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## Contribution to the Odonata of Kadavu, Fiji with erection of three new species (Insecta: Odonata)

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### Abstract

Updated information on the Odonata fauna of Kadavu Island, Fiji is presented. The new data are provided for proposing three new hypotheses for erecting the following taxa: *Nesobasis baidamuensium* sp. nov., *N. nedeltshvae* sp. nov. and *Nikoulabasis ilievae* sp. nov. as well as the first record of the female *Melanesobasis simmondsi* (Tillyard, 1924) which is described and illustrated below. Morphological description of the male *M. simmondsi* has been updated as well.

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

### Introduction

Marinov (2009) summarised the information gathered about Fijian Odonata for the whole 142-year history of collection since Brauer (1867a, b; 1869). The data on this Pacific archipelago have been continuously updated with field records (most of them unpublished). They have increased the overall number of entries in the Pacific Odonata Database (POD – free available on request from the authors) considerably. However, Fiji still ranks as the third best known Pacific nation (see Marinov 2015) in terms of information collected about the Odonata fauna stored at POD.

Naturally most of this information (93.7%) comes from the two largest islands within the group – Viti Levu (80.2%) and Vanua Levu (13.5%). All other islands and island groups of Fiji are represented with less than 2% each in POD.

While the small number of observations is justifiable for small islands like Koro, Ovalau or islands within the Lau group, the third and fourth largest islands of Taveuni and Kadavu seem to be highly understudied with 1.8% and 1.2% of the records in the POD respectively. Studies on Taveuni have been scattered all over the island (Donnelly 1984, 1987, 1994; Van Gossum et al. 2008). Kadavu on the other hand has been sampled exclusively from around the main town of Vunisea (Donnelly 1984, 1990; Van Gossum et al. 2007, 2008). So far members of only six taxa have been reported (Table I), some of them taken during a day trip only from the Fijian main island of Viti Levu. Here we add new information on the taxonomy and fauna of Odonata for Kadavu reporting the second part of the data from the field studies after the preliminary note in Marinov (2019).

**Table 1. Chronological literature review of Odonata records from Kadavu island, Fiji.**

Verbatim scientific name	Valid species name	Verbatim locality	Page	References
<i>MELANESOBASIS CORNICULATA</i> (TILLYARD)	<i>Melanesobasis corniculata</i> (Tillyard, 1924)	Kadavu, Vunisea	101	Donnelly (1984)
<i>MELANESOBASIS SIMMONDSI</i> (TILLYARD)	<i>Melanesobasis simmondsi</i> (Tillyard, 1924)	Kadavu, Vunisea	103	Donnelly (1984)
<i>Nesobasis rufostigma</i> n. sp.	<i>Nesobasis rufostigma</i> Donnelly, 1990	Tavuki Rd and Vunisea, Kadavu	102	Donnelly (1990)
<i>Nesobasis recava</i> n. sp.	<i>Nesobasis recava</i> Donnelly, 1990	Tavuki Rd and Vunisea, Kadavu	105	Donnelly (1990)
<i>Nesobasis longistyla</i> Selys 1891	<i>Nesobasis longistyla</i> Selys, 1891	Tavuki Rd, Kadavu	108	Donnelly (1990)
<i>Hemicordulia tuiwawai</i> sp. nov.	<i>Hemicordulia tuiwawai</i> Marinov, 2019	Wainitayuki River, Kadavu	1-9	Marinov (2019)

**Figure 1. Map of Fijian islands showing the location of Kadavu.**

## Material and Methods

The material for this study was collected on field trips to Kadavu Island (Fig. 1) within the vicinities of two villages Baidamudamu (5–11 June 2016) and Daviqele (25–26 April 2022); the latter related to sampling for a PhD project aiming at development of a biotic index for assessing the state of Fijian freshwater courses. Figure 2 shows the study area with all sampling localities.

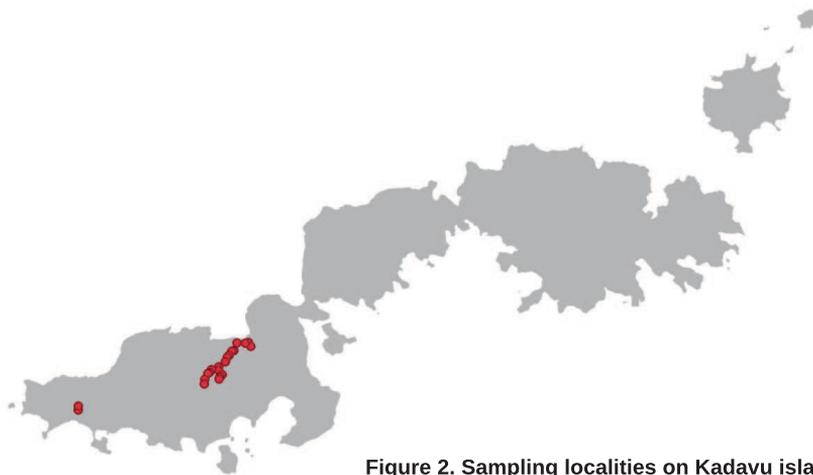
The freshwater habitats were investigated by walking in the water observing both banks of the streams. Small tributaries were walked to the source for as long as water continued trickling down the slopes.

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

Microscopic photos for the figures were produced using the Plant Health and Environment Laboratory, Christchurch, Ministry for Primary Industries, equipment in New Zealand. A series of images were taken under a high power Nikon AZ100M microscope and stacked with Helicon Focus 6.7.1 software in the Plant Health & Environment Laboratory, Christchurch. Morphological description follows Garrison et al. (2010).

Abbreviations: AL – abdomen length (appendages excluded); Fig. – figures used as illustrations in the present study; fig. – figures used as illustrations in previous studies and cited in here; FW – fore wing; HW – hind wing; HF – hind femur; MDBE – minimum distance between the eyes; P – pedicel; Sc – scape; S1–10 – abdominal segments 1 to 10. All measurements in millimetres (mm).

All specimens collected during the present study will be split between four collections: USP-ABC – University of South Pacific Aquatic Biodiversity Collection, Suva, Fiji; MLBM – Bean Life Science Museum, University of Utah, USA; NZAC – New Zealand Arthropod Collection, Manaaki Whenua Landcare Research, Auckland, New Zealand; RWGC – Rosser W. Garrison Collection, USA.



**Figure 2. Sampling localities on Kadavu island.**

### **Localities** (Fig. 2)

The following localities were investigated (localities presented in chronological order depending on the day of sampling):

1. Baidamudamu Village (19.0866S, 178.1087E; 20 m a.s.l.): 05 June 2016
2. Wainitayuki River by Baidamudamu village (19.0870S, 178.1072E; 18 m a.s.l.): 06 June 2016
3. Wainitayuki River above Baidamudamu village (19.0901S, 178.1052E; 28 m a.s.l.): 06 June 2016

4. Wainitayuki River about 750 m above Baidamudamu village (19.0916S, 178.1038E; 37 m a.s.l.): 06 June 2016
5. Tributary to Wainitayuki River about 1,100 m above Baidamudamu village (19.0950S, 178.1024E; 57 m a.s.l.): 06 June 2016
6. Stretch of Tributary to Wainitayuki River about 1,100 m above Baidamudamu village (19.0987S, 178.0975E to 19.1014S, 178.0976E; 119-156 m a.s.l.): 10 June 2016
7. Wainiela River about 2,000 m above Baidamudamu village (19.1008S, 178.0922E; 128 m a.s.l.): 07 June 2016
8. Stretch of Wainiela River about 2,000 m above Baidamudamu village (19.1030S, 178.0907E; 167 m a.s.l.): 07 June 2016
9. Wainiela River about 2,800 m above Baidamudamu village (19.1037S, 178.0895E; 187 m a.s.l.): 07 June 2016
10. Stretch of Wainiela River about 3,300 m above Baidamudamu village (19.1081S, 178.0872E to 19.1116S, 178.0869E; 208 – 235 m a.s.l.): 07 June 2016
11. On the road between Baidamudamu and Natumua (19.0809S, 178.1110E; 15 m a.s.l.): 08 June 2016
12. Unnamed puddle by Natumua Village (19.0805S, 178.1194E; 10 m a.s.l.): 08 June 2016
13. Vuniivi River by Natumua Village (19.0835S, 178.1212E; 25 m a.s.l.): 08 June 2016
14. Unnamed puddle by Natumua Village (19.0811S, 178.1172E; 8 m a.s.l.): 08 June 2016
15. Tributary to Wainitayuki River about 2,000 m above Baidamudamu village (19.1046S, 178.1001E; 125 m a.s.l.): 09 June 2016
16. Wainitayuki River about 2,500 m above Baidamudamu village (19.1062S, 178.0984E; 156 m a.s.l.): 09 June 2016
17. Tributary to Wainitayuki River about 2,500 m above Baidamudamu village (19.1079S, 178.0978E; 172 m a.s.l.): 09 June 2016
18. Daviqele village Farm creek, Nacavalagi creek, (19.131S, 177.994E; 107 m a.s.l.): 25 April 2022
19. Daviqele village water source dam creek headwaters, base of Mt. Washington, Dralau creek, (-19.128S, 177.994E; 171 m a.s.l.): 26 April 2022

## Results

### Species checklist

#### Coenagrionidae

##### *Agriocnemis exsudans* Selys, 1877

Localities: 3, 12, 13-14

Found at lower sections of the investigated stream habitats where the water flows through an almost flat terrain and banks overgrown with submerged vegetation. It was also common in the pools visited on the island.

First record for Kadavu.

***Ischnura aurora*** (Brauer, 1865)

Locality: 12, 14

Detected in one pool only where it was represented with single individuals.

