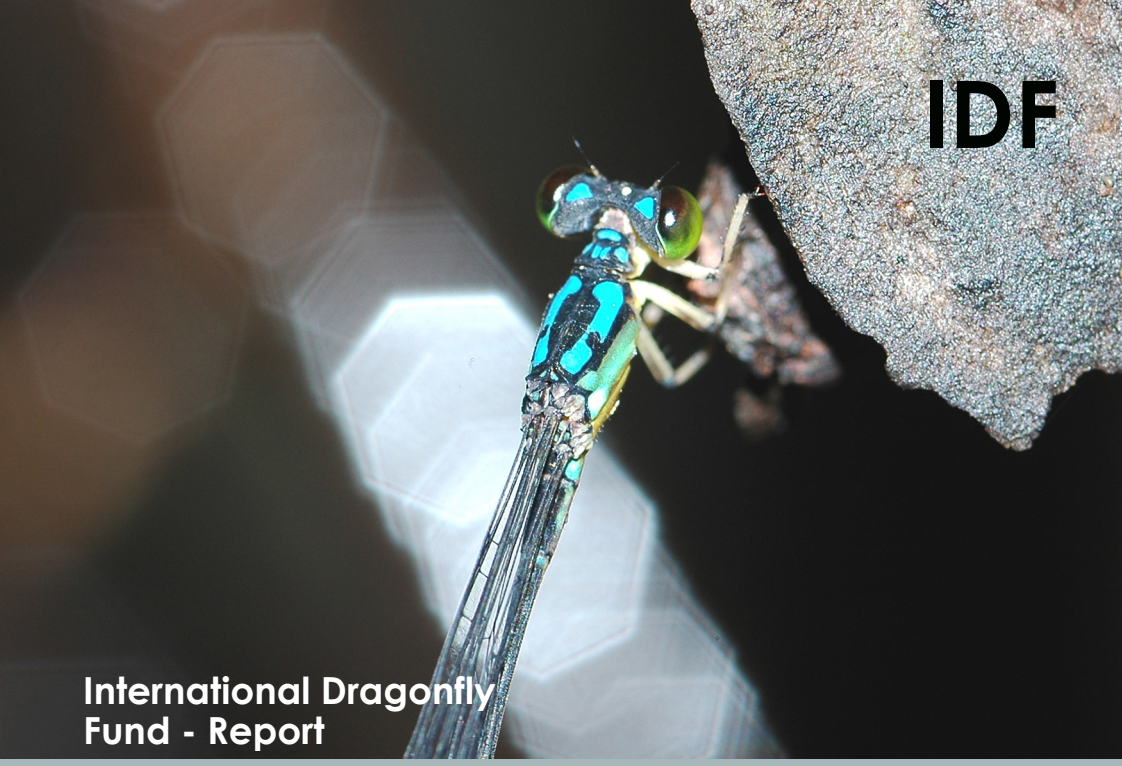

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**Rory A. Dow**

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| Photographer: | Graham T. Reels |

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# Odonata from Sri Aman Division south and west of the Lupar River and from the Kelingkang Range, Sarawak

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## Abstract

Records of Odonata from the southwest of Sri Aman Division and the extreme east of Serian Division in Sarawak are presented. The sampled areas are interesting not only because they are poorly known for Odonata but also because many are just to the south and west of the Lupar Line which is a division between the ancient Sunda shelf and more recent geological formations. Differences between the odonate faunas on either side of the Lupar Line are discussed. Eighty-five species of Odonata were recorded during the surveys reported on. The single most notable record is that of *Coeliccia southwelli* Dow & Reels, 2011, which represents a considerable extension to the known range of this species. Other interesting records include *Telosticta dupophila* (Lieftinck, 1933), *T.* species cf *longigaster* Dow & Orr, 2012, *Podolestes parvus* Dow & Ngiam, 2019 and *Heliogomphus* species cf *olivaceous* Lieftinck, 1961. Variation in the markings of *Stenagrion dubium* (Laidlaw, 1912) across its range is discussed and a gene tree using the COI marker is presented to illustrate the high variability of this species in this marker. However the variability in COI does not appear to be correlated with other characters.

**Key word**s: Lupar River, Lupar Line, *Stenagrion dubium*, DNA barcoding, *Coeliccia southwelli*

## Introduction

Sri Aman Division in Sarawak has been relatively poorly studied for Odonata. Most published records from the division are based on material collected by G.T. Reels and the author on trips to Batang Ai National Park (December 2007) and the Nanga Segerak area of the Lanjak Entimau Wildlife Sanctuary (July 2016), see Dow 2010a, 2010b, 2017, Dow, Hämäläinen & Stokvis 2015, Dow & Orr 2012, Dow & Reels 2018, Dow, Reels & Ngiam 2015a, Dow et al. 2018, Hämäläinen, Dow & Stokvis 2015, Seehausen & Dow 2016. Donnelly (1999) also includes some records from Batang Ai and some specimens collected by Donnelly are in the Naturalis Biodiversity Centre, for instance material listed in Hämäläinen, Dow & Stokvis 2015 and Kalkman & Villanueva 2011. The specimens collected by Donnelly in the last two publications mentioned were collected in 1997 on a trip reported in Donnelly (1997) but some of the published

records from that trip were collected at what was presumably Ranchan Recreational Park near Serian and now in the rather recently created Division of the same name (Donnelly states his location as Serian, saying "Serian is a popular park"; Serian is a town but Ranchan Recreational Park matches the description and is located just outside of the town) while most do not have a sufficiently well characterised location to be sure in what Division they originate from, although surely more come from Sri Aman than is currently clear to me.

