Barcode of Life Database (BOLD) (Ratnasingham and Hebert 2007) in search of high-similarity matches.

Aligned sequences were also evaluated in IQ-TREE 2.1.1 (Nguyen et al. 2015). ModelFinder (Kalyaanamoorthy et al. 2017) was used to select the best substitution model, which was TIM+F+I+G4 based on the Bayesian Information Criterion. Maximum likelihood tree reconstruction was inferred based on 1000 ultrafast bootstrap replicates (Minh et al. 2013). The resulting tree was edited in Adobe Illustrator.

Descriptions

Character matrices of morphological data were constructed using the online program vSysLab (<https://vsyslab.osu.edu/>). Names were assigned to specimens by comparison to holotypes of species from Australasia, Indonesia, and the Philippines (Table 2). If no matching types were found, species were described as new.

Results

Character discussion

Clypeal setae

All specimens of *Synopeas* examined had four clypeal setae, which may be a stable character across the genus (Figure 1). Occasionally two setae may arise from a common base, bringing the total number of setae to five. The relative lengths of the medial two setae to the lateral pair of setae can be helpful in identification, as can the relative distance between the medial and lateral setae. In many species, the medial pair of setae are distinctly longer than the lateral setae (Figure 1A). Some species have the medial pair of setae closer to each other than to the lateral setae (Figure 1B), while others have the four setae evenly spaced (Figure 1C). In *S. zhangii*, the medial setae are closer to the lateral setae than to each other.

Lateral ocellar depression

Some species of *Synopeas* bear a distinct furrow or pit between the lateral ocellus and the compound eye (Figure 16D).

Table 2. Species of *Synopeas* described from Australasia, Indonesia, and the Philippines.

Species	Year	Type locality	Holotype location	Host plant genus	Images of primary type (DOI)
<i>S. isus</i> (Walker)	1839	Tasmania	NHMUK		
<i>S. leda</i> (Walker)	1839	Tasmania	NHMUK		
<i>S. idarniforme</i> (Dodd)	1916	Australia	SAMA		https://doi.org/10.5281/zenodo.4503382
<i>S. saccharale</i> (Dodd)	1916	Australia	SAMA	<i>Saccharum</i>	https://doi.org/10.5281/zenodo.4503406
<i>S. decumbens</i> Buhl	1997	Papua New Guinea	ZMUC		https://doi.org/10.5281/zenodo.4501922
<i>S. lemkinensis</i> Buhl	1997	Papua New Guinea	ZMUC		https://doi.org/10.5281/zenodo.4501952
<i>S. saintexuperyi</i> Buhl	1997	Papua New Guinea	ZMUC		https://doi.org/10.5281/zenodo.4501968
<i>S. ventricosum</i> Buhl	1997	Papua New Guinea	ZMUC		https://doi.org/10.5281/zenodo.4501974
<i>S. acutiventris</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4503063
<i>S. balabacensis</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4503179
<i>S. crassiceps</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4503402
<i>S. luteolipes</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4503726
<i>S. montanum</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4503804
<i>S. mukerjeei</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4503979
<i>S. palawanense</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4504012
<i>S. pallescens</i> Buhl	1997	Philippines	ZMUC		https://doi.org/10.5281/zenodo.4504064
<i>S. csoszi</i> Buhl	2004	Papua New Guinea	HNHM		https://doi.org/10.5281/zenodo.4502781
<i>S. pleuralis</i> Buhl	2004	Australia	HNHM		https://doi.org/10.5281/zenodo.4502881
<i>S. queenslandicus</i> Buhl	2004	Australia	HNHM		https://doi.org/10.5281/zenodo.4503338
<i>S. achterbergi</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503326
<i>S. ciliaris</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503318
<i>S. flavispinum</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503314
<i>S. halmaherense</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503235
<i>S. infuscatus</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503181
<i>S. lombokensis</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503152
<i>S. longulum</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503105
<i>S. nigricoxum</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503038
<i>S. praemorsum</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4503000
<i>S. quasimodo</i> Buhl	2008	Indonesia	RMNH		https://doi.org/10.5281/zenodo.4502953
<i>S. dumogabonense</i>	2009	Indonesia	NMINH		https://doi.org/10.5281/zenodo.4502004
<i>S. masneri</i> Buhl	2009	Indonesia	NMINH		https://doi.org/10.5281/zenodo.4563030
<i>S. mineoi</i> Buhl	2009	Indonesia	NMINH		https://doi.org/10.5281/zenodo.4539460
<i>S. butterilli</i> Buhl	2013	Papua New Guinea	USNM	<i>Paramyristica</i>	https://doi.org/10.5281/zenodo.4501840
<i>S. psychotriae</i> Buhl	2013	Papua New Guinea	USNM	<i>Psychotria</i>	https://doi.org/10.5281/zenodo.4501681
<i>S. pterocarpus</i> Buhl	2013	Papua New Guinea	USNM	<i>Pterocarpus</i>	https://doi.org/10.5281/zenodo.4501868
<i>S. alternatum</i> Buhl	2014	Australia	ZMUC		https://doi.org/10.5281/zenodo.4501898
<i>S. bangmadseni</i> Buhl	2014	Australia	ZMUC		https://doi.org/10.5281/zenodo.4501912
<i>S. carlseni</i> Buhl	2014	Australia	ZMUC		https://doi.org/10.5281/zenodo.4503302
<i>S. eucalypti</i> Buhl	2014	Australia	ZMUC		https://doi.org/10.5281/zenodo.4503566
<i>S. salicorniae</i> Buhl	2014	Australia	ZMUC		https://doi.org/10.5281/zenodo.4504104
<i>S. striolagaster</i> Buhl	2014	Australia	ZMUC		https://doi.org/10.5281/zenodo.4504394
<i>S. triangulum</i> Buhl	2014	Australia	ZMUC		https://doi.org/10.5281/zenodo.4563047

Epomial carina

In the *Synopeas* species examined in this study, the epomial carina originates next to a pit at the anterodorsal end of the pronotal cervical sulcus (Figure 2). When complete, it extends to the dorsal margin of the pronotum. Occasionally, there is a pit posterior to the dorsal terminus of the carina, as in *S. klingunculum* (Figure 2A). The carina may be entirely absent (Figure 2B), dorsally weakened or incomplete.

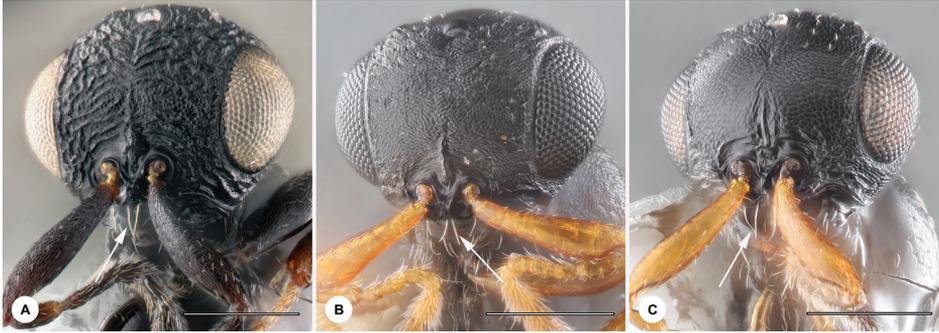


Figure 1. Arrangement of clypeal setae in *Synopeas* **A** *S. anunu* (FSCA 00090255) **B** *S. amandae* (FSCA 00000323) **C** *S. luli* (FSCA 00090412). Scale bars: 0.2 mm.

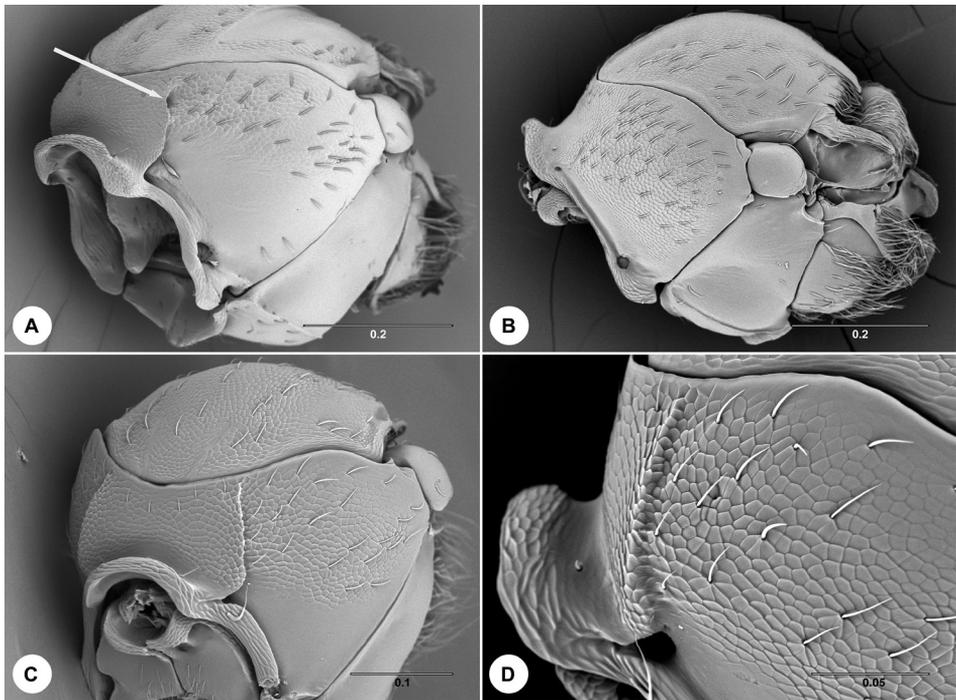


Figure 2. Epomial carina in *Synopeas* **A** *S. klingunculum* (FSCA 00000237) **B** *S. codex* (FSCA 00000310) **C** *S. toto* (FSCA 00000258) **D** *S. toto* (FSCA 00000258). Scale bars in mm.

Mesoscutellar spine

The shape of the mesoscutellar spine has historically been used as a species-level diagnostic character for *Synopeas*. However, there is some intraspecific variation, so it should not be solely relied upon for species diagnosis. The three categories used in this revision are: absent or inconspicuous (Fig 3A–C), short and pointed (Figure 3D–F), and long and blunt (Figure 3G, H).



Figure 3. Morphology of the mesoscutellar spine in *Synopeas* **A** *S. codex* (FSCA 00034030) **B** *S. amandae* (FSCA 00000403) **C** *Synopeas* sp. (FSCA 00000413) **D** *S. occultum* (FSCA 00090403) **E** *S. luli* (FSCA 00000334) **F** *S. butterilli* (FSCA 00090264) **G** *S. klingunculum* (FSCA 00000376) **H** *S. anunu* (FSCA 00090255) **I** *S. kira* (FSCA 00000398).

Margin of lateral propodeal carina in lateral view

In *Synopeas*, as in most Platygasteridae, the dorsal propodeum bears a pair of “keels” or well-developed carinae (Fig. 4), which are relatively close together. The margin of these carinae may be evenly rounded (Fig. 4B), or pointed dorsally (Fig. 4A, C), ventrally, or both. In some species not treated here, the carinae are relatively elongate and postero-dorsally flattened. This character can be difficult to interpret and the states require further refinement. The ventral margin of the carinae may be obscured by setae (Fig. 4D).

Mesoscutal lamella

The mesoscutal lamella is a posteromedial extension of the mesoscutum (Fig. 5). Typically, it has a line of setae on either side along the posterior margin of the mesoscutum.

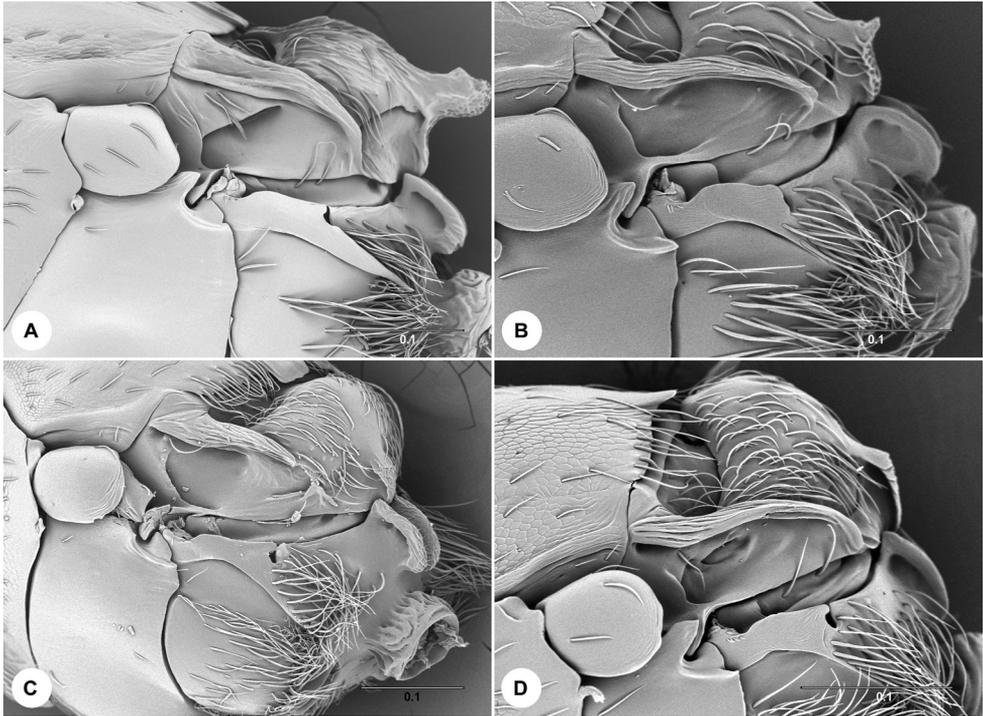


Figure 4. Margin of lateral propodeal carinae **A** *S. klingunculum* (FSCA 00000237) **B** *S. toto* (FSCA 00000258) **C** *S. codex* (FSCA 00000310) **D** *S. valavala* (FSCA 00000259). Scale bars in mm.

The mesoscutal lamella may be rounded (Fig. 5B), square (Fig. 5D), truncate (Fig. 5F), or roughly triangular (Fig. 5H). A broad mesoscutal lamella does not extend further than its own width beyond the posterior mesoscutal margin (Fig. 5B). A narrow mesoscutal lamella extends further than its own width beyond the posterior mesoscutal margin (Fig. 5A).

Microsculpture of S2 and T2

In most species, the presence of sculpture is absent or restricted to a narrow band on the posterior margins of S2 (Fig. 6) and T2 (Fig. 7). However, in some species, the sculpture is more extensive (Figs 6A–D, 7A, C) and the length and shape of the sculpture can be diagnostic. Here, a “long” band of sculpture on S2 or T2 is defined as an extensive area as long as or longer than S3 or T3, respectively. The length of the band is measured in an anterior-posterior direction.

