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Chlorogomphus manau sp. nov. from Sarawak, Malaysia (Odonata: Chlorogomphidae)

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Chlorogomphus manau sp. nov. (holotype ♂: Borneo, Sarawak, Kapit Division, Hose Mountains, 15 April 2011, RMNH) from Malaysia is described from the male and compared with other regional *Chlorogomphus* species.

Keywords: Odonata; Anisoptera; Chlorogomphidae; *Chlorogomphus manau*; Malaysia; Sarawak; Borneo

Introduction

Only one named species of the Chlorogomphidae, *Chlorogomphus dyak* (Laidlaw, 1911), has been known from the island of Borneo (Orr, 2003). Additionally a second species, questionably associated with *C. splendidus* Selys, 1878, is known from two old female specimens (Laidlaw, 1911, 1914). In April 2011 a male *Chlorogomphus* allied to, but differing from, *C. dyak* was collected in the Hose Mountains of Sarawak (Figure 1). It is described here as *C. manau* sp. nov.

Chlorogomphidae is often treated as a subfamily of Cordulegastridae (Karube, 2002; van Tol, 2005), but recent molecular evidence suggests that family rank may be more appropriate (Dumont et al., 2009; Letsch et al., 2009; Ware et al., 2007), a conclusion followed here. There is also uncertainty about relationships within the Chlorogomphidae; Carle (1995) treated the family in detail, but many details of his analysis have not been widely accepted, nor have most of the new genera he proposed. However Carle's subfamily Chloropetalinae and genus *Chloropetalia*, have been generally accepted. The new species described here clearly does not fall into the Chloropetalinae as defined by Karube (2002; where they are treated as a tribe Chloropetalini in the Cordulegastridae), who also pointed out that *Chlorogomphus dyak* had been placed in *Chloropetalia* in error by Carle (1995). For the remainder of the Chlorogomphidae, van Tol (2005) lists the genera *Chlorogomphus* Selys, *Orogomphus* Selys and *Sinorogomphus* Carle as valid, but lists no species in *Orogomphus*. The new species clearly does not belong to *Sinorogomphus* as defined by Carle (1995) and is placed here in *Chlorogomphus*, admittedly somewhat by default; using Fraser's (1936) definitions key it could fall into group III (*Orogomphus*) except that the

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Figure 1. *Chlorogomphus manau* sp. nov. holotype male; photograph by Robin W.J. Ngiam.

abdomen is not "markedly longer than the hind-wing". Similarly, with Carle's (1995) key it could fall into either *Chlorogomphus* or *Orogomphus*. However, if Fraser's definitions were followed then, for instance, *C. dyak* could also be placed in *Orogomphus*, where in fact it was originally described. We feel that *Orogomphus* is poorly characterised, and as the new species further blurs the distinction between *Chlorogomphus* and *Orogomphus*, it is best placed in *Chlorogomphus*.

The identity of the female *Chlorogomphus* from Sarawak referred questionably to *C. splendidus* has remained a mystery; *C. splendidus* itself is an enigmatic species, known with certainty only from the female type from Luzon in the Philippines (Selys, 1878). See Fraser (1929, p. 158) and Lieftinck (1954, p. 112, footnote) for further discussion of these female specimens. However, *C. manau* is unlikely to be the male of Laidlaw's species or of the true *splendidus*, as it is a significantly smaller insect than the females of these species. Thus it appears likely that at least three *Chlorogomphus* species occur in Borneo, all of which have been recorded from Sarawak. It is not possible to determine the relationship of *C. manau* to the female *Chlorogomphus* reported from Tabin Wildlife Reserve by Kitagawa et al. (1999) from the published information.