First record for Kadavu.

***Melanesobasis corniculata*** (Tillyard, 1924)

Localities: 6-10, 15-17

All specimens collected during this study were assigned to *M. corniculata* (Fig. 3) although small structural and colour variations were observed between Kadavu individuals when compared to Viti Levu populations. These will be discussed in another study comparing representatives of the genus from more Fijian islands.

Previously reported for Kadavu by Donnelly (1984).



**Figure 3.** *Melanesobasis corniculata*, male.

***Melanesobasis simmondsi*** (Tillyard, 1924)

Localities: 3, 5-6, 9, 16

Tillyard (1924) erected *M. simmondsi* as new to science from Viti Levu, however specimens classified under this taxon have been so far collected only in Kadavu (Donnelly 1984). It is known by males only. The female is described below for the first time (Figs. 4-5). No significant colour variations have been observed between the sexes. Diagnostic features of the male are provided in Donnelly (1984) and additionally illustrated here in Figure 6.

*Melanesobasis simmondsi* was encountered often within the sampling area (Fig. 7), however the observed abundance was low. This was attributed partly to the inferred species preference to shady areas of the streams with 100% canopy cover often in small tributaries (up to 4 m wide, but more common in less than 1 m), which are very hard to walk through because of the narrow cross-section of the water course (Fig. 8), overgrowing grasses, fallen trees and other debris. In those sites the water trickles under rocks, in some places disappearing, leaving separate pools on the surface. Individuals were mostly observed perched on the vegetation, rarely on rocks in the water.

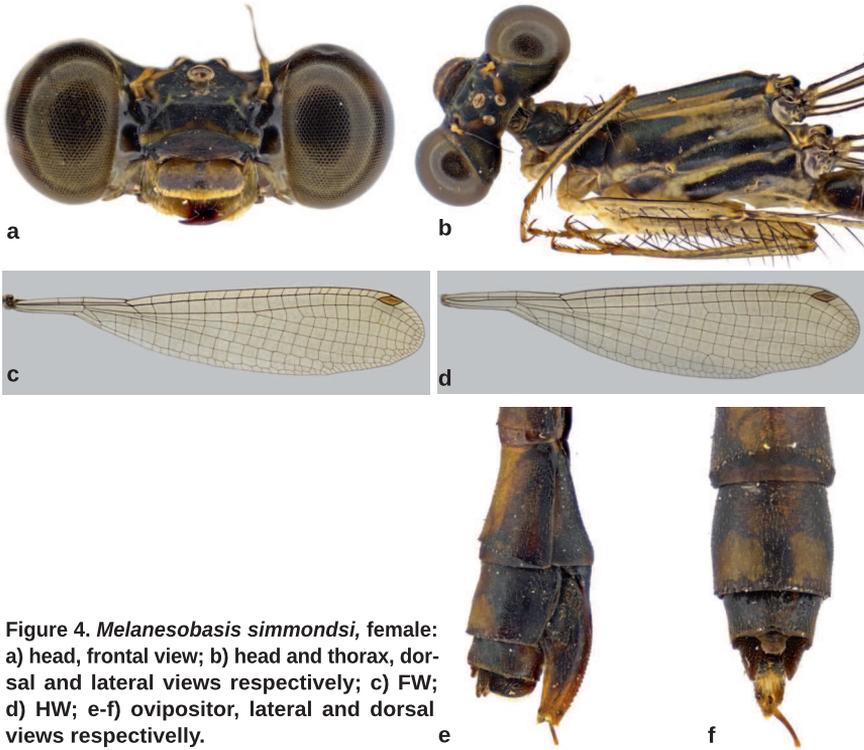
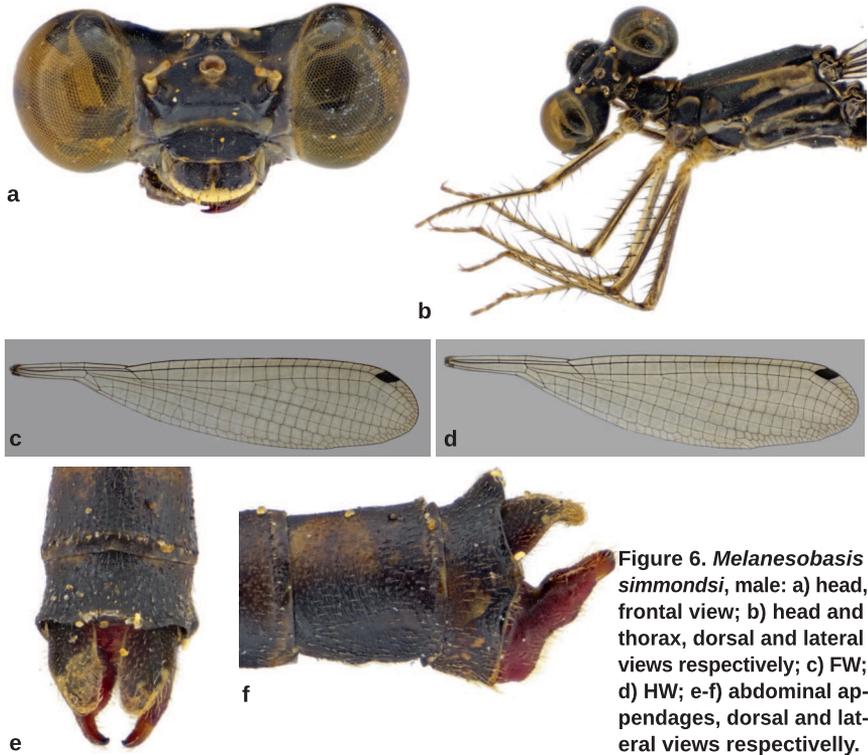


Figure 4. *Melanesobasis simmondsi*, female: a) head, frontal view; b) head and thorax, dorsal and lateral views respectively; c) FW; d) HW; e-f) ovipositor, lateral and dorsal views respectively.



Figure 5. *Melanesobasis simmondsi*, female.



**Figure 6.** *Melanesobasis simmondsi*, male: a) head, frontal view; b) head and thorax, dorsal and lateral views respectively; c) FW; d) HW; e-f) abdominal appendages, dorsal and lateral views respectively.

***Melanesobasis simmondsi*, female (NZAC04230796)**

**Head** (Fig. 4a-b). Labium pale yellow at the anterior half, light brownish posteriorly. Labrum yellow along the anterior edge, light brownish across the middle and dark yellow at the base; anteclypeus tucked under the overarching postclypeus and not fully exposed; the rest of the head dark with light predominantly bright yellow markings as follows: mandibular bases and genae at the area of attachment, pale streak continues up to above the level of the top surface of the postclypeus, anteclypeus seems to be dark yellow (from the obscure view to it), transverse bar across frons dorsal of the posterior end of postclypeus, almost whole scapes and pedicels with some shady areas at the bases and tips of these segments respectively, obscure wavy bar running from the outer edges of the lateral ocelli towards the bases of toruli, small obscure spot at the anterior part of the median ocellus, short bar along eyes at the levels of the antennal bases continuing approximately to the level of the middle of the ocellar triangle, dark spot with triangular shape between the lateral ocelli at the posterior part, very weak colouration at the bridge between the postocular lobes; rest of the head including the flagella black to dark brown with slight sheen at the lateral surfaces of the postocular lobes; eyes in live bi-coloured dark dorsally and blueish ventrally with a black cross band which is wider anteriorly (Fig. 5). Posterior surfaces of the lateral ocelli with 13-17 hairs each having paler basal areas.



**Figure 7.** *Melanesobasis simmondsi*, males (a-d) at various stages of maturity from teneral to mature.

*Thorax* (Fig. 4b). Prothorax predominantly black with two parallel yellow bars running through the lobes on both sides dorso-laterally, posterior lobe deeply incised shaped as two triangular lobes forming an obtuse angle at their bases. Pterothorax: dorsal carina and mesostigmal plate dark yellow, rest of mesepisternum dark with slight greenish reflection save for a wide dark yellow bar running from the mesostigmal plate towards the posterior of the segment—for most of its length it is sitting on the dorsum of the mesopleural suture; mesepimeron dark at the anterior part with two elongated triangular lobes giving the impression of an M-shaped figure, rest of the segment pale at the posterior end with a dark yellow round spot at the central dark area and pale area at the level of the metaspiracle descending towards the dorsal side of the mesinfraepisternum; mesinfraepisternum mostly dark with a yellow dorsal bar; both segments of metathorax dark at the middle and outlined with pale yellow becoming whitish at the ventral area; metinfraepisternum mostly dark with yellow at the ventro-posterior end. Legs predominantly pale yellow (becoming darker at the tarsal segments and claws) with dark ridges on the dorsal surfaces, leg spines black.



Figure 8. *Melanesobasis simmondsi*, habitat.

*Wings* (Fig. 4c-d) transparent with very weak infuscation, venation dark, arculus slightly distal or at the level of 2Ax in fore- and hind wings respectively, CuP closer to 2Ax in all wings; pterostigmata with costal edge shorter than posterior in all wings (better pronounced in fore wings), nodal index 18-2 / 2-18 in FW, 17-2 / 2-16 in HW; fore right wing with two intercalary cells. Posterior wing edge undulate between MP-RP<sub>3+4</sub>-RP<sub>2</sub>.

*Abdomen*. Predominantly dark (dark brown to black) with small light spots and lines as follows: antero-lateral ends of S1-6 (very tiny lines on the first two segments) ascending from the ventral area not meeting on the dorsum, weak lines at the posterior end of S1-6 almost touching on the dorsum on most of the segments with those on S2 widening on the dorsum into a triangular-shaped area pointing towards the anterior part of the segment, almost entire dorsum of S1, S7-8 and partly on S9 (NB: the lighter colouration of S7 may be a post mortem result). Ovipositor (Fig. 4e-f) slightly surpassing the level of the tips of the cerci.