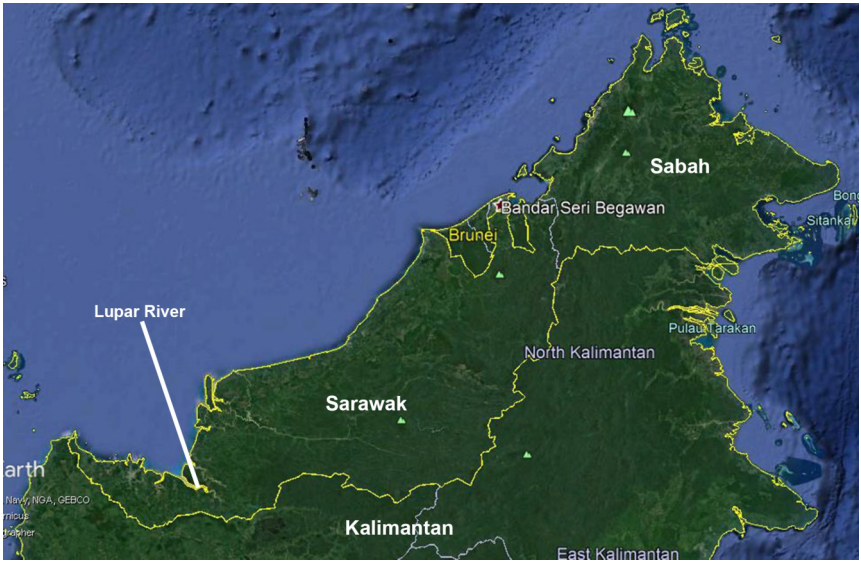



**Figure 1. Map of the north of Borneo showing the position of the Lupar River. Image made using Google Earth.**

Wherever most of the records in Donnelly (1997) actually originate from, Sri Aman away from Batang Ai and Lanjak Entimau is almost unknown from an odonatological point of view. However the west of Sri Aman Division is interesting not just because it is a blank or largely blank space on the odonatological map of Sarawak but because it is immediately south and west of the so-called Lupar Line (LL), which (approximately) follows the Lupar River (Fig. 1 shows the position of the Lupar River in Sarawak). Sarawak is geologically distinct on either side of the LL, with southwest Sarawak (used here to refer to the part south and west of the LL) forming part of the ancient Sunda Shelf and the rest dominated by younger rock formations (see Hazebroek & Morshidi 2001: 19). Differences between the odonate faunas on either side of the LL seem to exist, for instance a number of species appear to have ranges that seem to stop at or near the LL, sometimes with a pair of closely related species exists with one species known from one side of the LL and the other species from the other side (for instance *P. haematosoma* Lieftinck, 1937 and *P. hyperythra* (Selys, 1886)). Other species appear or had appeared to show differences in markings from one side to the other (for instance *Prodasineura dorsalis* (Selys, 1860) and *Stenagrion dubium* (Laidlaw, 1912)). The nearest data avail-

able to me from north and east of the LL is from Batang Ai National Park, but no data had been published from anywhere close on the southwest side. The areas close to the LL are of great interest since surveys there should reveal whether or not there are really hard divisions in distributions and appearance of some species at the LL, these issues are commented on in the Discussion.

In an effort to start to resolve some of the odonatological issues around the LL as well as the general deficit in odonatological knowledge of Sri Aman Division I made a series of visits to the southwest of Sri Aman in 2018. Travelling with my wife, we stayed both in Sri Aman town and (for parts of the second and third trips) at the Kumpang Langgir longhouse near to the small town of Engkilili. The Lupar River flows through Engkilili and Kumpang Langgir is to its south, near the border with Kalimantan and overlooked by two border hills, Bukit Baya and Bukit Parapau, with a third peak, Bukit Tiang Laju, a little to its northwest. Whilst using Sri Aman town as a base I also explored other sites in the Engkilili area, principally in the Wong Ajong (Ajong Rapids) area on a stream called Sungai Marup. During the latter two trips I also devoted some time to sampling in the Kelingkang Range and its surrounds. The Kelingkang Range runs along the Sarawak-Kalimantan border in the east of Serian Division and the west of Sri Aman Division before turning to the south and departing Sarawak entirely (see Fig. 2). Most work in this area was in the middle part of the range in the area of the Punggu Dadak longhouse but one day's work was also done at each of Marau Klasau (north from the western Kelingklang Range) and at Sabal Kruin in the extreme east of Serian Division, where the Kelingklang Range runs higher. The first trip (in April) was made using funding from the Sarawak Museum Campus Project, the second (July) and third (October) using funding from IDF.

**Locations**

Fig. 2 shows an overview of the locations sampled.


**Figure 2. Overview of collecting locations in Sri Aman Division and the east of Serian Division. Note that the position of Simunjan as shown by Google Earth is incorrect. Image made using Google Earth.**

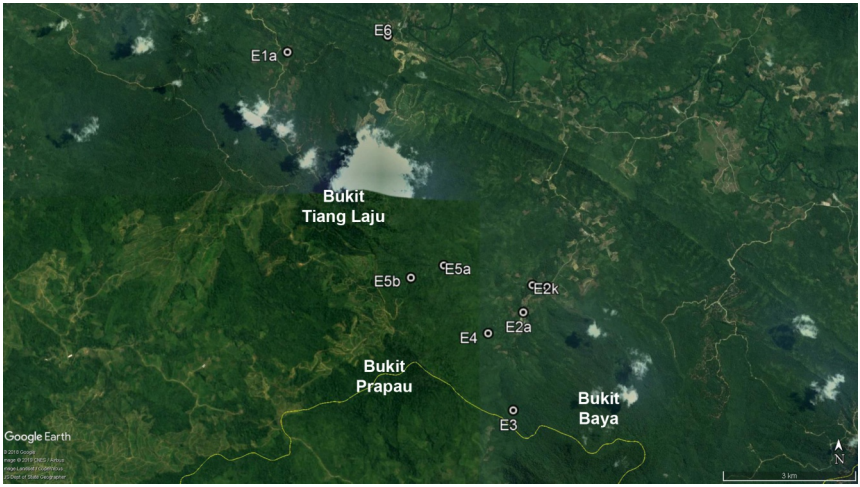



**Figure 3. Collecting locations in the Engkilili area. Image made using Google Earth.**

**Engkilili area**

Fig. 3 shows most of the locations sampled in the Engkilili area. To the author's admittedly limited understanding locations E1 and E6 are essentially on the LL (slightly south of the Lupar River in this area), the others south of it.

**E1. Wong Ajong Picnic Area:**

a. Sungai Marup, a nearly clear running, mostly rocky stream (representative coordinates in the sampled part 1.1094N, 111.6391E) in a mosaic of disturbed old growth forest, secondary forest and agricultural land.

b. Low gradient tributaries to Sungai Marup.

c. Tiny high gradient trickle.

d. Small ox bow/isolated backwater to Sungai Marup.

e. Trailside above Sungai Marup in Wong Ajong Picnic area.

f. At longhouse.