Bornean *Chlorogomphus* seem to be exceptionally elusive insects. There appear to be no records from Brunei or Kalimantan and the only records of adult *Chlorogomphus* from Sarawak, that we are aware of, are those referring to the type series of *C. dyak* and the females associated with *C. splendidus*, and of two additional females of *C. dyak* in Hincks (1930); all of these records date from prior to 1930. Laidlaw (1934) reported *C. dyak* from Mount Kinabalu in Sabah; the whereabouts of this specimen is unclear. The only other record from Sabah appears to be of the female, unidentified to species, in Kitagawa et al. (1999). The first author and associates have been conducting extensive fieldwork in Sarawak since 2005; the holotype of *C. manau* is the first adult *Chlorogomphus* that has come into his hands. S. Butler has collected single *Chlorogomphus* larvae on Mount Dulit and on Gunung Mulu; it was not possible to rear these to adulthood, so their identity remains a mystery.

Material and methods

The specimen was compared directly with the type and paratypes of *C. dyak* in the Natural History Museum, London (BMNH) and a paratype of *C. dyak* in NCB Naturalis, Leiden (RMNH), as well as with other regional *Chlorogomphus* species in these collections.

All specimens were examined using stereomicroscopes. Measurements were made with the aid of a measuring eyepiece calibrated to a known scale. The original illustrations were made with or with the aid of a Leica MZ16A equipped with a Leica DFC500 camera, motor focusing and LAS auto-imaging software at the RMNH.

Chlorogomphus manau sp. nov.

(Figures 1, 2, 3b, 4c, d)

Etymology

Manau, a noun in apposition; named for our friend Manau anak Budi, who comes from the Hose Range area of Sarawak, and who collected the holotype.

Specimens examined

Holotype ♂: SAR11_12_CHR1, Borneo, East Malaysia, Sarawak, Kapit Division, Hose Mountains, by side of old logging road, 600-700m, 15 iv 2011, leg. M. Budi. To be deposited in RMNH (Leiden).

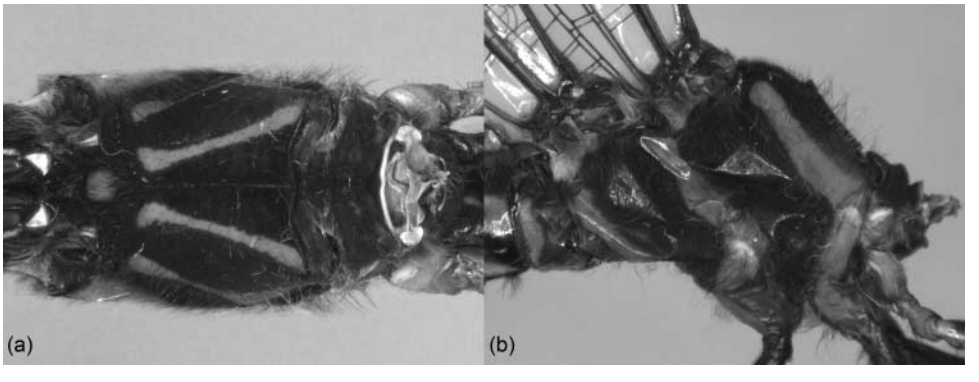

Figure 2. Synthorax of *C. manau* holotype: (a) dorsal; (b) lateral.

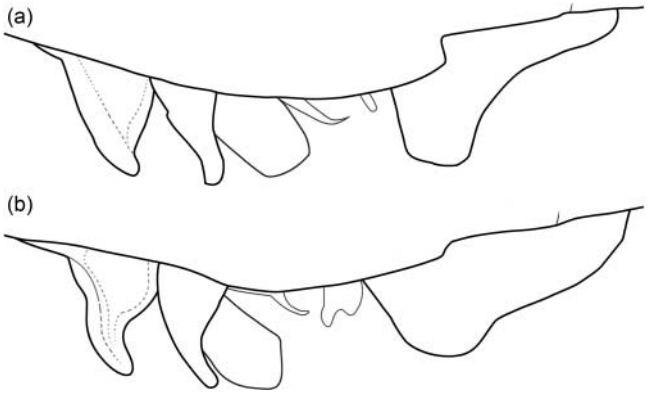

Figure 3. Accessory genitalia of *C. dyak* and *C. manau*: (a) *C. dyak* paratype; (b) *C. manau* holotype.