Linea setosa

The setae on the forewing disc vary in density and arrangement (Fig. 8). The wings of some species are uniformly setose (Fig. 8B). In others, the wing is proximally glabrous, with or without a linea setosa. The linea setosa is a novel term that we use for a curved



Figure 5. Mesoscutal lamella in *Synopeas* **A** *S. sanga* (FSCA 00000361) **B** *S. luli* (FSCA 00000334) **C** *S. valavala* (FSCA 00000350) **D** *S. codex* (FSCA 00034030) **E** *S. zhangii* (FSCA 00000383) **F** *S. klin-gunculum* (FSCA 00000411) **G** *S. kalubia* (FSCA 00000344) **H** *S. kira* (FSCA 00090416) **I** undescribed species (FSCA 00034033). Scale bars: 0.2 mm.

line of setae at the base of the forewing against a glabrous or sparsely setose background (Fig. 8C). It is thus the inverse of a linea calva, which is a glabrous line against a setose background. The linea setosa cannot be observed on a wing that is uniformly and densely setose.

Forewing marginal setae

Most *Synopeas* lack a long fringe of marginal setae at the posterior margin of the forewing, as is often seen in the closely related *Leptacis*. However, some *Synopeas* species have relatively short marginal setae on the anterior and posterior margins of the forewing, and the relative lengths of these setae are a useful character. In the species treated here, the setae on the posterior margin may be equal to (Fig. 8A) or longer than those on the anterior margin of the forewing (Fig. 8B–D).

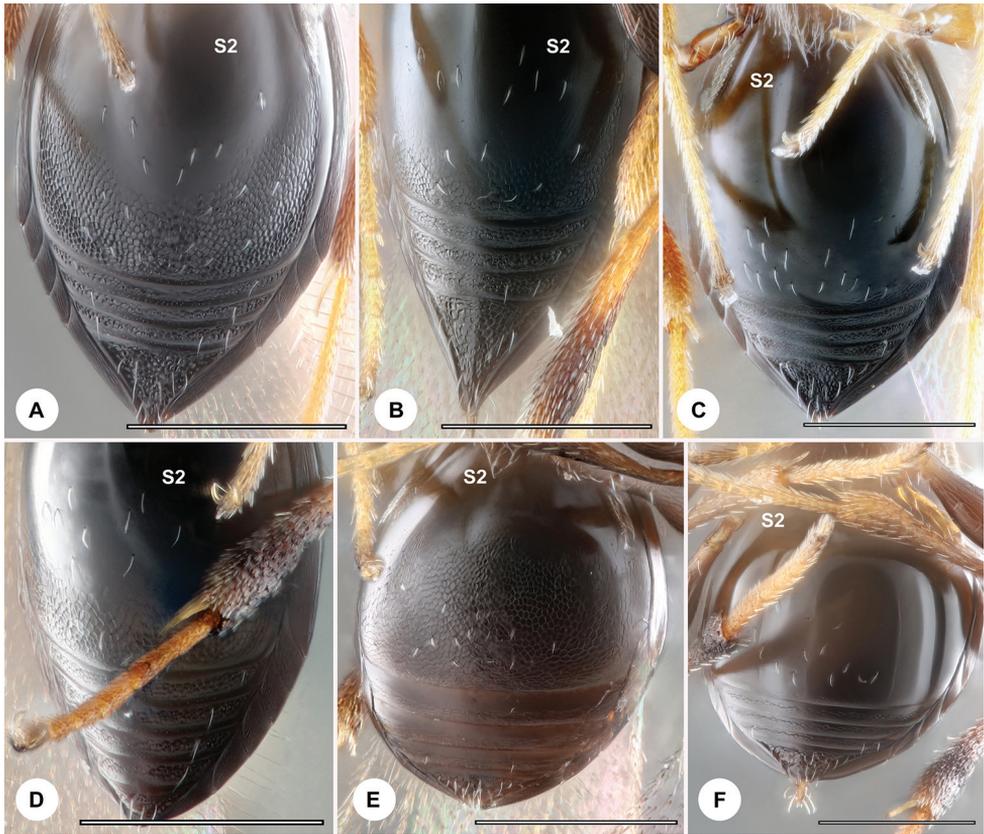


Figure 6. Sculpture of metasomal sternite 2 **A** *S. sanga* (FSCA 0000399) **B** *S. occultum* (FSCA 00090403) **C** *S. roncavei* (FSCA 00090249) **D** *S. kira* (FSCA 0000398) **E** *S. codex* (FSCA 00034030) **F** *S. luli* (FSCA 00090412). Scale bars: 0.2 mm.

Limits of *Synopeas*

Among the Platygasterinae, *Leptacis* and *Synopeas* (*Synopeadini sensu* Kozlov 1970) are characterized by having the lateral propodeal carinae close together, often with an elongate mesoscutellum forming a spine, and sparse to dense setae around the junction of T1 and T2. Masner (1960) differentiated the two genera by the shape and setation of T1 and the length of forewing marginal setae. Jackson (1969) found the fusion of T1 and T2 (Fig. 9A) to be a principal synapomorphy of *Synopeas*, separating it from *Leptacis*. He also described a deep depression in the anteroventral corner of the pronotum, or ventral pronotal pit, which is present in *Synopeas* (Fig. 9B) and absent in *Leptacis*.

We here follow Jackson's concept of *Synopeas*. The length of the forewing marginal setae is not always a reliable character for generic separation. On this basis, *Leptacis pleuralis* (Buhl, 2004), comb. nov., (Fig. 10) is transferred from *Synopeas*. Although *L. pleuralis* has very short forewing marginal setae like many *Synopeas* species, the structure of the metasoma and lack of a ventral pronotal pit lead us to place it in *Leptacis*.

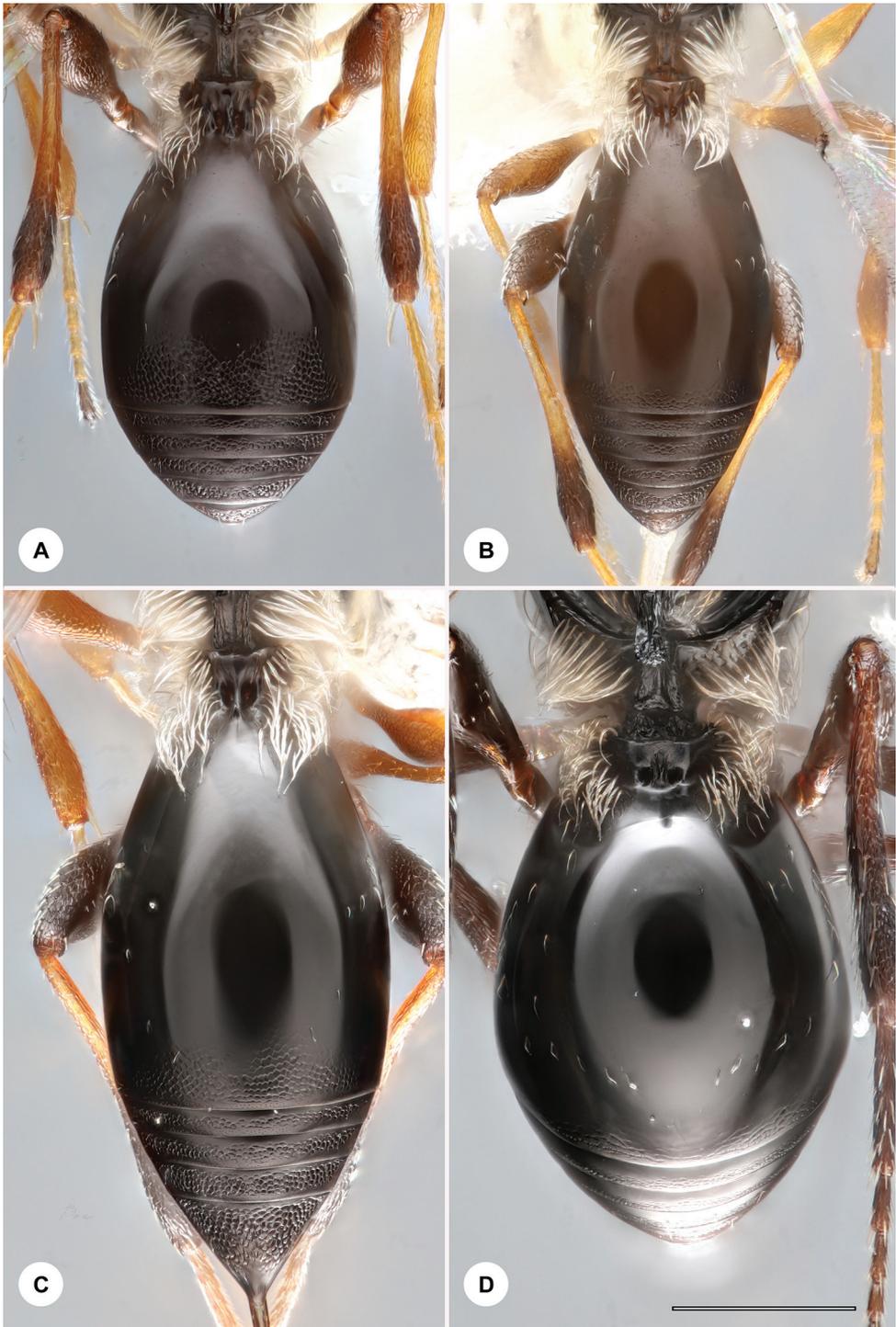


Figure 7. Sculpture of metasomal tergite 2 **A** *S. sanga* (FSCA 00094615) **B** *S. occultum* (FSCA 00094465) **C** *S. kira* (FSCA 00090258) **D** *S. klingunculum* (FSCA 00000411). Scale bar: 0.2 mm.

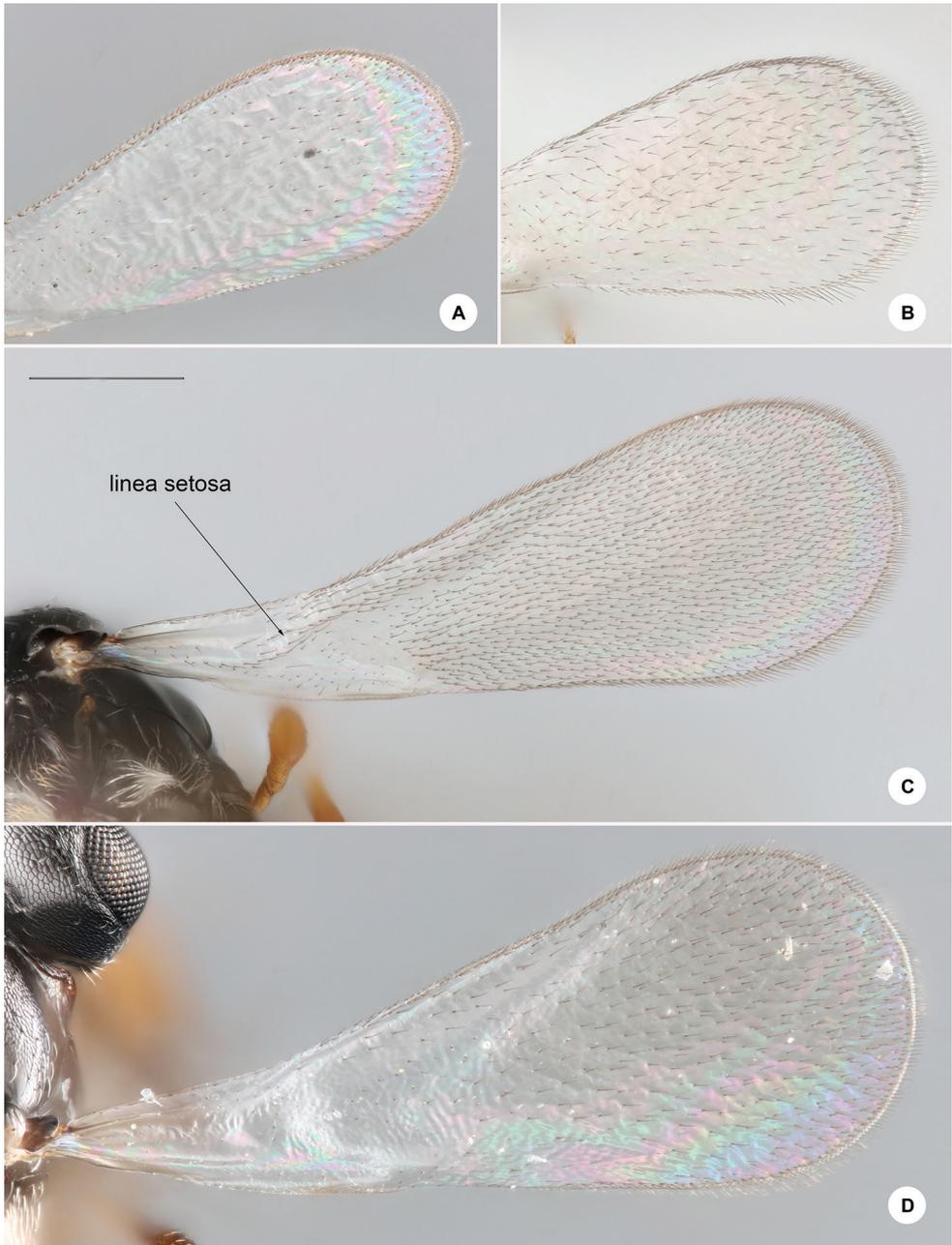


Figure 8. Forewing of *Synopeas* **A** *S. butterilli* (FSCA 00090264) **B** *S. kiki* (FSCA 00090410) **C** *S. roncavei* (FSCA 00094606) **D** *S. luli* (FSCA 00094549). Scale bar: 0.2 mm.

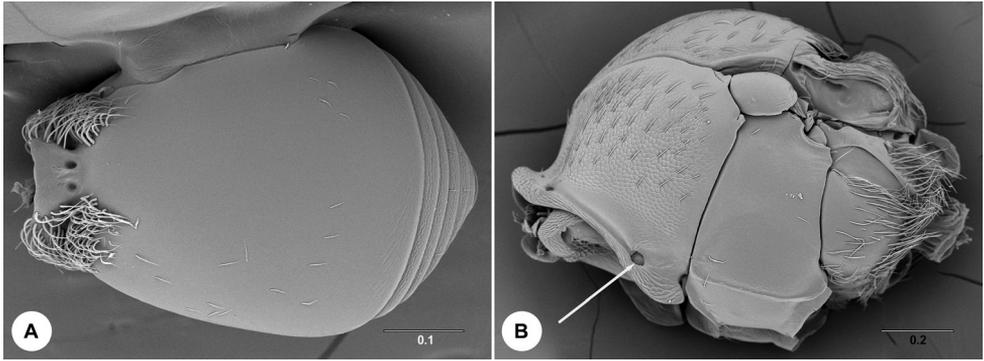


Figure 9. Generic characters for identification of *Synopeas* **A** Fusion of T1 and T2 in *S. klingunculum* (FSCA 00000237) **B** Ventral pronotal pit in *S. codex* (FSCA 00000310).