**E2. Kampung Kumpang Langgir Area:**

a. Sungai Kumpang, a clear rocky stream, accessed near to Kumpang Langgir (representative coordinates in sampled part 1.0528N, 111.6904E) in a mosaic of disturbed old growth forest, secondary forest and agricultural land.

b. Low gradient tributaries to above.

c. Pools beside above.

d. Small stream with oil palm on one bank near pond near Kumpang Langgir (1.0583N, 111.6956E).

e. Small stream in kerangas near Kumpang Langgir.

f. Peaty pools in kerangas, Kumpang Langgir.

g. Pond near Kumpang Langgir (1.0583N, 111.6956E).

h. Pools in forest by and on way to Sungai Unggar, Kumpang Langgir.

i. In farmland near Kumpang Langgir.

j. In kampung.

k. Sungai Unggar from confluence with Sungai Kumpang (1.0587N, 111.6924E) to mouth of Sungai Engkhara (1.0618N, 111.6827E), second growth forest and agricultural land..

l. Sungai Engkhara (coordinates upstream 1.0588N, 111.6804E), second growth forest.

m. Small streams in second growth forest near Sungai Unggar and Sungai Engkhara.

n. Pond at school.

**E3. Bukit Baya.**

a. Sungai Kumpang on Bukit Baya (1.0317N, 111.6881E), mosaic of second growth and disturbed old growth forest.

b. Tributaries to Sungai Kumpang on Bukit Baya.

**E4. Bukit Parapau**

a. Sungai Langgir at the foot of Bukit Parapau, in second growth forest (1.0483N, 111.6827E).

b. Tributaries to Sungai Langgir on Bukit Parapau, disturbed old growth forest.

c. Tiny muddy tributaries to Sungai Langgir at foot of Bukit Parapau.

**E5. A ridge joing Bukit Parapau to Bukit Tiang Laju**

a. Sungai Ungar, at foot (1.063N, 111.6731E) and on lower slopes of the ridge (1.0604N, 111.666E), old second growth forest at foot changing to disturbed old growth forest on lower slopes.

b. Tributaries to Sungai Ungar.

**E6. Trailside at Batu Nabau (1.113N, 111.6609E).**

**Central Kelingklang Range and to its north**

Fig. 4 shows the collecting locations in this area.

**K1. Kampung Punggu Dadak:**

a. Stream at Kpg Punggu Dadak (1.0903N, 111.2421E), old second growth forest.

b. Stream at foot Kelingkang Range reached from Kpg Punggu Dadak (1.0852N, 111.2419E), second growth and disturbed old growth forest.

**K2. Sungai Tembong Beringin.**

a. Sungai Tembong Beringin (representative coordinates 1.121N, 111.2206E), a stream running through agricultural land, disturbed and second growth forest in its lower part, mostly disturbed old growth forest in the upper part sampled.

b. Tiny tributary to above, high gradient in part.

c. Trail near Sg Tembong Beringin.

**K3. Sungai Tapang Rumput:**

a. Sungai Tapang Rumput (1.0694N, 111.2923E), a stream in mixed disturbed kerangas forest and agricultural land.

b. Ponded open section on Sungai Tapang Rumput.

c. Small tributaries to Sungai Tapang Rumput on hillside, disturbed old growth forest.

d. Trailside.

**K4. Marau Klasau**

a. Disturbed peat swamp forest (1.1174N, 111.0947E).

b. Blackwater drain by a.

c. A large stream (Sungai Selintik) and surrounding disturbed and secondary alluvial forest (1.12N, 111.0955E).


**Figure 4. Collecting locations in and north of the central Kelingklang Range. Pekan Pantu is the same place as Pantu but duplicated by Google Earth in an erroneous position. Image made using Google Earth.**

**Western Kelingkang Range (in Serian Division)**

**WK: Sabal Kruin near foot of the Kelingkang Range.**

a: A large stream in logged forest on the lower slopes of the Kelingkang Range (1.051N, 110.9639E).

b: Small streams between Sabal Kruin and Kelingkang Range (representative coordinates 1.0536N, 110.966E) in disturbed and second growth forest.

**List of species collected**

A **SA** after the species authority indicates the first published record definitely from Sri Aman Division.

A **Se** after the species authority indicates the first published record definitely from Serian Division.

**Zygoptera**

**Platystictidae**

1. *Drepanosticta attala* Lieftinck, 1934

   **E2c** – ♂, 23.iv.2018, RD.

2. *Drepanosticta* species cf *crenitis* Lieftinck, 1933

   **E4b** – ♀, 30.vii.2018, RD. **K2b** – 2 ♂♂, 25.vii.2018, RD. **WKa** – ♂, 17.x.2018, RD.

3. *Drepanosticta* species cf *dentifera* Kimmins, 1936 SA

   **E2c** – ♂, 26.iv.2018, RD.

4. *Drepanosticta rufostigma* (Selys, 1886)

   **E1a** – ♂, 24.iv.2018, RD. **E1b** – ♂, 24.iv.2018, RD; ♂, 26.iv.2018, RD. **E1c** – ♂, 26.iv.2018, RD. **E1e** – ♀, 16.x.2018, RD. **E2b** – ♂, 23.iv.2018, RD; ♂, 27.vii.2018, RD; ♂, 19.x.2018, RD. **E2l** – ♀, 18.x.2018, RD. **E3a** – 3 ♂♂, 29.vii.2018, RD. **E4b** – 3 ♂♂, 30.vii.2018, RD. **E5b** – 3 ♂♂, 25.iv.2018, RD; ♂, ♀, 20.x.2018, RD. **K2a** – 4 ♂♂, 25.vii.2018, RD. **K3c** – ♂, 26.vii.2018, RD. **WKa** – 2 ♂♂, ♀, 17.x.2018, RD. **WKB** – 2 ♂♂, 17.x.2018, RD.

5. *Drepanosticta versicolor* (Laidlaw, 1913)

   **E5b** – 4 ♂♂, 20.x.2018, RD.

6. *Telosticta dupophila* (Lieftinck, 1933) SA

   This is by far the furthest east that this species has been recorded. At most locations *T. dupophila* has been found in old growth forest but the population reported here was found at a very small, relatively low gradient stream in clearly second growth forest.

   **E2b** – 3 ♂♂, 19.x.2018, RD.

7. *Telosticta* species cf *longigaster* Dow & Orr, 2012

   This taxon is somewhat problematic, the male resembles that of *T. longigaster* very closely except that the apical parts of the cerci are modified. It is not clear whether this just represents variation in a small isolated population at the edge of the range of *T. longigaster* (which is known from Batang Ai National Park but, at least until now, no further west) or a distinct, sister, species. More populations need to be found to resolve this issue; whilst it might be thought that DNA Barcoding could also be useful, given the extreme variability of *T. longigaster* in the COI marker (see Dow & Stokvis in preparation) in reality it may well not be useful in this case.

