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***Phaenandrogomphus safei*, a new species from Sabah, northern Borneo (Odonata: Anisoptera: Gomphidae)**

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Abstract

Phaenandrogomphus safei is described from a male from the Kalabakan Forest Reserve, Sabah, Malaysian Borneo. It is the first species of *Phaenandrogomphus* to be recorded from Borneo. *Onychogomphus treadawayi*, known from Busuanga Island in the Palawan region of the Philippines, is transferred to *Phaenandrogomphus*.

Key words: Odonata, Anisoptera, Gomphidae, Onychogomphinae, *Phaenandrogomphus*, *safei*, *treadawayi*, new species, new combination, Borneo, Palawan, Malaysia, Philippines, Sabah

Introduction

The genus *Phaenandrogomphus* Lieftinck, 1964 has representatives from India and China to peninsular Malaysia, but no species included in the genus had been recorded from outside of mainland Asia until now. In 2013 the second author collected a small and distinctive gomphid species from a lowland dipterocarp forest stream that forms part of the Stability of Altered Forest Ecosystems (SAFE) Project research site within the Kalabakan Forest Reserve, Sabah. See Ewers *et al.* (2011) for details of the site. Although this species differs in some regards from mainland *Phaenandrogomphus* species, it shares with them an unusual penis structure and form of epiproct and is described here as *Phaenandrogomphus safei*. The species most closely allied to *P. safei* is none of the mainland *Phaenandrogomphus*, but rather *Onychogomphus treadawayi* Müller & Hämäläinen, 1993, known from a single male from Busuanga Island near Palawan in the Philippines (Müller & Hämäläinen 1993). *Onychogomphus treadawayi* shares a similar penis structure, structure of anterior hamules and penis vesicle, colouration and wing venation with *P. safei* and is therefore here transferred to *Phaenandrogomphus*.

Terminology used below mostly follows Watson & O'Farrell (1991) except that the terms cerci and epiproct are preferred over superior and inferior anal appendages. The acronym RMNH is used below for the Naturalis Biodiversity Center (Leiden). As well as the type specimens of *P. safei* and *P. treadawayi* listed below, the following *Phaenandrogomphus* specimens were examined:

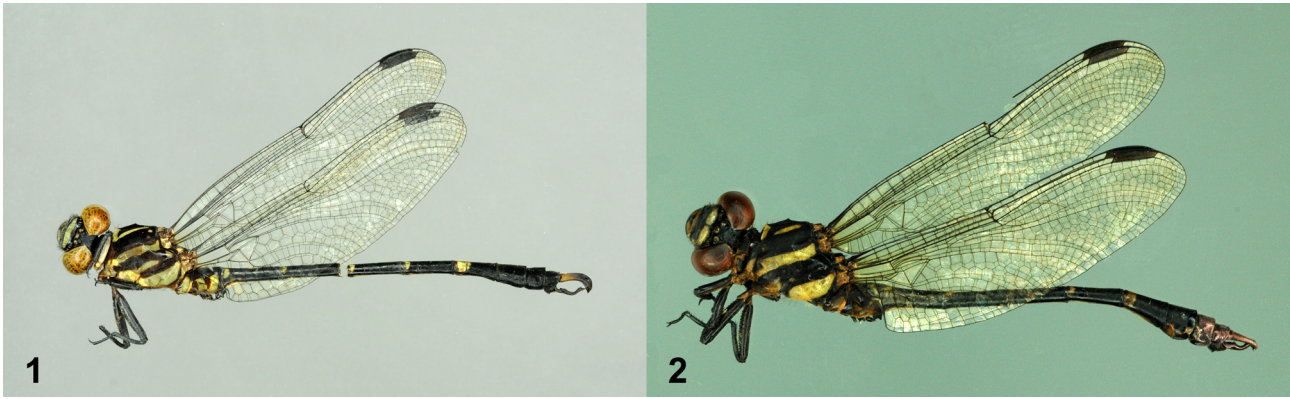
Phaenandrogomphus asthenes Lieftinck, 1964—holotype ♂, Malaysia, Selangor, Templer Park, Kuala Lumpur 12–13 mile, 26 iii 1963, leg. M. A. Lieftinck, in RMNH. ♂, Thailand, Chiang Mai, boundary of Doi Suthep National Park, Mae Tachang Stream, 12 viii 2006, leg. R. A. Dow, in coll. R. A. Dow.