Figure 10. *Leptacis pleuralis* (Buhl), comb. nov. Inset: anterior metasoma. Scale bar: 0.5 mm.

Key to the species of *Synopeas* of New Guinea (females)



Figure 11. Lateral habitus **A** *S. coszi* **B** *S. occultum* (FSCA 00090403).

- 1 T2 longer than the head and mesosoma combined (Fig. 11A) *Synopeas coszi* Buhl
- T2 equal to or less than length of head and mesosoma combined (Fig. 11B).... 2

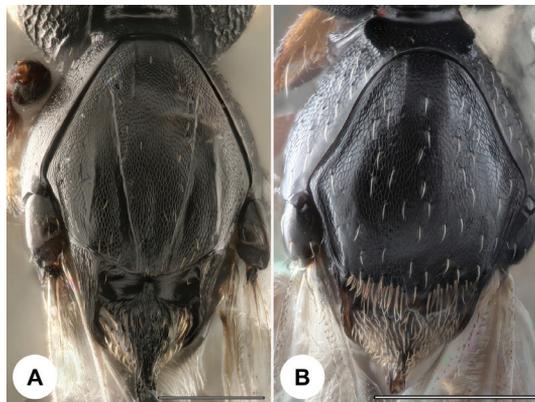


Figure 12. Dorsal mesoscutum and mesoscutellum **A** *S. anunu* (FSCA 00090255) **B** *S. occultum* (FSCA 00090403). Scale bars: 0.2 mm.

- 2 Notaulus distinctly grooved (Fig. 12A); mesoscutellar spine distinct and conspicuous; lateral portion of frons with rugose macrosculpture 3
- Notaulus unmarked or faintly suggested (Fig. 12B); mesoscutellar spine variable; lateral portion of frons without rugose macrosculpture 4

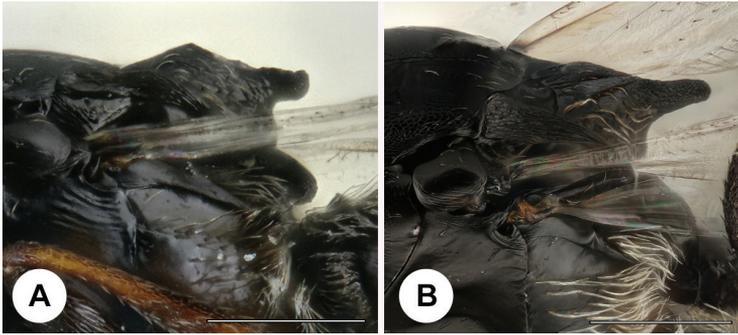


Figure 13. Mesoscutellar spine **A** *S. klingunculum* (FSCA 00000376) **B** *S. anunu* (FSCA 00090255). Scale bars: 0.2 mm.

- 3 Length of mesoscutellar spine only slightly greater than its thickness in lateral view; lateral pronotum with microsculpture dorsally, smooth ventrally, with smooth band anterior to tegula (Fig. 13A); pit present posterior to dorsal terminus of epomial carina..... *Synopeas klingunculum* sp. nov.
- Length of mesoscutellar spine more than twice its thickness at its midpoint; lateral pronotum with microsculpture dorsally, smooth ventrally (Fig. 13B); without pit near dorsal terminus of epomial carina..... *Synopeas anunu* sp. nov.

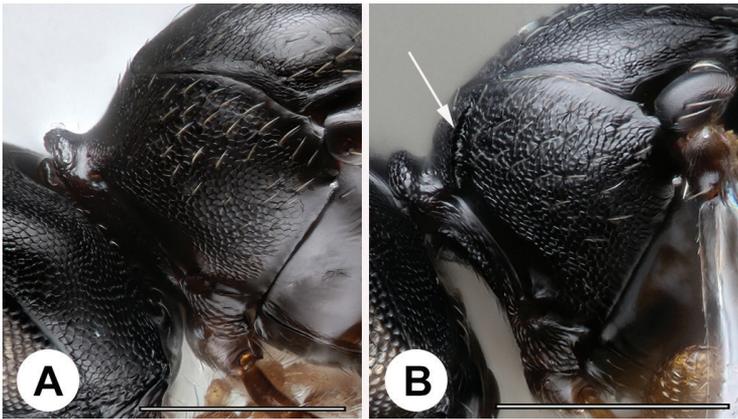


Figure 14. Lateral pronotum **A** *S. codex* (FSCA 00034030) **B** *S. amandae* (FSCA 00000403). Scale bars: 0.2 mm.

- 4 Epomial carina absent or reduced, extending less than halfway up pronotum (Fig. 14A) *Synopeas codex* sp. nov.
- Epomial carina distinct and extending more than halfway up pronotum (Fig. 14B) 5

- 5 Mesoscutellar spine absent or inconspicuous (Fig. 3A–C) 6
- Mesoscutellar spine present, with variable form, often long or pointed (Fig. 3D–I) 9

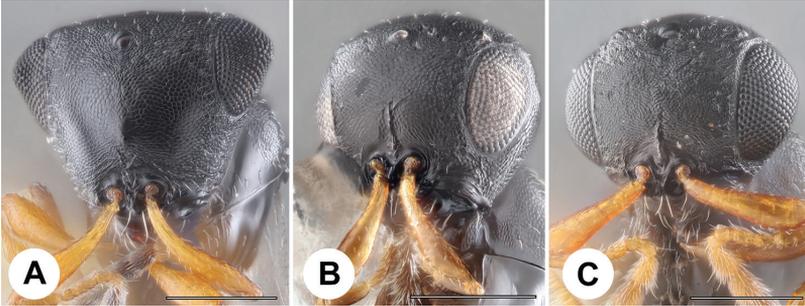


Figure 15. Frontal head **A** *S. valavala* (FSCA 00033890) **B** *S. codex* (FSCA 00034030) **C** *S. amandae* (FSCA 00000323). Scale bars 0.2 mm.

- 6 Head large and triangular in anterior view (Fig. 15A); dorsal margin of compound eyes nearly colinear with vertex; length of malar space about equal to height of compound eye *Synopeas valavala* sp. nov.
- Head circular or ovoid in anterior view (Fig. 15B, C); dorsal margin of compound eyes not colinear with vertex; length of malar space less than height of compound eye 7

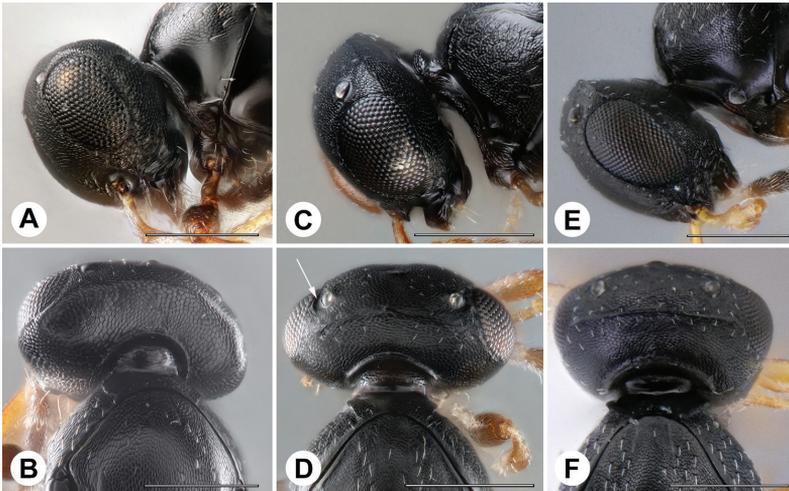


Figure 16. Lateral and dorsal head **A** *S. zhangii* (FSCA 00000291) **B** *S. zhangii* (FSCA 00000383) **C** *S. amandae* (FSCA 00000403) **D** *S. amandae* (FSCA 00000403) **E** *S. pterocarpi* (USNMENT01335974) **F** *S. pterocarpi* (USNMENT01335974). Scale bars: 0.2 mm.

- 7 Hyperoccipital carina absent or very weak (Fig. 16A, B); head in frontal view ovoid, distinctly wider than high..... *Synopeas zhangii* sp. nov.
- Hyperoccipital carina present and complete (Fig. 16C–F); head in frontal view circular to ovoid..... 8

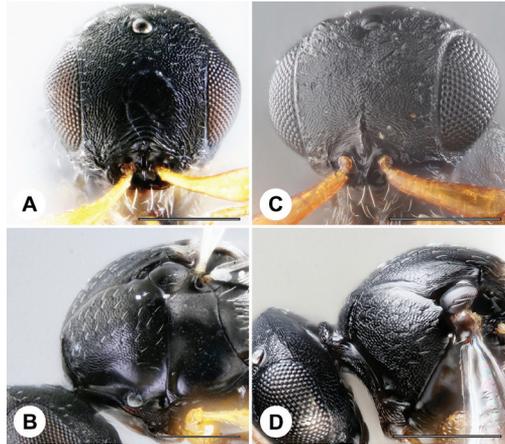


Figure 17. Frons and lateral pronotum **A** *S. pterocarpi* (USNMENT01335974) **B** *S. pterocarpi* (USNMENT01335974) **C** *S. amandae* (FSCA 00000323) **D** *S. amandae* (FSCA 00000403). Scale bars: 0.2 mm.

- 8 Frons with parallel, arched rugae above torulus; clypeal setae evenly spaced; lateral pronotum without microsculpture in ventral third (Fig. 17A, B) *Synopeas pterocarpi* Buhl
- Frons without parallel, arched rugae (but may have minute, irregular epiclypeal rugulae); median pair of clypeal setae closer to each other than to lateral setae; lateral pronotum with microsculpture throughout or with narrow smooth area at ventral apex (Fig. 17C, D)..... *Synopeas amandae* sp. nov.
- 9 Mesoscutellar spine long and blunt (Fig. 3G–I) 10
- Mesoscutellar spine short and pointed (Fig. 3D–F)..... 11

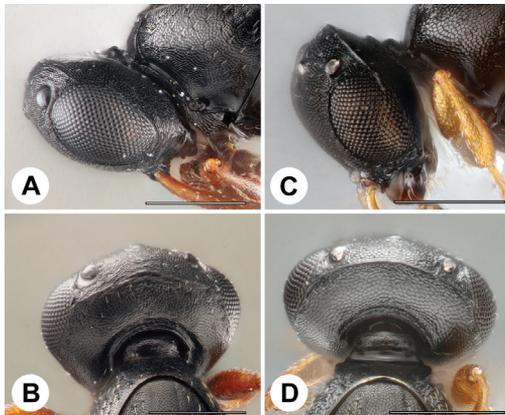


Figure 18. Lateral and dorsal head **A** *S. kalubia* (FSCA 00000344) **B** *S. kalubia* (FSCA 00000344) **C** *S. kira* (FSCA 00000398) **D** *S. kira* (FSCA 00090258). Scale bars: 0.2 mm.

- 10 Hyperoccipital carina weakly developed and interrupted (Fig. 18A, B) *Synopeas kalubia* sp. nov.
- Hyperoccipital carina robust and complete (Fig. 18C, D)..... *Synopeas kira* sp. nov.

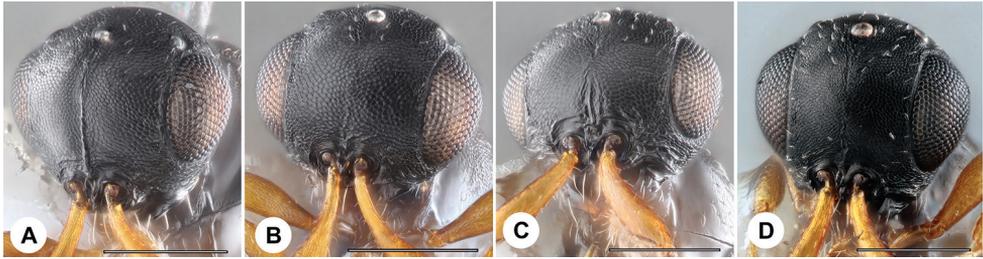


Figure 19. Central keel **A** *S. toto* (FSCA 00090421) **B** *S. sanga* (FSCA 00000399) **C** *S. luli* (FSCA 00090412) **D** *S. psychotriae* (FSCA 00090261). Scale bars: 0.2 mm.

- 11 Central keel well developed and extending to median ocellus (Fig. 19A).....
.....*Synopeas toto* sp. nov.
- Central keel absent, weakly developed, or not extending to median ocellus (Fig. 19B–D) **12**
- 12 Patch of microsculpture on posterior S2 extensive, longer than S3 (Fig. 6A, B, D, E) **13**
- S2 with no microsculpture or with very narrow band at posterior margin (Fig. 6C, F)..... **14**
- 13 T2 with extensive band of microsculpture at posterior margin that is longer than T3 (Fig. 7A).....*Synopeas sanga* sp. nov.
- T2 without microsculpture, or with narrow band at posterior margin (Fig. 7B) *Synopeas occultum* sp. nov.

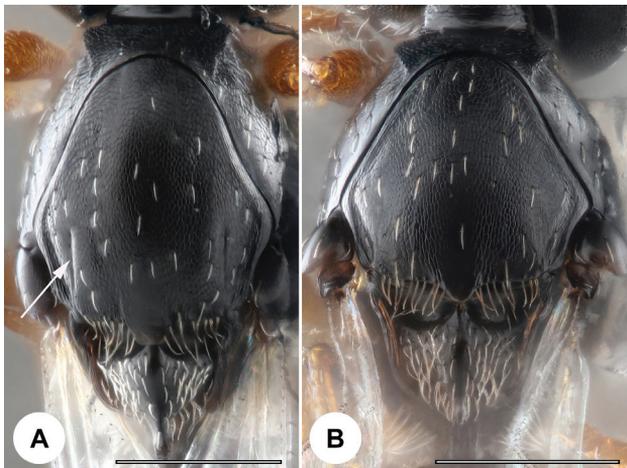


Figure 20. Dorsal mesosoma showing parapsidal lines **A** *S. psychotriae* (FSCA 00090261) **B** *S. butterilli* (FSCA 00090264). Scale bars: 0.2 mm.