Measurements (in mm): AL 35, HW 25.5

#### Variations in other females (N = 9)

The colouration generally follows the pattern described above. Intensity of the colouration is age dependant. Younger specimens may be characterised with much paler colouration revealing additional spots that disappear with age. Head: spot at the anterior end of median ocellus connected to two lateral bars creating one continuous transverse cross bar; other spots and areas much wider with the brighter areas extending to the eyes. Very old speci-

mens have labrum mostly uniformly coloured leaving for a pale yellow bar along the anterior edge. Colouration of the pterothorax: breadth of the light bar on the mesepisternum may be very reduced, dark area on the metepimeron interrupted in the middle, abdomen with dark area at the posterior areas rest of the segments light brownish; light areas on the dorsum almost non-existing, whitish pruinescence build up on the ventral area of the thorax. Two specimens with inorganic substances covering more than 2/3 of the dorsum of the pterothorax – may be bottom substrate left from ovipositing attempts. Infumation of the wings deepens and their cross veins appear outlined with pale yellow areas. Measurements (in mm): BL 33–37; HW 24–27.

***Nesobasis baidamuensium* sp. nov.**

(Fig. 9; Plates 1-3)

**Holotype.** ♀ (NZAC04212529), KADAVU, stretch of Wainiela River about 3,300 m above Baidamudamu village (19.1081S, 178.0872E to 19.1116S, 178.0869E; 208–235 m a.s.l.), 7 June 2016, MM leg.

**Paratypes.** 5 ♀ ♀ all from Kadavu Island and deposited in four collections: NZAC: 2 ♀ ♀ (NZAC0423071–2), tributary to Wainitayuki River about 2,500 m above Baidamudamu village, 19.1079S, 178.0978E; 172 m a.s.l., 9 June 2016; USP-ABC: 1 ♀ (USPac\_12622, USP), tributary to Wainitayuki River about 2,500 m above Baidamudamu village, 19.1079S, 178.0978E; 172 m a.s.l., 9 June 2016; RWGC: 1 ♀, tributary to Wainitayuki River about 2,500 m above Baidamudamu village, 19.1079S, 178.0978E; 172 m a.s.l., 9 June 2016; MLBM: 1 ♀, same data as holotype. All specimens collected by MM.



**Figure 9.** *Nesobasis baidamuensium*, female live colouration: a) head, frontal view, b) habitus.

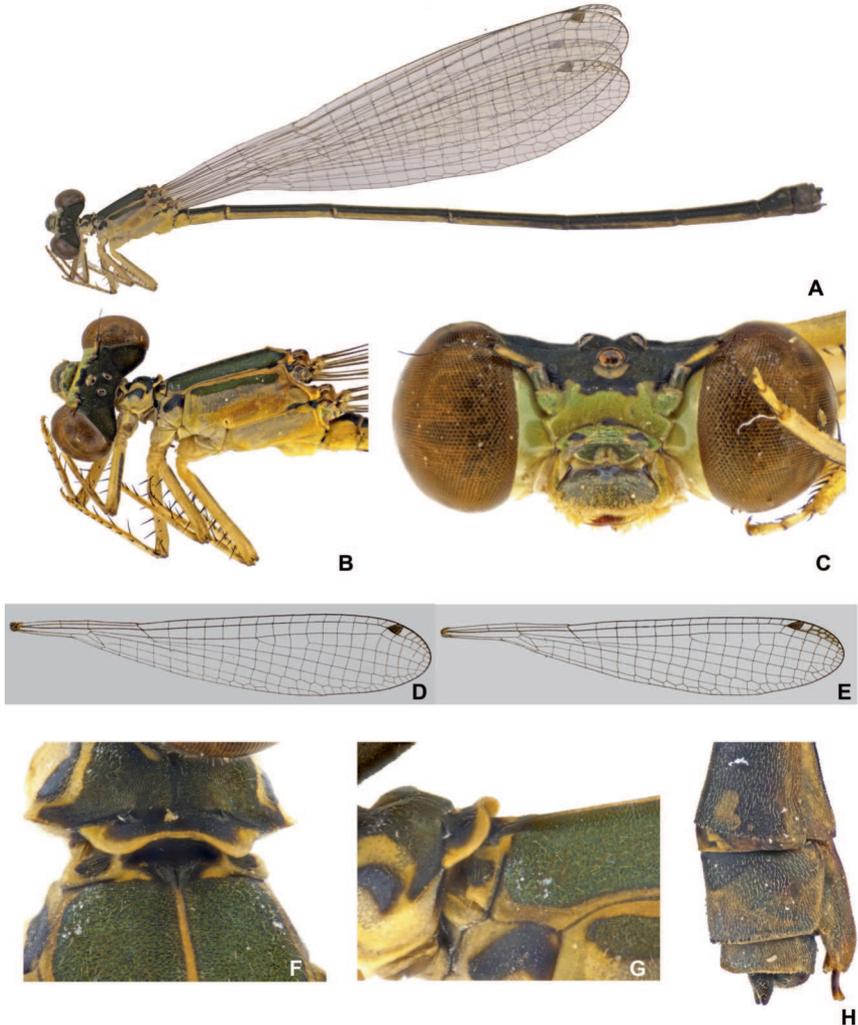
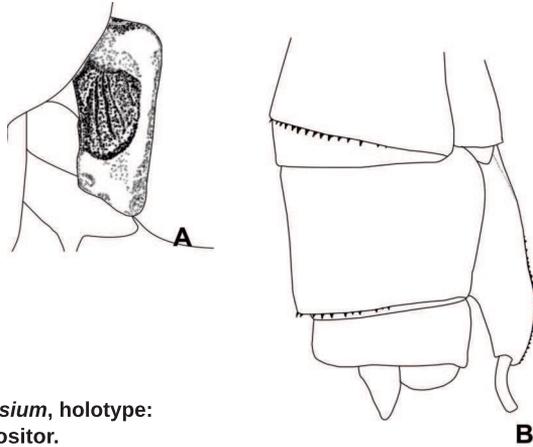


Plate 1. *Nesobasis baidamuensium*, holotype: a) habitus, b) head and thorax, dorsal and lateral views respectively; c) head, frontal view; d) FW; e) HW; f-g) mesostigmal late and posterior edge of pronotum, dorsal and lateral views respectively; h) ovipositor, lateral view.

**Etymology.** The name is a shortened version of the name of the village Baidamudamu combined with *-ensium*, a Latin morpheme denoting its inhabitants in the genitive case intended as a tribute to the villagers' hospitality and kindness during the sampling period (noun in the genitive case).



**Plate 2. *Nesobasis baidamuensium*, holotype:**  
 a) mesostigmal plate, b) ovipositor.

### Description of holotype

(Plate 1)

*Head* (Plate 1a-c). Labium yellow. Face green yellow up to the dorsal end of the scapes with dark spots as follows: central median at the posterior edge of labrum and faint brownish lines going sideways towards the posterolateral corners, two black spots at the antero-lateral corners of postclypeus with a weak cross line at the posterior edge of it; scapes same colour as the face, pedicels yellowish on the anterior face and darker on the posterior area, flagellum black; vertex dark with a very weak sheen, dark area continues as two small diverging horn-like projections between the bases of antennal toruli, light spots anterior at the base of the median ocellus and a faint spot midway between the occipital lobes; eyes in life bicoloured: red and green with a sharp contrast between on the dorsal area – red occupies posterior 1/3 of the eye crossing the eye diagonally, leaving the frontal, anterior and ventral parts of the eyes for a vivid green which brightness is further highlighted by a touch of pale yellow.

*Thorax* (Plate 1b). Prothorax mostly black on the dorsum with the dark area continuing anteriorly half way up the anterior lobe and posteriorly  $\frac{3}{4}$  of the surface of the posterior lobe, one curved bar (roughly half-moon shape) on each lateral side of the midlobe, rest of the prothorax (as well as two elongated spots on the midlobe) yellow; posterior lobe elevated with wavy dorsal edge. Pterothorax dark with green sheen on the dorsum, laterally orange yellow going ventrally to about metapleural suture, metepimeron bright yellow; dorsal carina as well as carinae outlining the prealar ridge orange yellow; thin orange yellow running on the ventral edge of mesepisternum interrupted approximately about  $\frac{1}{7}$ – $\frac{1}{9}$  before the posterior end with the dark area joining the mesopleural suture; mesepimeron with a thick dark bar with green sheen not connecting with the sutures at both ends; black curved bar (similar shape to the lateral sides of prothorax) on the mesinfraepisternum dorsally touching the suture; other black spots as follows: one irregular shaped at the dorso-posterior corner of metepimeron, semi-circle sitting on the dorsum of metapleural suture

