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Description of *Hemicordulia tuiwawai* sp. nov. from Kadavu Island, Fiji (Odonata: Corduliidae)

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Abstract

Hemicordulia tuiwawai sp. nov. (Odonata: Corduliidae) is described and diagnosed based on material collected from Kadavu Island, Fiji; holotype: Wainitayuki River about 750 m above Baidamudamu village, -19.0916, 178.1038; 37 m a.s.l., 06 June 2016, M. Marinov leg. This species is distinguished from its congeners in the field by the contrasting colouration – dark green metallic body with bright yellow spots on the synthorax and base of the abdomen. This pattern is comparable to *H. pacifica* Selys, 1871. However, *Hemicordulia tuiwawai* sp. nov. can be recognised by the larger size and unique shape of the caudal appendages and genital hamule (in males) and vulvar scale (in females).

Key words: Odonata, Kadavu, Fiji, *Hemicordulia*, new species

Introduction

Studies on Odonata of Fiji have been initiated more than 150 years ago (Marinov 2011), however, there are still unsolved taxonomic issues even for the largest island of Viti Levu (Marinov & Waqa-Sakiti 2013).

Kadavu Island, being the fourth largest island of Fiji, has been opportunistically sampled during field studies focusing mainly on Viti Levu (Donnelly 1984, 1990; Van Gossum et al. 2007, 2008). So far only five Odonata species have been reported for Kadavu. Considering the size of Kadavu (411 km^2), five species seemed improbably few. Therefore, a special trip was organised to the island to study the composition of the local Odonata fauna. The faunistic results will be published separately. The current paper reports of one of the new species discovered during the trip.

Material and Methods

Kadavu Island was visited between 05 – 11 June 2016. The time was spent in the village of Baidamudamu with daily trips along the length of the Wainitayuki River and its tributaries.

Mainly adult odonates were collected with aerial nets and either killed in ethanol, dried and transferred into paper envelops or preserved in 95% ethanol for molecular analysis.

Microscopic pictures for the figures were produced using the Plant Health and Environment Laboratory, Christchurch, Ministry for Primary Industries, New Zealand equipment. A series of images were taken under high power Nikon AZ100M microscope and stacked with Helicon Focus 6.7.1 software.

Morphological description follows Watson & O'Farrell (1991), wing venation designation follows Riek & Kukalová-Peck (1984).

Abbreviations:

Morphology: AL – abdomen length (appendages excluded); HW – hind wing; S1-10 – abdominal segments 1 to 10.

Museum collections: MLBM – Bean Life Science Museum, Brigham Young University, USA; NZAC – New Zealand Arthropod Collection, Manaaki Whenua Landcare Research, Auckland, New Zealand; RWGC – Rosser W. Garrison Collection, USA

Results

Hemicordulia tuiwawai sp. nov. (Figs. 1-9)

Holotype. Male (NZAC04212531, NZAC), FIJI, Kadavu Island, Wainitayuki River about 750 m above Baidamudamu village (-19.0916, 178.1038; 37 m a.s.l.): 06 June 2016, M. Marinov leg.

Allotype. 1♀ (NZAC04200819, NZAC), same data as holotype.

Paratypes. 2♀♀ collected from the author and deposited in two collections: MLBM: 1♀ Stretch of Tributary to Wainitayuki River about 1,100 m above Baidamudamu village (-19.0987, 178.0975 to -19.1014, 178.0976; 119-156 m a.s.l.), 10 June 2016; RWGC: 1♀ Wainiela River about 2,000 m above Baidamudamu village (-19.1008, 178.0922; 128 m a.s.l.), 07 June 2016.

Etymology. The species is named for Mr Marika Tuiwawa (noun in the genitive case) in appreciation of his constant nature conservation work within Fijian islands. Marika is a great mentor for his students from the University of South Pacific with a significant influence and considerable achievements in the nature protection of the Melanesian and Polynesian islands.

Description of holotype (Figs. 1-5)

Head (Fig. 1) yellow from labium to ventral half of antefrons, rest of head including vertex, dark metallic with sheen appearing green on frontal part and blue on the dorsum, dark brown areas descend from postfrons along the eyes about halfway before the ventral edge of the dark area of antefrons. Scapes and pedicels dark, flagella missing in both antennae; occipital triangle light brown with two weakly outlined yellow lobes posteriorly, not visible from the dorsum; rear of head black with a metallic sheen. Head covered with setae as follows: white on surface of labial lobes and rear part; yellow along the anterior edge of lateral lobes of labium; ventral edge of labrum and ventrolateral edges of postclypeus; remainder of head dark.

Thorax (Fig. 2). Prothorax predominantly matt black with bright yellow on entire dorsum

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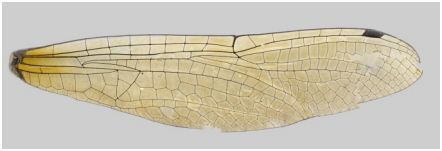

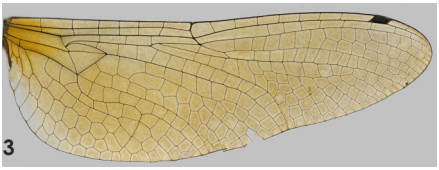

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Figure 1. *Hemicordulia tuiwawai*, holotype, head frontal.