- 14 Parapsidal lines well impressed (Fig. 20A); ocular-ocellar length (OOL) less than 1 ocellar diameter *Synopeas psychotriae* Buhl
- Parapsidal lines unmarked or faintly indicated (Fig. 20B); OOL variable.... **15**

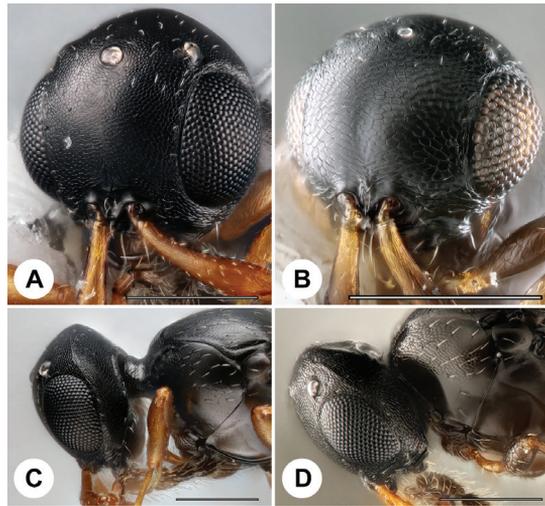


Figure 21. Head and lateral pronotum **A** *S. butterilli* (FSCA 00090264) **B** *S. kiki* (FSCA 00090410) **C** *S. butterilli* (FSCA 00090264) **D** *S. luli* (FSCA 00000334). Scale bars: 0.2 mm.

- 15 Distance between lateral ocellus and hyperoccipital carina at least 1.5 times ocellar diameter (Fig. 21A); dorsal margin of lateral pronotum smooth (Fig. 21C).....***Synopeas butterilli* Buhl**
- Distance between lateral ocellus and hyperoccipital carina less than 1.5 times ocellar diameter (Fig. 21B); dorsal margin of lateral pronotum with microsculpture (Fig. 21D)..... **16**
- 16 Hyperoccipital carina robust and complete..... **17**
- Hyperoccipital carina weak or incomplete..... **19**

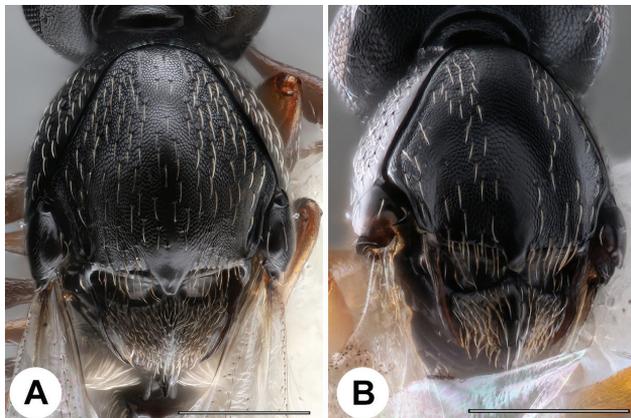


Figure 22. Setation of dorsal mesoscutum and mesoscutellum **A** *S. pulupulu* (FSCA 00090430) **B** *S. roncavei* (FSCA 00090249). Scale bars: 0.2 mm.

- 17 Mesoscutum evenly setose; mesoscutellum evenly setose (Fig. 22A) ***Synopeas pulupulu* sp. nov.**
- Mesoscutum medially glabrous or with few scattered setae; mesoscutellum medially glabrous (Fig. 22B) **18**

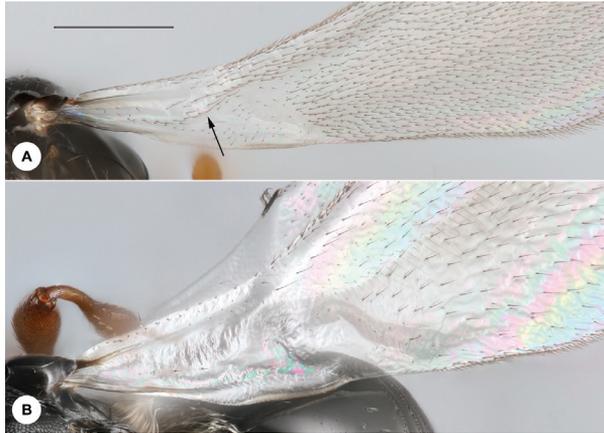


Figure 23. Setation of forewing disc including linea setosa **A** *S. roncavei* (FSCA 00094606) **B** *S. pattiae* (FSCA 00090423). Scale bar: 0.2 mm.

- 18 Forewing disc proximally glabrous with linea setosa (Fig. 23A) *Synopeas roncavei* sp. nov.
- Forewing disc without linea setosa (Fig. 23B) *Synopeas pattiae* sp. nov.

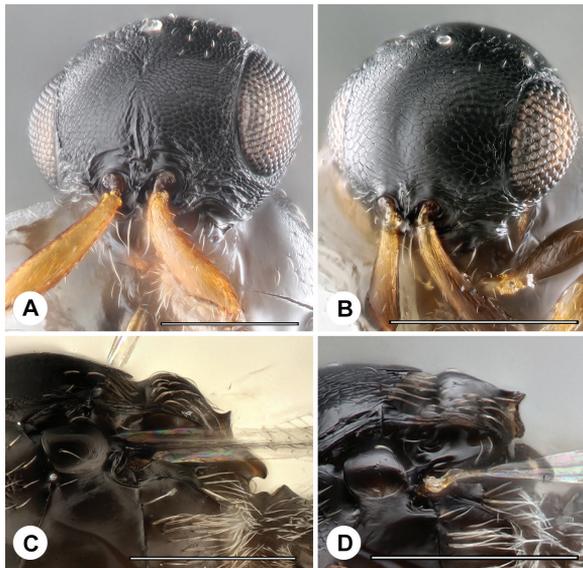


Figure 24. Head, mesoscutellum, and lateral propodeal carina **A** *S. luli* (FSCA 00090412) **B** *S. kiki* (FSCA 00090410) **C** *S. luli* (FSCA 00000334) **D** *S. kiki* (FSCA 00090410). Scale bars: 0.2 mm.

- 19 Central keel impressed or partially present only in ventral part of frons (Fig. 24A); mesoscutellar spine angled posterodorsally (Fig. 24C); posterior margin of lateral propodeal carina pointed ventrally in lateral view (Fig. 24C) *Synopeas luli* sp. nov.
- Central keel absent (Fig. 24B); mesoscutellar spine posteriorly pointed (Fig. 24D); posterior margin of lateral propodeal carina rounded ventrally in lateral view (Fig. 24D) *Synopeas kiki* sp. nov.

Descriptions

Synopeas amandae Awad, sp. nov.

<http://zoobank.org/6CFF5F61-9DF3-41FB-B243-393DA706D82F>

Description. Body length 0.9–1.25 mm. Body color: black. Color of legs: coxae brown, otherwise yellow. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: slightly ovoid. Central keel: complete; partial. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Lateral ocellar depression: present laterally. Hyperoccipital carina: complete. Hyperoccipital carina strength: laterally weakened. Distance between lateral ocellus and hyperoccipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present throughout. Lateral pronotal sculpture coverage: more than 3/4. Mesoscutellar spine: absent or inconspicuous. Posterior margin of lateral propodeal carina in lateral view: rounded. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: moderately dense. Mesoscutal lamella: broad and square. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin; approximately uniform in length on anterior and posterior margins.

Diagnosis. *Synopeas amandae* has the pronotum entirely covered with reticulate microsculpture, which is not typical among the species treated here. The absent or inconspicuous mesoscutellar spine also helps to identify it. It can be distinguished from the similar *S. codex* by the shape of the head, which is blocky in *S. codex*, and by the epomial carina, which is complete or nearly so in *S. amandae* and absent or reduced in *S. codex*.

Comments. The central keel is variable, often present only in the ventral part of the frons, but sometimes complete or nearly so, extending to the median ocellus. The length of the forewing marginal setae is only slightly longer on the posterior margin than on the anterior margin.

Etymology. This species is named in honor of the entomologist Amanda Hodges.



Figure 25. *Synopeas amandae* **A** lateral habitus (female holotype; FSCA 00000403) **B** dorsal habitus (female holotype; FSCA 00000403) **C** ventral habitus (female paratype; FSCA 00000323).

Plant associations. Reared from variously shaped galls on *Nauclea* sp. (Rubiaceae) [GALL218, GALL219, GALL223].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 16.XI.2010, Philip Butterill leg., *Nauclea* sp. 1, (FSCA 00000403). *Paratypes:* PAPUA NEW GUINEA: 7♀, Morobe, Yawan, 15.XI.2010, *Nauclea* sp. 1, (FSCA 00000037, 00000313–00000318); 2♀, Morobe, Yawan, 16.XI.2010, *Nauclea* sp. 1, (FSCA 00094594–00094595); 1♀, Morobe, Yawan, 25.XI.2010, *Nauclea* sp. 1, (FSCA 00000323); 1♀, Morobe, Yawan, 26.I.2011, *Nauclea* sp. 1, (FSCA 00000331); 6♀, Morobe, Yawan, 04.X.2012, *Nauclea* sp. 1, (FSCA 00090253, 00094584–00094588).

***Synopeas anunu* Awad, sp. nov.**

<http://zoobank.org/5596ED1E-3E87-457E-A392-97A1E8D45275>

Description. Body length 1.3–1.9 mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: distinctly ovoid. Central keel: partial. Sculpture on frons: rugose macrosculpture. Epitorular sculpture: rugose. Number of clypeal

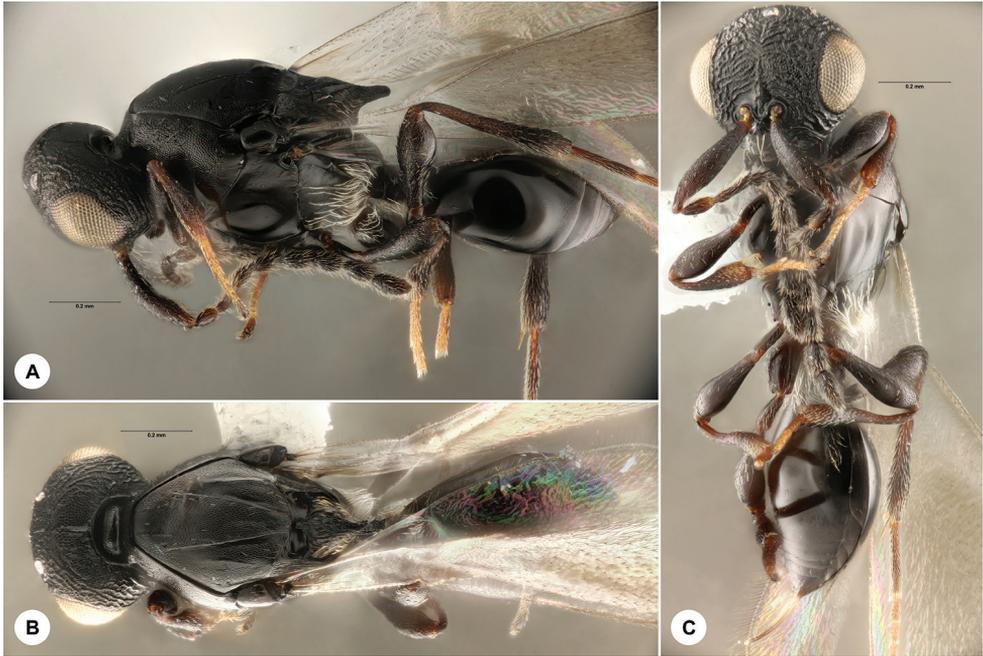


Figure 26. *Synopeas anunu* (female holotype; FSCA 00090255) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): approximately 1 ocellar diameter; greater than 1 ocellar diameter. Hyperoccipital carina: absent.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/4 to 1/2. Mesoscutellar spine: long and thick. Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: pointed dorsally and ventrally. Mesosomal dorsum in lateral view: convex. Notauli: distinctly grooved. Parapsidal lines: marked by absence of sculpture. Setation of mesoscutum: sparse. Mesoscutal lamella: truncate, with striate sculpture. Setation of mesoscutellum: present lateral to striate sculpture.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: microsculpture present in patch at posterior margin, not extending to posterolateral corners. Length of T2: shorter than mesosoma.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: moderately dense. Arrangement of setae on disc of forewing: setose distally, glabrous proximally. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. The head of this species is mostly covered in rugose macrosculpture and the notauli are distinctly grooved, characters which it shares with *S. klingunculum*.

The mesoscutellar spine of *S. anunu* is long and thick, with its length more than twice the thickness at its midpoint (Fig. 13B). *Synopeas klingunculum* has a mesoscutellar spine that is more wart-shaped, with the length only slightly greater than its thickness in lateral view (Fig. 13A). The sculpture of the lateral pronotum in *S. klingunculum* is present dorsally and absent ventrally, with a smooth band anterior to the tegula. This smooth band is lacking in *S. anunu*. Additionally, the epomial carina of *S. klingunculum* terminates posteriorly in a pit, while that of *S. anunu* does not.

Comments. The central keel is variable and difficult to discern due to the sculpture of the frons. The keel is present ventrally, and occasionally also present dorsally, just ventral to the median ocellus.

Etymology. The epithet “anunu” is Manam for “shadow” (Osmond and Ross 2016). It is applied to this species because it resembles *S. klingunculum*, being distinguishable based on the silhouette or shadow of the mesoscutellar spine. The name is to be treated as a noun in apposition.

Plant associations. Reared from a vein swelling gall on *Nauclea* sp. (Rubiaceae) [GALL217].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 30.XI.2010, Philip Butterill leg., *Nauclea* sp. 1 (FSCA 00090255). *Paratypes:* PAPUA NEW GUINEA: 1♀1♂, Morobe, Yawan, 6.14141°S, 146.87415°E, 30.XI.2010, Philip Butterill leg., *Nauclea* sp. 1 (FSCA 00094589–00094590).

Synopeas butterilli Buhl, 2013

Description. Body length 1.3 mm. Body color: black. Color of legs: coxae brown, otherwise yellow. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: circular. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: evenly spaced; medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: greater than 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present medially, absent ventrally and dorsally. Lateral pronotal sculpture coverage: 1/4 to 1/2. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly; angled posterodorsally. Posterior margin of lateral propodeal carina in lateral view: rounded. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: short, projecting less than its width beyond margin; broad and rounded. Setation of mesoscutellum: laterally dense, medially sparse.