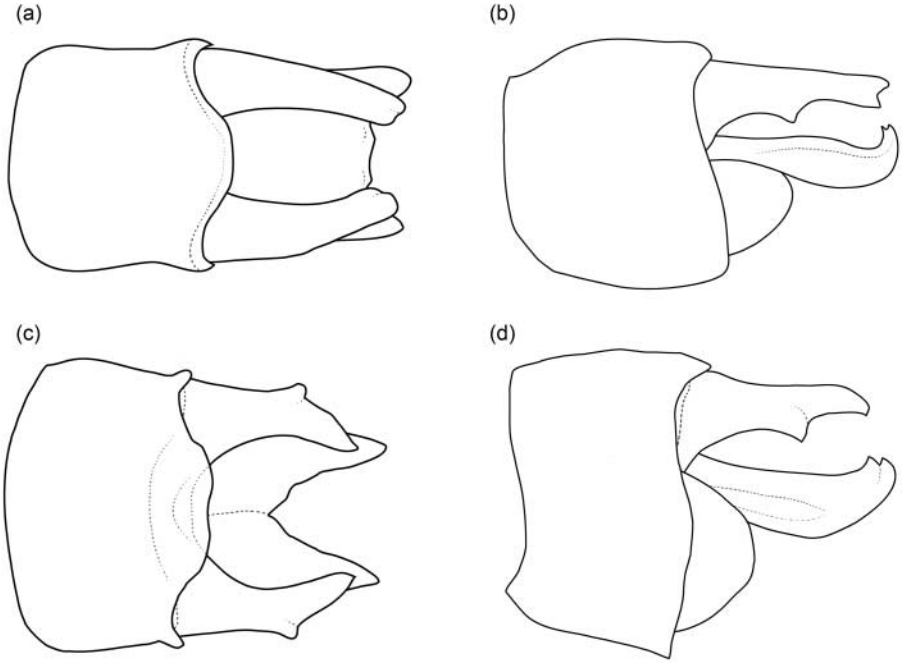

Figure 4. Caudal appendages of *C. dyak*, adapted from Fraser (1929, figure 35), and *C. manau*: (a) *C. dyak* dorsal view; (b): *C. dyak* lateral view; (c) *C. manau* holotype dorsal view; (d) *C. manau* holotype lateral view.

Diagnosis

A small species of *Chlorogomphus*, distinguished from all other species by the structure of its caudal appendages in combination with its markings and short abdomen. In particular it is distinguished from the males of the similarly patterned *C. dyak* and *C. yoshihiroi* Karube, 1994, with which it might co-occur, by the tooth on the superior anal appendages clearly visible in dorsal view and the shape of the tip of the superior appendage and of the branches of the deeply divided inferior appendage.

Description of holotype male

Head. Labium brownish yellow. Labrum black. Anteclypeus brownish grey, postclypeus yellowish green. Frons black except narrowly along ridge of antefrons, where yellowish. Occiput black.

Thorax. Pronotum with anterior and middle lobes black except along anterior ridge of anterior lobe, where yellow; posterior lobe brown, greyish laterally. Propleuron obscurely yellow and brown. Synthorax black with greenish yellow markings (Figures 1, 2a, b): pair of narrow humeral stripes, expanded slightly near antealar carina, a pair of broader antehumeral stripes continued on to meseinfraepisternum, region between humeral and antehumeral stripes diffusely pale near prothorax, metepisternal stripe running from antealar carina to spiracle and continuing onto metainfraepisternum, yellow metepimeral stripe. Legs largely black but with coxae and trochanters of anterior two pairs brownish yellow, this just carried onto the extensor surface of femur, and brownish yellow stripe along the rear of the posterior coxae. Wings: hyaline, Pterostigma black, covering from just over two to three underlying cells. Triangles crossed once in all wings. Anal

loop with 8 cells, anal triangle with 3 cells. 20 Ax in Fw, 14 (left) or 17 (right) in Hw; 12 (left) or 11 (right) Px in Fw, 14 in Hw.