Figure 2. *Hemicordulia tuiwawai*, holotype, thorax lateral view.

Figure 3. *Hemicordulia tuiwawai*, holotype, wings: a) fore wing, b) hind wing.

Figure 4. Hemicordulia tuiwawai, holotype, secondary genitalia.

Figure 5. *Hemicordulia tuiwawai*, holotype, caudal appendages: a) lateral view, b) dorsal view.

of raised anterior lobe, flat posterior lobe with a faint line on dorsum of middle lobe. Synthorax predominantly metallic green with yellow setae densely covering ventral areas of mesepisternum; light brown anterior to mesostigmal area, cross bar at posterior of metepimeron ventrally and thin lines along thoracic sutures; matt black posterior to mesostigmal area across entire dorsal surface and outlines of the antealar sinus. Yellow as follows: thin vertical bar on ventrolateral corners of mesepisternum and dorsal surface of antealar sinus; club-like stripe on the central area of mesepimeron parallel-sided on ventral half to just dorsal of metastigma, then expanding backwards toward the metepimeron; pear-like spot on metepimeron extending to metastigma anteriorly, confluent with metapleural suture posteriorly and almost entire metakatepisternum; two roughly triangular markings on metepimeron, anterior marking midway with posterior edge at centre of segment, posterior marking very obscure to almost dull orange. Legs black except for light brown areas on anterior faces of coxae (yellow posteriorly) and yellow as follows: pro- and mesotrochanters posteriorly; ca. 2/3 of profemora basally, lighter anteriorly; mesofemora basally with corresponding posterior area almost dark orange; claws dark reddish. Wings (Fig. 3) hyaline with yellow flavescence throughout, but darker basally proximal to anal loop; venation dark; nodal index 6-7 / 7-6 in FW, 7-5 / 5-7 in HW; pterostigmata dark brown with paler outlines.

Abdomen (broken and glued between S4-S5) almost entirely dark with green metallic sheen except S1 and S10 black. Ventral surface of tergites dark yellow to orange as follows: marking with acute dorsal projection at middorsal area of S2 touching midsegmental carina; triangular marking at posterior end of S2 ascending alongside border of S3; genital lobe anteroventral corner and inner edges of tergites parallel from S2-S9 expanding laterally on S7-S8.

Secondary genitalia as in Figure 4. Anal appendages (Fig. 5) black, slightly shorter than S9-S10 together, superior appendages curved about midway of length, cylindrical with an outer carina running just dorsal of curvature, curved inwards with almost parallel sides for ca. 1/3 distally (dorsal view).

Measurements (in mm): AL 30, HW 29.

Allotype (Fig. 6-9). Body colouration identical to male except (Figs. 6-7): green area of thorax is more expanded and replacing the dark along the sutures encroaching down to the surface of metkatepisternum. Abdomen mostly black with slight green to purple sheen; yellow on S2 reduced slightly with the marking lacking the acute dorsal projection and the triangular marking smaller; yellow on the ventral side of tergites brighter especially at abdominal base. Wings (Fig. 8) with yellow flavescence much deeper dark basal areas on both pairs; nodal index 5-8 / 8-6 in FW; 7-6 / 5-7 in HW. Appendages black slightly dorsoventrally flattened. Vulvar scale (Fig. 9) bilobed, lobes roughly triangular shape.

Measurements (in mm): AL 29, HW 29.5.

Variations in the paratypes. No notable colour differences apart from small variations of round lateral marking on S2. Wings almost completely hyaline with yellow-tinged bases of both pairs. Nodal indexes vary between specimens; a composite index is presented here with variations given in brackets 5(6)-7 / 7(8)-6 in FW; 7(8)-5 / 5-7 in HW.

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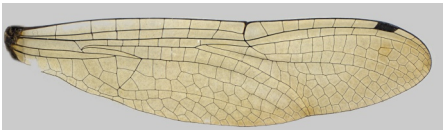

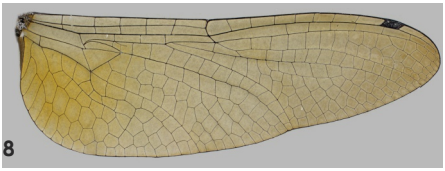

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Figure 6. *Hemicordulia tuiwawai*, allotype, head frontal view.

Figure 7. *Hemicordulia tuiwawai*, allotype, thorax lateral view.

Figure 8. *Hemicordulia tuiwawai*, allotype, wings: a) fore wing, b) hind wing.

Figure 9. *Hemicordulia tuiwawai*, allotype, vulvar scale.

Measurements (in mm): AL 33-33.5, HW 31.5-33.