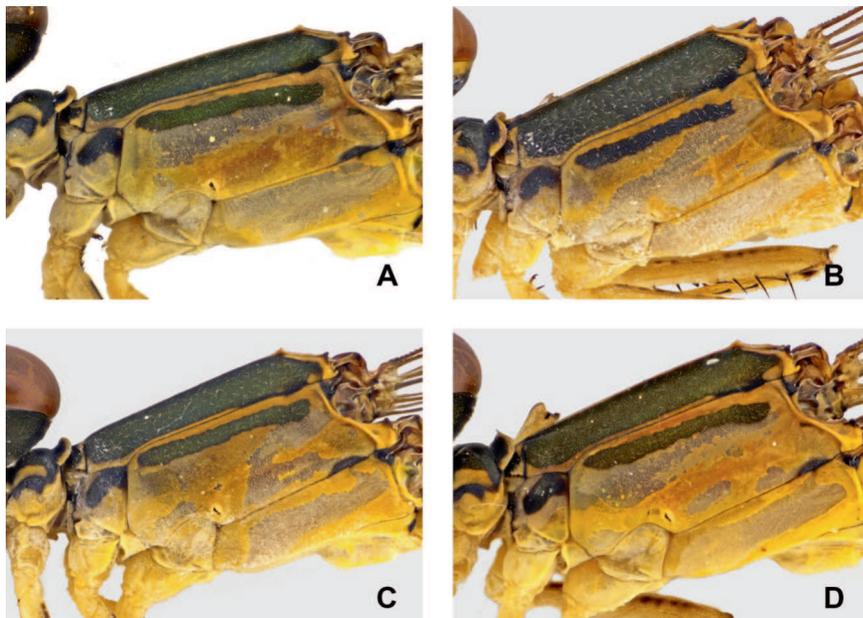


Plate 3. *Nesobasis baidamuensium*, variations of the thorax, lateral views: a) holotype, b-d) paratypes.

about  $\frac{1}{7}$ – $\frac{1}{9}$  before the end of the segment with its ventro-posterior corner weakly expanded and joining posterior end of the suture, vertical bar on the posterior edge of poststernum; mesostigmal plate (Plate 1f-g) mostly flat with longer dorsal and oblique ventral side yellow with a black central spot rounded at the posterior edge of the plate. Legs yellow with darker areas developed on the posterior surfaces of all femora, faint black longitudinal lines at the bases of the tibia on their anterior faces, leg spines black, tip of claws dark reddish.

*Wings* (Plate 1d-e). Hyaline with faint yellowish traces mostly along the leading veins especially at the area around the nodes; acrolus distal than 2Ax, CuP separated from the base of CuP&AA and positioned closer to 1Ax in fore wings and at the middle between 1 and 2Ax in hind wings; pterostigmata pale brownish in all wings with the costal edge more than twice shorter than the posterior edge, one extra cell only on the fore right wing; second row of 4–5 cells distally from the pterostigmata in both hind wings; FW: 14/15 Px, RP<sub>2</sub> at 6<sup>th</sup> Px,; HW: 12 Px, RP<sub>2</sub> at 6<sup>th</sup>/5  $\frac{1}{2}$ <sup>th</sup> Px.

*Abdomen*. Generally dark on the dorsal as far as S8 and yellow on the ventral sides. Dark on the dorsum with green sheen which is bright towards the base and gradually becoming obscure to almost disappearing around midway on S7, two kidney-shaped dark yellow spots dorso-laterally at the posterior end of S8, dark extends to almost half-way on the dorsum of S9, the rest of S9 and whole of S10 grey-blue save for a darker area at the ventral part of S10; anal appendages black; ovipositor (Plate 1h) with its tip aligned with the posterior end of S10 but the styli projecting further and aligned with the tips of the anal ap-

pendages, styli dark red with bright tips; yellow on the ventral side is bright at the base and is gradually darkening becoming dark yellow to orange at about posterior end of S5; sternites 2–8 increasing in size towards the posterior part of the abdomen; yellow ascending at the anterior lateral corners of S3–6.

Measurements (in mm): AL 31.5; HW 23.5; HF 2.5; S 0.2; P 0.38; MDBE 1.48.

**Variations within the paratype series** (Plate 3). Similar to almost identical to holotype with small variations of the colouration of the labrum (much darker in some specimens), shape of the mesoepimeral bar, shape of the horn-like extensions between the antennal bases, lateral curved bar on the prothorax joined with the dark area descending from the dorsum, expansion of the dark spot on the mesostigmal plate occupying almost entirely the dorsal surface, second row of cells distal to the pterostigmata present in all specimens but the number may be reduced to three (either in a single line or one detached from the other two), wing venation much paler, shape of the spots on S8 and the extension of the black area on S9. AL 30–31, HW 22.5–23.

**Differential diagnosis.** Bright coppery-yellow insects (Fig. 9) known by females only. Specimens investigated for this study resemble members of the so called *erythrops*-group (sensu Donnelly 1990) for the presence of pits between plate and dorsal carina, keeled middle lobe of the prothorax (Plate 1f), flat mesostigmal plate (Plate 2a) and the fine serration of the ovipositor (Plate 2b). *Nesobasis baidamuensium* females look very much like *N. rufostigma* in general facies and especially by the bright red eyes in live individuals (cf. Fig. 9b and 17b). Both occur on Kadavu Island. They are recognisable by the following characters and colouration typical of *N. baidamuensium* (*N. rufostigma* presented within the parentheses): HW with double rows of cells distal of pt (single), pterostigmata in all wings with costal edge almost twice shorter than posterior (subequal), metepisterna lack triangular spot (present), mesepimera with dark area reduced to a cross bar (occupying almost the entire surface of the segment), dorsal carina outlined with yellow along its length (almost completely dark leaving for some light streaks in the midsections).

*Habitat.* Mid-sections of streams about 5-7m wide.

### ***Nesobasis nedeltshvae* sp. nov.**

(Fig. 10; Plates 4-8)

**Holotype.** ♂ (NZAC04212531), KADAVU, Tributary to Wainitayuki River about 2,500 m above Baidamudamu village, 19.1079S, 178.0978E; 172 m a.s.l., 9 June 2016, MM leg.

**Paratypes.** KADAVU: 4 ♀ ♀ deposited in three collections: NZAC: 1 ♀ (NZAC04230697), same data as holotype; 1 ♀ (NZAC04230699), stretch of tributary to Wainitayuki River about 1,100 m above Baidamudamu village, 19.0987S, 178.0975E to 19.1014S, 178.0976E; 119–156 m a.s.l., 10 June 2016; RWGC: 1 ♀, stretch of tributary to Wainitayuki River about 1,100 m above Baidamudamu village, 19.0987S, 178.0975E to 19.1014S, 178.0976E; 119–156 m a.s.l., 10 June 2016; MLBM: 1 ♀, same data as holotype; all specimens collected by MM; 2 ♀ ♀ (USPac\_12707-8), Daviqele village Farm creek, Nacavalagi creek, 19.131S, 177.994E; 107 m a.s.l., 25 April 2022, BR leg.

**Allotype.** ♀ (NZAC04230698), same data as holotype.

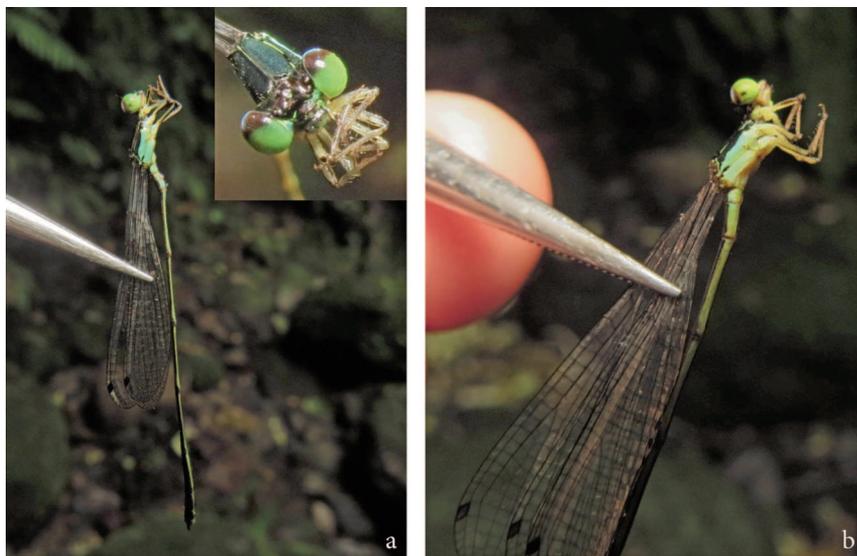


Figure 10. *Nesobasis nedeltshevae*, live colouration: a) male, b) female.