Abdomen. Slender but expanded slightly from circa midway along S6, widest around S7–8, then gently tapering. Black with yellow markings: S1 with transverse lateral apical stripe separated from apical dorsal stripe; S2 with narrow yellow ring, divided dorsally, situated immediately behind transverse carina, running over upper part of auricle where it broadens and turns to meet S1, and narrow apical yellow ring, barely divided dorsally. S3 with narrow yellow ring behind transverse carina, barely interrupted dorsally and bi-lobed transverse apical dorsal stripe. S4–5 with bi-lobed apical dorsal markings, that on S5 small and just divided into two parts. S6 with larger apical dorsal marking. S7–10 black. Additionally S2–S9 with yellow stripe running along lower margin of tergite, broadest on S2, where continuous with the apical ring, becoming narrower and less distinct on successive segments, and only visible in ventral view after S3. Accessory genitalia as shown in Figure 3b. Caudal appendages (Figures 4c, d) black. Superior appendage with lateral ventral tooth at circa two thirds length, clearly visible in dorsal as well as lateral view, appendage slightly in-turned from this point and slightly down-turned at the tip. Inferior appendage slightly longer than superior pair, deeply divided, tip of each branch slightly upturned, each with double tooth, branches with their tips only slightly outside of those of the superior appendages.

Measurements (mm). Hw 38.5, abdomen 42.5 (excluding appendages), superior appendage c.1.5.

Remarks

Chlorogomphus manau is very similar in general appearance to *C. dyak* and *C. yoshihiroi*. It differs from these species most notably in its caudal appendages and accessory genitalia. The caudal appendages of *C. dyak* are shown for comparison in Figures 4a, b, and its accessory genitalia in Figure 3a. The tooth on the superior appendage is positioned more laterally in *C. manau* than in the other two species, so that it is clearly visible in dorsal view. The tip of the superior appendage of *C. manau* is shaped differently from that of *C. dyak*, which is shaped similarly to that of *C. yoshihiroi*. The tips of the branches of the inferior appendage in *C. dyak* are markedly more produced dorsally than that of *C. manau*, whereas that of *C. yoshihiroi* is barely upturned. The branches of the inferior appendage in *C. manau* are less widely separated than those of either *C. dyak* or *C. yoshihiroi*, but far more deeply divided. It differs further from these two species in that the abdomen is relatively shorter compared with the Hw, ratio *c*.1.14 (including caudal appendages) in *C. manau* but almost 1.4 on average in *C. dyak*; this difference is immediately apparent when specimens are directly compared. The posterior pronotal lobe of *C. manau* is brown whereas that of *C. dyak* bears yellow marks and that of *C. yoshihiroi* has greenish yellow markings (Karube, 1994, p. 8). There are other small differences in the markings of the thorax and abdomen. Judging from Karube's illustration (Karube, 1994, figure 5) the accessory genitalia of *C. yoshihiroi* is closely similar to that of *C. dyak*, but that of *C. manau* differs quite markedly, as can be seen from Figure 3, particularly in the shapes of the hamules and the vesicle.

There are greater differences in markings, as well as in the caudal appendages, between *C. manau* and other species from the Chlorogomphidae known from Sundaland: *Chlorogomphus arooni* Asahina, 1981, *C. magnificus* Selys, 1854 and *Chloropetalia kimminsi* (Fraser, 1940). With an abdomen length including appendages of just *c*.44 mm, *C. manau* is one of if not the smallest species known from the Chlorogomphidae.

Distribution

Chlorogomphus manau is so far only known from the Hose Mountains in Sarawak's Kapit division.

