

## Research article

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# Review of the *effusus* group of the Lanternfly genus *Pyrops* Spinola, 1839, with one new species and notes on trophobiosis (Hemiptera: Fulgoromorpha: Fulgoridae)

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**Abstract.** The species group *effusus* of the genus *Pyrops* Spinola, 1839 is reviewed and the nomenclatural history of the genus *Pyrops* is briefly summarized. One new species from eastern Borneo, *Pyrops synavei* sp. nov., is described. *P. gunjii* (Satô & Nagai, 1994) stat. nov. is proposed as a valid species instead of a subspecies of *P. whiteheadi* (Distant, 1889). *P. maquilinganus* (Baker, 1925) is removed from the *effusus* group and placed back into the *candelaria* group. *P. cyanirostris* (Guérin-Méneville, 1845) is removed from the group and not attributed to any of the currently defined species groups. An illustrated key to the species of the group with the addition of *P. intricatus* (Walker, 1857) and a distribution map are given. The *effusus* group is restricted to Borneo and adjacent Laut Island and presently contains 4 species: *P. effusus* (Distant, 1891), *P. gunjii* (Satô & Nagai, 1994) stat. nov., *P. synavei* sp. nov. and *P. whiteheadi* (Distant, 1889). Trophobiosis observations with the gecko *Gehyra mutilata* (Wiegmann, 1835) (Reptilia: Squamata: Gekkonidae) and two species of cockroaches (Insecta: Blattodea), one *Dorylaea* sp. and an unidentified species of Pseudophyllodromiinae, are reported and illustrated for *P. whiteheadi*; observation with a cockroach, *Dorylaea* sp., is reported for *P. intricatus*.

**Keywords.** Indonesia, Malaysia, Lanternfly, Fulgoroidea, citizen science

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## Introduction

The Lanternfly genus *Pyrops* Spinola, 1839 contains colourful, spectacular and popular species which are immediately recognized as Lanternflies by all entomologists because of their typical cephalic process. It is widely distributed in the Indomalayan region, from Sri Lanka to the Himalayas (north India, south China), eastwards to Taiwan and Vietnam, and southwards to Sulawesi and neighbouring islands through Indonesia and the Philippines. It currently covers 58 species and 16 subspecies (Bourgoin 2015), but despite the publication of revisions and catalogues (e.g., Lallemand 1963; Nagai & Porion 1996) its taxonomy is far from comprehensively resolved and still contains many errors and inconsistencies (Constant, unpublished).

The genus was divided into 5 species groups by Baker (1925) [at the time under the genus name *Fulgora* Linnaeus, 1767], a view followed by Lallemand (1963) [also under *Fulgora*] and by Nagai & Porion, 1996, both of the latter with minor changes.

The issue concerning the inconsistent use of the genus names *Fulgora* Linnaeus, 1767, *Pyrops* Spinola, 1839 and *Laternaria* Linnaeus, 1764, despite the wise treatment proposed by Kirkaldy (1902), was finally fixed in a similar way by a decision of the International Commission on Zoological Nomenclature (1955), who designated *Cicada laternaria* Linnaeus, 1758 as the type-species of the genus *Fulgora*, which is restricted to the Neotropics (the “peanut-headed lanternflies”). It also suppressed the genus name *Laternaria* because its type species was also *Cicada laternaria*. Consequently, the genus name *Pyrops*, with *Cicada candelaria* Linnaeus, 1758 as type-species, validly grouped the species of South-East Asia related to *candelaria*. However Lallemand (1960a,b, 1963), Chou *et al.* (1985) and Satô & Nagai (1994) continued erroneously using *Fulgora* instead of *Pyrops*. Nagai & Porion (1996) correctly used *Pyrops* for all species of SE Asia, but left species epithets feminine, an error corrected later by Liang (1998), who erroneously stated that he proposed new combinations (most probably because he was not aware of Nagai & Porion’s (1996) work) and that the decision of the International Commission on Zoological Nomenclature (1955) contained a formal designation of the genus name *Pyrops* for the species of the Oriental region. Sadly enough, some recent papers still contain and spread incorrect use of the name *Laternaria*, e.g., Leong *et al.* (2009), who even state that the use of *Pyrops* is incorrect because of the priority of *Laternaria* (sic!), or Kemal & Koçak (2012).

The *effusus* group in the genus *Pyrops* Spinola, 1839 was erected by Baker (1925), at that time as the *effusa* group in *Fulgora*. He defined the *effusus* group for medium to small sized species sharing characters such as the shape of the cephalic process, which is “very short but not very stout”, apically more or less swollen or vertically expanded, in most cases strongly bent or curved upwards and at least partly bright blue-green. The tegmina are greenish basally with various yellowish dots or markings, and castaneous apically, the hind wings blue basally and broadly black apically. He included 3 species in the group: *P. effusus* (Distant, 1891), *P. viridicastaneus* (Baker, 1925) and *P. transversolineatus* (Baker, 1925), the latter two species described in the same paper. He actually erroneously identified specimens of *P. whiteheadi* (Distant, 1889) under the name *effusus* and redescribed *P. effusus* as a new species, *P. viridicastaneus*. The placement of *P. transversolineatus* in the group is strange as the shape of the head does not match the characters given for the group and the author even mentioned similarities with the genera *Saiva* Distant, 1906 and *Prolepta* Walker, 1851 or with two species he placed in the *candelaria* group: *Pyrops maquilinganus* (Baker, 1925) and *P. delesserti* (Guérin-Méneville, 1840).

Lallemand (1963) renamed Baker’s (1925) *effusus* group “quatrième groupe: type *whiteheadi*”, most probably because he synonymized *effusus* under *whiteheadi*. He restricted the characters of the group to those of the cephalic process: less than 12 mm long, rounded apically, forming a little ball and more or less club-shaped. He included 4 species in the group: *P. maquilinganus* (Baker, 1925), *P. dimotus* (Lallemand, 1960), *P. sapphirinus* (Schmidt, 1908) and *P. whiteheadi*. He transferred *P. transversolineatus* to the genus *Saiva* Distant, 1906 and synonymized *P. effusus* and *P. viridicastaneus* with *P. whiteheadi*. He also mentioned that *P. dimotus* shows intermediate characters between *Saiva* and *Pyrops*, and that it might only be a variety of *P. sapphirinus*. Finally, he stated that *whiteheadi* was a variable species and that in the series of specimens he had identified as *whiteheadi* from eastern Borneo, one perfectly matched the description of *P. effusus* while another matched that of *viridicastaneus*. Strangely enough, that statement seems to have been given to justify the synonymy of *effusus* and *viridicastaneus* with *whiteheadi*. Actually, Lallemand’s collection contains 2 specimens of *P. effusus* erroneously identified by him as *P. whiteheadi*. Accordingly, the male genitalia illustrated in Lallemand’s (1963) work (pl. X, figs 11–13) and erroneously attributed to *P. whiteheadi*, pertain to *P. effusus*.

Satô & Nagai (1994) described and illustrated *Fulgora whiteheadi gunjii* from Borneo, perpetuating the erroneous use of *Fulgora* instead of *Pyrops*, and considered *viridicastaneus* Baker, 1925 as a subspecies of *P. whiteheadi*.

Nagai & Porion (1996) followed the classification proposed by Lallemand (1963), but correctly used *Pyrops* as a genus name. In the “groupe IV”, as defined by Lallemand, they included 3 species and one subspecies: *P. cyanirostris* (Guérin-Ménéville, 1845), *P. maquilinganus*, *P. whiteheadi* and *P. whiteheadi gunjii*. They synonymized *dimotus* and *sapphirinus* with *cyanirostris*, and followed Lallemand in considering *effusus* and *viridicastaneus* as junior synonyms of *whiteheadi*. They illustrated the types of *P. dimotus*, *P. effusus*, *P. whiteheadi* and *P. whiteheadi gunjii*, as well as specimens of *P. cyanirostris*, *P. maquilinganus* and one specimen of *P. effusus* from Lallemand’s collection erroneously cited under the name *P. whiteheadi*.

Later, in 2004, Nagai & Porion reconsidered the nomenclature of *P. whiteheadi* and its synonyms and illustrated specimens of *P. whiteheadi* and *P. effusus*. They reinstated *P. effusus* as a valid species with *P. viridicastaneus* as a junior synonym. They erroneously mentioned 1960 instead of 1963 as the date of publication of Lallemand’s revision.

The present paper aims at clarifying the nomenclature and proposing an accurately illustrated identification key for the species of the group, and at describing a new species from eastern Borneo. The current knowledge of the distribution of the species of the *effusus* group is illustrated by a map.

The updated nomenclature of all cited taxa will be documented in FLOW (Bourgoin 2015).

## Materials and methods

Type specimens of all species have been examined. The male genitalia were dissected as follows: the pygofer was cut from the abdomen of the softened specimen with a needle blade, then boiled for about one hour in a 10% solution of potassium hydroxide (KOH). The phallic complex was dissected with a needle blade and all pieces examined in ethanol, the whole placed in glycerine for preservation. Observations were done with a Leica MZ8 stereo-microscope. Pictures were taken with a Canon EOS 300 D camera with Sigma DG Macro lens and optimized with Adobe Photoshop CS3. Inflation of the phallus was not performed due to the difficulty of obtaining good and replicable results and because it is not indispensable to separate the species in the genus *Pyrops*.