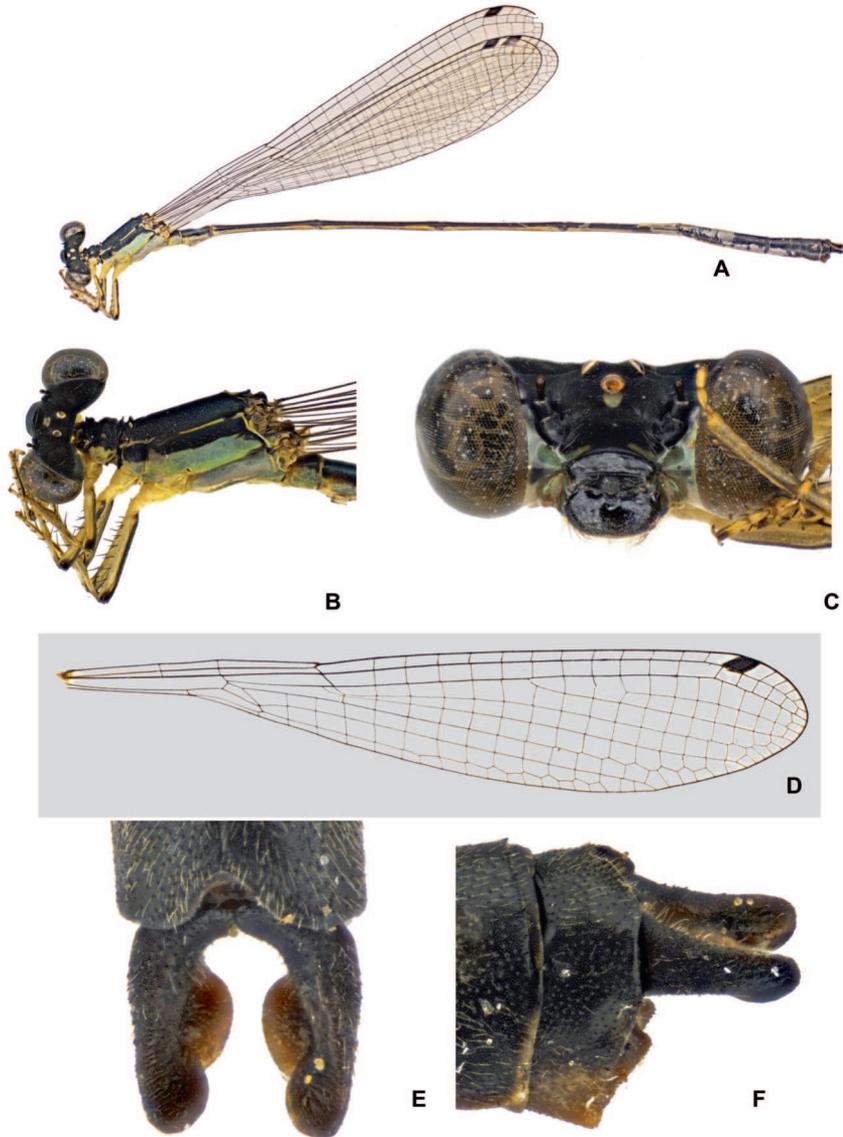
**Etymology.** The scientific name is derived from the mother's name of one of us (MM) by her patronym Nedeltsheva being a reference to his grandfather as well (noun in the genitive case).

#### Description of holotype

(Plates 4, 5)

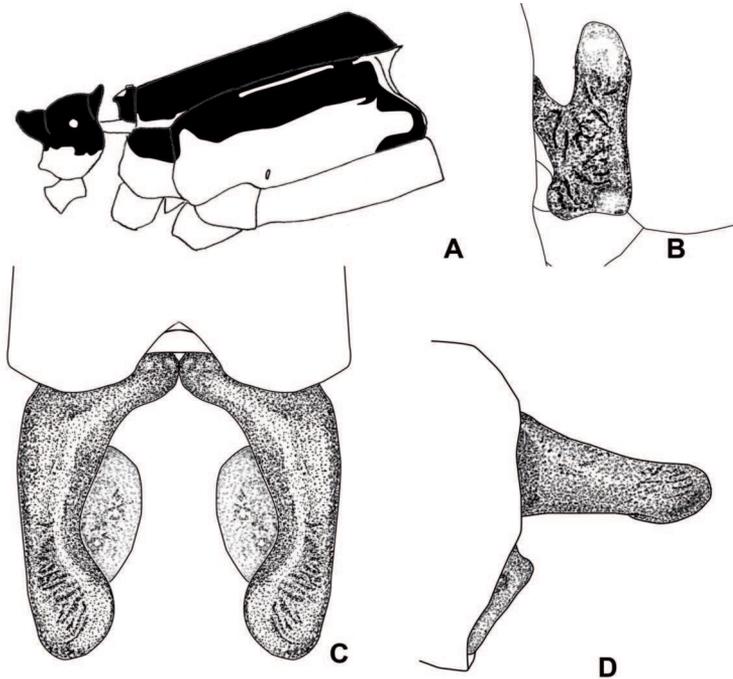
**Head** (Plate 4a-c). Labium yellow. Labrum, entire clypeus, scapes, pedicels, frons and vertex almost uniformly black; blue areas developed on genae ascending up along the eyes to the ventral edge of antennae continuing as an oblique line at the level of the scapes, bases of mandibles, faint tint along the anterior edge of labrum, two invaginations going towards each other on the frons just dorsal of the posterior end of postclypeus, faint spot at the anterior end of median ocellus; eyes bicoloured – brown on the dorsum third and green on the rest transitioning to yellowish on the ventral area.

**Thorax** (Plates 4b, 5a). Prothorax entirely black on the dorsum with the dark area descending and surpassing the midline of the lateral sides of the prothorax, one small yellow spot on each lateral side of the midlobe, posterior lobe flat upturned and slightly curved forwards. Pterothorax black on the dorsum and blue on the sides becoming yellow towards the ventral part. Black developed as follows: almost completely on the mesepisternum saved for a thin blue line running along the dorsal edge of dorsum of mesinfraepisternum and faint yellow line on the posterior half of the dorsal carina, wide bar on the mesepimeron occupying almost the entire segment (saved for a thin yellow central line wider at the posterior end and tapering towards the anterior part) running anteriorly with a rounded invagination close to the mesinfraepisternum, the latter receives the bar for almost the entire length ending in a rounded tip close to the anterior edge of the segment, posterior end of metepisternum with



**Plate 4.** *Nesobasis nedeltshvae*, holotype: a) habitus, b) head and thorax, dorsal and lateral views respectively; c) head, frontal view; d) HW; e-g) abdominal appendages, dorsal and lateral views.

the spot curved and continuing along the metapleural suture, posterior end of metapost-sternum. Mesostigmal plate (Plate 5b) black with roughly rectangular shape, its dorso-



**Plate 5.** *Nesobasis nedeltshevae*, holotype: a) thorax, lateral view, b) mesostigmal plate, c-d) abdominal appendages, dorsal and lateral views respectively.

posterior corners yellow and elevated. Leg mostly yellow with black surfaces at the posterior areas of all femora with the dark expanding towards the junctions with the tibia, all tibia with light brownish lines along their anterior faces and additional darker areas along the outer posterior surfaces of front tibia and shaped as small triangles at the bases of the posterior surfaces of mid- and hind tibia; leg spines black; claws yellow with dark red tips.

*Wings* (Plate 4d). Hyaline with black venation (slightly paler at the bases) and deep dark red to almost black pterostigmata with rhomboidal shape; arcus slightly distal to 2Ax, CuP midway between 1–2Ax FW: 14 Px, RP<sub>2</sub> at just proximal of 7<sup>th</sup> Px; HW: 12 Px, RP<sub>2</sub> at just proximal to 6<sup>th</sup> Px.

*Abdomen*. Almost entirely black on the dorsum for the whole length saved for two round obscure spots on the lateral sides of S9; black area gradually encompassing larger surface of the abdominal segments descending to the ventral side starting from S6 and covering completely lateral sides of last four segments from the about the midlength of S7; ventral side bright blue on S1–2 and yellow from S3 till midlength of S7; S8–9 with faint lines along the ventral edge ascending up for 1/3 of the height of the segment on the intersegmental membrane; cerci (Plates 4e-f, 5c-d) black longer than S10 broadly rounded at the tips, inner surfaces with a light brownish expansion about midway; para-procts light brownish short hardly sticking out of the posterior end of S10. Abdomen is broken

(and glued back) on three points one of them is the border between S2–3. Therefore, the penis was not detached from the body and inspected from ventral view only for the shape of the distal lobe. The latter is T-shaped with the stem trapezoid slightly expanding towards the transverse distal part which is almost as wide as the stem at the middle and extended backward at both lateral ends.

Measurements. AL 33.0; HW 21; HF 2.1; S 0.12; P 0.24; MDBE 1.4.

### Description of allotype

(Plates 6, 7)

**NOTE:** female was associated with the male on similarities of the thoracic colour and habitat where they both were collected from.

*Head* (Plate 6a-c). Labium yellow. Labrum blue-yellowish with large central spot at the middle of the posterior edge and brownish areas encompassing postero-lateral corners; frontal part mostly blue gradually becoming more yellow towards the ventral side around the bases of the mandibles, rest of the blue area developed as follows: genae ascending along the eyes up to about dorsal end of toruli, anteclypeus, two central bars going towards each other on the postclypeus, antefrons, anterior faces of toruli and dorsal outer corners of scapes; rest of the head black except a light spot anteriorly at the base of median ocellus and pedicels which are red-brownish; postclypeus with a black T-shaped spot; eyes bicoloured – brown on the dorsum third and green on the rest transitioning to yellowish on the ventral area.

*Thorax* (Plate 6b). Prothorax black on the dorsum spread anteriorly on the anterior lobe and descending down to more than half surface area on the lateral sides; yellow developed as follows: two lateral spots midway, entire ventral area, lateral corners at the bases of the posterior lobe, midway on the edge of the posterior lobe. Pterothorax dark on the dorsum with faint green sheen with black developed as follows: almost entire mesepisternum, wide cross bar running anteriorly parallel to the mesopleural suture but not touching it about  $\frac{1}{10}$  of the base before the mesinfraepisternum, invagination going up towards mesopleural suture just before the bar continues on the mesinfraepisternum, the latter is bicoloured with the black running across the dorsal half, posterior end of the intersegmental suture coloured like a thin black line with the black continuing along the posterior edge of the metepisternum but not reaching the metapleural suture, semi-circular spot sitting on the dorsal part of metapleural suture, posterior edge of poststernum; yellow on the dorsal carina, thin line on the anterior  $\frac{1}{4}$  of the antero-lateral corners of mesepisternum running on the dorsal part of the mesinfraepisternum and continuing along the mesopleural suture, same line overlaps a cross bar running on mesepimeron parallel of the mesopleural suture to the posterior end; rest of the pterothorax pale blue on most of metepisternum and metepimeron with yellow tinge towards the ventral sides of both; mesostigmal plate (Plates 6f-g, 7a) roughly rectangular shape wider at the dorsal part black with yellow postero-ventral corner, dorso-posterior corners yellow elevated like small tubercles. Legs yellow with posterior surfaces on the femora slightly expanding towards the tips and light brownish areas at the bases of tibiae at the anterior surfaces, small light brownish triangular spots at the bases of the posterior surfaces, leg spines black, claws yellow with dark reddish tips.