Phaenandrogomphus tonkinicus (Fraser, 1926)—♂, Thailand, Chiang mai, Doi Inthanon, Siribhum waterfall, 1250m, 12 vi 1991, leg. M. Hämäläinen, in RMNH.

***Phaenandrogomphus safei* sp. nov.**

(Figs. 1, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16)

Material. Holotype: ♂, Malaysia, Sabah, Kalabakan Forest Reserve, 4° 43'N, 117° 37'E, 29 iv 2013, leg. S. H. Luke. To be deposited at the Forest Research Centre, Sepilok, Sabah.



FIGURES 1–2. Habitus: (1) *Phaenandrogomphus safei* holotype; (2) *Phaenandrogomphus treadawayi* holotype.



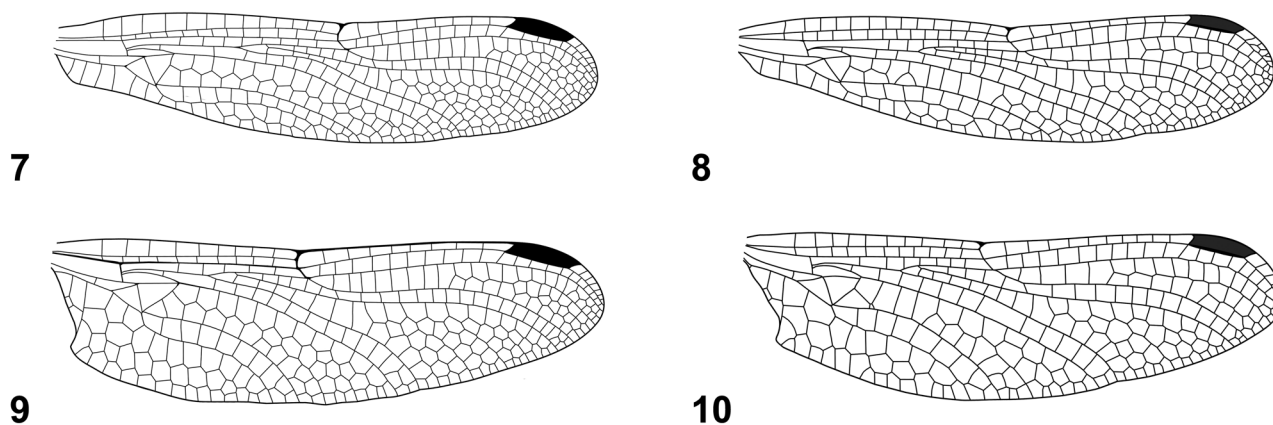
FIGURES 3–6. *Phaenandrogomphus safei* holotype: (3) head, anterior view; (4) head, dorsal view; (5) synthorax lateral view; (6) mesepisternum dorsal view.

Etymology. *safei*, a noun in the genitive case, formed from the acronym of the Stability of Altered Forest Ecosystems (SAFE) Project, where the type specimen was collected.

Description of holotype male. Head (Figs. 3–4): Labium pale grey centrally, whitish basally and laterally, black along free margin of median lobe and narrowly on apical outer margin of palps. Labrum black with pair of broad pale markings in upper half, narrowly divided centrally. Mandible bases pale, genae mostly olivaceous. Anteclypeus with lower margin slightly concave (Fig. 3), greyish-green coloured. Postclypeus mostly black with pair of pale lateral marks. Ante- and postfrons not very sharply divided, black with green transverse stripe on

anterior half of postfrons (Fig. 4). Vertex and occiput mostly black to very dark brown, with poorly defined paler areas behind median ocellus and between eyes at level of their closest approach to one another. Pair of tubercles behind lateral ocelli; ocelli pale yellowish.