Differential diagnosis. *Hemicordulia tuiwawai* was compared to other Pacific representatives of the genus: museum specimens of *H. australiae* (Rambur, 1842); *H. cupricolor* Fraser, 1927; *H. fidelis* McLachlan, 1886; *H. hilaris* Lieftinck, 1975; *H. oceanica* Selys, 1871 and *H. pacifica* Fraser, 1925. The following species were included in the analysis based on their original descriptions: *H. assimilis* Hagen in Selys, 1871; *H. continentalis* Martin, 1906; *H. erico* Asahina, 1940; *H. haluco* Asahina, 1940; *H. lulico* Asahina, 1940 and *H. mumfordi* Needham, 1933.

Live *H. tuiwawai* are characterised by dark green body with yellow markings on the lateral side of the thorax and base of the abdomen dorsal of the secondary genitalia. Also, abdomen lacks dorsal yellow markings in mature specimens as opposed to *H. australiae* and *H. fiedelis*. With the latter two species, these abdominal markings persist (not becoming obscured) even when they are fully mature.

The brilliant metallic green contrasting with the distinct yellow markings of *H. tuiwawai* resembles *H. pacifica* and *H. lulico*. Other Pacific species have the yellow thoracic markings dull, diffuse, and not crisply delineated. Based upon the original descriptions *H. lulico* seems to have yellow colouration developed over larger areas of synthorax whereas *H. tuiwawai* and *H. pacifica* have yellow spots of very similar shapes. *Hemicordulia tuiwawai* is immediately recognised from *H. pacifica* by (description of *H. pacifica* in parentheses): larger body size of 40-44.5mm (vs 33-35mm), extra yellow spots on mesepisternum and metepimeron (vs mesepimeral marking only), S2 marking with acute projection on middorsal section (vs round).

Also, *H. tuiwawai* males can be readily distinguished from most of their Pacific congeners by morphology of caudal appendages in males and vulvar scale in females. In dorsal view, superior appendages are incurved proximally with distal 1/3 parallel. This general character shared with *H. pacifica*. Figure 10 compares the difference between these two species in what considered to be the most important diagnostic traits.

It is important to note that *H. tuiwawai* is closest to an undescribed species which is thought to be endemic to Viti Levu (T. Donnelly, per. comm.). Since its description is still pending, no illustrations and explanations of the observed differences will be provided here except a general mentioning that they can be differentiated based on the shape of male anal appendages and the ventral projection of the genital hamule.

Discussion

Based on morphological features and colour patterns of the mature adults, Pacific *Hemicordulia* species can be split into three groups characterised by:

1) male superior appendages toothed, converging touching or not at the tips; yellow spots on dorsum of the abdominal segments present; representatives: *H. australiae* and *H. fiedelis;*
2) male superior appendages not toothed, converging and touching at the tips; no yellow spots on the dorsum of the abdominal segments; representatives: *H. cupricolor; H. hilaris* and *H. oceanica;*
3) male superior appendages not toothed, parallel-sided for the apical 1/3; no yellow spots on the dorsum of the abdominal segments; representatives: *H. pacifica* and *H. tuiwawai*.

This division is made here for convenience due to the increasing sampling material from the Pacific which needs to be analysed and systematised. It does not necessarily reflect the phylogenetic relations which need to be established with the help of molecular methods. The grouping is made only for the species available to the author for a direct comparison of museum specimens. Probably most of the rest of the species included in the differential diagnostic above will fall into the second group. At the time of their original descriptions *H. assimilis* and *H. continentalis* were compared to each other and *H. oceanica* and found to be very similar based on the shape of the male caudal appendages (Selys 1871, 1874; Martin 1906). Caudal appendages of *H. erico*, *H. haluco* and *H. lulico* also follow the general shape described for this group,

Figure 10. Comparison between *Hemicordulia tuiwaiwai* (left) and *H. pacifica* (right): a) male secondary genitalia; b) male caudal appendages lateral view; c) male caudal appendages (dorsal view); d) female vulvar scale.

however, their placement is unsure because the body colouration was not compared on preserved specimens. *Hemicordulia mumfordi* is a probable candidate for Group 3, however, it has been left out of the grouping suggested above because no specimens were available for a direct comparison. Diagnostic images kindly provided by Dan Polhemus (Bishop Museum, Honolulu) show the male superior appendages parallel sides

in their distal 1/3 and the body seems to be uniformly green. This species is known as endemic to the remote Marquesas Islands where at least another undescribed species exists (Marinov et al. 2016).

The discussion with the preliminary grouping of the Pacific *Hemicrodulia* is given here to highlight two points: a) *H. tuiwawai* is clearly a distinct species which is closer to *H. pacifica* from Samoa (from the described congeners), and b) Pacific *Hemicordulia* need a thorough revision. Field collecting within the Pacific targeting *Hemicordulia* has already been initiated and discussed in several other studies (cf. Marinov 2012; Marinov et al. 2015, 2019).

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