   **E3b** – 4 ♂♂, 28.vii.2018, RD; ♂, 29.vii.2018, RD.

**Argiolestidae**

8. *Podolestes orientalis* Selys, 1862 SA

   **E1b** – ♂, 26.iv.2018, RD. **E1d** – ♂, 24.iv.2018, RD. **E2b** – ♂, 23.iv.2018, RD. **E5b** – ♀, 25.iv.2018, RD. **K1a** – ♂, 24.vii.2018, RD. **K4a** – ♂, 15.x.2018, RD.

9. *Podolestes parvus* Dow & Ngiam, 2019 SA

   A new species known from only three locations in peat swamp forest around the Lupar River, the first and only records from Sri Aman Division were made during this study. See Dow & Ngiam (2019) for details. **K4a**.

**Calopterygidae**

10. *Neurobasis longipes* Hagen, 1887

**E2a** – ♀, 23.iv.2018, RD; ♂, 27.vii.2018, RD. **E2k** – ♂, 18.x.2018, RD. **E5a** – ♂, 25.iv.2018, RD.

11. *Vestalis amaryllis* Lieftinck, 1965 Se

**E1b** – ♂, 26.iv.2018, RD. **E2b** – ♂, 23.iv.2018, RD. **E2e** – ♂, 25.iv.2018, RD. **E4b** – ♂, 30.vii.2018, RD. **E5b** – 2 ♂♂, 25.iv.2018, RD; ♂, 20.x.2018, RD. **K1b** – 3 ♂♂, 24.vii.2018, RD. **K2a** – 7 ♂♂, 25.vii.2018, RD. **K3a** – 2 ♂♂, 26.vii.2018, RD. **WKB** – ♂, 17.x.2018, RD.

12. *Vestalis amoena* Hagen in Selys, 1853

**E1a** – 2 ♂♂, 24.iv.2018, RD; 2 ♂♂, 26.iv.2018, RD; **E1b** – ♂, 24.iv.2018, RD; 2 ♂♂, 26.iv.2018, RD; 3 ♂♂, 16.x.2018, RD. **E2a** – 2 ♂♂, 23.iv.2018, RD; 2 ♂♂, 27.vii.2018, RD. **E2b** – ♂, 19.x.2018, 3 ♂♂, 18.x.2018, RD. **E2k** – ♂, 22.x.2018, RD; ♂, ♀, 22.x.2018, S. ak Engkamat. **E2l** – 3 ♂♂, 18.x.2018, RD.

13. *Vestalis atropha* Lieftinck, 1965

**E1b** – ♂, 16.x.2018, RD. **E2b** – ♂, 27.vii.2018, RD. **E5a** – 2 ♂♂, 25.iv.2018, RD; 3 ♂♂, 20.x.2018, RD.

**Chlorocyphidae**

14. *Heliocypha biseriata* (Selys, 1859)

**E1a** – ♂, 24.iv.2018, RD. **E1b** – ♂, 26.iv.2018, RD; ♂, 16.x.2018, RD. **E2a** – 2 ♂♂, 23.iv.2018, RD; ♂, 27.vii.2018, RD; 2 ♂♂, 19.x.2018, RD; ♀, 22.x.2018, S. Engkamat. **E2k** – ♂, 18.x.2018, RD. **E2l** – ♂, 18.x.2018, RD. **K2a** – 2 ♂♂, ♀, 25.vii.2018, RD. **WKa** – ♂, 17.x.2018, RD.

15. *Libellago aurantiaca* (Selys, 1859) SA

**K3a** – 2 ♂♂, 26.vii.2018, RD.

16. *Libellago hyalina* (Selys, 1859) SA

**E2d** – ♂, 23.iv.2018, RD. **K2a** – ♂, ♀, 25.vii.2018, RD. **K3c** – ♀, 26.vii.2018, RD. **K4c** – ♂, ♀, 15.x.2018, RD.

17. *Libellago* stictica (Selys, 1859)

**E2a** – ♂, 23.iv.2018, RD; 2 ♂♂, 27.vii.2018, RD; 2 ♂♂, 2 ♀♀, 19.x.2018, RD. **E2k** – 2 ♂♂, 18.x.2018, RD.

18. *Sundacypha petiolata* (Selys, 1859) SA

**E2m** – ♂, 20.x.2018, RD. **K1a** – ♀, 24.vii.2018, RD. **K1b** – 2 ♂♂, 24.vii.2018, RD. **K3c** – ♂, 26.vii.2018, RD.

**Devadattidae**

19. *Devadatta clavicauda* Dow, Hämäläinen & Stokvis, 2015

**E1b** – ♂, 24.iv.2018, RD; ♂, 26.iv.2018, RD. **E2b** – ♂, 27.vii.2018, RD; ♂, 19.x.2018, RD. **E3a** – ♂, 29.vii.2018, RD. **E4b** – 4 ♂♂, ♀, 30.vii.2018, RD; 4 ♂♂, ♀, 30.vii.2018, P. ak Gawang. **E5b** – 3 ♂♂, ♀, 25.iv.2018, RD; ♂, 20.x.2018, RD. **K1b** – ♂, 24.vii.2018, RD. **K2a** – 3 ♂♂, 25.vii.2018, RD. **K3c** – ♂, 26.vii.2018, RD. **WKa** – ♂, 17.x.2018, RD.

**Euphaeidae**

20. *Dysphaea dimidiata* Selys, 1853

**E1a** – ♂, 26.iv.2018, RD; 2 ♂♂, 22.x.2018, RD. **E1b** – ♂, 16.x.2018, RD. **E2a** – ♂, 23.iv.2018, RD; ♂, 27.vii.2018, RD. **E2k** – 2 ♂♂, 18.x.2018, RD. **E2m** – ♂, 22.x.2018, RD.