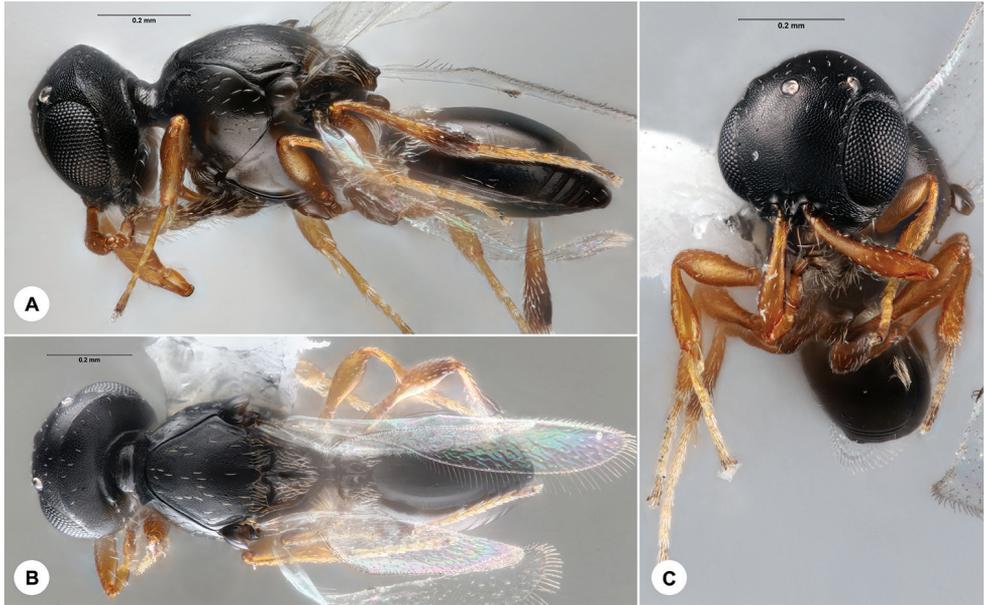


Figure 27. *Synopeas butterilli* (male specimen; FSCA 00090264) **A** lateral habitus **B** dorsal habitus **C** anteroventral habitus.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: sparse. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: approximately uniform in length on anterior and posterior margins.

Diagnosis. The lateral ocellus and the hyperoccipital carina are widely separated in *S. butterilli*, by approximately 1.5 ocellar diameters. The sculpture of the lateral pronotum is restricted to a narrow line medially, and the lateral pronotum is smooth dorsally and ventrally. These two characters set it apart from other species with a short, pointed mesoscutellar spine: *S. luli*, *S. occultum*, *S. roncavei*, *S. sanga*, and *S. toto*.

Comments. The female holotype and paratype of *S. butterilli* have a posterodorsally pointed mesoscutellar spine. The male specimens examined have a posteriorly pointed mesoscutellar spine. The angle of the mesoscutellar spine may be sexually dimorphic in this species, but more specimens are needed to confirm this. The central keel is present and complete, but very weak and may be difficult to see.

Plant associations. Reared from galls on *Paramyristica* cf. *sepicana* (Myricaceae). Occasionally found in the same gall as *Inostemma* sp.

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Madang, Mis 5.183°S, 145.758°E; 15.IX.2010–17.II.2011, Philip Butterill leg. *Paramyristica* sp. (US-

NMENT01335986). *Paratype*: PAPUA NEW GUINEA: ♀, Madang, Mis 5.183°S, 145.758°E; 15.IX.2010–17.II.2011; Philip Butterill leg.; *Paramyristica* sp. (US-NMENT01335984). *Other material*: ♂, Madang, Mis, 5.183°S, 145.758°E; 16.VII.2010; Philip Butterill leg. *Paramyristica* cf *sepicana*. (FSCA 00090264); ♂, Madang, Mis, 17.II.2011, *Paramyristica* cf *sepicana*. (FSCA 00090428).

***Synopeas codex* Awad, sp. nov.**

<http://zoobank.org/171B1B25-FD5B-4BA2-959D-29383A0AD0D0>

Description. Body length 1.1–1.5 mm. Body color: black; dark brown. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: blocky. Central keel: partial. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Lateral ocellar depression: present laterally. Hyperoccipital carina: present in medial third. Hyperoccipital carina strength: uniformly weak. Distance between lateral ocellus and hyperoccipital carina: greater than 1 ocellar diameter.

Mesosoma. Epomial carina: absent; present only in ventral half. Microsculpture of lateral pronotum: present throughout. Lateral pronotal sculpture coverage: more than 3/4. Mesoscutellar spine: absent or inconspicuous. Posterior margin of lateral propodeal carina in lateral view: rounded; pointed dorsally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: unmarked. Setation of mesoscutum: absent medially, present laterally. Mesoscutal lamella: broad and rounded; broad and square. Setation of mesoscutellum: absent medially.

Metasoma. Microsculpture of S2: present on posterior half. Sculpture of T2: long transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with lineae setosa. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. The shape of the head in *S. codex* is distinctly blocky in anterior view. Among the species treated here, *Synopeas codex* may be recognized by the absent or reduced epomial carina. When present, the epomial carina is short, extending less than halfway up the pronotum. S2 is covered with reticulate microsculpture on the posterior half (Fig. 6E), and there is a wide band of microsculpture at the posterior margin of dorsal T2.



Figure 28. *Synopeas codex* (female paratype; FSCA 00034030) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

Etymology. The epithet “codex” is Latin for a book or block of wood. We here used it to refer to the shape of the head in this species. The name is to be treated as a noun in apposition.

Comments. The distance between the dorsal margin of the eye and the vertex is very small, as in *S. valavala*. It thus may represent an intermediate form between the typical head shape in *Synopeas* and the extreme found in *S. valavala*. The bidentate mandibles are rather short, just meeting in the middle rather than overlapping.

Plant associations. Reared from vein swelling, globoid, pimple, and blister galls on *Nauclea* (Rubiaceae) [GALL217, GALL218, GALL222, GALL219]. One record each from *Homalanthus nervosus* (Euphorbiaceae) [GALL354] and *Ficus adenosperma* (Moraceae) [GALL318].

Material examined. Holotype: **PAPUA NEW GUINEA:** ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 26.XI.2010, Philip Butterill leg., *Nauclea* sp. 1 (FSCA 00000385). *Paratypes:* **PAPUA NEW GUINEA:** 1♀, Morobe, Yawan, 24.VII.2010, *Nauclea* sp. 1 (FSCA 00000352); ♂, Morobe, Yawan, 16.XI.2010, *Nauclea* sp. 1 (FSCA 00000374); ♀, Morobe, Yawan, 17.XI.2010, *Homalanthus nervosus*, (FSCA 00000377); ♀ 2♂, Morobe, Yawan, 25.XI.2010, *Nauclea* sp. 1 (FSCA 00034030, 00094609–00094610); ♂, Morobe, Yawan, 26.XI.2010, *Nauclea* sp. 1 (FSCA 00000386) 4♀ 4♂, Morobe, Yawan, 30.XI.2010, *Nauclea* sp. 1 (FSCA 00000380–00000382, 00000388–00000392); ♂, Morobe, Yawan, 25.I.2011, *Ficus adenosperma*, (FSCA 00090425); 3♀, Morobe, Yawan, 08.X.2012, *Nauclea tenuiflora*, (FSCA 00000310, 00034029 00094583).



Figure 29. Holotype of *Synopeas csoszi*.

Synopeas csoszi Buhl, 2004

Description. Body length 1.7–2.3 mm. Body color: brown. Color of legs: coxae brown, legs otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: distinctly ovoid. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae. Number of clypeal setae: unknown. Length of median pair of clypeal setae: unknown. Arrangement of clypeal setae: unknown. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): approximately 1 ocellar diameter. Hyperocipital carina: complete. Hyperocipital carina strength: uniformly robust. Distance between lateral ocellus and hyperocipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present anterodorsally, absent posteroventrally. Lateral pronotal sculpture coverage: unknown. Mesoscutellar spine: long and thin. Mesoscutellar spine in lateral view: pointing posteriorly. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: uncertain, absent medially, present laterally. Mesoscutal lamella: broad and rounded; roughly triangular. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: longer than head and mesosoma combined.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: approximately uniform in length on anterior and posterior margins.

Diagnosis. *Synopeas csoszi* is easily recognized by the extraordinary length of the second metasomal segment, which is longer than the head and mesosoma combined. The metasoma is narrow anteriorly, expanding posteriorly to become wider than the rest of the body at the junction between metasomal segments 2 and 3. The shape of the antennal scape is unusually expanded distally forming a club, then contracting into a narrowly curved apex (Fig. 29).

Comments. The forewing disc is setose distally and glabrous proximally, with a broad linea setosa.

Plant associations. Unknown.

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Mt. Wilhelm, alt. 3900 m, 1324.IX.1968, Janos Balogh leg. *Paratypes:* PAPUA NEW GUINEA: ♀ ♂, Mt. Wilhelm, alt. 3900 m, 1324.IX.1968, Janos Balogh leg. (deposited in HHNM).

Synopeas kalubia Awad, sp. nov.

<http://zoobank.org/39116FC3-6B13-46B8-9F78-6581B1322F1C>

Description. Body length 1.6 mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: slightly ovoid. Central keel: absent. Sculpture on frons: rugulose macrosculpture. Epitorular sculpture: minute rugulae. Number of clypeal setae: 4. Length of median pair of clypeal setae: uncertain, longer than lateral pair. Arrangement of clypeal setae: unknown. Shape of mandible: unknown. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperocipital carina: complete. Hyperocipital carina strength: medially weakened. Distance between lateral ocellus and hyperocipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present throughout. Lateral pronotal sculpture coverage: more than 3/4. Mesoscutellar spine: long and thick. Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: pointed dorsally. Mesosomal dorsum in lateral view: weakly convex. Notauli: unmarked or faintly suggested. Parapsidal lines: weakly impressed. Setation of mesoscutum: moderately dense. Mesoscutal lamella: short and narrow. Setation of mesoscutellum: laterally dense, medially sparse.



Figure 30. *Synopeas kalubia* (female holotype; FSCA 00000344) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: approximately uniform in length on anterior and posterior margins.

Diagnosis. Important characters for identifying *S. kalubia* include the weak hyperoccipital carina and the microsculpture of the lateral pronotum, which is absent only in the ventralmost portion. It can be distinguished from *S. kira* by the pattern of microsculpture on S2. In *S. kalubia*, the microsculpture is limited to a narrow band along the posterior margin that is half as long as that of *S. kira* (Fig. 6D), and *S. kira* also has a well-developed hyperoccipital carina. The notauli of *S. kalubia* are not indicated, which allows it to be easily separated from *S. klin-gunculum* and *S. anunu*.

Etymology. The epithet “kalubia” is Bariai for “barracuda” (Osmond, 2011) and refers to the streamlined appearance of this species. The name is to be treated as a noun in apposition.

Plant associations. Reared from a blister gall on *Nauclea* sp. (Rubiaceae) [GALL219].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 30.XI.2010, Philip Butterill leg., *Nauclea* sp. 1 (FSCA 00000344).

***Synopeas kiki* Awad, sp. nov.**

<http://zoobank.org/0364A60A-39EB-4402-9B16-EFADE3D120E4>

Description. Body length 0.9 mm. Body color: dark brown. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: slightly ovoid. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae. Number of clypeal setae: unknown. Length of median pair of clypeal setae: unknown. Arrangement of clypeal setae: uncertain, medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): approximately 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: medially weakened; uniformly weak. Distance between lateral ocellus and hyperoccipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present anterodorsally, absent posteroventrally. Lateral pronotal sculpture coverage: 1/4 to 1/2. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: rounded. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: long and narrow. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: absent. Sculpture of T2: absent; narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: moderately dense. Arrangement of setae on disc of forewing: unknown. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. Identification of *S. kiki* requires the use of numerous characters because it does not have any obviously distinct features. It is similar to *S. roncavei*, from which it can be separated by the development of the hyperoccipital carina, which is medially weakened in *S. kiki* and uniformly robust in *S. roncavei*. It is also similar to *S. luli*, but *S. kiki* has a posteriorly angled mesoscutellar spine and no central keel, while *S. luli* has a posterodorsally angled mesoscutellar spine and a partial central keel. The forewing of *S. luli* has setae of approximately equal length around the wing margin, while in *S. kiki*, the setae are distinctly longer on the posterior margin (Fig. 8).



Figure 31. *Synopeas kiki* (female holotype; FSCA 00090410) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

Etymology. The epithet “kiki” is Proto-Oceanic for “small” (Ross and Osmond 2016) and refers to the relatively diminutive size of this species. The name is to be treated as a noun in apposition.

Plant associations. Reared from a pimple gall on *Nauclea* sp. (Rubiaceae) [GALL222].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 25.XI.2010, Philip Butterill leg., *Nauclea* sp. 1 (FSCA 00090410).

***Synopeas kira* Awad, sp. nov.**

<https://zoobank.org/1CB11619-16D6-46B6-979A-7328DFA0204C>

Description. Body length 1.2–1.6 mm. Body color: black. Color of legs: coxae brown, otherwise yellow. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: slightly ovoid. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: evenly spaced; medial setae close-



Figure 32. *Synopeas kira* **A** lateral habitus (female paratype; FSCA 00000398) **B** dorsal habitus (female paratype; FSCA 00090258) **C** ventral habitus (female paratype; FSCA 00000398).

er to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: less than 1 ocellar diameter; approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: $1/2$ to $2/3$; $2/3$ to $3/4$. Mesoscutellar spine: long and thick. Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: pointed dorsally and ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: long and narrow; roughly triangular. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: long band at posterior margin. Sculpture of T2: long transverse band of microsculpture at posterior margin; microsculpture present in patch at posterior margin, not extending to posterolateral corners. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. *Synopeas kira* is similar to *S. kalubia*, from which it can be separated by the pattern of microsculpture at the posterior margin of S2. In *S. kira*, the sculpture forms a wide band, longer than S3 (Fig. 6D), and in *S. kalubia* it is limited to a very narrow band. The absent or faint notauli of *S. kira* enable it to be easily separated from *S. klingunculum* and *S. anunu*. *Synopeas kira* has a dorsally convex and blunt mesoscutellar spine, distinguishing it from *S. sanga* and *S. occultum*, both of which have a short, pointed mesoscutellar spine.

Comments. The arrangement of the clypeal setae is variable, with the median pair of setae either closer to each other than to the lateral setae, or with all four setae evenly spaced.

Etymology. The epithet “kira” is Manam for “stone axe” (Osmond and Ross 1998) and refers to the shape of the mesoscutellar spine. The name is to be treated as a noun in apposition.

Plant associations. Reared from galls on *Cypholophus* (Urticaceae) [GALL266, GALL428, GALL429]. One record from *Debregeasia longifolia* (Urticaceae) [GALL268].

Specimens examined. *Holotype*: PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 17.VII.2012, Philip Butterill leg., *Cypholophus macrocephalus* (FSCA 00090258). *Paratypes*: PAPUA NEW GUINEA: ♀, Morobe, Yawan, 25.XI.2010, *Debregeasia longifolia*, (FSCA 00090431); ♂, Morobe, Yawan, 25.I.2011, *Cypholophus friesianus* (FSCA 00090434); 12♀ 2♂, Morobe, Yawan, 28.III.2012, *Cypholophus* sp. 1 (FSCA 00090416, 00094498–00094501, 00094516–00094523, 00094616); 2♂, Morobe, Yawan, 29.III.2012, *Cypholophus* sp. 1 (FSCA 00000416, 00094503); 2♂, Morobe, Yawan, 10.VII.2012, *Cypholophus* sp. 1 (FSCA 00000398, 00094546); ♀ ♂, Morobe, Yawan, 17.VII.2012, *Cypholophus macrocephalus* (FSCA 00094566–00094567).