*Wings* (Plate 6d-e). Hyaline with mostly dark venation (pale at the base), arculus distal of 2Ax in all wings, CuP proximal of the base of CuP&AA; pterostigmata rhomboidal dark brown; FW: 13 Px, RP<sub>2</sub> at 6<sup>th</sup> Px; HW: 11/12 Px, RP<sub>2</sub> at 5<sup>th</sup> Px.

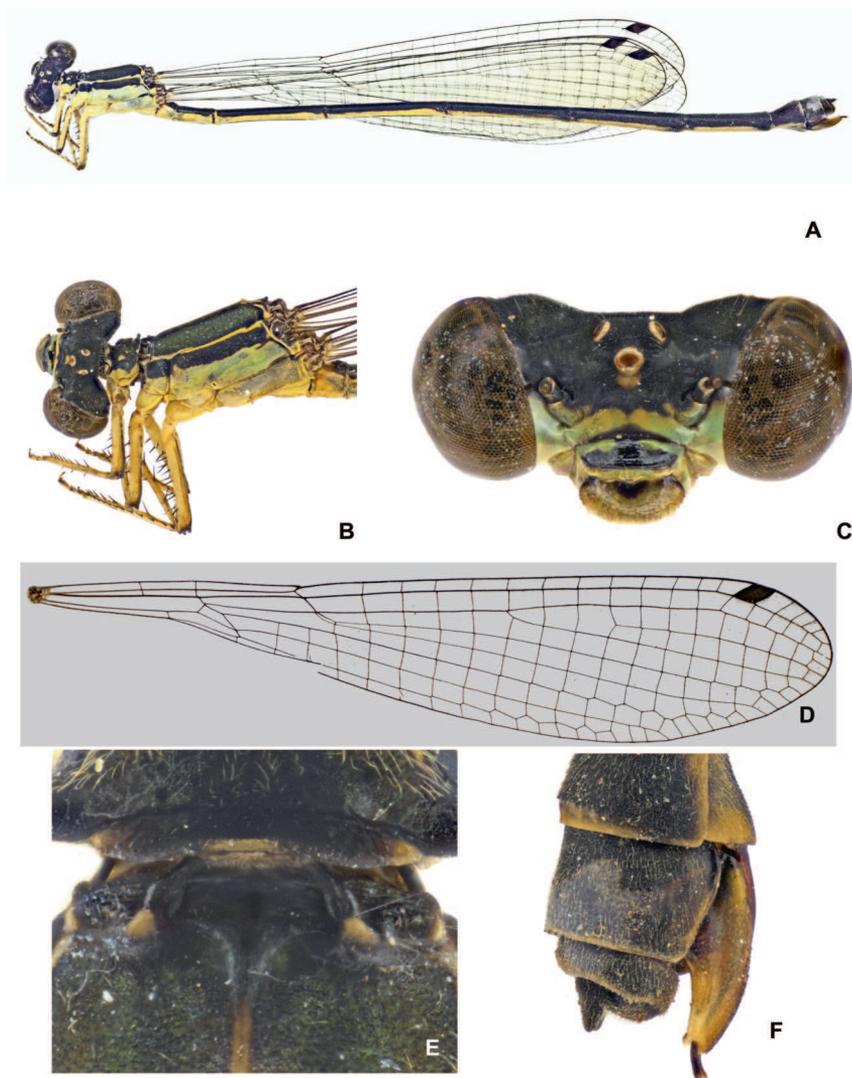
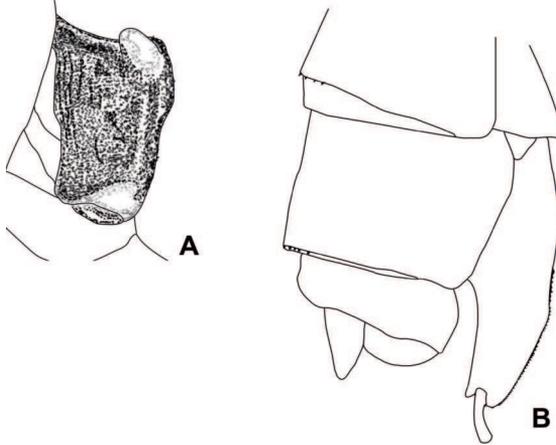


Plate 6. *Nesobasis nedeltshevae*, allotype: a) habitus, b) head and thorax, dorsal and lateral views respectively; c) head, frontal view; d) HW; e) mesostigmal plate and posterior edge of pronotum; f) ovipositor, lateral view.

*Abdomen.* Black on the dorsum for entire length of S2–8, S1 light brown at the base half way then black, S9 black at the dorsum descends laterally and anteriorly towards midway laterally then continues towards the posterior end of the segment saved for a invagination lighter area going down the segment, rest of S9 grey blue; S10 slightly black at the base and

**Plate 7. *Nesobasis nedelt-shevae*, female allotype: a) mesostigmal plate, b) ovipositor.**



grey blue on the dorsum to about half way on the lateral sides then black towards the ventral side of the segment; black interrupted by a very thin line on the mid-dorsum running for the whole length of S3–5 and obscure traces on S2 and S6; black descending towards the postero-ventral corners of S5–8; ventral side of the abdomen yellow decreasing in intensity from S5 onwards to the tip; ovipositor (Plates 6h, 7b) yellow aligned with the tips of the appendages; styli dark red with light tips.

Measurements. AL 29.5; HW 22.5; HF 2.1; S 0.14; P 0.26; MDBE 1.4.

**Variations within the paratype series** (Plate 8). Same general colouration as the allotype with most notable differences in the width of the two yellow lines on pterothorax dorsal and ventral of the mesopleural suture – they are not touching (identical to the holotype) or dorsal going to about half way and ventral may be interrupted towards the posterior end where a black bar is descending from the mesepisternum and joining the transverse bar on the mesepimeron; the T-shaped black spot on postclypeus variously developed with elongation towards the posterior end obscure to almost missing leaving only one transverse black bar on the anterior edge; shape of the black area on S9; expansion of the black area on the prothorax encompassing the whole of the dorsum.

Measurements: AL 29.5–30, HW 20.5–22.

**Differential diagnosis.** Overall dark insects (Fig. 10) with greenish thorax and blue dorsal surface of the posterior abdominal segments in females (Fig. 11). The following combination of characters observed in both sexes of *N. nedelt-shevae* make them good candidates to be included as members of the so called *longistyla*-group (sensu Donnelly 1990): elevated dorso-posterior corners of the mesostigmal plate (Plates 5b, 7a), short pedicel (Plate 4c, 6c), male paraprocts much shorter than cerci to almost vestigial (Plates 4e-g, 5c-d), ovipositor with fine dentation (Plates 6f, 7b). The shape of the cerci of the males is closer to *N. caerulea* Donnelly, 1990, *N. longistyla* Selys, 1891, *N. campioni* Tillyard, 1924 and the structure of the penis resembles most *N. campioni* being T-shaped and having the transverse distal part almost as wide as the stem. Male of *N. nedelt-shevae* is distinguished from all three by the general shape of the cerci which from the dorsal view appear to have almost parallel sided outer edges (widely rounded more pincer-like in the rest) and the position of the inner expansion being almost centred at the mid-section (more apical in the rest). By the general body colouration (black with green to blue-green) females *N. nedelt-shevae* are

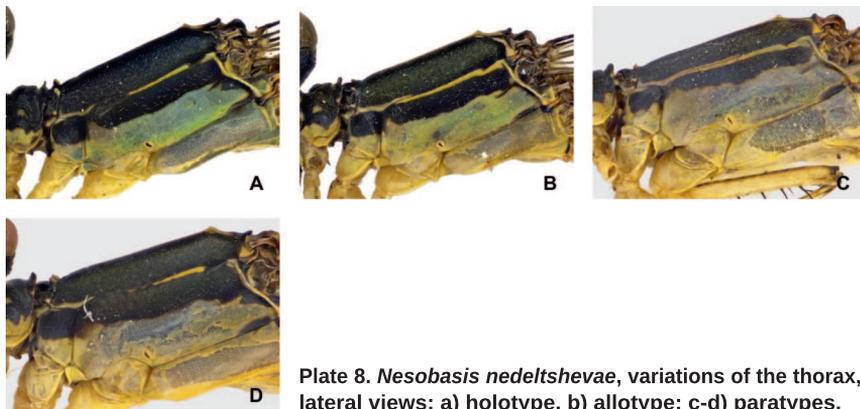


Plate 9. Comparison between diagnostic characters on the thorax of: a-b) *N. nedeltshevae* (mesostigmal plate and lateral view respectively), c-d) *N. longistyla* (mesostigmal plate and lateral view respectively).

closer to *N. caerulecaudata/longistyla* than to *N. campioni* (black with yellow). Female of *N. caerulecaudata* has not been described yet, but it is supposed to be very similar to indistinguishable from *N. longistyla* (Donnelly 1990). Females of *N. nedeltshevae* can be differentiated by shape of the mesostigmal plate and the pattern of the thorax (Plate 9).

**Figure 11.** *Nesobasis nedeltshevae*, female perching site.



*Habitat.* Holotype collected at the bottom of a waterfall in a section of the stream which was completely covered by the tree canopy. Females were encountered at the same habitat with the holotype as well as other shady sections of the streams within the area.