21. *Euphaea impar* Selys, 1859

**E1b** – ♂, 26.iv.2018, RD. **E2a** – ♂, 23.iv.2018, RD; ♂, 27.vii.2018, RD. **E2b** – ♂, 23.iv.2018, RD. **E2k** – ♂, 18.x.2018, RD. **E2l** – ♂, 18.x.2018, RD. **E4a** – 2 ♂♂, 30.vii.2018, RD; ♂, 30.vii.2018, P. ak Gawang. **E5a** – ♂, 25.iv.2018, RD. **E5b** – ♂, 25.iv.2018, RD; ♂, 20.x.2018, RD. **K1a** – ♂, 24.vii.2018, RD. **K2a** – 3 ♂♂, ♀, 25.vii.2018, RD. **K3a** – ♂, 26.vii.2018, RD. **WKa** – 2 ♂♂, 17.x.2018, RD.

22. *Euphaea subcostalis* Selys, 1873

**E1a** – ♂, 24.iv.2018, RD; ♂, 22.x.2018, S. ak Engkamat. **E1b** – ♂, 16.x.2018, RD. **E2a** – ♂, 19.x.2018, RD. **E3a** – ♂, 28.vii.2018, RD; ♂, 28.vii.2018, S. ak Engkamat; ♂, 29.vii.2018, RD. **E4a** – ♂, 30.vii.2018, RD; ♂, 30.vii.2018, *P.* ak Gawang. **E5a** – 2 ♂♂, 20.x.2018, RD. **E5b** – ♂, 25.iv.2018, RD.

23. *Euphaea tricolor* Selys, 1859

**E1a** – ♂, 26.iv.2018, RD; ♂, 16.x.2018, RD; **E2a** – 3 ♂♂, 23.iv.2018, RD; ♂, 27.vii.2018, RD. **E2k** – ♂, 22.x.2018, RD; 3 ♂♂, 22.x.2018, S. ak Engkamat. **E2l** – ♂, 18.x.2018, RD.

**Philosinidae**

24. *Rhinagrion borneense* (Selys, 1886)

A number of males of this species collected in the area covered here have the pale dorsal markings on the terminal abdominal segments a deeper blue than is typical in this species in Sarawak and Brunei. This character is shared with some populations near to the Indonesian border further to the west in Serian Division and some populations more remote from the border in Kuching Division.

**E1a** – ♂, 24.iv.2018, RD; ♂, 26.iv.2018, RD; ♂, 16.x.2018, RD. **E1b** – 3 ♂♂, 16.x.2018, RD. **E2a** – ♂, 23.iv.2018, RD; ♂, 27.vii.2018, RD. **E2b** – ♂, 19.x.2018, RD. **E2k** – 3 ♂♂, 18.x.2018, RD ♂, 22.x.2018, S. ak Engkamat. **E2l** – ♂, 18.x.2018, RD. **K1a** – ♂, 24.vii.2018, RD. **K2a** – 3 ♂♂, 25.vii.2018, RD. **WKB** – ♂, 17.x.2018, RD.

**Platycnemididae**

25. *Coeliccia* cyaneothorax Kimmins, 1936

**E3a** – 2 ♂♂, 29.vii.2018, RD.

26. *Coeliccia flavostriata* Laidlaw, 1918 SA

The specimens reported here are the easternmost yet found.

**E3b** – 2 ♂♂, ♀, 28.vii.2018, RD. **E5b** – ♂, 25.iv.2018, RD.

27. *Coeliccia* species cf *nemoricola* Laidlaw, 1912

**E3b** – ♂, 28.vii.2018, RD. **E5b** – 2 ♂♂, 25.iv.2018, RD; 2 ♂♂, 20.x.2018, RD.

28. *Coeliccia nigrohamata* Laidlaw, 1918

    See the discussion.

    **E1e** – ♂, 24.iv.2018, RD. **E2b** – ♂, 23.iv.2018, RD; 4 ♂♂, ♀, 19.x.2018, RD. **E2e** – ♂, ♂+♀, 25.iv.2018, RD. **E2m** – ♂, 20.x.2018, RD. **E4c** – 2 ♂♂, 30.vii.2018, RD. **E5b** – 6 ♂♂, ♂+♀, 25.iv.2018, RD, 3 ♂♂, ♂+♀, 20.x.2018, RD. **K1b** – 2 ♂♂, 24.vii.2018, RD. **K2b** (low gradient part) – ♂, 25.vii.2018, RD. **K3c** – ♂, ♀, 26.vii.2018, RD.

29. *Coeliccia southwelli* Dow & Reels, 2011 SA

    This is probably the most surprising finding reported here. *Coeliccia southwelli* was known from Mount Dulit and the Ulu Moh areas of northeast Sarawak and a location in Kalimantan, all sites are remote from the locations dealt with here and at higher altitude; I had not expected to find it west of the Lupar.

    **E3b** – ♂, 28.vii.2018, RD.

30. *Copera vittata* (Selys, 1863) SA

    **E2b** – ♂, 23.iv.2018, RD. **E2c** – ♂, 27.vii.2018, RD. **E2h** – ♂, 25.iv.2018, RD. **K1a** – ♂, 24.vii.2018, RD.

31. "*Elattoneura*" *analis* (Selys, 1860) SA

    **E1b** – 2 ♂♂, 16.x.2018, RD. **E2a** – ♂, 23.iv.2018, RD; ♂, 27.vii.2018, RD; 2 ♂♂, 19.x.2018, RD. **E2b** – ♂, 23.iv.2018, RD; ♂+♀, 27.vii.2018, RD; ♂, 19.x.2018, RD. **E2k** – ♂, 18.x.2018, RD. **E2l** – ♂, ♂+♀, 18.x.2018, RD. **E3a** – ♂, 28.iv.2018, RD. **E5b** – 3 ♂♂, 25.iv.2018, RD; ♂, 20.x.2018, RD. **K2a** – 3 ♂♂, 2 ♀♀, 25.vii.2018, RD. **K3a** – 3 ♂♂, 26.vii.2018, RD. **WKa** – ♂, 17.x.2018, RD.

32. Onychargia atrocyana Selys, 1865 SA

    **K4c** – ♂, 15.x.2018, RD.

33. *Prodasineura dorsalis* (Selys, 1860)

    See the discussion.

    **E1b** – 2 ♂♂, 26.iv.2018, RD; ♂, ♀, 16.x.2018, RD; 3 ♂♂, 19.x.2018, RD. **E2l** – ♂, 18.x.2018, RD. **E5b** – 2 ♂♂, 25.iv.2018, RD. **K1b** – ♂, 24.vii.2018, RD. **K2b** (low gradient part) – 2 ♂♂, ♂+♀, 25.vii.2018, RD. **K3c** – ♂, 26.vii.2018, RD.