***Synopeas klingunculum* Awad, sp. nov.**

<http://zoobank.org/99E34843-09D9-4EBB-8EB4-42860C733415>

Description. Body length 1.2–1.8 mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: distinctly ovoid. Central keel: partial. Sculpture on frons: rugose macrosculpture. Epitorular sculpture: rugose. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): approximately 1 ocellar diameter. Hyperoccipital carina: interrupted medially; present in medial third; absent; obscured by sculpture. Hyperoccipital carina strength: uniformly weak. Distance between lateral ocellus and hyperoccipital carina: approximately 1 ocellar diameter; greater than 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally, smooth band anterior to tegula. Lateral pronotal sculpture coverage: 1/4 to 1/2. Mesoscutellar spine: long and thick.



Figure 33. *Synopeas klingunculum* **A** lateral habitus (female paratype; FSCA 00000376) **B** dorsal habitus (male paratype; FSCA 00000411) **C** ventral habitus (male paratype; FSCA 00000411).

Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: rounded; pointed dorsally. Mesosomal dorsum in lateral view: convex. Notauli: distinctly grooved. Parapsidal lines: marked by absence of sculpture. Setation of mesoscutum: sparse. Mesoscutal lamella: truncate, with striate sculpture. Setation of mesoscutellum: present lateral to striate sculpture.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: sparse. Arrangement of setae on disc of forewing: densely setose distally, sparsely setose proximally. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. The head of *S. klingunculum* is mostly covered in rugose macrosculpture and the notauli are distinctly grooved, characters which it shares with *S. anunu*. The mesoscutellar spine of *S. klingunculum* is papilliform or wart-like, with the length of the spine only slightly greater than its thickness in lateral view. *Synopeas anunu* has a mesoscutellar spine that is similar in form, but its length is more than twice the thickness at its midpoint (Fig. 13). The sculpture of the lateral pronotum in *S. klingunculum* is present dorsally and absent ventrally, with a smooth band anterior to the tegula. This smooth band is lacking in *S. anunu*. Additionally, the epomial carina of *S. klingunculum* terminates posteriorly in a pit, while that of *S. anunu* does not.

Comments. The central keel is variable and difficult to discern due to the sculpture of the frons. The keel is present ventrally, and occasionally also present dorsally, just ventral to the median ocellus. Similarly, the hyperoccipital carina is often obscured by head sculpture, but when visible, it is weak and incomplete. The epomial carina terminates posteriorly in a pit.

Etymology. The epithet “klingunculum” means “little Klingon” and refers to the rugose head sculpture, which resembles that of the fictional alien race from “Star Trek”.

Plant associations. Reared from vein swelling and globoid galls on *Nauclea* spp. (Rubiaceae) [GALL217, GALL218].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 17.X.2012, Philip Butterill leg., *Nauclea tenuiflora* (FSCA 00034032). *Paratypes:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 01.VII.2010, *Nauclea* sp. 1 (FSCA 00000365); ♀, Morobe, Yawan, 23.VII.2010, *Nauclea* sp. 1 (FSCA 00000368); ♀, Morobe, Yawan, 24.VIII.2010, *Nauclea* sp. 1, (FSCA 00000309); 2♀ 3♂, Morobe, Yawan, 22.IX.2010, *Nauclea tenuiflora* (FSCA 00000362–00000364, 00000378–00000379); ♀, Morobe, Yawan, 26.X.2010, *Nauclea* sp. 1 (FSCA 00000369); 2♂, Morobe, Yawan, 30.X.2010, *Nauclea* sp. 1 (FSCA 00090254–00094591); ♀, Morobe, Yawan, 12.XI.2010, *Nauclea* sp. 1 (FSCA 00000354); ♂, Morobe, Yawan, 26.XI.2010, *Nauclea* sp. 1 (FSCA 00000411); ♀ ♂, Morobe, Yawan, 29.XI.2010, *Nauclea* sp. 1 (FSCA 00000343, 00090408); ♀, Morobe, Yawan, 26.I.2011, *Nauclea* sp. 1 (FSCA 00000375); ♀, Morobe, Yawan, 01.VIII.2012, *Nauclea* sp. 1 (FSCA 00000366); 15♀ 4♂, Morobe, Yawan, 13.XI.2012, *Nauclea* sp. 1 (FSCA 00000237, 00000355, 00034028, FSCA 00094485–00094492, 00094504–00094510); ♀, Morobe, Yawan, 21.XI.2012, *Nauclea* sp. 1 (FSCA 00000376).

***Synopeas luli* Awad, sp. nov.**

<http://zoobank.org/0E4B9ECA-F719-49AB-8983-2BBBBBE8553FB>

Description. Body length 1.1–1.3 mm. Body color: black; dark brown. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: slightly ovoid. Central keel: absent; partial; impressed. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: equal to lateral pair. Arrangement of clypeal setae: evenly spaced; medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): approximately 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly weak. Distance between lateral ocellus and hyperoccipital carina: less than 1 ocellar diameter; approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally, smooth band anterior to tegula. Lat-



Figure 34. *Synopeas luli* **A** lateral habitus (male paratype; FSCA 0000334) **B** dorsal habitus (male paratype; FSCA 0000334) **C** ventral habitus (female holotype; FSCA 00090412).

eral pronotal sculpture coverage: $1/4$ to $1/2$. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: angled posterodorsally. Posterior margin of lateral propodeal carina in lateral view: pointed dorsally and ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint; marked by absence of sculpture. Setation of mesoscutum: sparse. Mesoscutal lamella: broad and rounded; roughly triangular. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: absent. Length of T2: shorter than mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: moderately dense. Arrangement of setae on disc of forewing: setose distally, glabrous proximally; densely setose distally, sparsely setose proximally. Forewing marginal setae: approximately uniform in length on anterior and posterior margins.

Diagnosis. *Synopeas luli* has a short, pointed mesoscutellar spine that is angled upward, and a weak but complete hyperoccipital carina. It resembles *S. kiki* and may be distinguished by the presence of a partial central keel on the frons and by the mesoscutellar spine, which is posterodorsally angled in *S. luli* and posteriorly angled in *S. kiki*. The forewing of *S. luli* has setae of approximately equal length around the wing margin, while in *S. kiki*, the setae are distinctly longer on the posterior margin (Fig. 8).

Comments. The central keel is variable in this species. It can be absent, or present ventrally within a shallow longitudinal depression.

Etymology. The epithet “luli” is Numbani for “thorn” (Evans 2008) and refers to the shape of the mesoscutellar spine. The name is to be treated as a noun in apposition.

Plant associations. Reared from galls on *Neuburgia corynocarpa* (Apocynaceae) [GALL236] and *Piper macropiper* (Piperaceae) [GALL307].

Specimens examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 22.X.2012, Philip Butterill leg., *Neuburgia corynocarpa* (FSCA 00090412). *Paratypes:* PAPUA NEW GUINEA: 5♀ 3♂, Morobe, Yawan, 22.IX.2010, *Neuburgia corynocarpa* (FSCA 00090427, 00090437–00090438, 00094466–00094470); 3♀ 2♂, Morobe, Yawan, 03.XI.2010, *Piper macropiper* (FSCA 00090426, 00090429, 00094482–00094484); ♀, Morobe, Yawan, 30.III.2012, *Neuburgia corynocarpa* (FSCA 00090440); ♂, Morobe, Yawan, 14.VI.2012, *Neuburgia corynocarpa* (FSCA 00090439); 7♀ 4♂, Morobe, Yawan, 22.X.2012, *Neuburgia corynocarpa* (FSCA 00094524–00094528, 00094548–00094549, 00000332–00000335).

***Synopeas occultum* Awad, sp. nov.**

<http://zoobank.org/80494C1F-0D6A-4474-8A0C-B27312E5587D>

Description. Body length 1.1–1.5mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: slightly ovoid. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Lateral ocellar depression: present laterally. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: less than 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/2 to 2/3. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: pointed ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: short, projecting less than its width beyond margin. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: present at posterior margin and in posterolateral corners. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of fore-



Figure 35. *Synopeas occultum* (female holotype; FSCA 00090403) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

wing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. *Synopeas occultum* has a short, pointed scutellar spine and a robust, complete hyperoccipital carina. It may be distinguished from similar-looking species by the patch of microsculpture on posterior and posterolateral S2 (Fig. 6B). It resembles *S. sanga*, but differs in the length of T2, which is much more elongate in *S. occultum* (compare Figs 35 and 41). Additionally, *S. sanga* has a long patch of microsculpture at the dorsal margin of T2, which in *S. occultum* is much shorter (Fig. 7).

Etymology. The epithet “occultum” is Latin for “hidden”. It is applied to this species because it was not initially recognized from morphology alone, and its hidden identity was revealed by DNA barcoding.

Plant associations. Reared from nodule-like galls on *Cypholophus friesianus* (Urticaceae) [GALL266] .

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 24.V.2012, Philip Butterill leg., *Cypholophus friesianus* (FSCA 00090403). *Paratypes:* PAPUA NEW GUINEA: ♀ 4♂, Morobe, Yawan, 04.X.2010, *Cypholophus friesianus* (FSCA 00090435, 00094460–00094463); 3♂, Morobe, Yawan, 07.X.2010, *Cypholophus friesianus* (FSCA 00090436, 00094464–00094465); ♂, Morobe, Yawan, 29.XI.2010, *Cypholophus friesianus* (FSCA 00090433); ♀, Morobe, Yawan, 24.V.2012, *Cypholophus friesianus* (FSCA 00094493).



Figure 36. *Synopeas pattiae* (female holotype; FSCA 00090423). **A** Lateral habitus **B** Dorsal habitus **C** Ventral habitus.

Synopeas pattiae Awad, sp. nov.

<http://zoobank.org/874328AE-B34E-4DEC-8BEE-E9000D619412>

Description. Body length 1.5–1.7 mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: circular. Central keel: absent; partial. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/2 to 2/3. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly; angled posterodorsally. Posterior margin of lateral propodeal carina in lateral view: pointed ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Seta-

tion of mesoscutum: absent medially, present laterally. Mesoscutal lamella: broad and rounded; roughly triangular. Setation of mesoscutellum: absent medially; laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: uncertain, longer than distance between setal bases. Density of setae on disc of forewing: moderately dense. Arrangement of setae on disc of forewing: setose distally, glabrous proximally. Forewing marginal setae: approximately uniform in length on anterior and posterior margins.

Diagnosis. *Synopeas pattiae* has a short, pointed mesoscutellar spine and a robust, complete hyperoccipital carina. *Synopeas pattiae* can be differentiated from *S. pulupulu* by the setation of the mesoscutum and mesoscutellum, which are medially glabrous in *S. pattiae* and uniformly setose in *S. pulupulu*. *Synopeas pattiae* is similar to *S. roncavei*, but the forewing of *S. pattiae* lacks a linea setosa, which is present in *S. roncavei* (Fig. 23).

Comments. The central keel may be ventrally present or entirely absent. The forewing disc is proximally glabrous or with a few scattered setae.

Etymology. This species is named in honor of botanist Patti J. Anderson.

Plant associations. Reared from globoid galls on *Syzygium decipiens* (Myrtaceae) [GALL419].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 03.XII.2010, Philip Butterill leg., *Syzygium decipiens* (FSCA 00090423). *Paratypes:* PAPUA NEW GUINEA: 3♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 03.XII.2010, Philip Butterill leg., *Syzygium decipiens* (FSCA 00094479–00094481).

Synopeas psychotriae Buhl, 2013

Description. Body length 1.3–1.4 mm. Body color: dark brown. Color of legs: coxae brown, otherwise yellow. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: circular; slightly ovoid. Central keel: complete and weakly developed. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly weak. Distance between lateral ocellus and hyperoccipital carina: less than 1 ocellar diameter; approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/4 to 1/2. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly; angled posterodorsally. Posterior margin of lateral propodeal ca-

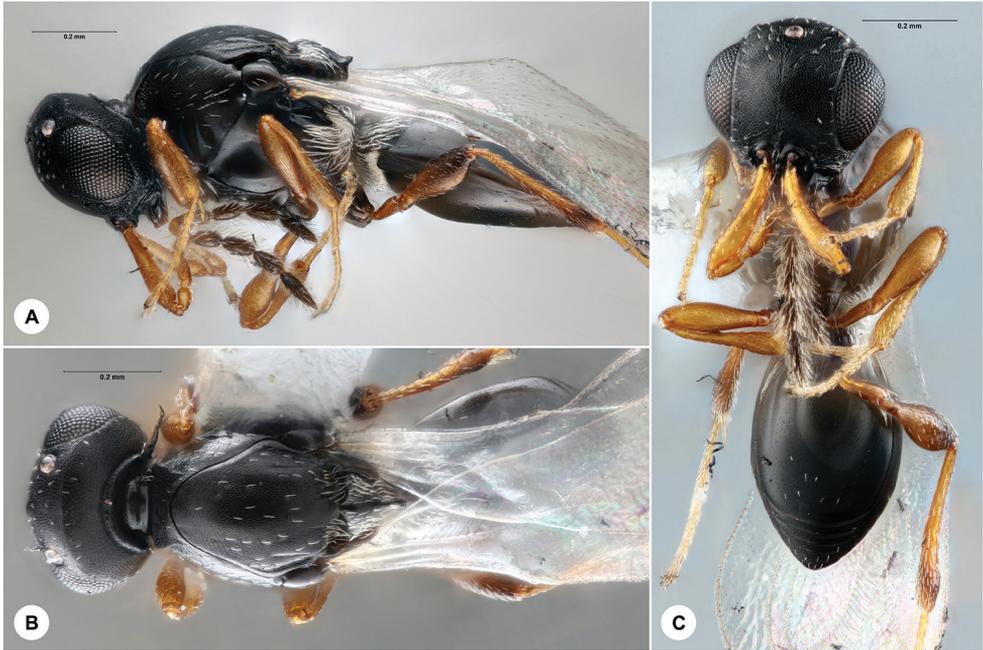


Figure 37. *Synopeas psychotriae* (male specimen; FSCA 00090261) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

rina in lateral view: pointed dorsally and ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: well impressed. Setation of mesoscutum: sparse. Mesoscutal lamella: broad and square. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: absent; narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: sparse. Arrangement of setae on disc of forewing: setose distally, glabrous proximally. Forewing marginal setae: approximately uniform in length on anterior and posterior margins.