For the transcription of the labels of the types, the wording on each single label is given in square brackets.

The measurements were mainly taken as in Constant (2004) and the following abbreviations are used:

- BF = breadth of the frons
  - BTg = breadth of the tegmen
  - BPrH = breadth of the cephalic process at half length
  - LF = length of the frons
  - LTg = length of the tegmen
  - LPr = length of the cephalic process
  - TL = total length
- (LF, LPr and TL measured to/from ante-ocular carina at the base of the cephalic process)

In the results section, species are treated in alphabetical order.

Acronyms used for the collections (name of the curator in parentheses):

BMNH = Natural History Museum, London, United Kingdom (M. Webb, M. Barclay)

EUM = Ehime University Museum, Matsuyama, Japan (H. Yoshitomi)

FSAG = University of Liège, Gembloux Agro-Bio Technologies, Gembloux, Belgium (J. Bortels)

MHNL = Muséum d'Histoire Naturelle de Lyon, France (C. Audibert)

RBINS = Royal Belgian Institute of Natural Sciences, Brussels, Belgium (W. Dekoninck)

RMNH = Nationaal Natuurhistorisch Museum (“Naturalis”), Leiden, Netherlands (J. van Tol, Y. van Nierop)

USNM = National Museum of Natural History, Washington D.C., U.S.A. (S. McKamey)

## Results

Class Hexapoda Blainville, 1816

Order Hemiptera Linnaeus, 1758

Suborder Auchenorrhyncha Duméril, 1806

Infraorder Fulgoromorpha Evans, 1946

Superfamily Fulgoroidea Latreille, 1807

Family Fulgoridae Latreille, 1807

Genus *Pyrops* Spinola, 1839

*Pyrops* Spinola, 1839: 231. Type species: *Pyrops candelaria* (Linnaeus, 1758) by subsequent designation by Duponchel (1840: 200).

*Hotinus* Amyot & Serville, 1843: 490 [synonymized by Blanchard 1845: 425]. Type species: *Pyrops candelaria* (Linnaeus, 1758) by original designation.

## Diagnostic characters

The characters defining the genus as given by Lallemand (1963) under *Fulgora* are here slightly modified, i.e., head with cephalic process, sometimes very long, narrowing progressively beyond the eyes; apically it can be dilated or even spherical. Vertex about 4 times as broad as an eye. Before eyes, genae truncate with a transverse carina which sometimes extends to vertex. Two longitudinal carinae on frons, a third median one starting on base of cephalic process. Fronto-clypeal suture usually slightly bisinuate; median carina on clypeus. Pronotum with median carina (sometimes obsolete) and a small but strongly impressed point on each side of it. Mesonotum with median and peridiscal carinae, sometimes obsolete. Tegmina at most 3 times as long as broad, with apical margin more or less rounded and with transverse veinlets on all surfaces. Clavus open and elongate, vein A1+A2 extending far towards apex. Legs slender.

## The *effusus* species group

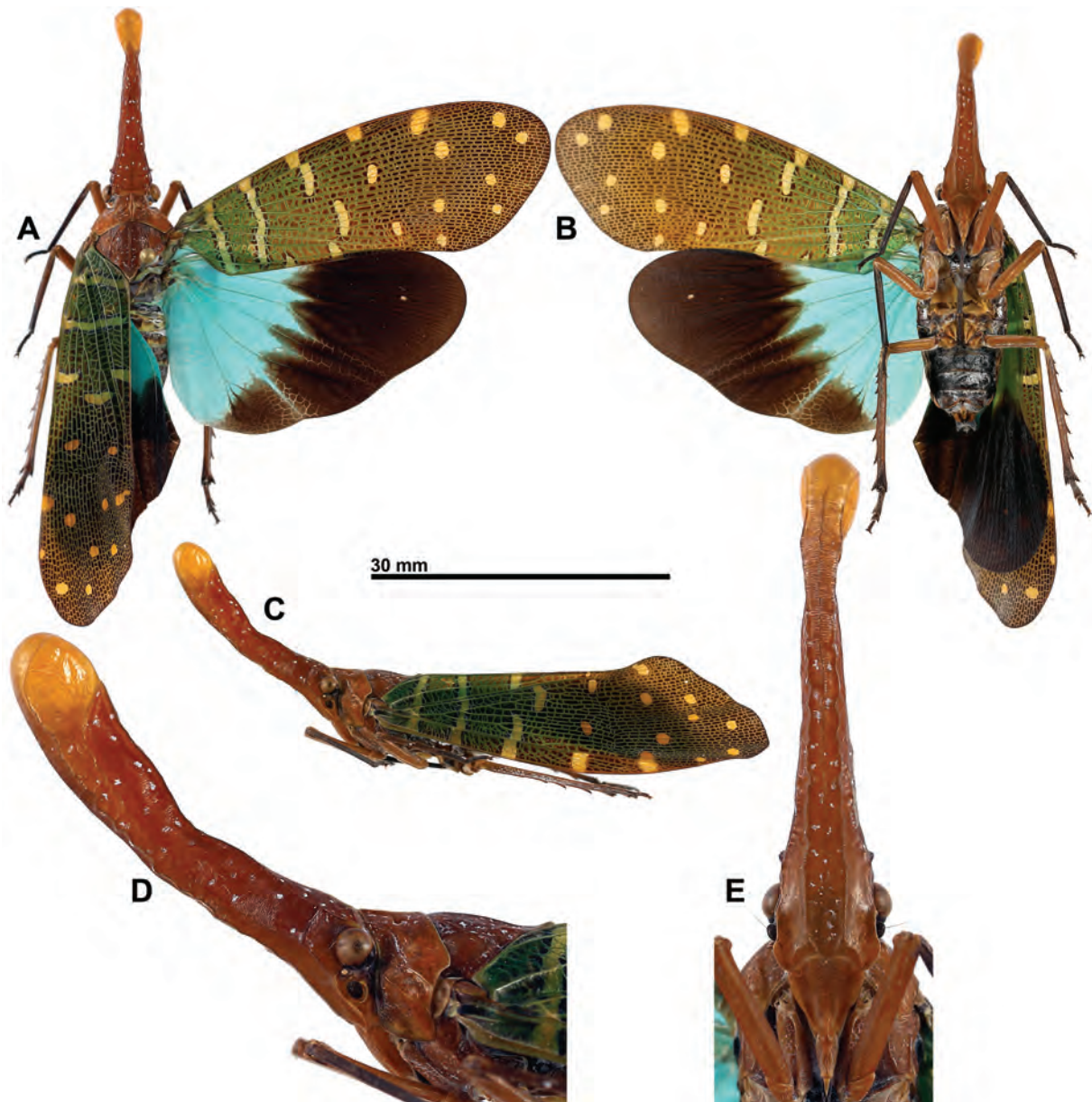
The characters of this very consistent group mainly follow Baker's (1925: 348) definition: (1) medium sized species; (2) cephalic process very short, clavate, bent in middle, strongly curved upwards, and with at least apical half blue or green; (3) tegmina green or blue basally, with yellow dots or markings; (4) hind wings blue basally and broadly black apically, the black colour extending towards the base along the main veins; (5) legs brown.

As compared to the list of included species given by Nagai & Porion (1996), *Pyrops cyanirostris* (Guérin-Méneville, 1845) and *P. maquilinganus* (Baker, 1925) are here removed from the *effusus* group, the first because it does not match characters (3) and (4), the latter because it does not match characters (2), (4) and (5). *P. maquilinganus* is returned to the *candelaria* group as originally proposed by Baker (1925); *P. cyanirostris* cannot be attributed to any of the currently defined species groups in *Pyrops*.



All 4 species included here in the group are restricted to Borneo and adjacent islands. Noteworthy, *P. cyanirostris* is recorded from Java (Guérin-Méneville 1845) and Sumatra (Nagai & Porion 1996) and *P. maquilanganus* from the Philippines (Baker 1925).

The group seems to be close to the *pyrorhynchus* species group which shares characters (3) and (4), but contains large sized species with an elongate cephalic process. However, the cephalic process in the latter group is also bent in the middle – even if not so strongly curved upwards – and slightly dilated apically like in *effusus* group. In some way the members of the *effusus* group could be regarded as dwarfed members of the *pyrorhynchus* group.



**Fig. 1.** *Pyrops intricatus* ♀, Kalimantan, Mt Bawan (RBINS). **A.** Habitus, dorsal view. **B.** Habitus, ventral view. **C.** Habitus, lateral view. **D.** Head and thorax, lateral view. **E.** Frons, normal view. Scale bar = 30 mm (D–E not to scale).

Noteworthy, of all members of the *pyrorhynchus* group, the Bornean species *P. intricatus* (Walker, 1857) (Fig. 1) shows the greatest affinities in the pattern of the tegmina with the *effusus* group.

### Identification key to the species of the *effusus* group

A Bornean species pertaining to the *pyrorhynchus* group, but sharing a number of characters with the species of the *effusus* group, *P. intricatus* (cf. above), is included in the key and illustrated to avoid misidentifications.