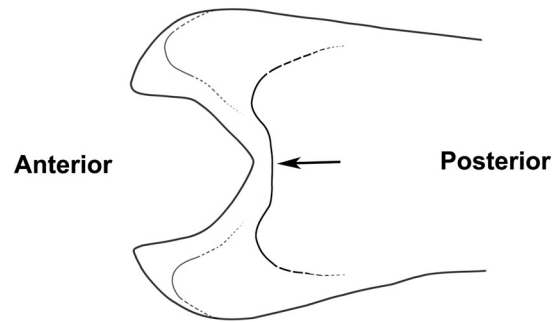
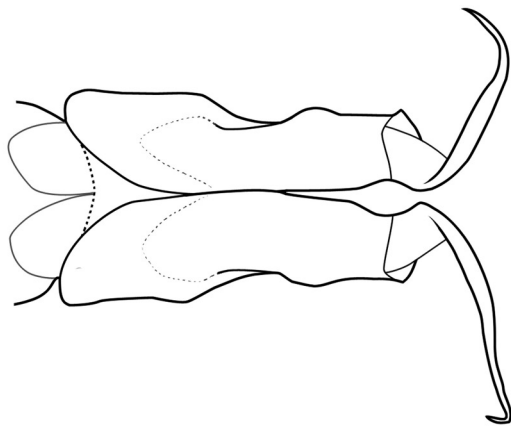
Thorax: Prothorax almost entirely dark brown and black, except anterior pronotal lobe, where central part of anterior carina and area behind pale. Synthorax dark brown to black with pale yellow-green markings as follows (Figs. 5–6): short mesothoracic collar, narrowly divided at mid-dorsal carina, joined to narrow antehumeral stripes that extend beyond level of apex of antealar triangle, terminating just short of antealar carina. Small spot below antehumeral marking on mesepisternum, near antealar carina. Stripe running length of mesepimeron. Metepisternum with stripe running below spiracle from metinfraepisternum, separated from ca triangular spot at antealar carina. A broad stripe occupying all of metepimeron except narrowly below metapleural suture. Mesinfraepisternum mostly dark brown, metinfraepisternum pale. Venter pale with brown stripe on either side. Legs robust and relatively short with posterior femur not reaching base of S1. Coxae mostly pale, trochanters brown and black, flexor surface of anterior femora, and distal ca one-third of flexor surface of middle femora pale, rest mostly black. Wings (Figs. 7–8): Sectors of arculus separated at origin with 2 cross veins before first bifurcation of superior sector in Fw and 1 in Hw. Discoidal field with 2 rows of cells from origin to level of nodus in both wings. 13 (left) or 15 (right) Ax in Fw, 9 (left) or 10 (right) in Hw, 8 (left) or 9 (right) Px in Fw, 8 (left) or 9 (right) in Hw. Pt very dark brown, covering just over 4 underlying cells in Fw, ca 4-1/2 underlying cells in Hw.



FIGURES 7–10. Wings: (7) left forewing *Phaenandrogomphus safei* holotype; (8) right forewing *Phaenandrogomphus asthenes* holotype, flipped to left for comparison; (9) left hindwing *Phaenandrogomphus safei* holotype; (10) right hindwing *Phaenandrogomphus asthenes* holotype, flipped to left for comparison.

Abdomen: Slender after base of S3, expanding moderately from base of S7, maximum width and height reached apical part of S8, then almost constant. Black with pale markings as follows (Fig. 1): S1 mostly pale yellowish laterally. S2 pale yellowish around and including auricle laterally, except free margin of auricle, another yellowish lateral mark placed posteriorly, narrow yellowish mid-dorsal stripe. S3–6 with small dorso-lateral markings at base, divided dorsally. S3–4 with small elongate oval yellow mark mid-dorsally, this reduced to small spot on S5 and absent on S6. S7 with more extensive yellow dorso-lateral marking at base, occupying slightly less than two-thirds of tergite and narrowly divided dorsally. S8–10 entirely black. Cerci (Figs. 14–15) curved down and moderately dorso-ventrally expanded in apical ca one-third, bearing robust teeth on inner edge apically. Pale brown at base, darkening towards apices, especially on upper surface where almost black. Epiproct (Figs. 14, 16) black, shorter than cerci, deeply divided, branches running approximately parallel on their inner margins for almost their entire length, apices pointed and slightly out-turned. In lateral view (Fig. 14) branches curved downward for short distance from base, then straightening, with upper margin abruptly raised at this point, before curving upwards again at ca two-thirds length, finally straightening again apically, where upper margin gently concave before apex. Accessory genitalia as shown in Figs. 11–13, with anterior hamule moderate sized, directed postero-ventrally, apical half narrow and hook shaped, penis with terminal segment (Figs. 11–12) divided centrally and bearing cornua, penis vesicle moderately large, but not extending ventrally beyond level of hamuli, its posterior apex only weakly bifurcate (Fig. 13).