34. *Prodasineura haematosoma* Lieftinck, 1937

    See the Discussion.

    **WKB** – ♂, 17.x.2018, RD.

35. *Prodasineura hosei* (Laidlaw, 1913) SA Se

    **E1b** – ♂, 26.iv.2018, RD; 3 ♂♂, 16.x.2018, RD. **E2a** – ♂, 19.x.2018, RD. **E2l** – 2 ♂♂, 18.x.2018, RD. **E5b** – ♂, 25.iv.2018, RD; 2 ♂♂, 20.x.2018, RD. **WKB** – ♂, 17.x.2018, RD.

36. *Prodasineura notostigma* (Selys, 1860) SA Se

    These records represent an extension to the range known for the species in Sarawak.

    **K1b** – 2 ♂♂, ♂+♀, 24.vii.2018, RD. **K2a** – 2 ♂♂, 25.vii.2018, RD. **K3a** – 3 ♂♂, ♀, 26.vii.2018, RD. **K3c** – ♂+♀, 26.vii.2018, RD. **WKB** – ♂+♀, 17.x.2018, RD.

37. *Prodasineura verticalis* (Selys, 1860)

    The male from E2k collected on 18.x.2018 was in a same sex tandem (in the "female" position) with the male *Pseudagrion perfuscatum* collected.

**E1a** – ♂, 24.iv.2018, RD; ♂+♀, 27.vii.2018, RD. **E1b** – ♂, 26.iv.2018, RD; ♂, 16.x.2018, RD. **E2a** – 2 ♂♂, 23.iv.2018, RD. **E2b** – ♂+♀, 23.iv.2018, RD. **E2d** – ♂, 23.iv.2018, RD. **E2k** – ♂, 18.x.2018, RD. **K2a** – ♂, 24.vii.2018, RD. **WKa** – ♂, 17.x.2018, RD.

**Coenagrionidae**

38. *Aciagrion borneense* Ris, 1911 SA

**E2g** – 4 ♂♂, 23.iv.2018, RD.

39. *Agriocnemis femina* (Brauer, 1868)

**E2g** – ♂, 23.iv.2018, RD.

40. *Agriocnemis minima* Selys, 1877 SA

In the past I have generally found this species in low pH habitats in Borneo, but that is not the case with one of the records presented here (Location E2g).

**E2g** – ♀, 23.iv.2018, RD. **K4b** – 2 ♀♀, 15.x.2018, RD.

41. *Amphicnemis* species *martini*-group SA

The species of the *martini*-group of *Amphicnemis* are most often found in peat swamp forest, but also, as in the present case, sometimes in peaty pools and swampy areas in kerangas forest.

**E2f** – 3 ♂♂, 2 ♀♀, 25.iv.2018, RD.

42. *Amphicnemis wallacii* Selys, 1863 SA

**K4a** – 9 ♂♂, ♀, 15.x.2018, RD. **K4c** – ♀, 15.x.2018, RD.

43. *Archibasis tenella* Lieftinck, 1949 SA

**E1a** – ♂, 24.iv.2018, RD; ♂, 26.iv.2018, RD. **E1b** – ♂, 26.iv.2018, RD. **E2a** – ♂, 22.x.2018, RD. **E2k** – ♂, 18.x.2018, RD. **K1a** – ♂, 24.vii.2018, RD. **K3a** – ♀, 26.vii.2018, RD.

44. *Argiocnemis* species

**E2c** – ♀, 23.iv.2018, RD. **E2h** – 2 ♀♀, 25.iv.2018, RD.

45. *Ceriagrion cerinorubellum* (Brauer, 1865) SA

**E2g** – ♂, 23.iv.2018, RD. **E2h** – ♂, 18.x.2018, RD. **K4b** – ♂, 15.x.2018, RD.

46. *Pericnemis dowi* Orr & Hämäläinen, 2013

**K1b** – ♀, 24.vii.2018, RD.

47. *Pseudagrion lalakense* Orr & van Tol, 2001 SA

**E2b** – ♀, 22.x.2018, RD. **E2g** – ♂, 24.iv.2018, RD.

48. *Pseudagrion microcephalum* (Rambur, 1842)

**K4b** – 2 ♂♂, 15.x.2018, RD.

49. *Pseudagrion perfuscatum* Lieftinck, 1937

Also see under *Prodasineura verticalis*.

**E2a** – ♂, 23.iv.2018, RD. **E2k** – ♂, 18.x.2018, RD.

50. *Stenagrion dubium* (Laidlaw, 1912)

See the discussion.

**E3b** – ♂, 28.vii.2018, RD. **E5b** – ♂, ♂+♀, 20.x.2018, RD. **K3c** – ♂, 26.vii.2018, RD.

**Anisoptera**

**Aeshnidae**

51. *Anax guttatus* (Burmeister, 1839) SA

**E2n** – ♂, 22.x.2018, inhabitant of Kumpang Langgir.

52. *Gynacantha dohrni* Krüger, 1899

**E6** – ♂, 24.iv.2018, RD.

**Gomphidae**

53. *Gomphidia maclalchlani* Selys, 1873 SA

**E2k** – ♂, 22.x.2018, RD.

54. *Heliogomphus* species cf *olivaceous* Lieftinck, 1961 SA

See Dow & Stokvis (2018) for a discussion of this species.

**E1a** – ♂ (teneral), 16.x.2018, RD.

55. *Ictinogomphus decoratus melaenops* (Selys, 1858)

**E2k** – ♂, 18.x.2018, RD. **K4b** – ♂, 15.x.2018, RD.

56. *Leptogomphus coomansi* Laidlaw, 1936

**E2k** – ♀, 22.x.2018, RD.

57. Macrogomphus quadratus Selys, 1878 SA

I have sometimes found this species relatively abundant on deep, sediment bottomed streams but on one morning in July I found a number of males within a short stretch of a narrow, shallow and rather rocky stream near the foot of the Kelingkang Range.

**K2a** – 2 ♂♂, 25.vii.2018, RD.

58. *Megalogomphus* species A SA

See the comments in Dow et al. (2019).

**E2a** – ♂, 22.x.2018, S. ak Engkamat.

**Macromiidae**

59. *Macromia cydippe* Laidlaw, 1922 SA

On one morning in October 2018 this species was apparently abundant along a boulder strewn section of Sungai Kumpang well upstream from the longhouse. Although only three specimens were collected at least four times as many *Macromia* of the same size and exhibiting the same behaviour (patrolling relatively short sections of the stream) were seen. Further upstream on the same stream but on the slopes of Bukit Baya the next species was abundant on a day in July 2018.