- 1 Head with cephalic process longer than half of tegmen (Fig. 1A, C); cephalic process slightly curved upwards, brown with bright yellow apex, without blue or green (Fig. 1D–E); ratio LPr/LF > 4; LPr/BPrH > 9 ..... ***P. intricatus*** (Walker, 1857) [*pyrorhynchus* group]
- Head with cephalic process shorter than half of tegmen (Figs 2A, C, 4A, C); cephalic process strongly curved upwards, at least partly green or blue (Figs 2D–E, 4D–E); ratio LPr / LF < 2.5; LPr/BPrH < 7... .. **2**
- 2 Basal half of head yellow-brown, strongly contrasting with green or blue apical half of cephalic process (Fig. 2A, C) ..... **3**
- Head unicolorous blue or green, at best slightly paler basally (Figs 4A, C, 5A, C) ..... **4**
- 3 Tegmina green on basal half, getting progressively more yellow on membrane, infusate along apical margin; spots on tegmina yellow and rather large, visible on membrane (Fig. 2A) ..... ***P. effusus*** (Distant, 1891)
- Tegmina with basal half dark blue-green followed by a contrasting large oval yellow patch and broadly dark brown along apical margin; spots on tegmina pale yellow-white and rather small, getting indistinct on membrane (Fig. 3A) ..... ***P. gunjii*** (Satô & Nagai, 1994)
- 4 Tegmina with transverse yellow bands on corium, the basal one complete (Fig. 4A); pro- and mesonotum concolorous (Fig. 4A); head dark olivaceous blue-green (Fig. 4A, D–E) ... ***P. synavei*** sp. nov.
- Tegmina with small round yellow spots (Fig. 5A); pronotum yellow to orange, mesonotum dark blue-green (Fig. 5A); head bright blue (often faded in collection specimens) (Fig. 5A, D–E) ..... ***P. whiteheadi*** (Distant, 1889)

#### ***Pyrops effusus*** (Distant, 1891)

Figs 2A–E, 6–7A–C, 10A, C–F

*Fulgora effusa* Distant, 1891: 518, pl. XX, figs 4, 4a (Type in NHM) [described, illustrated and compared with *P. whiteheadi* (Distant, 1889)].

*Fulgora viridicastanea* Baker, 1925: 359, pl. 3, fig. 5, pl. 4 fig. 8 (Type in USNM) [described, illustrated and compared with *P. whiteheadi* erroneously mentioned and illustrated as “*Fulgora effusa*”]. Synonymized under *P. effusus* by Nagai & Porion (2004).

*Fulgora effusa* – Schmidt 1905: 349 [comparative note with other species]; 354 [mention of a specimen in the Stettiner Museum]. — Lallemand 1963: 88 [synonymized under *whiteheadi* (erroneous)]. — Liang 1998: 45 [listed as junior synonym of *P. whiteheadi* (erroneous)].

*Pyrops effusa* (sic!) – Schmidt 1926: 47 [transferred to *Pyrops*; compared with *P. peltzeri* Schmidt, 1926, the latter synonymized under *P. pythicus* (Distant, 1891) by Lallemand (1963)]. — Nagai & Porion 1996: 26 [transferred back to *Pyrops*; catalogued as junior synonym of *P. whiteheadi* (erroneous)], pl. 11, fig. 163 [type of *P. effusus* illustrated under the name of *P. whiteheadi*]. — Nagai & Porion 2004: 6 [removal from synonymy with *P. whiteheadi*; notes on morphology; senior synonym of *P. viridicastaneus* and distribution], pl. 1, figs 2, 4 [illustrated from 2 localities].

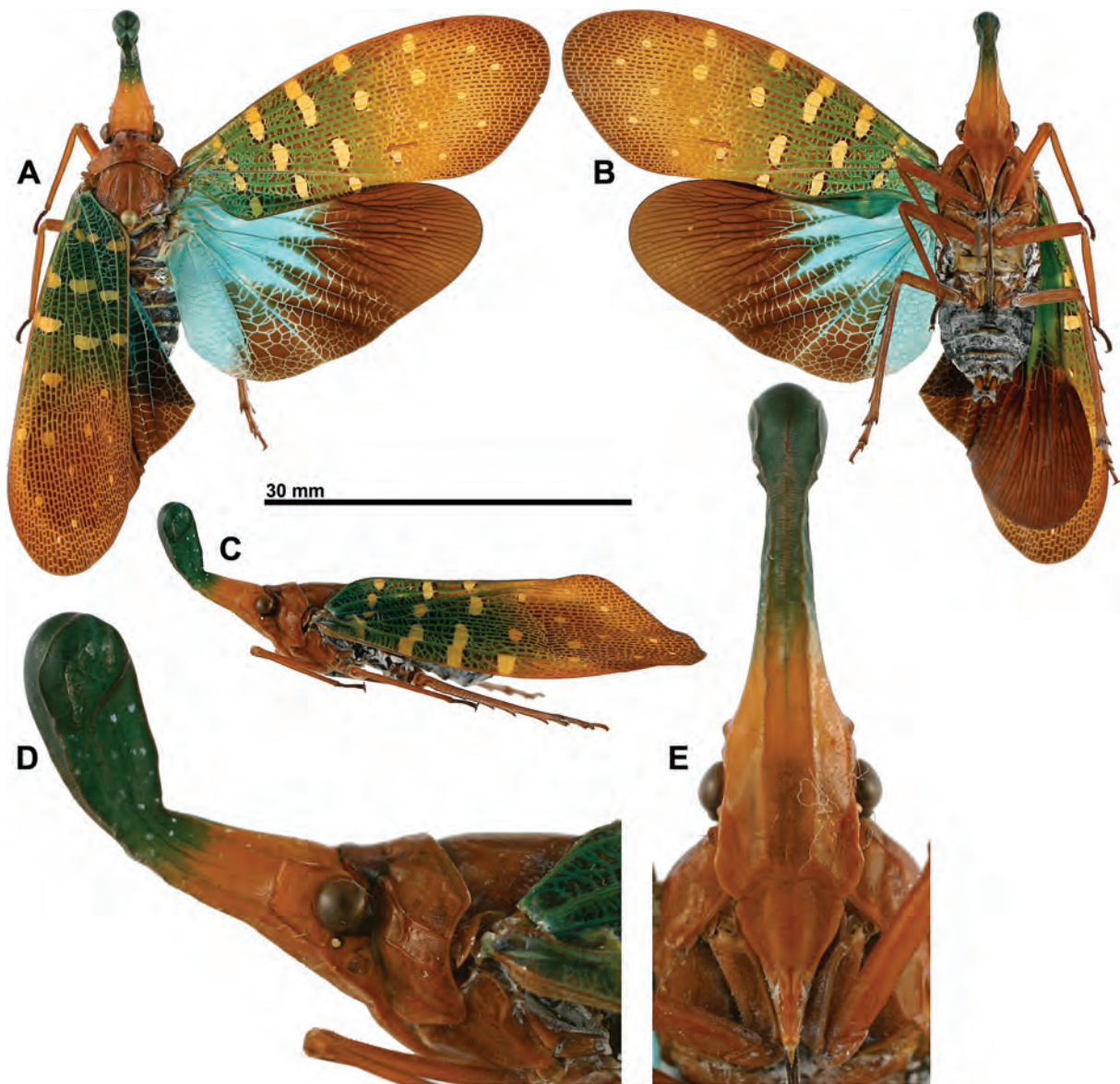
*Laternaria effusa* – Metcalf 1947: 196 [transferred to *Laternaria*; catalogued]. — Liang 1998: 45 [listed as junior synonym of *P. whiteheadi* (erroneous)].

*Laternaria viridicastanea* – Metcalf 1947: 207 [transferred to *Laternaria*; catalogued]. — Liang 1998: 45 [listed as junior synonym of *P. whiteheadi* (erroneous)].

*Fulgora viridicastanea* – Lallemand 1963: 88 [synonymized under *P. whiteheadi* (erroneous) and compared with *P. whiteheadi* and *P. effusus*; transferred back to *Fulgora* (erroneous)]. — Liang 1998: 45 [listed as junior synonym of *P. whiteheadi* (erroneous)].

*Fulgora whiteheadi* – Lallemand 1963: 88, pl. X, figs 11–13 [keyed, comments illustration of male genitalia (based on misidentified specimens of *P. effusus*)].

*Fulgora whiteheadi viridicastanea* – Satô & Nagai 1994 [considered as a subspecies of *P. whiteheadi* (erroneous) and compared with “*Fulgora whiteheadi gunjii*”].



**Fig. 2.** *Pyrops effusus* ♀, Kalimantan, Batulicin (RBINS). **A.** Habitus, dorsal view. **B.** Habitus, ventral view. **C.** Habitus, lateral view. **D.** Head and thorax, lateral view. **E.** Frons, normal view. Scale bar = 30 mm (D–E not to scale).



*Pyrops viridicastanea* – Nagai & Porion 1996: 26 [transferred back to *Pyrops*; catalogued as junior synonym of *P. whiteheadi* (erroneous)]. — Nagai & Porion 2004: 6 [synonymized under *P. effusus*, notes].