Measurements [mm]: Hw 26, abdomen without anal appendages 31.5, cerci ca 3, epiproct ca 2.7.



FIGURES 11–13. *Phaenandrogomphus safei* holotype: (11) accessory genitalia, lateral view; (12) terminal segment of penis, ventral view; (13) penis vesicle, ventral-posterior view, posterior apex indicated by arrow.

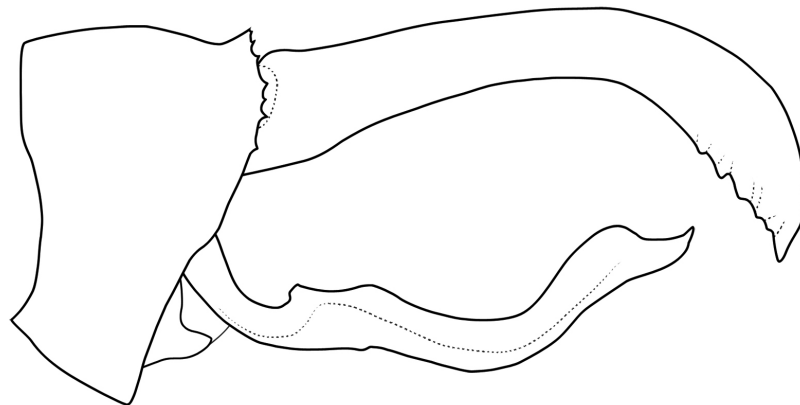
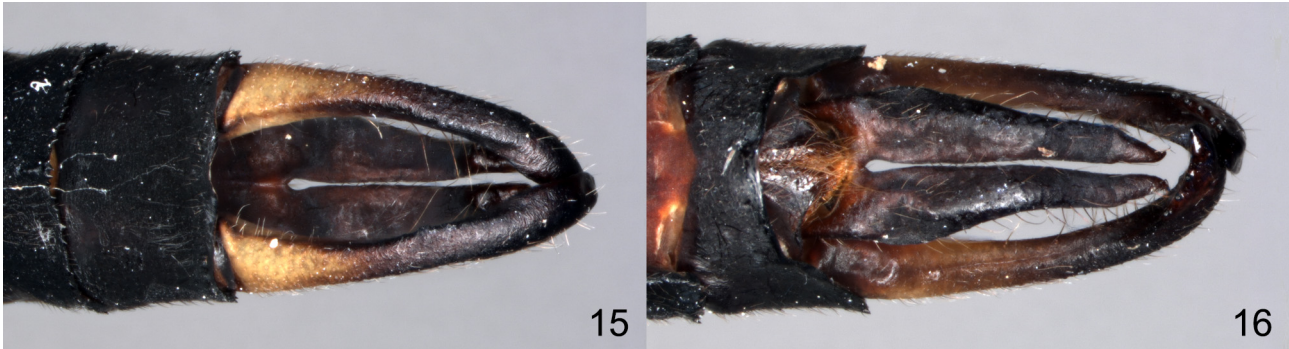


FIGURE 14. *Phaenandrogomphus safei* holotype, lateral view anal appendages.



FIGURES 15–16. *Phaenandrogomphus safei* holotype, anal appendages: (15) dorsal view; (16) ventral view.