**E2a** – 3 ♂♂, 19.x.2018, RD.

60. *Macromia westwoodii* Selys, 1874

**E3a** – 3 ♂♂, ♀, 29.vii.2018, RD.

**Synthemistidae**

61. *Idionyx yolanda* Selys, 1871 SA

See Dow & Stokvis (2018) for comments on this and the next species.

**E5b** – ♀, 25.iv.2018, RD.

62. *Idionyx* species cf *yolanda* Selys, 1871

**E5b** – ♀, 25.iv.2018, RD.

63. *Macromidia fulva* Laidlaw, 1915 SA

**E1b** – ♀, 26.iv.2018, RD. **E2a** – ♀, 19.x.2018, RD. **E2b** – ♂, 19.x.2018, RD.

**Libellulidae**

64. *Aethriamanta gracilis* (Brauer, 1878) SA

**K3b** – ♂, 26.vii.2018, RD.

65. *Agrionoptera sexlineata* Selys, 1879 SA

**E2b** (small pool near) – ♂, 16.x.2018, RD. **K1a** – ♀, 26.iv.2018. RD.

66. *Brachygonia oculata* (Brauer, 1878) SA

**K1a** – ♂, 24.vii.2018, RD. **K2c** – ♂, 25.vii.2018, RD. **K4b** – ♂, 15.x.2018, RD.

67. *Cratilla metallica* (Brauer, 1878)

**E2a** – ♀, 23.iv.2018, RD. **E2h** – ♂, 25.iv.2018, RD. **E6** – ♂, 24.iv.2018, RD.

68. *Nannophya pygmaea* Rambur, 1842 SA

**E2b** – ♂, 19.x.2018, RD. **E2g** – 2 ♂♂, 23.iv.2018, RD. **K4b** – 2 ♂♂, 15.x.2018, RD.

69. *Neurothemis fluctuans* (Fabricius, 1793)

**E1b** – ♂, 26.iv.2018, RD. **E2a** – ♂, 23.iv.2018, RD. **E2i** – ♂, 28.vii.2018, RD. **E2k** – ♂, 18.x.2018, RD. **K1a** – ♂, 24.vii.2018, RD. **K2c** – ♂, 25.vii.2018, RD. **K3d** – ♂, 26.vii.2018, RD. **K4b** – ♂, 15.x.2018, RD.

70. *Neurothemis ramburii* (Brauer, 1866) SA

**E2a** – ♀, 23.iv.2018, RD; ♂, 27.vii.2018, RD.

71. *Neurothemis terminata* Ris, 1911 SA

**E1e** – ♂, 24.iv.2018, RD. **E2i** – ♂, 28.vii.2018, RD; ♂, 19.x.2018, RD.

72. *Orchithemis pulcherrima* (Brauer, 1866)

**E1e** – ♀, 26.iv.2018, RD. **E2e** – ♂, 20.x.2018, RD.

73. *Orthetrum chrysis* (Selys, 1891)

**E1a** – ♂, 24.iv.2018, RD. **E1b** – ♂, 26.iv.2018, RD. **E2a** – ♂, 23.iv.2018, RD; ♂+♀, 27.vii.2018, RD. **E2j** – ♂, 29.vii.2018, S. ak Engkamat. **E2k** – ♂, 18.x.2018, RD. **K2a** – ♂, 25.vii.2018, RD. **K4b** – ♂, 15.x.2018, RD.

74. *Orthetrum glaucum* (Brauer, 1865)

**E1f** – ♂, 26.iv.2018, *P.* Dow. **E2j** – ♂, 29.vii.2018, RD.

75. *Orthetrum sabina* (Drury, 1773)

**E2a** – ♂, 27.vii.2018, RD. **E2g** – ♂, 23.iv.2018, RD. **K3d** – ♂, 26.vii.2018, RD.

76. *Orthetrum testaceum* (Burmeister, 1839)

**E1f** – 3 ♂♂, 2 ♀♀, 26.iv.2018, *P.* Dow. **E2j** – ♂, 28.vii.2018, RD; ♂+♀, 19.x.2018, RD.

77. *Rhyothemis obsolescens* Kirby, 1889 SA

**K4b** – ♂, 15.x.2018, RD.

78. *Rhyothemis phyllis* (Sulzer, 1776) SA

**E1f** – 2 ♂♂, 26.iv.2018, P. Dow.

79. *Tetrathemis hyalina* Kirby, 1889

**E2a** – ♂, 27.vii.2018, RD. **E2k** – 4 ♂♂ (in backwaters and small oxbows), 18.x.2018, RD.

80. *Tholymis tillarga* (Fabricius, 1798) SA

**K2i** – ♀, 22.x.2018, RD.

81. *Trithemis aurora* (Burmeister, 1839)

**E2a** – ♂, 27.vii.2018, RD; ♂, 22.x.2018, S. ak Engkamat. **E2k** – ♂, 18.x.2018, RD.

82. *Trithemis festiva* (Rambur, 1842)

**E2a** – 2 ♂♂, 22.x.2018, S. ak Engkamat. **E2k** – 2 ♂♂, 18.x.2018, RD.

83. *Tyriobapta laidlawi* Ris, 1919 SA

**E1b** – ♂, 26.iv.2018, RD.

84. *Tyriobapta torrida* Kirby, 1889

**E2a** – 22.x.2018, RD. **E2b** – ♂, 23.iv.2018, RD. **E2h** – ♂, 25.iv.2018, RD. **E2i** – ♂, 19.x.2018, RD. **E2k** – ♂, 18.x.2018, RD. **E3a** – ♂, 28.vii.2018, RD.

85. *Urothemis signata insignata* (Selys, 1872) SA

**K3b** – ♂, 26.vii.2018, RD. **K4b** – ♂, 15.x.2018, RD.

## Discussion

### General

The three surveys reported here, although brief, have added considerably to what is known about the Odonata of Sri Aman Division and generated the first odonatological data from the Kelingkang Range. Of the 85 species recorded during the surveys the single most remarkable record is of *Coeliccia southwelli*. Other interesting records include *Telosticta dupophila*, *T.* species cf *longigaster*, *Podolestes parvus* and *Heliogomphus* species cf *olivaceous*. The form of *Coeliccia* nigrohamta occurring near Engkilili is also interesting (see below). A number of the records represent extensions to the known range of species, with the ranges of *Telosticta dupophila*, *Coeliccia flavostriata* and *Prodasineura notostigma* extended to the east and *Coeliccia southwelli* and (maybe) *Telosticta longigaster* to the west. Even though only one days collecting was carried out in the east of Serian Division during the fieldwork reported here, three new records for the division were made. There was no published record definitely from Sri Aman Division of no fewer than 40 of the species recorded before this.