*Pyrops whiteheadi* (Distant, 1889) – Nagai & Porion 1996, pl. 11, fig. 163 [illustration of the type of *P. effusus* (Distant, 1891)].

non *Fulgora effusa* – Baker 1925: 359, pl. 3, fig. 4, pl. 4, fig. 7 [described, illustrated (misidentification of *Pyrops whiteheadi*)].

### Diagnosis

In addition to the characters defining the *effusus* group, the species can be recognized by: (1) head yellow-brown with apical half of cephalic process blue (often faded to greenish in collection specimens) (Fig. 2D–E); (2) pro- and mesonotum yellow-brown (Fig. 2A); (3) tegmina green with yellow spots also beyond nodal line; on basal half, spots transverse and sometimes coalescent (Fig. 2A); (4) tegmina without large pale yellow patch at nodal line and apical margin slightly infusate (Fig. 2A).

### Material examined

#### Type material

INDONESIA: Holotype of *Fulgora effusa* (examined on photographs), ♂: [Borneo] [*effusa* Dist.] [Distant Coll. 1911—383.] (BMNH).

INDONESIA: Holotype of *Fulgora viridicastanea* (examined on photographs, Fig. 10C–F), ♀: [Banjermassin, Borneo] [*Fulgora viridicastanea* Baker] (USNM).

#### Additional material

INDONESIA: 2 ♂♂, 2 ♀♀: Kalimantan, Batulicin, Apr. 2008 (RBINS); 2 ♂♂: Laut Island, Jan. 2008 (RBINS); 1 ♀, Laut Island, Jun. 2004 (RBINS); 1 ♂, E-Borneo, Midden, 10 Oct. 1925, H.C. Siebers (FSAG); 1 ♂, idem, 4 Oct. 1925 (FSAG); 1 ♂, SE Borneo, Atkinson coll. (BMNH); 1 ♂, 1 ♀, Borneo, 1909 (BMNH); 1 ♀, North Borneo (BMNH).

#### Examined on photograph

INDONESIA: 1 specimen (Fig. 10A), Kalimantan, Wehea Protected Forest, 25 Sep. 2010, Kara Norby.

### Measurements and ratios

TL: ♂ (n = 4): 35.1 mm (34.3–36.0); ♀ (n = 2): 40.2 mm (40.0–40.5); TL+process: ♂ (n = 4): 42.5 mm (41.0–43.2); ♀ (n = 2): 46.7 mm (46.4–47.0); LTg/BTg = 2.33; BF/BPrH = 3.0; LPr/LF = 2.18; LPr/BPrH = 6.92.

### Male genitalia

Pygofer and anal tube dark brown; gonostyli brown, paler dorsally and dark brown basoventrally. Pygofer higher than long, with posterior margin sinuate in lateral view (Fig. 7A). Anal tube slightly elongate, 1.20 times as long as broad, broader at 2/3 of total length (Fig. 7A–B); lateral margins slightly sinuate (Fig. 7B) and apical margin strongly notched in dorsal view (Fig. 7B). Gonostyli (Fig. 7A) elongate with posterior margin broadly rounded (Fig. 7A, C).

### Distribution

Known from Borneo, South Kalimantan and southern East Kalimantan, and Laut Island (Fig. 6).



### Biology

No host tree has been identified for this species, for which records are available for the months January, April, June, September and October.

### Note

Nagai & Porion (2004) mentioned the existence of 2 types of specimens showing (1) strongly and (2) weakly contrasted colour of the tegmina and illustrated both (Nagai & Porion 2004: figs 2, 4). They mentioned the strongly contrasted ones from Laut Island and Kutai, and the weakly contrasted ones from Loksado (confirmed by the examination of the specimens in MHNL collections by H. Labrique, pers. comm. Mar. 2015). Since then strongly contrasted specimens were found in several locations on Borneo and weakly contrasted ones on Laut Island, which seems to confirm that they occur together. The occurrence of pale and dark forms in the same species was already known from other species of *Pyrops*, e.g., *P. sultanus* (Adams & White, 1847) (see also Nagai & Porion 1996: figs 189, 191), and *P. lathburii* (Kirby, 1818) (see also Nagai & Porion 1996: figs 194, 196, 198).

### *Pyrops gunjii* (Satô & Nagai, 1994) stat. nov.

Figs 3A–E, 6, 8A–C, 10B

*Fulgora whiteheadi gunjii* Satô & Nagai 1994: 308, figs 2, 9 (Type in EUM) [described, illustrated and compared with *P. whiteheadi* and *P. effusus*, the latter mentioned as “*F. whiteheadi viridicastanea*”].

*Pyrops whiteheadi gunjii* – Nagai & Porion, 1996: 26, pl. 17, fig. 210 [transferred to *Pyrops*; listed, illustrated]. — Liang 1998: 45 [listed, erroneous mention of new combination already proposed by Nagai & Porion (1996)].

### Diagnosis

In addition to the characters defining the *effusus* group, the species can be recognized by: (1) head yellow-brown with apical half of cephalic process blue (often faded to green in collection specimens) (Fig. 3D–E); (2) pro- and mesonotum yellow-brown (Fig. 3A); (3) tegmina dark blue-green on corium, with small yellow-white spots; on basal half, spots slightly transverse and rarely coalescent, spots barely distinct on membrane (Fig. 3A); (4) tegmina with large pale yellow-brown patch at nodal line and apical margin broadly infusate (Fig. 3A).

### Material examined

#### Type material

Holotype ♂ (examined on photographs): [Embalut, E. Kalimantan, INDONESIA, Sep. 22. 1988] [Holotype *Fulgora whiteheadi gunjii*, M. Sato & S. Nagai, 1994] (EUM).

Note: Satô & Nagai (1994) stated that the type was collected by S. Okada and suggested that the type location was probably “Ambalut, Samarinda” rather than “Embalut”.

#### Additional material

INDONESIA: 2 ♂♂, E Kalimantan, Samarinda, Mt Beratus, Aug. 2006, S. Jakl (RBINS); 1 ♀, no data (RMNH).

#### Examined on photographs

INDONESIA: 1 specimen (Fig. 10B), East Kalimantan, 0°32'4.70"S 117°27'46.73"E, 3 Jul. 2011, Martin Hauskrecht; 1 specimen, East Kalimantan, Kutai National Park, 7 Jan. 2009, Martin Dancak; 1 specimen, East Kalimantan, Kutai National Park, 26 Sept. 2009, “Sophie & Dale”; 1 specimen, East

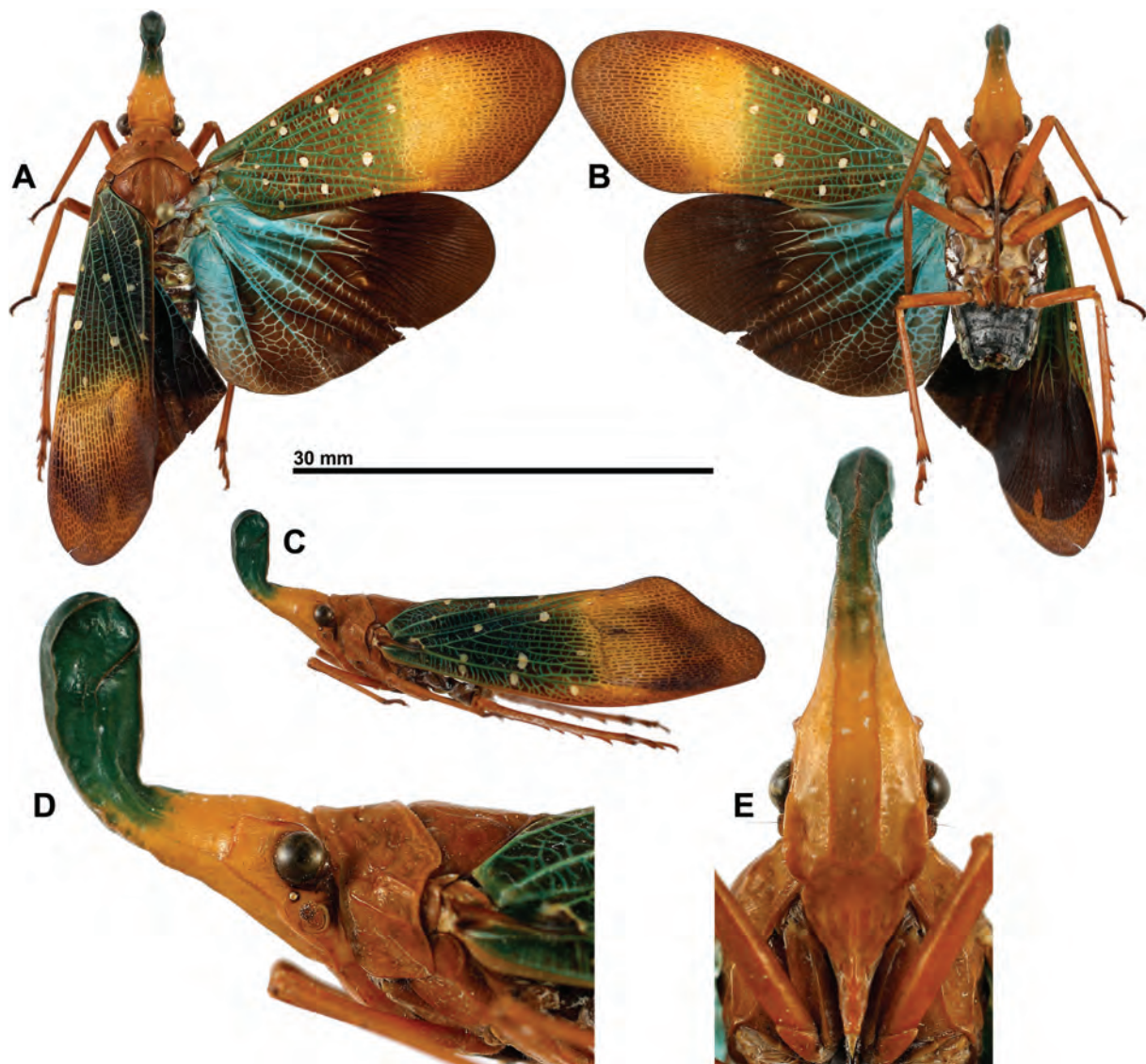
Kalimantan, Kutai National Park, 28 Jan. 2010, Darwyn Moffatt-Mallett; 1 specimen, East Kalimantan, Penajam Paser Utara, 17 Mar. 2010, “Emjanda”.