Diagnosis. The parapsidal lines of *S. psychotriae* are well impressed (Fig. 20A), distinguishing it from the similar *S. luli*, which has unmarked or very faint parapsidal lines. The metasomal microsculpture of *S. psychotriae* is minimal, being absent or restricted to very narrow bands at the posterior margins of each segment, whereas *S. sanga*, *S. occultum*, and *S. kira* have more extensive metasomal sculpturing (Fig. 6). There is no central keel, but rather an impressed line running from the toruli to the median ocellus. The mesoscutellar spine may be angled posteriorly or posterodorsally.

Comments. The female types of *S. psychotriae* have a posterodorsally pointed mesoscutellar spine. The male specimen has a posteriorly pointed mesoscutellar spine, while that of the female from the same gall is posterodorsally pointed. The angle of the

mesoscutellar spine may be sexually dimorphic in this species, but more specimens are needed for confirmation.

Plant associations. Reared from galls on *Psychotria ramuensis* (Rubiaceae).

Material examined. Holotype: PAPUA NEW GUINEA: ♀, Madang, 5°08'S, 145°47'E, 27.I–5.IV.2011, Philip Butterill leg., *Psychotria ramuensis* (USNMENT01335972). Paratype: PAPUA NEW GUINEA: ♀, Madang, 5°08'S, 145°47'E, 27.I–5.IV.2011, Philip Butterill leg., *Psychotria ramuensis* (USNMENT01335982). Other material: PAPUA NEW GUINEA: ♀ ♂, Morobe, Ohu, 5.233°S, 145.686°E, 22.II.2011, Philip Butterill leg., *Psychotria ramuensis*, (FSCA 00090261, 00094619).

Synopeas pterocarpi Buhl, 2013

Description. Body length 1.4–1.5 mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: circular. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: parallel, arched rugae. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: evenly spaced. Shape of mandible: unknown. Distance between lateral ocellus and compound eye (OOL): approximately 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: uncertain, approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/2 to 2/3. Mesoscutellar spine: absent or inconspicuous. Posterior margin of lateral propodeal carina in lateral view: rounded. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: broad and rounded. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: unknown. Sculpture of T2: absent. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: sparse. Arrangement of setae on disc of forewing: unknown. Forewing marginal setae: unknown.

Diagnosis. The frons of *S. pterocarpi* is characterized by parallel, arched rugae above the toruli, not found in other *Synopeas* from New Guinea.

Plant associations. Reared from galls on *Pterocarpus indicus* (Fabaceae).

Material examined. Holotype: PAPUA NEW GUINEA: ♀, Madang, Ohu, 5°14'S, 145°41'E, 13.IX.2010–19.I.2011, Philip Butterill leg., *Pterocarpus indicus* (USNMENT01335974). Paratype: PAPUA NEW GUINEA: ♀, Madang, Ohu, 5°14'S, 145°41'E, 13.IX.2010–19.I.2011, Philip Butterill leg., *Pterocarpus indicus*, ZMUC.



Figure 38. Holotype of *Synopeas pterocarpi* (USNMENT01335974) **A** lateral habitus **B** dorsal habitus **C** anterior head **D** dorsolateral habitus. Scale bar: 0.1 mm.

Synopeas pulupulu Awad, sp. nov.

<http://zoobank.org/898560E2-5367-4892-8352-EAF65149DD90>

Description. Body length 1.6–1.8 mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: circular. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 2/3 to 3/4. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly; angled posterodorsally. Posterior margin of lateral propodeal carina in lateral view: pointed dorsally and ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: moderately dense. Mesoscutal lamella: roughly triangular. Setation of mesoscutellum: present throughout.



Figure 39. *Synopeas pulupulu* (female holotype; FSCA 00090430) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

Metasoma. Microsculpture of S2: absent. Sculpture of T2: absent. Length of T2: approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: approximately uniform in length on anterior and posterior margins.

Diagnosis. *Synopeas pulupulu* has a short, pointed mesoscutellar spine and a robust, complete hyperoccipital carina. *Synopeas pulupulu* can be differentiated from *S. roncavei* and *S. pattiae* by the setation of the mesoscutum and mesoscutellum, which are uniformly setose in *S. pulupulu* and medially glabrous in *S. roncavei* and *S. pattiae*. Additionally, the sculpture of the lateral pronotum in *S. pulupulu* is more extensive than that of *S. roncavei* and *S. pattiae*, covering more than two thirds of the sclerite.

Etymology. The epithet “pulupulu” is Manam for “hairy” (Osmond and Ross 2016) and refers to the relatively dense setae on the mesoscutum. The name is to be treated as a noun in apposition.

Plant associations. Reared from galls on *Palmeria* sp. (Monimiaceae) [GALL331].

Material examined. **Holotype:** PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 20.XI.2010, Philip Butterill leg., *Palmeria* sp. 1 (FSCA 00090430). **Paratype:** PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 20.XI.2010, Philip Butterill leg., *Palmeria* sp. 1 (FSCA 00094459).



Figure 40. *Synopeas roncavei* (female holotype; FSCA 00090249) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

Synopeas roncavei Awad, sp. nov.

<http://zoobank.org/C2B1C19E-AE81-4198-B6D4-1F63DCE3AEC3>

Description. Body length 1.2–1.5 mm. Body color: black. Color of legs: coxae brown, otherwise yellow; coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: circular. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/2 to 2/3. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: rounded. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: absent medially, pre-

sent laterally. Mesoscutal lamella: broad and rounded; roughly triangular. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. *Synopeas roncavei* has a short, pointed mesoscutellar spine and a robust, complete hyperoccipital carina. The metasomal sculpture on T2 is restricted to a narrow band at the posterior margin (Fig. 40). It is similar to *S. kiki*, and these can be differentiated by the hyperoccipital carina. In *S. kiki*, the hyperoccipital carina is medially weakened and laterally present as a thin carina, whereas in *S. roncavei*, the hyperoccipital carina is uniformly robust. *Synopeas roncavei* can be differentiated from *S. pulupulu* by the setation of the mesoscutum and mesoscutellum, which are medially glabrous in *S. roncavei* and uniformly setose in *S. pulupulu*. *Synopeas roncavei* is similar to *S. pattiae*, but the forewing of *S. pattiae* lacks a linea setosa, which is present in *S. roncavei* (Fig. 23).

Etymology. This species is named in honor of the biological control researcher and beetle taxonomist Ronald D. Cave.

Plant associations. Primarily reared from blister galls on *Piper amboinense* and *Piper celtidiforme* (Piperaceae) [GALL273, GALL300]. One specimen reared from *Cypholophus friesianus* (Urticaceae) [GALL266].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 12.X.2010, Philip Butterill leg., *Piper celtidiforme* (FSCA 00090249). *Paratypes:* PAPUA NEW GUINEA: ♀ ♂, Morobe, Yawan, 20.IX.2010, *Piper amboinense* (FSCA 00000407, 00000322); ♂, Morobe, Yawan, 05.X.2010, *Piper* sp. (FSCA 00090417); 2♀, Morobe, Yawan, 12.X.2010, *Piper celtidiforme*, FSCA 00094605–00094606); 4♀, Morobe, Yawan, 15.X.2010, *Piper amboinense* (FSCA 00000339–00000342); ♀, Morobe, Yawan, 15.X.2010, *Cypholophus friesianus* (FSCA 00090432); ♂, Morobe, Yawan, 18.X.2010, *Piper amboinense* (FSCA 00000408); 3♀ 3♂, Morobe, Yawan, 25.X.2010, *Piper amboinense* (FSCA 00090259, 00090411, FSCA 00094495–00094496, 00094607–00094608); ♂, Morobe, Yawan, 11.XI.2010, *Piper amboinense* (FSCA 00000253).

***Synopeas sanga* Awad, sp. nov.**

<http://zoobank.org/E835FBC1-391D-4AD8-B30C-C7127D019B9F>

Description. Body length 1.1–1.4mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.



Figure 41. *Synopeas sanga* (female holotype; FSCA 00000399) **A** lateral habitus **B** dorsal habitus **C** ventral habitus.

Head. Shape of head in anterior view: slightly ovoid. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: evenly spaced. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly robust. Distance between lateral ocellus and hyperoccipital carina: less than 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/2 to 2/3. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: pointing posteriorly. Posterior margin of lateral propodeal carina in lateral view: pointed ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: long and narrow. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: present at posterior margin and in posterolateral corners. Sculpture of T2: wide transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with linea setosa. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. *Synopeas sanga* has a short, pointed scutellar spine and a robust, complete hyperoccipital carina. It may be distinguished from similar species by the patch of microsculpture on posterior and posterolateral S2 (Fig. 6A) and the long band of reticulate microsculpture on dorsal T2 (Fig. 7A). It resembles *S. occultum* but differs in the length of T2, which is much more elongate in *S. occultum* (compare Figs 35 and 41). *Synopeas sanga* has sparser setation on the frons than does *S. roncavei* sp. 2 (compare Figs 40 and 41).

Etymology. The epithet “sanga” is Proto-Oceanic for “forked” (Evans, 2008) and refers to the forked microsculpture pattern on posterior S2. The name is to be treated as a noun in apposition.

Plant associations. Reared from blister galls on *Saurauia conferta* and *Saurauia schumanniana* (Actinidiaceae) [GALL397, GALL499].

Material examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 03.IX.2012, Philip Butterill leg., *Saurauia conferta* (FSCA 00000399). *Paratypes:* PAPUA NEW GUINEA: 3♀ 2♂, Morobe, Yawan, 17.V.2012, *Saurauia conferta* (FSCA 00000345–00000349); 2♀, Morobe, Yawan, 03.IX.2012, *Saurauia schumanniana* (FSCA 00000397, 00094474); 7♀ 3♂, Morobe, Yawan, 03.IX.2012, *Saurauia conferta* (FSCA 00094511–00094514, 00094532–00094536, 00094615); 3♀ 3♂, Morobe, Yawan, 05.XI.2012, *Saurauia conferta*, (FSCA 00000356–00000361); ♂, Morobe, Yawan, 20.XI.2012, *Saurauia conferta* (FSCA 00000396).

***Synopeas toto* Awad, sp. nov.**

<http://zoobank.org/69DA47BC-585A-43AD-A1DE-10BEAD7139C6>

Description. Body length 1.1–1.5 mm. Body color: black. Color of legs: coxae brown, otherwise yellow. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: circular. Central keel: complete and well developed. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: uncertain, minute rugulae; uncertain, reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: medial setae closer to each other than to lateral setae. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: complete. Hyperoccipital carina strength: uniformly weak. Distance between lateral ocellus and hyperoccipital carina: approximately 1 ocellar diameter.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/2 to 2/3. Mesoscutellar spine: short and pointed. Mesoscutellar spine in lateral view: angled posterodorsally. Posterior margin of lateral propodeal carina in lateral view: pointed ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: roughly triangular. Setation of mesoscutellum: absent medially.



Figure 42. *Synopeas toto* **A** lateral habitus (female paratype; FSCA 00000245) **B** dorsal habitus (female paratype; FSCA 00090421) **C** ventral habitus (female paratype; FSCA 00090421).

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: sparse. Arrangement of setae on disc of forewing: densely setose distally, sparsely setose proximally. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. *Synopeas toto* has a strong, distinct central keel on the frons. *Synopeas psychotriae* also has a line on the frons that extends from between the toruli to the median ocellus, but it is impressed rather than raised. Additionally, the parapsidal lines of *S. psychotriae* are well impressed (Fig. 20A) and are very weak in *S. toto* (Fig. 42). *Synopeas butterilli* can have a complete central keel, but it is weakly developed. The sculpture of the lateral pronotum in *S. butterilli* is restricted to a narrow medial band (Fig. 27), rather than covering the dorsal half of the lateral pronotum as in *S. toto*.

Etymology. The epithet “toto” is Proto-Oceanic for “cut” (Ross et al. 1998) and refers to the complete central keel dividing the frons. The name is to be treated as a noun in apposition.

Plant associations. Reared from galls on *Nauclea* (Rubiaceae) [GALL217, GALL218].

Specimens examined. *Holotype:* PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 01.XII.2010, Philip Butterill leg., *Nauclea* sp. 1 (FSCA

00000252). *Paratypes*: **PAPUA NEW GUINEA**: ♀♂, Morobe, Yawan, 11.XI.2010, *Nauclea* sp. 1 (FSCA 00090421, 00094597); 2♂, Morobe, Yawan, 25.XI.2010, *Nauclea* sp. 1 (FSCA 00090420, 00094494); ♂, Morobe, Yawan, 26.XI.2010, *Nauclea* sp. 1, FSCA 00000412); ♀, Morobe, Yawan, 01.XII.2010, *Nauclea* sp. 1 (FSCA 00000330); ♀ 2♂, Morobe, Yawan, 26.I.2011, *Nauclea* sp. 1 (FSCA 00000406, 00094592–00094593); 5♀ 4♂, Morobe, Yawan, 21.XI.2012, *Nauclea* sp. 1 (FSCA 00000245, 00000258, 00000336–00000338, 00000393, 00094563–00094565).

***Synopeas valavala* Awad, sp. nov.**

<http://zoobank.org/EFE1EECC-26D4-4839-977E-35004769C41A>

Description. Body length 1.3–1.5 mm. Body color: black. Color of legs: coxae brown, otherwise yellow. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: triangular. Central keel: absent. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of clypeal setae: longer than lateral pair. Arrangement of clypeal setae: evenly spaced. Shape of mandible: bidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: absent. Hyperoccipital carina strength: unknown. Distance between lateral ocellus and hyperoccipital carina: unknown. Postgenal region: medially impressed.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally, smooth band anterior to tegula. Lateral pronotal sculpture coverage: 1/2 to 2/3. Mesoscutellar spine: absent or inconspicuous. Posterior margin of lateral propodeal carina in lateral view: rounded. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: moderately dense. Mesoscutal lamella: short, projecting less than its width beyond margin. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: uncertain, absent. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: longer than distance between setal bases. Density of setae on disc of forewing: dense. Arrangement of setae on disc of forewing: uniformly setose distally, proximally glabrous with lineae setosa. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. *Synopeas valavala* has an exceptionally large, triangular head, unlike any other known species of *Synopeas*. The malar space is long, about equal to the height of the compound eye, and the mesoscutellar spine is inconspicuous to absent.

Comments. A similar head shape is found in *Inostemma macarangae* Buhl, 2013 (Fig. 44), which has also been reared from *Macaranga* galls, suggesting convergent evolution. There is no central keel, but the angle of the frons may give the impression of a keel when viewed at certain angles.



Figure 43. *Synopeas valavala* **A** lateral habitus (female holotype; FSCA 00033890) **B** dorsal habitus (female paratype; FSCA 00000350) **C** ventral habitus (female holotype; FSCA 00033890).

Etymology. The epithet “valavala” is Maenge for “Macaranga” (Ross, 2008) and refers to the identity of the gall host plant. The name is to be treated as a noun in apposition.