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References

Carle, F.L. (1995). Evolution, taxonomy, and biogeography of ancient Gondwanian Libelluloides, with comments on Anisopteroid evolution and phylogenetic systematics (Anisoptera: Libelluloidea). *Odonatologica, 24*, 383–424.

Dumont, H.J., Vierstraete, A., & Vanfleteren, J.R. (2009). A molecular phylogeny of the Odonata (Insecta). *Systematic Entomology, 35*, 6–18.

Fraser, F.C. (1929). A revision of the Fissilabiodae (Cordulegasteridae, Petaliidae and Petaluridae) (Order Odonata). Part I. – Cordulegasteridae. *Memoirs of the Indian Museum, 9*, 69–167, plates IX–XII.

Fraser, F.C. (1936). *The Fauna of British India, including Ceylon and Burma*. Odonata. Vol. III. Taylor & Francis, London, pp. xi + 461, plates I–II.

Hincks, W.D. (1930). Some notes on a collection of Sarawak Odonata. *Sarawak Museum Journal, 4*, 49–56.

Karube, H. (1994). A new species and a newly recorded species of the genus *Chlorogomphus* (Odonata, Cordulegastridae) from West Malaysia. *Bulletin Kanagawa prefectural Museum (Natural Sciences), 23,* 7–12.

Karube, H. (2002). *Watanabeopetalia* gen. nov., a New Genus of the Dragonflies (Odonata, Cordulegastridae, Chlorogomphinae). *Special Bulletin of the Japanese Society of Coleopterology, Tokyo, 5*, 67–85.

Kitagawa, K., Yagi, T., Nakanishi, A., Wahid, N., & Mohamed, M. (1999). Dragonflies of Tabin wildlife reserve. In M. Mohamed, M. Andau, M.N. Dalimin, & T.P. Malim, *Tabin Scientific Expedition* (pp. 79–85). Kota Kinabalu: Universiti Malaysia Sabah.

Laidlaw, F.F. (1911). Descriptions of two species of Dragon flies (Odonata) from Sarawak. *Journal Straits Branch Royal Asiatic Society, 57*, 190–193.

Laidlaw, F.F. (1914). Contributions to a study of the dragonfly fauna of Borneo. Part II. The Gomphinae and Chlorogomphinae. *Proceedings Zoological Society London, 1914*, 51–63, plate I.

Laidlaw, F.F. (1934). A note on the dragonfly fauna (Odonata) of Mount Kinabalu and of some other mountain areas of Malaysia, with a description of some new or little known species. *Journal of the Federated Malay States Museums, 17*, 549–561.

Letsch, H.O., Greve, C., Kück, P., Fleck, G., Stocsits, R.R., & Misof, B. (2009). Simultaneous alignment and folding of 28S rRNA sequences uncovers phylogenetic signal in structure variation. *Molecular Phylogenetics and Evolution, 53*, 758–771.

Lieftinck, M.A. (1954). Handlist of Malaysian Odonata. A catalogue of the dragonflies of the Malay Peninsula, Sumatra, Java and Borneo, including the adjacent small islands. *Treubia (Supplement), 22*, i–xiii + 1–202.

Orr, A.G. (2003). *A Guide to the Dragonflies of Borneo: Their Identification and Biology*. Kota Kinabalu: Natural History Publications (Borneo).

Selys-Longchamps, E. de (1878). Quatrièmes additions au synopsis des gomphines. (II). *Bulletin Academie royale Belgique Serie, 2,* 46(12), 659–698.

van Tol, J. (2005). Global Species Database Odonata. Retrieved June 8, 2011 from http://www.odonata.info.

Ware, J., May, M., & Kjer, K. (2007). Phylogeny of the higher Libelluloidea (Anisoptera: Odonata):An exploration of the most speciose superfamily of dragonflies. *Molecular Phylogenetics and Evolution, 45*, 289–310.