#### Measurements and ratios

TL: ♂ (n = 2): 35.1 mm (34.5–35.6); ♀ (n = 1): 38.6 mm; TL+process: ♂ (n = 2): 39.7 mm (39.0–40.3); ♀ (n = 1): 44.0 mm; LTg/BTg = 2.53; BF/BPrH = 3.0; LPr/LF = 1.88; LPr/BPrH = 6.97.

#### Male genitalia

Dark brown with gonostyli paler dorsally. Pygofer higher than long, with posterior margin sinuate in lateral view (Fig. 8A). Anal tube slightly elongate, 1.10 times as long as broad, broader at  $\frac{4}{5}$  of total length (Fig. 8A–B); lateral margins slightly sinuate (Fig. 8B) and apical margin strongly notched in dorsal view (Fig. 8B). Gonostyli (Fig. 8A) elongate with posterior margin roundly pointed (Fig. 8A, C).



**Fig. 3.** *Pyrops gunjii* ♂, E Kalimantan, Samarinda, Mt Beratus (RBINS). **A.** Habitus, dorsal view. **B.** Habitus, ventral view. **C.** Habitus, lateral view. **D.** Head and thorax, lateral view. **E.** Frons, normal view. Scale bar = 30 mm (D–E not to scale).

### Distribution

Known from Borneo, south-eastern East Kalimantan (Fig. 6).

### Biology

No host tree has been identified for this species, for which records are available from the months of January, March, July, August and September.

### Remarks

The species epithet refers to the Japanese entomologist Mr Yoshiaki Gunji.

*Pyrops synavei* sp. nov.

[urn:lsid:zoobank.org:act:B502AF69-AEC2-4245-B440-57F75BF8559E](https://zoobank.org/urn:lsid:zoobank.org:act:B502AF69-AEC2-4245-B440-57F75BF8559E)

Figs 4A–E, 6, 11A–D

### Diagnosis

In addition to the characters defining the *effusus* group, the species can be recognized by: (1) head entirely dark olivaceous blue-green (Fig. 4D–E); (2) pro- and mesonotum bluish-brown (Fig. 4A); (3) tegmina green with yellow spots also beyond nodal line; on corium, basal row of spots fused in a transverse band, next rows fused into incomplete transverse bands (Fig. 4A); (4) tegmina without large pale yellow patch at nodal line and apical margin very slightly infusate (Fig. 4A).

### Etymology

The species epithet refers to the late Belgian hemipterist Henry Synave (1921–1981). He was the author of numerous publications on Auchenorrhyncha, and of all drawings of Lallemand's revisions of the Fulgoridae (1959, 1963).

### Material examined

#### Type material

INDONESIA: Holotype, ♀: [N.O. Borneo, S. Peleben, 7.u.8.1935, Baron Plessen] [R.I.Sc.N.B., I.G. 23.860] [H. Synave det., 1968, *Laternaria intricata* Walk.] (RBINS). Coordinates of S Peleben: 2°47'N 116°35'E.

#### Examined on photographs

1 specimen (Fig. 11A–B): Kalimantan, Long Alango, Lalut Birai Sacred Forest, 2 Sep. 2011, Joost Woltering; 1 specimen (Fig. 11C–D): Kalimantan, Lalut Birai Forest, 13 Mar. 2009, Dave Forney. Coordinates of Lalut Birai Forest: 3°12'N 115°30'E.

### Measurements and ratios

TL: ♀ (n = 1): 40.9 mm; TL+process: ♀ (n = 1): 47.7 mm; LTg/BTg = 2.50; BF/BPrH = 2.78; LPr/LF = 2.48; LPr/BPrH = 6.78.

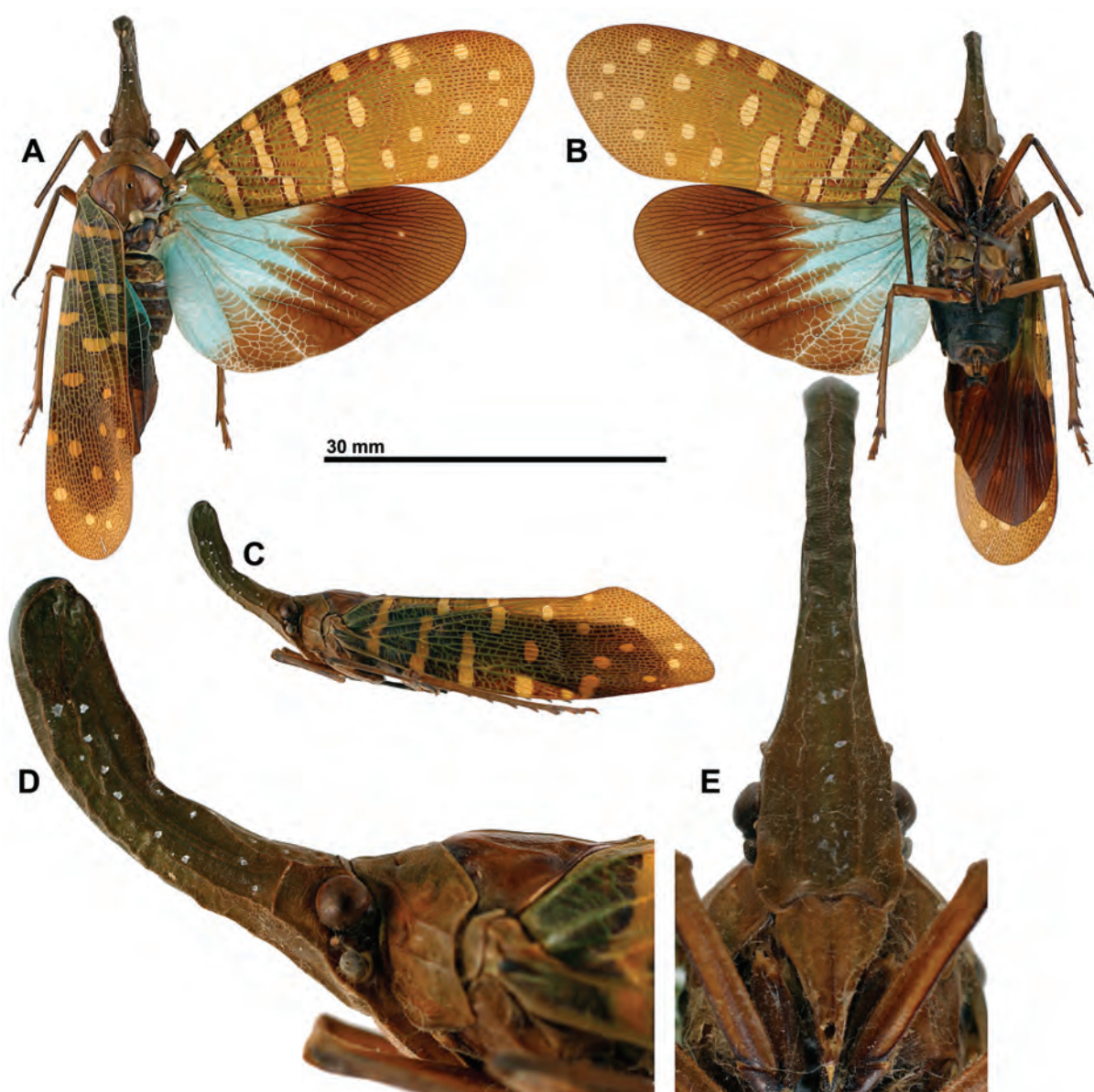
### Description

HEAD. Dark olivaceous blue-green progressively turning more brownish basally (Fig. 4A, D–E). Cephalic process slightly longer than frons and clypeus together in normal view of frons (Fig. 4E), strongly curved anterodorsad and bent in middle dorsally (Fig. 4D); apical half slightly dilated and rounded apically in lateral view (Fig. 4D), with sides parallel in anteroventral view (Fig. 4E). Two longitudinal carinae on frons extending on sides of cephalic process up to apex, undulated. Median, ventral undulated



carina on apical half of cephalic process (Fig. 4E). Frons subquadrate (Fig. 4E). Clypeus elongate with smooth median carina. Labium brown-black, slightly surpassing posterior trochanter. Antennae brown.