***Nesobasis recava*** Donnelly, 1990

Localities: 3-10, 13, 16-17

Very common within the investigated area. Males select perching sites at shady areas (Fig. 12) of a variety of habitats with canopy cover of nearly 90-95%, lower on the marginal vegetation overhanging the water (Fig. 13). Individuals from both sexes (Fig. 14) were encountered in small overgrown sections of the streams where it was nearly impossible to pene-



**Figure 12.** *Nesobasis recava*, habitat.



Figure 13. *Nesobasis recava*, male perching site.



Figure 14. *Nesobasis recava*, live colouration: a) male, b) female.



Figure 15. *Nesobasis recava*, tandem.

trate to rivers more than 7m wide. Males were seen facing each other in what was considered as a territorial display. Similarly, male *N. recava* was observed chasing female *N. rufostigma*. One tandem was observed (Fig. 15) with the female touching water with her abdomen, however, not a clear indication of oviposition.

Endemic to Kadavu and previously reported by Donnelly (1990), van Gossum et al. (2007, 2008).



Figure 16. *Nesobasis rufostigma*, habitat.



a



b

Figure 17. *Nesobasis recava*, live colouration: a) female, b) male.

***Nesobasis rufostigma*** Donnelly, 1990

Localities: 3, 5-7, 10, 13, 16

Very common within the investigated area recorded in various types of environments in both shaded and exposed parts (Fig. 16) of the instream habitats. Both sexes are recognisable by the red eyes and copper dorsal part of the thorax (Fig. 17). Note that *N. baidamusensium* also has characteristic red eyes. For more on the distinguishing characters see the diagnosis above.

Previously reported for Kadavu by Donnelly (1990), van Gossum et al. (2008).

***Nikoulabasis ilievae*** sp. nov.

(Fig. 18; Plates 10-12)

**Holotype.** ♀ (NZAC04230754), KADAVU, Wainiela River about 2,800 m above Baidamudamu village, 19.1037S, 178.0895E, 187 m a.s.l., 7 June 2016, MM leg.

**Paratypes.** KADAVU: 3 ♀ ♀, same data as holotype, deposited in: NZAC (NZAC04212530), RWGC, MLBM. All specimens collected by MM.

**Etymology.** The scientific name is dedicated to the wife of MM by her patronym Ilieva being a reference to his father-in-law as well (noun in the genitive case).

**Description of holotype**

(Plates 10-11)

**Head** (Plate 10a-c). Bright yellow on labium, bases of mandibles, genae up to approximately apical end of scapes, anterior edge of labrum, base of postclypeus, larger part of the frons up to the anterior edge of the median ocellus, scapes; mandibular tips reddish, labrum obscure bluish at the base with short dark streaks continuing within the yellow area along the anterior edge; anteclypeus tucked under postclypeus and colour not visible; wide wavy black cross bar at the anterior edge of postclypeus with two semi-circular cuts along the



posterior edge, middle lobe of the bar weakly pointing towards the posterior end of postclypeus where opposite to it is sitting a pale brownish spot; pedicels and flagella black; vertex entirely dark with greenish iridescent, same colour spot situated at a depression in front of the median ocellus – spot with irregular shape having a rounded posterior edge and sharply point-

**Figure 18.** *Nikoulabasis ilievae*, female live colouration.

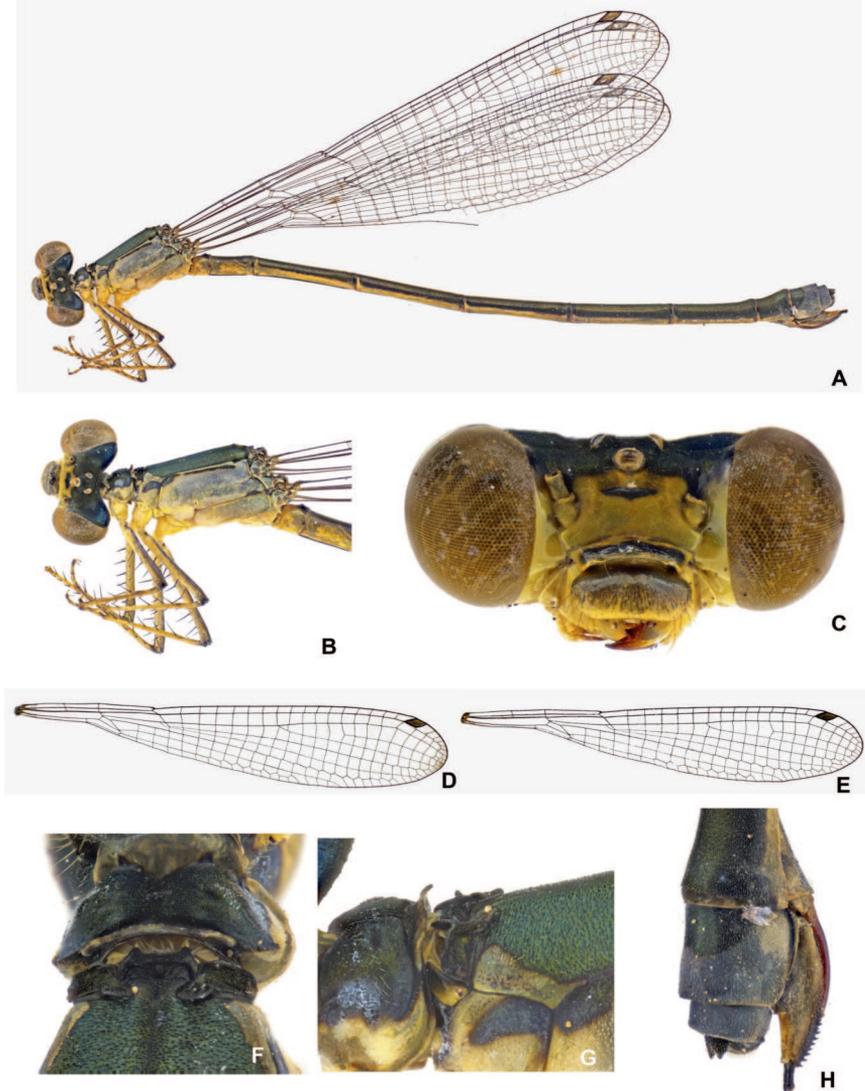
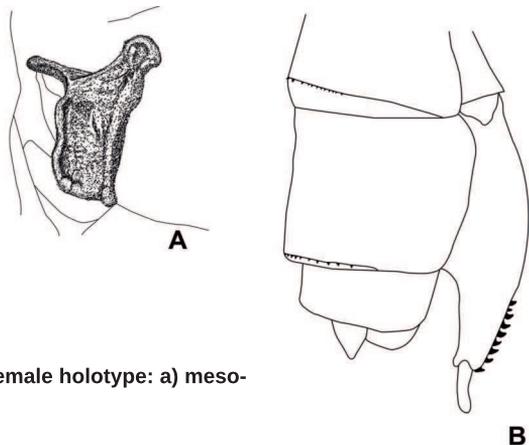


Plate 10. *Nikoulabasis ilievae*, holotype: a) habitus, b) head and thorax, lateral views respectively; c) head, frontal view; d) FW; e) HW; f-g) mesostigmal plate and posterior edge of pronotum, dorsal and lateral views respectively; h) ovipositor, lateral view.

ed median extrusion of the anterior edge and weak pruinescence at the base; eyes bicoloured in life brownish at the dorsum and yellow-green laterally and ventrally.



**Plate 11.** *Nikoulabasis ilievae*, female holotype: a) mesostigmal plate, b) ovipositor.

*Thorax* (Plate 10b). Prothorax: anterior lobe with the leading edge dark otherwise rest pale blue on the dorsum and obscure yellow at the lateral sides; middle lobe dark with strong green sheen descending laterally to about half way down on the lateral sides becoming black around the edges and having a strong pruinescence at the middle, ventral part of the lateral sides yellow; posterior lobe flat and raised with a roughly trapezoid shape pale at the top part and dark at the base. Pterothorax generally dark with green sheen on the dorsum of mesepisternum and light blue at the side becoming bright yellow towards the ventral side with the following additional spots: pale bluish bar along the anterior part of the mesepisternum on the dorsal edge of mesinfraepisternum, yellow line on the posterior end of the dorsal carina on the continuation to the alar area, dark spot at the dorso-posterior corner of the mesinfraepisternum with roughly triangular shape with the tip curved towards the ventral side, dark line with irregular shape (wide circular anteriorly interrupted and becoming thinner with approximately parallel sides posteriorly) running on the mesepimeron almost parallel to the mesopleural suture stopping about  $\frac{1}{10}$  before the end, two dark spots on the metepisternum: one weak dark spot arched at the dorso-posterior corner of the metepisternum and the other below it on semi-circular sitting on the top of the metapleural suture, dark spot on the posterior edge of the poststernum. Mesostigmal plate (Plate 10f-g, 11a) roughly rectangular shape with anterior edge elevated at the dorsal corner shaped almost like an ear, dorso-posterior corner flat elongated and widely rounded at the end. Legs: coxae bright yellow, second trochanters weakly dark on the posterior surface with dark area running all the way on the femora, tibiae mostly dark yellow with pale brownish spots joined in elongated lines on the front tibiae, tarsal segments dark yellow with reddish tips, terminal tarsi having dark red developed for almost  $\frac{1}{3}$  of the length, claws dark yellow with dark red tips.