Plant associations. Reared from round, fuzzy galls on *Macaranga strigosa* (Euphorbiaceae) [GALL357].

Material examined. *Holotype*: PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 21.XI.2012, Philip Butterill leg., *Macaranga strigosa* (FSCA 00033890). *Paratypes*: PAPUA NEW GUINEA: 2♀, Morobe, Yawan, 21.XI.2012, Philip Butterill leg., *Macaranga strigosa* (FSCA 00000259–00000350).

***Synopeas zhangi* Awad, sp. nov.**

<http://zoobank.org/44A5DF49-D075-491A-A170-D1B4749D4F15>

Description. Body length 1.1–1.3 mm. Body color: black. Color of legs: coxae brown, otherwise yellow to brown. Color of mesoscutellar spine: concolorous with mesoscutellar disc.

Head. Shape of head in anterior view: distinctly ovoid. Central keel: absent; partial. Sculpture on frons: reticulate microsculpture. Epitorular sculpture: minute rugulae; reticulate microsculpture. Number of clypeal setae: 4. Length of median pair of



Figure 44. *Inostemma macarangae* (male specimen; FSCA 00090262) **A** lateral habitus **B** dorsal habitus **C** anteroventral habitus.



Figure 45. *Synopeas zhangii* **A** lateral habitus (female paratype; FSCA 00000291) **B** dorsal habitus (female paratype; FSCA 00000383) **C** ventral habitus (female paratype; FSCA 00000383).

clypeal setae: longer than lateral pair. Arrangement of clypeal setae: uncertain, medial setae closer to lateral setae than to each other. Shape of mandible: unidentate. Distance between lateral ocellus and compound eye (OOL): less than 1 ocellar diameter. Hyperoccipital carina: absent.

Mesosoma. Epomial carina: present, complete or nearly so. Microsculpture of lateral pronotum: present dorsally, absent ventrally. Lateral pronotal sculpture coverage: 1/4 to 1/2. Mesoscutellar spine: absent or inconspicuous. Posterior margin of lateral propodeal carina in lateral view: pointed dorsally and ventrally. Mesosomal dorsum in lateral view: convex. Notauli: unmarked or faintly suggested. Parapsidal lines: very faint. Setation of mesoscutum: sparse. Mesoscutal lamella: roughly triangular. Setation of mesoscutellum: laterally dense, medially sparse.

Metasoma. Microsculpture of S2: narrow band at posterior margin. Sculpture of T2: absent; narrow transverse band of microsculpture at posterior margin. Length of T2: shorter than mesosoma; approximately as long as mesosoma.

Wing. Length of setae on disc of forewing: shorter than distance between setal bases. Density of setae on disc of forewing: sparse. Arrangement of setae on disc of forewing: setose distally, glabrous proximally. Forewing marginal setae: setae on posterior margin distinctly longer than setae on anterior margin.

Diagnosis. *Synopeas zhangii* may be recognized by its head shape, which is distinctly wider than high, the unidentate mandible, and the absence of a hyperoccipital carina. The dorsal mesosoma is moderately convex, allowing it to be easily distinguished from an undescribed species known from a single male specimen, which has an extremely convex mesosoma.

Etymology. This species is named in honor of the hymenopterist Yuanmeng Miles Zhang.

Plant associations. Reared from galls on *Nauclea* spp. (Rubiaceae) [GALL218, GALL219, GALL222], *Macaranga strigosa* (Euphorbiaceae) [GALL357], *Ficus adenosperma* (Moraceae) [GALL318], and *Elaeocarpus dolichostylus* (Elaeocarpaceae) [GALL241].

Material examined. **Holotype:** PAPUA NEW GUINEA: ♀, Morobe, Yawan, 6.14141°S, 146.87415°E, 26.I.2011, Philip Butterill leg., *Macaranga strigosa* (FSCA 00090250). **Paratypes:** PAPUA NEW GUINEA: ♂, Morobe, Yawan, 15.XI.2010, *Nauclea* sp. 1 (FSCA 00000367); ♂, Morobe, Yawan, 16.XI.2010, *Nauclea* sp. 1 (FSCA 00090407); ♂, Morobe, Yawan, 01.I.2011, *Elaeocarpus dolichostylus* (FSCA 00090422); ♀ 4♂, Morobe, Yawan, 24.I.2011, *Nauclea* sp. 1 (FSCA 00033887, 00094611–00094614); 3♀ 9♂, Morobe, Yawan, 25.I.2011, *Nauclea tenuiflora* (FSCA 00000291, 00000370–00000373, 00000383–00000384, 00033886, 00094475–00094478); ♀, Morobe, Yawan, 25.I.2011, *Ficus adenosperma* (FSCA 00090424); 1♀ 4♂, Morobe, Yawan, 26.I.2011, *Macaranga strigosa* (FSCA 00090252, 00094472–00094473, 00094497, 00094582); ♀ ♂, Morobe, Yawan, 26.I.2011, *Nauclea* sp. 1 (FSCA 00000324, 00000353); ♂, Morobe, Yawan, 08.X.2012, *Nauclea tenuiflora* (FSCA 00000387).

COI Results

Neighbor-joining and maximum likelihood analyses recovered cohesive clusters of morphospecies, within which all individuals were more similar to each other than to any other species (Figs 46, 47). Some clusters were strongly supported. *Synopeas sanga*, *S. occultum*, *S. kira*, and the specimen from the UK formed a cluster with over 99% support. *Synopeas amandae* and *S. codex* formed a cluster with over 97% support. A large and well-supported cluster (over 97%) included *S. zhangji*, *S. kiki*, *S. toto*, *S. luli*, *S. psychotriae*, *S. pattiae*, and *S. butterilli*. *Synopeas klingunculum*, *S. anunu*, and the specimen from Myanmar formed a cluster with over 75% support in the neighbor-joining analysis.

The New Guinea material did not all cluster together. *Synopeas* specimens from the US, the UK, and Myanmar were placed relatively far apart from one another. The US and Myanmar specimens clustered with *S. klingunculum* and *S. anunu*. As stated above, the UK specimen clustered with *S. sanga*, *S. occultum*, and *S. kira*, although it was distinct from the New Guinea species. The specimen from the UK was tentatively identified as *S. larides* (Walker) by comparison to a paralectotype specimen photographed by Elijah Talamas.

The COI sequences of three species, *S. luli*, *S. sanga*, and *S. zhangji*, had 99–100% matches with undetermined species of *Synopeas* collected in South Korea. The plant genus from which *S. sanga* was reared, *Saurauia*, is widespread in tropical and subtropical Asia. The plant species from which *S. luli* was reared, *Neuburgia corynocarpa* and *Piper macropiper*, are distributed from Taiwan to the western Pacific (POWO 2020). *Synopeas zhangji* was reared from diverse plant taxa and may be a generalist.

We recognize the possibility that these species are widespread and may have already been described. However, *Synopeas* species from the Palearctic cannot be reliably identified without a thorough taxonomic treatment, a task far beyond the scope of this project. In the event that these species have been described before, we believe we have made it straightforward to treat them as junior synonyms.

Discussion

Some morphological characters formed discernible patterns. The cluster including *S. klingunculum*, *S. anunu*, and the specimen from Myanmar was morphologically identifiable. The notauli of species in this cluster are distinctly grooved, and there is striate sculpture on the mesoscutal lamella and medial mesoscutellum. Therefore, future analysis may find that the grooved notauli identify a distinct species group within *Synopeas*. Similar notauli are also found in *Inostemma*, an early-diverging group, which could mean that grooved notauli represent the plesiomorphic state for Platygastriinae. Masner and Huggert (1989) applied the same polarity to this character at the genus and subfamily levels.

Other small clusters have more subtle morphological similarities. *Synopeas zhangji* and an undescribed species with similar COI are characterized by a distinctly ovoid head in frontal view and a unidentate mandible. All other *Synopeas* species in the analy-

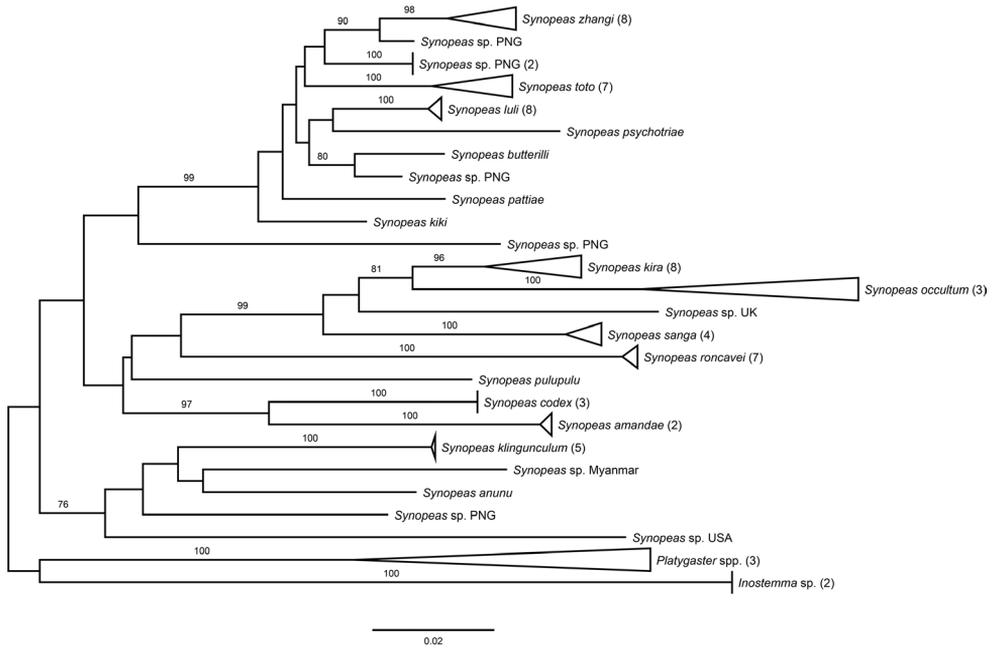


Figure 46. Neighbor-joining tree of *Synopeas* 5'-CO1 barcodes. Terminal taxa are labeled to their narrowest identification level. Numbers in parentheses after terminal taxa indicate how many sequences are represented in each cluster. Bootstrap support values greater than 75% are indicated on the tree.

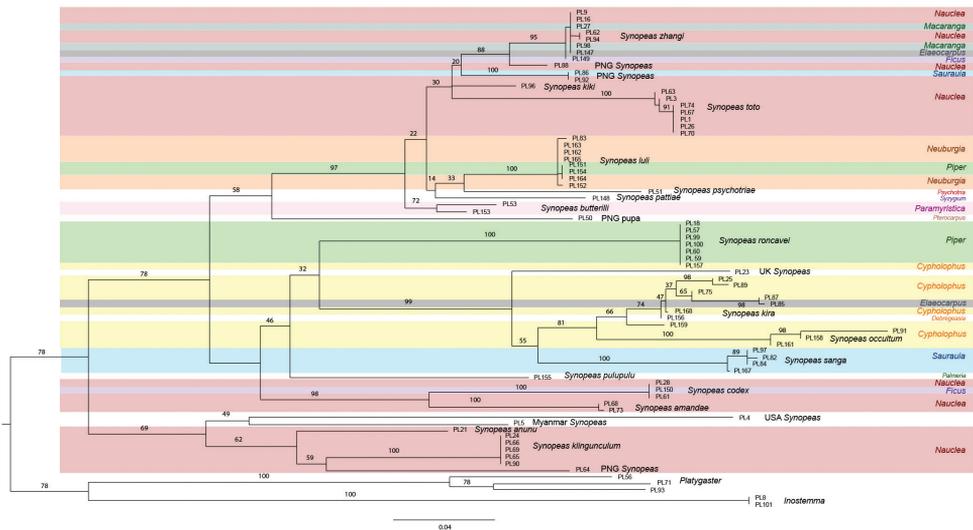


Figure 47. Maximum likelihood tree of *Synopeas* 5'-CO1 barcodes. Colored boxes indicate gall host plant genera from which multiple specimens were barcoded.

sis have a bidentate mandible. *Synopeas amandae* and *S. codex* both have the lateral pronotum with microsculpture throughout, whereas the other species in the analysis have the lateral pronotum only partially sculptured. *Synopeas sanga*, *S. occultum*, and *S. kira*

have more extensive sculpturing on the metasoma than do most other species treated here, although this character is also present in *S. codex*, which is not closely related.

Of the 19 *Synopeas* species with known plant associations, twelve were reared from a single gall host and seven from at least two gall hosts. From the latter, five species came from galls on two or more plant genera. Thus we can report evidence that some *Synopeas* species use multiple host galls and plants, and that individual gall types (morphospecies) can support multiple platygastriid species.

For example, the cluster of five gall types formed on *Nauclea* spp. (Rubiaceae) supported 8 species of *Synopeas*, and at least one, but likely several, species of other platygastriid genera. The most structurally complex gall (a globoid leaf gall, GALL218) supported five *Synopeas* species. Only *S. anunu*, *S. kalubia*, and *S. kiki* were reared from a single gall type. The others were found in at least two *Nauclea* gall types, and both *S. zhangii* and *S. codex* were reared from galls formed on different plant genera (7 and 6 gall types, respectively, including the *Nauclea* galls).

The number of reared parasitoids is directly related to the number of host galls reared, and the *Nauclea* galls were by far the most abundant and frequently reared galls throughout the project, which may in part explain the apparently rich platygastriid fauna associated with them. Despite this, the emerging picture does suggest a richer, more complex, and more generalised community associated with galls than perhaps was expected. Additionally, it is possible that some *Synopeas* species are associated with cecidomyiid inquiline or predators rather than with the gall formers themselves.

More data are needed to confirm host associations and, to that end, further work is underway in order to establish the relationships among the host cecidomyiid gall formers (Kolesik and Butterill, unpublished data). Future workers are encouraged to acquire specimens through rearing of host material, due to the value of ecological data in understanding *Synopeas* diversity.

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Supplementary material 1

List of specimens and their depositories

Authors: Jessica Awad, Jonathan S. Bremer, Philip T. Butterill, Elijah J. Talamas

Data type: material examined

Explanation note: List of specimens examined, depositories, type status, and image links. Link to holotype image repository: https://zenodo.org/communities/platygastroidea_primary_types/

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Link: <https://doi.org/10.3897/jhr.87.65563.suppl1>

Supplementary material 2

COI data in Genbank

Authors: Jessica Awad, Jonathan S. Bremer, Philip T. Butterill, Elijah J. Talamas

Data type: COI data

Explanation note: List of barcode vouchers, internal identifiers, and Genbank accession numbers. Link to PNG image repository: https://zenodo.org/communities/synopeas_from_png/

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Link: <https://doi.org/10.3897/jhr.87.65563.suppl2>