THORAX (Fig. 4A, D). Olivaceous brown, pro- and mesonotum greener in middle. Pronotum irregularly wrinkled with smooth longitudinal carina and 2 strongly impressed points on anterior half of disc (Fig. 4A), dorsolateral and lateral carinae well marked (Fig. 4A, D). Mesonotum with disc wrinkled and sides smooth; 3 smooth longitudinal carinae not reaching anterior margin, median one reaching base of scutellum posteriorly; slight impression along posterior margin at base of scutellum; scutellum slightly elevated apically. Tegulae olivaceous brown.



**Fig. 4.** *Pyrops synavei* sp. nov. ♀, holotype (RBINS). **A.** Habitus, dorsal view. **B.** Habitus, ventral view. **C.** Habitus, lateral view. **D.** Head and thorax, lateral view. **E.** Frons, normal view. Scale bar = 30 mm (D–E not to scale).



TEGMINA (Fig. 4A). Dark green-brown with veins green turning to brown near apical margin. 3 more or less interrupted transverse yellow bands on corium; more basal one complete; median **one** sometimes cut at costal vein or/and claval suture; third band in 2–3 parts often not aligned. Row of 3 more or less oval yellow spots on nodal line. Yellow markings on corium and nodal line bordered with dark brown. 8–9 round yellow spots on membrane. Apical margin oblique with angles broadly rounded; costal margin slightly rounded.

HIND WINGS (Fig. 4A). Bright blue with apex and sutural margin largely brown-black; brown black extending into blue along main veins; cross-veinlets blue in brown-black area on baso-sutural half. Hind wings slightly broader than tegmina.

LEGS (Fig. 4A–B). Dark olivaceous brown. Metatibiae with 6 lateral and 7 apical spines.

ABDOMEN (Fig. 4A–B). Tergites brown-black; sternites black; genital segments tinged with yellow-brown.

### Distribution

Known from Borneo, North Kalimantan (see map Fig. 6).

### Biology

No host tree has been identified for this species for which records are available from the months of March, July – August and September.

#### *Pyrops whiteheadi* (Distant, 1889)

Figs 5A–E, 6, 9A–C, 12A–E

*Fulgora whiteheadi* Distant 1889: 422 (Type in NHM) [described and compared to *P. delesserti* (Guérin-Méneville, 1840)].

*Fulgora whiteheadi* – Distant 1891: 518 [compared to *P. effusus*]. — Lallemand 1963: 88 [considered as senior synonym of *P. effusus* and *P. viridicastaneus* (erroneous); described, keyed; interpretation of the species mixing *P. effusus* and *P. whiteheadi*]. — Satô & Nagai 1994: 308 [compared with *P. gunjii*].

*Fulgora effusa* – Baker 1925: 359 [comparison between *P. effusus* and *P. whiteheadi* based on specimens of *P. whiteheadi* erroneously identified as *P. effusus*].

*Laternaria whiteheadi* – Metcalf 1947 [transferred to *Laternaria*; catalogued].

*Pyrops whiteheadi* – Nagai & Porion 1996: 26 [transferred to *Pyrops*; listed], pl. 11, fig. 160 [type illustrated]. — Liang 1998: 45 [listed]. — Nagai & Porion 2004: 6 [comparison with *P. effusus*], pl. 1, fig. 6 [illustration of habitus].

non *Fulgora whiteheadi* – Lallemand 1963: pl. X, figs 11–13 [illustration of the genitalia of *P. effusus* erroneously identified as *P. whiteheadi*].

non *Pyrops whiteheadi* – Nagai & Porion 1996: pl. 17, fig. 213 [illustration of a specimen of *P. effusus* erroneously identified as *P. whiteheadi*].

### Diagnosis

In addition to the characters defining the *effusus* group, the species can be recognized by: (1) head entirely blue (often faded to greenish in collection specimens) (Fig. 5D–E); (2) pronotum yellow-brown, mesonotum blue-brown (Fig. 5A); (3) tegmina green with small yellow spots also beyond nodal line;

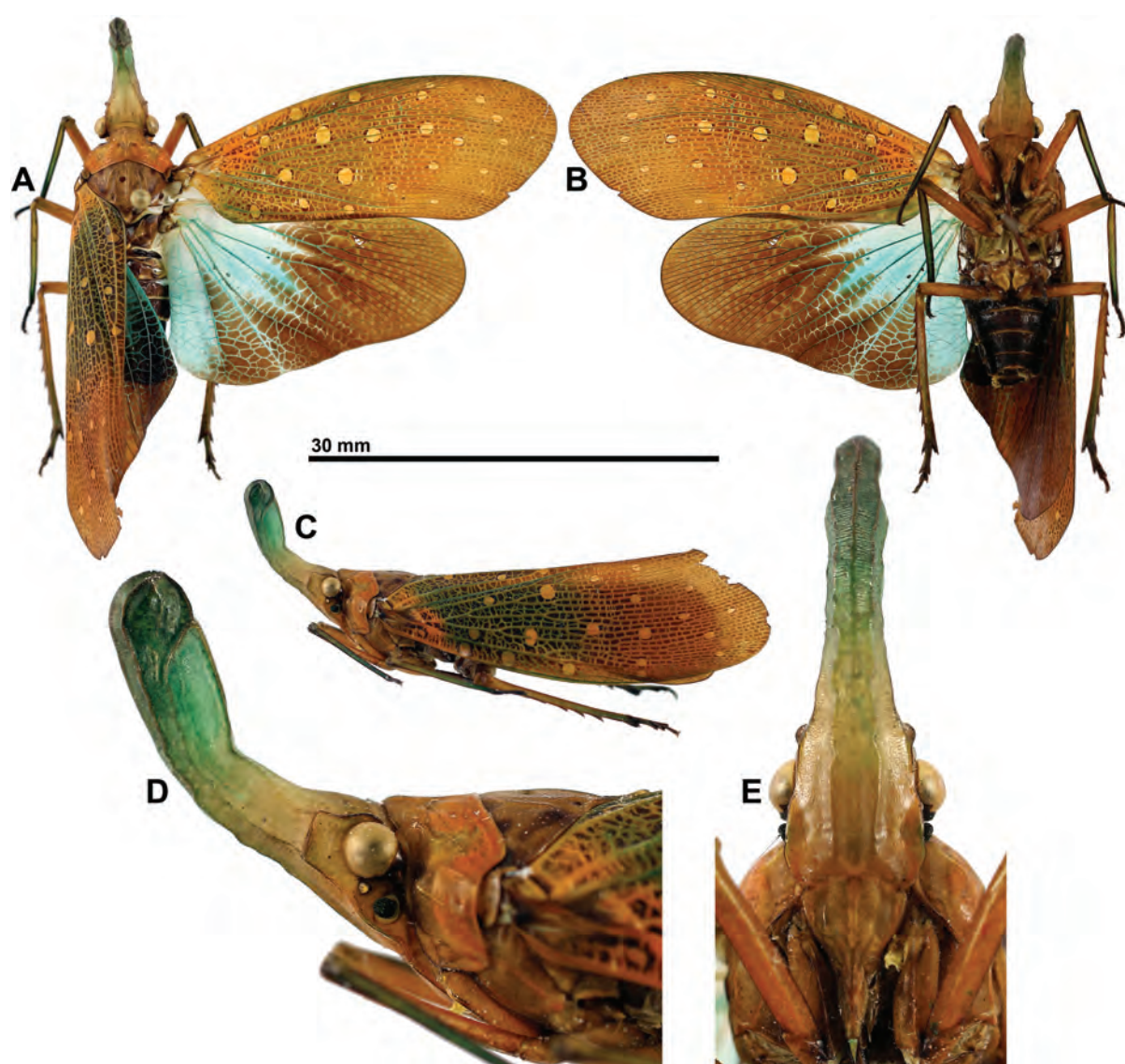
spots rounded and not coalescent (Fig. 5A); (4) tegmina without large pale yellow patch at nodal line and with apical margin slightly infusate (Fig. 5A).

#### Material examined

##### Type material

MALAYSIA: Lectotype: ♂, here designated to provide a reference standard for the species (examined on photographs): East Malaysia, [Kina Balu (Whitehead)] [*Whiteheadi* Dist.] [Distant Coll. 1911—383.] [Type] (BMNH).