Diagnosis. A moderately small gomphid (Figure 1), brightly coloured in life. It differs from all other *Phaenandrogomphus* species except *P. treadawayi* in having a smaller penis vesicle with posterior part of apex much less strongly bifurcated (compare with Fig. 3 in Lieftinck (1964)). It also differs in the form of the anterior hamule, which in the mainland species, while ventrally directed at base, makes an abrupt turn posteriad shortly after it emerges from the genital fossa. Additional differences from the mainland species include the less extensive pale markings on thorax and abdomen and sectors of arculus well separated at origin. *P. safei* can be separated from *P. treadawayi* by the accessory genitalia with terminal hooked part of anterior hamule longer and penis vesicle differently shaped in lateral view, more flattened terminal segment of the penis, the markings of the synthorax, the more downcurved and expanded apical part of the cerci with large apical teeth, and the epiproct which has the upper margin expanded abruptly and is upturned more apically than in *P. treadawayi*.

Remarks. The holotype was found flying over a shallow stream, approximately 2 km downstream from its source, and flowing through lowland dipterocarp forest that had previously been selectively logged several times. The stream channel was fairly open following a large flooding event in 2011 that caused long distance transport of logs and extensive erosion of stream banks. In life the pale markings of the synthorax were more blue-green than yellow and the eyes were blue.

***Phaenandrogomphus treadawayi* (Müller & Hämäläinen, 1993) comb. nov.**

(Fig. 2)

Onychogomphus treadawayi Müller & Hämäläinen 1993: 41–45 (original description ♂, Busuanga);—Hämäläinen & Müller 1997: 268, 305 (listed);—Karube & Sasamoto 2014: 68, 69 (brief discussion).

Material. Holotype: ♂, The Philippines, Palawan region, Busuanga Island, Coron, Mabentangen River, 4–7 v 1991, leg. T. Borromeo, in RMNH, JvT number 11935.

Remarks. The habitus of the holotype is shown in Fig. 2. Müller & Hämäläinen (1993: Fig. 2) gave a lateral view of the accessory genitalia of *P. treadawayi* but no ventral view of the terminal segment of the penis. In fact the terminal segment of the penis has the same distinctive, bifurcate appearance in ventral view as that of *P. safei* and mainland species of *Phaenandrogomphus*. Because of the form of the penis and the shape of the epiproct, *P. treadawayi* is here included in *Phaenandrogomphus*. It is most closely related to *P. safei*; further discussion of these two species and their placement in *Phaenandrogomphus* is given below.

Discussion

Lieftinck (1964) erected *Phaenandrogomphus* for *P. asthenes*. Later Lieftinck (1969) also included *P. tonkinicus* and *P. aureus* (Laidlaw, 1922). Zhou (1999) described *P. yunnanensis* Zhou, 1999, although judging from the description, this species may be poorly differentiated from *P. aureus*. *Onychogomphus dingavani* Fraser, 1924 is also sometimes included in *Phaenandrogomphus*, e.g. by Yang & Davies (1993).

Although the first author recently (Dow 2014) reiterated the conservative viewpoint expressed by Müller &

Hämäläinen (1993) regarding the generic placement of southeast Asian Onychogomphinae, *Phaenandrogomphus* is sufficiently distinctive in its penis structure for its generic status to remain secure. *Phaenandrogomphus safei* and *P. treadawayi* differ in some respects from mainland species: less extensive pale colouration, denser wing venation (see holotype of *P. asthenes* in Figs. 9–10 for comparison), anterior hamule without a posteriad turn, and smaller penis vesicle. Possibly the differences in structure of the anterior hamule, size of penis vesicle and general colouration between mainland and insular representatives of *Phaenandrogomphus* might warrant further division into subgenera or even placement of the insular species into a separate genus, but we prefer to wait until more material and molecular data become available.

Lieftinck (1964) drew attention in *P. asthenes* to the tubercles on the rear of the occiput at the end of the ridges that run on either side of the point of attachment with the prothorax, more developed in the female but also present in the male. Such tubercles are absent in *P. safei*, absent in a male of *P. tonkinicus* from Thailand examined, and barely present in a male of *P. asthenes* from Thailand. The presence of these tubercles, at least in males, cannot be considered a defining character for *Phaenandrogomphus* nor can their absence be used to separate the mainland and island branches of the genus.

Although the Onychogomphinae have formerly been regarded as absent from Borneo (e.g. Orr 2003), *P. safei* is the third member of the subfamily now known to occur on the island (Karube & Sasamoto 2014, Dow 2014). It seems probable that other species from the subfamily will be found to occur in Borneo with further fieldwork.

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