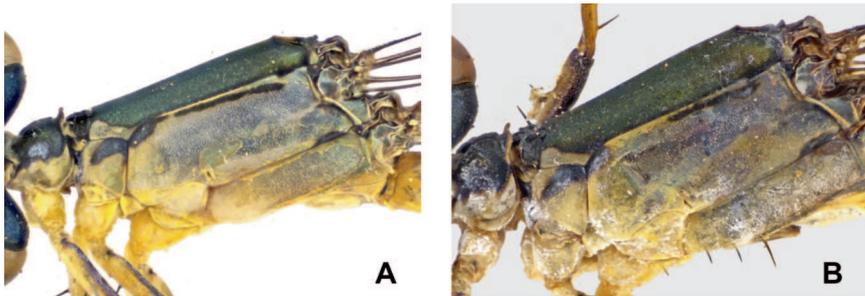
*Wings* (Plate 10d-e). Hyaline with dark venation; arculus slightly distal from the 2Ax, CuP almost half way between the two antenodal crossveins in fore wings and slightly distal towards 2Ax in hind wings originating at the base of CuP&AA at the front wings and slightly distal of it in hind wings; pterostigmata roughly rhomboid shape, pale brown with dark edges; FW: 16 Px, RP<sub>2</sub> at 7<sup>th</sup> Px; HW: 14 Px, RP<sub>2</sub> at 6<sup>th</sup> Px.

**Abdomen.** Overall dark on the dorsum with green sheen which intensifies towards the posterior end and bright yellow on the ventral side with yellow ascending slightly along the anterior edges, yellow on S1 through to anterior part of S3 with slight blue tint; deviation from this description are last segments which have blue areas developed as follows: S9 posterior half of it on the dorsum with the blue descending towards the ventral part and anteriorly joining the posterior end of S8 half way laterally, S10 entirely blue; anal appendages black; ovipositor (Plate 10h) surpassing the end of S10 reaching as far as end of appendages with styli pointing out behind, the overall colour is dark yellow with weak bluish central area dark red line along the distal edge beneath the serration, the latter characterized with 8–10 stout teeth, styli dark red with light spots at the bases and the tips. Sternites predominantly black except for S1.

Measurements: AL 26; HW 20; HF 3; S 0.2; P (missing); MDBE 1.6.

**Variations within the paratype series** (Plate 12). Width of the bar at the anterior border of the postclypeus, spot at the depression with anterior edge almost straight, deep pruinescence developed lateral on the thorax and S1, ventral part of the abdomen with bluish tint, mesepimeron – black line with a big gap almost half way missing and connected to the dark area of mesepimeron, or not interrupted solid joined to the dark area of mesepisternum for almost complete length saved for a small bluish spot close to the posterior end, spot on S9 with variable shape with dark going towards the posterior edge of the segment, labrum almost entirely yellow, pair of blue spots on the dorsum of S8.

Measurements: AL 24–26, HW 20–21.5.



**Plate 12.** *Nikoulabasis ilievae*, variations of the thorax, lateral views: a) holotype, b) paratype.

**Differential diagnosis.** This taxon is erected based on females only. The specimens included were assigned to genus *Nikoulabasis* Ferguson, Marinov, Saxton, Rashni & Bybee, 2023 for the lack of keel on the posterior edge of the middle prothoracic lobe, hind legs surpassing the posterior end of the poststernum and coarse dentation of the ovipositor (Plate 11b). This is the sole representative of the genus on Kadavu. Specimens could be recognised from other known congeneric members by the following unique characteristics: a) live individuals have a combination of bright blue colouration of the thorax and yellow on the entire venter (Fig. 18); b) mesostigmal plate (Plate 11a) with postero-dorsal corer



Figure 19. *Nikoulabasis ilievae*, habitat.

broadly rounded and expanded as a low and flat circular structure almost touching on the dorsum of the mesepisternum close to the dorsal carina; c) ovipositor projected posteriorly and slightly surpassing the tips of cerci.

*Habitat* (Fig. 19). All specimens collected from a single spot in one section of the stream. Individuals perched on overhanging branches.

### **Corduliidae**

#### ***Hemicordulia tuiwawai* Marinov, 2019**

Localities: 4, 6-7

More *Hemicordulia*-like individuals were observed, but not collected at locality 3.

*Hemicordulia tuiwawai* was erected as new to science based on material collected from Kadavu and so far is known as endemic to that island (Marinov 2019).

#### ***Procordulia irregularis* Martin, 1907**

Localities: 9, 16

Individuals observed at upper sections of the stream away from settlements. They were collected from the instream sections of the habitats flying low over the water (Fig. 20). Some of the sections were densely overgrown and very difficult to walk through.

First record for Kadavu.



Figure 20. *Procordulia irregularis*, habitat.



Figure 21. *Orthetrum serapia*, male.

### Libellulidae

#### ***Diplacodes bipunctata*** (Brauer, 1865)

Localities: 3, 4, 12, 14

Observed close to inhabited places on the island – lower sections of the stream and an artificial pool.

First record for Kadavu.

#### ***Orthetrum serapia*** Watson, 1984

Locality: 12

Found only at one locality, however this dragonfly (Fig. 21) is likely to be more widespread over the island.

First record

#### ***Pantala flavescens*** (Fabricius, 1798)

Localities: 4, 8, 11-12, 14

Single individuals were flying over the secondary roads between the settlements and an artificial pool. Not observed inside the streams in upper sections.

First record for Kadavu.

### Discussion

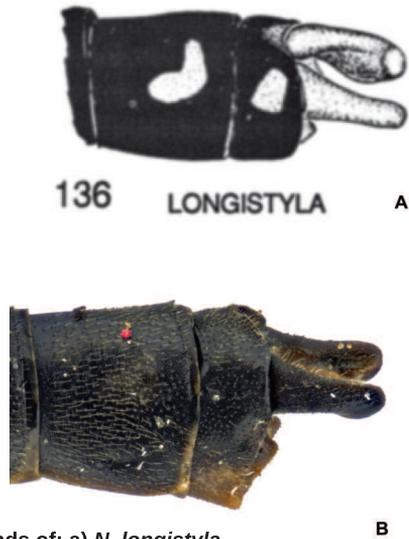
Kadavu is of a significant interest for the wider scientific audience because it is an important centre for many groups (M. Heads, per. comm.). Plants there, for example are often more closely related to other archipelagos than to the rest of Fiji although Kadavu is situated less than 80 km straight-line distance from the main Fijian island of Viti Levu (Heads 2014). Crimson Shining-parrot, *Prosopeia splendens* (Peale, 1848) (Fig. 22) is endemic to Kadavu and its offshore island of Ono (BirdLife International 2016).



**Figure 22. Crimson shining parrot, *Prosopeia splendens*, endemic to Kadavu.**

Therefore, it was expected that endemism of Odonata on Kadavu was not restricted to *N. recava* and *H. tuiwawai* only. With the present study we provide more data on the Odonata fauna and increase the Kadavu endemics to five adding three new taxa assigned to two genera *Nesobasis* (Selys, 1891) and *Nikoulabasis*. They and other new dragonflies and damselflies for Kadavu reported here increase the number of Odonata for this island to 15. Fourteen of them are included in the present report, but *Nesobasis longistyla* was not collected during our study. It was reported for Kadavu twice: one specimen in Donnelly (1990) and four specimens in van Gossum et al. (2008). Donnelly (1990) reported that his specimen was *significantly smaller* (Italic added) than other damselflies from Viti Levu where *N. longistyla* is common. The measurements given (AL 32.0; HW 19.75; HF 2.47) are closer to the holotype of *N. nedeltshevae* presented above (AL 33.0; HW 21; HF 2.1), therefore the conspecificity between the two specimens were contemplated. However, based on the illustration of the posterior end of the abdomen in Donnelly (1990; fig. 136), Kadavu *N. longistyla* does not look similar to *N. nedeltshevae* (Fig. 23). Therefore, *N. longistyla* presently is considered as present on Kadavu, but this data needs validation by comparison of the previously sampled material to the holotype of *N. nedeltshevae*.

Certainly, more work is highly recommended for the fourth largest Fijian island. Our study resulted in erection of four new taxa (one in Marinov 2019 and three here) some of which were found in single sites only. Individuals classified under *N. ilievae* are bright blue-yellow damselflies which were recorded from the vegetation of sunlit sites, therefore presumably easy to detect in life. However, only four females were found at a single spot although the stream was investigated with an increased attention after discovering these individuals. Both *N. baidamuensium* and *N. nedeltshevae* were more common, but still mainly in the upper sections of the investigated sites. This highlights the necessity of more studies of the higher zones of the island.



**Figure 23.** Comparison between the posterior ends of: a) *N. longistyla* (Donnelly 1990: fig. 136), b) *N. nedeltshevae* (holotype).

### Acknowledgements

The field sampling trips were organised with the financial support of the International Dragonfly Fund and the Pacific Scholarship for Excellence in Research Innovation (PSERI) and a Strategic Research Theme (SRT) Grant, University of the South Pacific and the Ministry of Itaukei Affairs (MTA) for the research permit [MTA— 42/2-3].

Thomas Donnelly kindly reviewed the samples and compared them to what he had already collected from other parts of the Fijian islands.

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MM keeps his breath to the end in order to express his deepest respect and greatest thanks to the villagers of Baidamudamu:

*“For the week stay on the island we become not just friends but more like a true family. They made me feel part of the village life with no barrier in communication. The jokes we made during the evening family gatherings were the perfect relaxation therapy and everlasting smiles on their faces took me closer to my other home in Bulgaria. Naturally my thoughts were with my closest relatives with my mother and wife coming first. Therefore, all new scientific names introduced in here are related to my family members from the two parts of the world where I truly feel home – Bulgaria and Fiji. Both my mother and wife were school teachers known to their students by their patronyms which derived from the personal names of my grandfather and father-in-law. My final thanks are reserved as a special recognition to my hosts from Baidamudamu and especially to Ropate Vurawaqa and Ateca Dicocotabua”.*

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