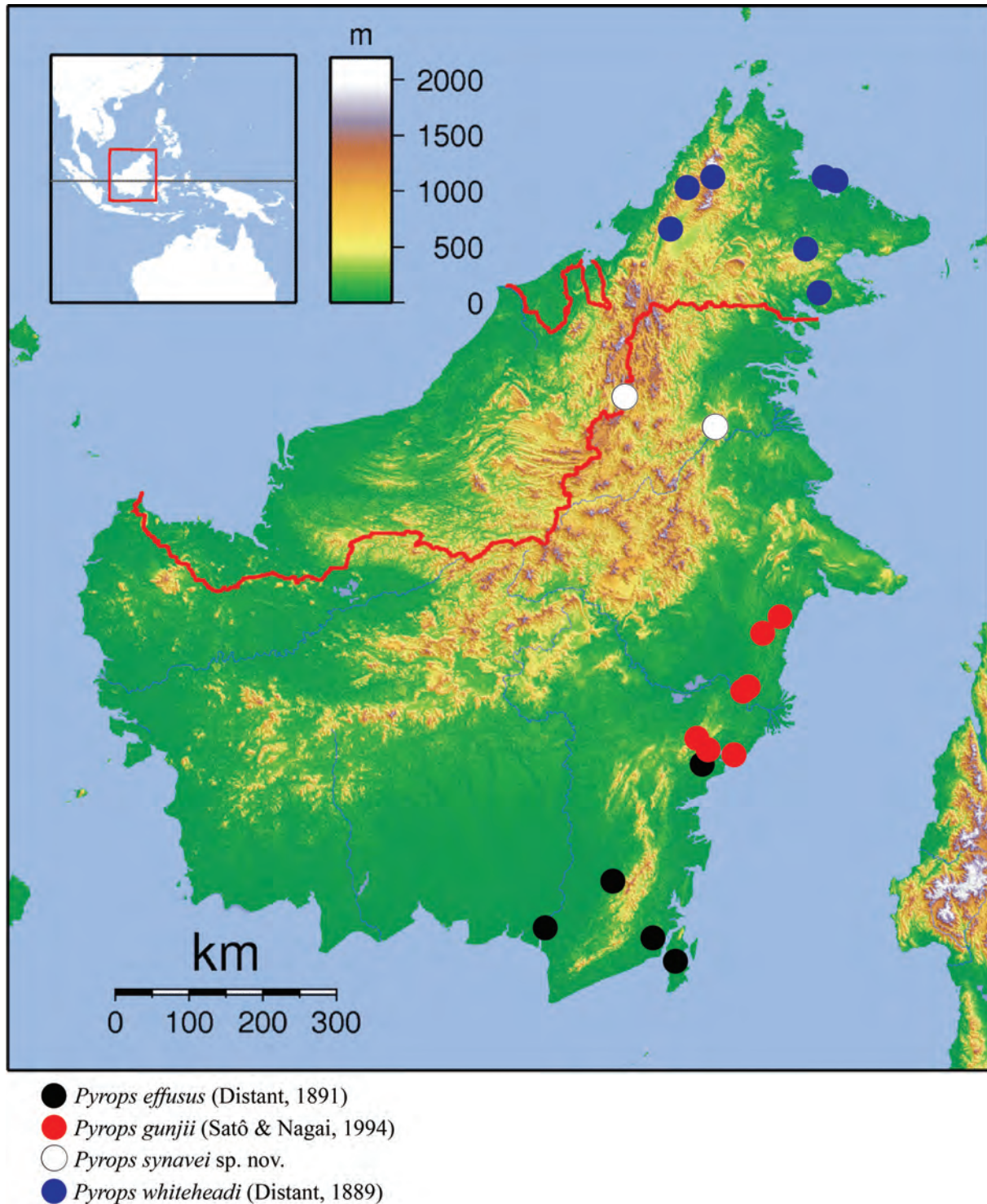
MALAYSIA: Paralectotypes: 2 ♂♂, 2 ♀♀ (examined on photographs): East Malaysia, [Kina Balu (Whitehead)] [*Whiteheadi* Dist.] [Distant Coll. 1911—383.] (BMNH).



**Fig. 5.** *Pyrops whiteheadi* ♂, Sabah, Danum Valley (RMNH). **A.** Habitus, dorsal view. **B.** Habitus, ventral view. **C.** Habitus, lateral view. **D.** Head and thorax, lateral view. **E.** Frons, normal view. Scale bar = 30 mm (D–E not to scale).

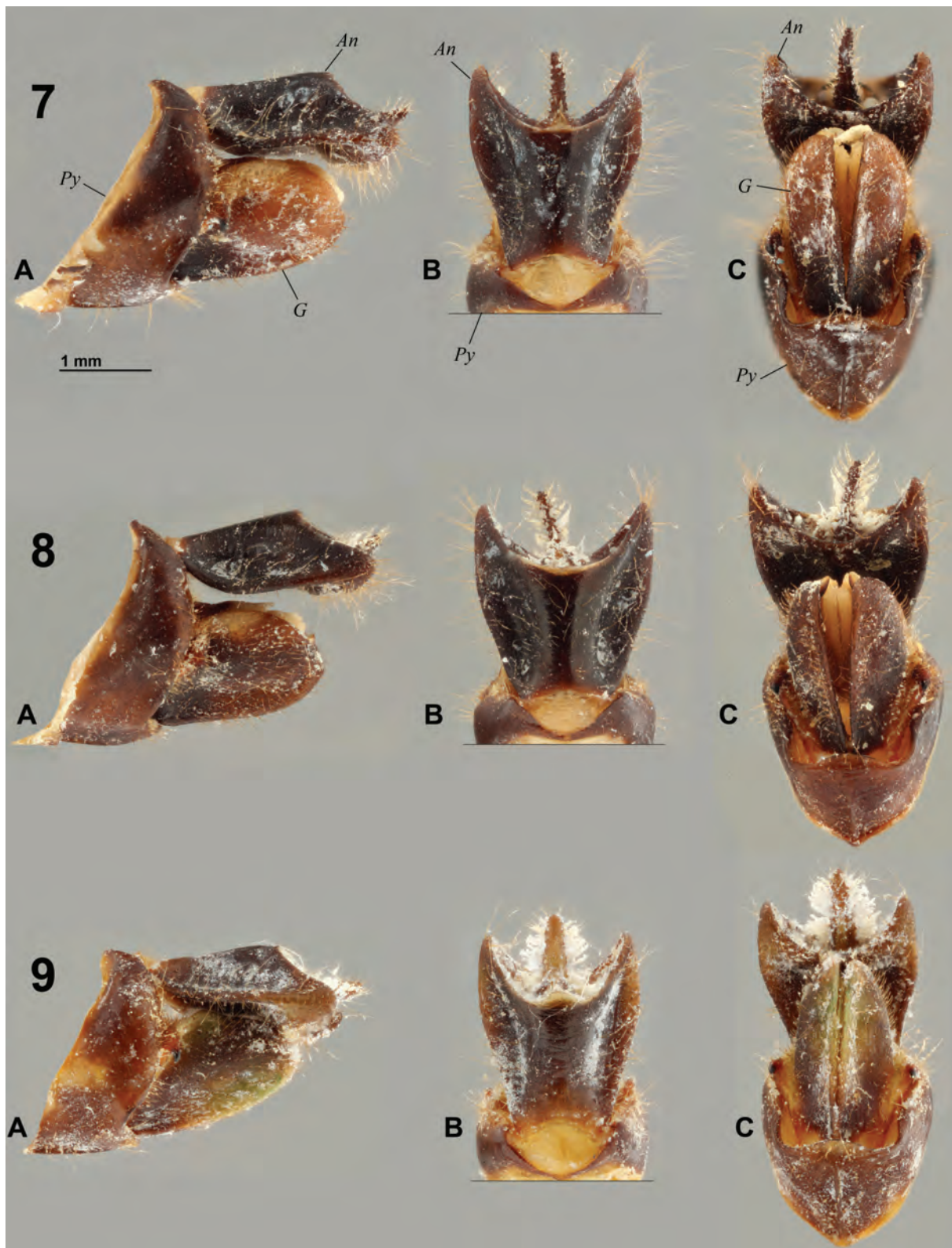
**Additional material**

MALAYSIA: 1 ♂, Sabah, Kinabalu National Park, Poring Hot Spring, 21 Apr. 1999, T. Trilar (RBINS); 1 ♀, Sabah, 23 km W of Sandakan, Sepilok tree tower, 5°49'N 118°06'E, 1 Nov. 1987, 0–100 m, J. Huisman & R. de Jong (RMNH); 1 ♂, Sabah, Danum Valley, 70 km W of Lahad Datu, rainforest along narrow stream, at light, next to bridge Nature Trail, 50 m, 1 Dec. 1989, M.J. & J.P. Duffels (RMNH).



**Fig. 6.** *Pyrops effusus* group, distribution map.





**Figs 7–9.** *Pyrops effusus* group, ♂ genitalia. 7. *Pyrops effusus*. 8. *Pyrops gunjii*. 9. *Pyrops whiteheadi*. — A. Lateral view. B. Dorsal view. C. Posteroventral view. An = anal tube, G = gonostylus, Py = pygofer. Scale bar = 1 mm. Photographs by J. Brecko.



**Note**

One specimen labelled: Selangor, Banting, 2 Oct. [19]89, Ismail & Ruslan in the collections of BMNH, has been examined on photograph. The location is in West Malaysia and the specimen is assumed to be mislabelled.



**Fig. 10.** — **A.** *Pyrops effusus*, in natura, Borneo, Kalimantan, Wehea Protected Forest, 25 Sep. 2010, K. Norby. — **B.** *Pyrops gunjii*, in natura, Borneo, East Kalimantan, 0°32'4.70"S 117°27'46.73"E, 3 Jul. 2011, M. Hauskrecht. — **C–F.** *Fulgora viridicastanea*, holotype (Photographs A. Kennedy). **C.** Dorsal view. **D.** Left lateral view. **E.** Head, normal view of frons. **F.** Labels.

**Examined on photographs**

EAST MALAYSIA: 1 specimen (Fig. 12A–B), Sabah, Danum Valley, 4 Jul. 2013, Anton Sorokin; 1 specimen, idem, 13 Jun. 2013; 1 specimen, idem, 3 Oct. 2010, Hok Ping Guek; 1 specimen, idem, 4 Oct.



**Fig. 11.** *Pyrops synavei* sp. nov. in natura. **A–B.** Borneo, Kalimantan, Long Alango, Lalut Birai Sacred Forest, 2 Sep. 2011, J. Woltering. **C–D.** Borneo, Kalimantan, Lalut Birai Forest, 13 Mar. 2009, D. Forney.



2013; 1 specimen, idem, 18 Aug. 2008, Thomas Bridle; 2 specimens, idem, 27 Sept. 2009, Tim Moss; 1 specimen, idem, 3 Jun. 2007, Karin Saner; 1 specimen, idem, Aug. 2004, Dirk Mezger; 1 specimen (Fig. 12C), Sabah, Danum Valley, 15 Dec. 2008, Ch'ien C. Lee; 1 specimen (Fig. 12D), Sabah, Lower Kinabatangan River, 9 Aug. 2012, Nicola Messina; 1 specimen (Fig. 12E), Sabah, Sepilok, 6 Jun. 2013, Ch'ien C. Lee; 2 specimens, Keningau, 24 Sep. 2011, Khairin Saili; 2 specimens, Kinabatangan, 14 Feb. 2008, Christophe Maerten; 1 specimen, idem, 21 Jan. 2008, Andrea Ferrari; 1 specimen, idem, 17 Oct. 2009, "Pietra & Paoli"; 1 specimen, idem, 24 May 2010, Frank Joas; 1 specimen, Kinabatangan, Sukau, 12 Aug. 2011, J.M. Gayman; 1 specimen, Sandakan, 27 Mar. 2013, Gavin Golden; 1 specimen, Sandakan, Sukau, 14 Aug. 2009, Samuel Tan; 1 specimen, Taman Bukit Tawau, 17 Aug. 2012, Subki Abdul Hadi; 1 specimen, Sepilok, 1 Aug. 2010, J.P. Lawrence; 1 specimen, idem, 15 Aug. 2011.

### Measurements and ratios

TL: ♂ (n = 2): 34.8 mm (34.3–35.2); ♀ (n = 1): 38.0 mm; TL+process: ♂ (n = 2): 39.8 mm (38.7–40.9); ♀ (n = 1): 42.2 mm; LTg/BTg = 2.73; BF/BPrH = 3.0; LPr/LF = 2.5; LPr/BPrH = 5.4.

### Male genitalia

Brown with gonostyli paler dorsally and ventrally. Pygofer higher than long, with posterior margin sinuate in lateral view (Fig. 9A). Anal tube slightly elongate, 1.25 times as long as broad, broader at 4/5 of total length (Fig. 9A–B); lateral margins very slightly sinuate (Fig. 9B) and apical margin strongly notched in dorsal view (Fig. 9B). Gonostyli (Fig. 9A) elongate with posterior margin rounded, slightly narrowing (Fig. 9A, C).

### Distribution

Borneo, known from Sabah (Fig. 6).

### Biology

No host tree has been identified for this species, for which records are available from all months of the years, with a higher number of records (8/26) in August. However, we do not conclude that the species is more abundant in August; as most data are from photographs taken by tourists, it is possible that the higher amount of available data is biased by the fact that August is a holiday period in many countries.

### Notes on trophobiosis with *Pyrops whiteheadi* and *P. intricatus*

Trophobiosis with ants commonly occurs in Hemiptera, and ant-attendance involving Fulgoromorpha was reviewed by Bourgoïn (1997) who recorded the phenomenon in 5 families of Fulgoromorpha (Cixiidae, Delphacidae, Issidae, Hypochthonellidae and Tettigometridae). He recognized 4 main types of ant-attendance, from opportunistic attendance by ants to long term attendance where ants collect honeydew directly from the anal opening of the planthopper. At the time, no interaction was known to involve Fulgoridae.

Trophobiotic interactions between Fulgoridae and other animals attracted by the droplets of honeydew produced by the lanternflies were only recently reported by (1) Roth & Naskrecki (2001), involving Neotropical species of the genera *Copidocephala* Stål, 1869 and *Enchophora* Spinola, 1839, with Blattodea; (2) Naskrecki & Nishida (2007), involving Neotropical species of the genera *Copidocephala*, *Enchophora* and *Phrictus* Spinola, 1839, with Blattodea, Lepidoptera and gastropods; (3) Kemal & Koçak (2012) between *Pyrops candelaria* (Linnaeus, 1758) and the gecko *Hemidactylus platyurus* (Schneider, 1792) (Squamata: Gekkonidae) in Thailand.

Interactions between geckos (5 species belonging to 3 different genera) and another family of Fulgoroidea, Flatidae, in Madagascar, were previously reported and analyzed by Fölling *et al.* (2001).



**Fig. 12.** *Pyrops whiteheadi* and *P. intricatus*, in natura, trophobiosis. — **A–E.** *P. whiteheadi*. **A–B.** Tended by cockroaches (Blattodea, *Dorylaea*, probably *D. magna* (Schelford, 1909)), Sabah, Danum Valley, 4 Jul. 2013, A. Sorokin. **C.** Tended by small cockroach (Blattodea, Pseudophyllodromiinae), Sabah, Danum Valley, 15 Dec. 2008, C.C. Lee. **D.** Sabah, Lower Kinabatangan River, 9 Aug. 2012, N. Messina. **E.** Tended by an adult gecko, *Gehyra mutilata* (Wiegmann, 1835) (Squamata: Gekkonidae), Sabah, Sepilok, 6 Jun. 2013, C.C. Lee. — **F.** *P. intricatus* tended by cockroach (Blattodea, *Dorylaea* sp.), Sarawak, Mulu National Park, 15 Oct. 2009, C.C. Lee.



Similar interactions have been observed and documented between *Pyrops whiteheadi* and two species of Blattodea in Sabah, Danum Valley: one species of the subfamily Pseudophyllodromiinae (C.C. Lee pers. comm., Fig. 12C) and one species of the genus *Dorylaea* (A. Sorokin pers. comm., Fig. 12A–B), possibly *D. magna* (Schelford, 1909) (identifications of the Blattodea by G. Beccaloni, Dec. 2014).

Interactions between one species of gecko (Squamata: Gekkonidae), *Gehyra mutilata* (Wiegmann, 1835) (identification by O. Pauwels, Dec. 2014) and *P. whiteheadi* was also observed and documented in Sabah, Sepilok (C.C. Lee pers. comm., Fig. 12E). Geckos generally are attracted by sugar-rich food (O. Pauwels pers. comm., 2014).

Although it does not belong to the *effusus* group, I should also mention that interactions between *Pyrops intricatus* (Walker, 1857) and Blattodea of the genus *Dorylaea* have been documented in Sarawak, Mulu National Park (C.C. Lee pers. comm., Fig. 12F).

The unavailability of such observations for the three other species of the *effusus* group can probably be explained by the fact that *P. whiteheadi* and *P. intricatus* are present and apparently rather common in several preserved areas (e.g., Danum Valley, Sepilok, Kinabatangan for the first, Mulu for the second) which are extensively visited by naturalists and ecotourists, while the other species are found in more remote regions. All observations reported here come from such sources and it is likely that the same interactions will be documented for the other species in the future.

## Discussion

The present paper illustrates the critical need for taxonomic work in a spectacular and apparently well-known group of insects. The production of clear, updated and accurately illustrated identification keys, which requires an in-depth revision, including the examination of all types, is necessary to avoid further spreading of erroneous information and wrong identifications which are currently commonplace, e.g., on the internet.

The collaboration with amateur naturalists and nature photographers leads again to very interesting results (see also Constant 2014; Constant & Alisto 2015): in the present paper, many data on the distribution and biology of the species including all trophobiosis observations come from such “citizen science” sources. Some data also originate from websites and blogs whose authors are unfortunately difficult to track and contact.

Twelve species of *Pyrops* are currently recorded from Borneo (Nagai & Porion 1996, 2002, 2004). However, several of them are known from single or very few specimens and the biology, life-history and phenology of all is practically undocumented. Hopefully in the future, with the help of local biologists and citizen-scientists, it will be possible to fill those gaps. This, together with the availability of more material and the clarification of some taxonomical issues (Constant, unpublished), will allow the publication of a comprehensive key to the species of *Pyrops* from Borneo.

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