All of the hill forest locations visited during the surveys reported here were difficult to work in, not just because of the normal problems of steep terrain and logged forest, but also because most streams appear to run under the ground or to be dry for large

parts of the year. This problem appears to be particularly marked in the Kelingkang Range where, based on information from local people and from what I saw myself, it may be challenging to find any running water above ground at more than half of the maximum altitude in any given section. An additional issue around Kumpang Langgir is that Indonesians frequently cross the border to hunt on the hills around the longhouse without permission, apparently there have been a number of cases where these hunters have accidently shot someone and then simply vanished back over the border to avoid the consequences; this makes working on these hills rather more hazardous than is desirable.

**Taxonomic issues for which the Lupar Line may be significant**

*Drepanosticta* species cf *crenitis* and *Drepanosticta* species cf *dentifera* may both be complexes of very similar species and in both cases the form found south and west of the Lupar might be a distinct, unnamed species. Material collected during the surveys reported here does not in itself resolve this issue but will certainly contribute towards its eventual solution.

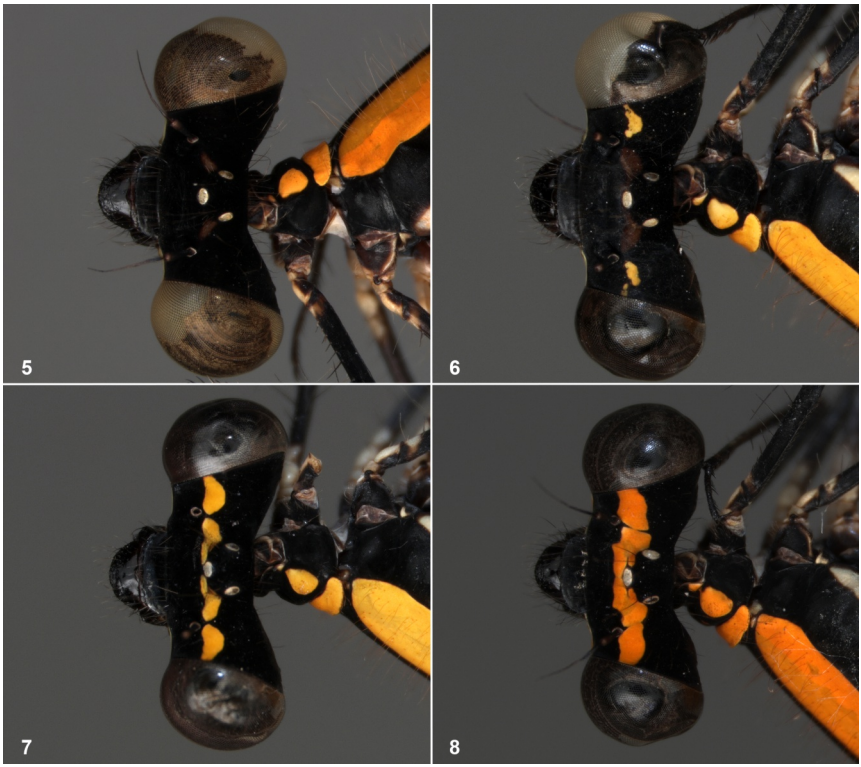
*Telosticta longigaster* and *T.* species cf *longigaster* are a newly discovered problem (see the text in the list of material collected).

*Vestalis amnicola* Liefinck, 1965 occurs east of the LL, a form clearly allied to *V. amnicola* but that differs consistently in its cerci, is known from many hilly and mountainous locations considerably to the west of the LL (referred to as *V.* species cf *amnicola* here). The available molecular evidence for most of the *V. amoena*-group (as-yet-unpublished data from the Naturalis Biodiversity Center) is, depending on the marker used and view taken on disparities between molecular and morphological evidence, either bizarre or uninformative or suggests that there are fewer species than currently recognised. It would have been of great interest to find either taxa (or intermediate specimens) during the survey reported here but neither was found. Although this apparent absence might be taken as evidence of entirely allopatric distributions in distinct species, the problem of proving a negative should be borne in mind; I am certainly not attempting to make an argument from ignorance that the two are distinct, especially with the relatively small amount of sampling done in the areas reported on here.

*Devadatta.* Considering the COI marker, *Devadatta clavicauda* could possibly (although this is not the view of this author) consist of a number of cryptic species occurring in different parts of Borneo (see Dow, Hämäläinen & Stokvis 2015). Material collected during this study will hopefully eventually help to resolve at least part of this issue. Also *Devadatta podolestoides* Laidlaw, 1934 occurs to the south and west of the LL, *D. somoh* Dow, Hämäläinen & Stokvis, 2015 to the north and east, the two are morphologically very similar. The fact that neither species was found during this survey is of interest in the same way as the *Vestalis amnicola* and *V.* species cf *amnicola* pair.

*Coeliccia nigrohamata* and *C. resecta* also present a similar case to the *Vestalis amnicola* and *V.* species cf *amnicola* pair, except that to this author's mind at least they are less likely to be distinct species. *Coeliccia resecta* was described from the Sungai Mentawir area in East Kalimantan (Lieftinck 1953) and is poorly differentiated

from *C. nigrohamata*. I, along with others, have generally felt that the two are synonymous, however if not then the form found north and east of the LL should probably be called *C. resecta*. Interestingly specimens from the surveys reported on here have differences in the female prothorax from typical individuals of either the form found further west or that found north and east of the LL. However this population may otherwise resemble the eastern form (e.g. *resecta*) more than typical *nigrohamta* and possibly the Engkilili form represents character displacement at the boundary of the ranges of two distinct but closely related species. However I personally still suspect that *resecta* is a junior synonym or at best a subspecies of *C. nigrohamata*. Collection of additional material from the west of the Kelingkang Range and border areas between there and Serian may help resolve this issue, which will be dealt with in more detail in the future.




**Figures 5-8. Markings of the dorsum of the head in male *Prodasineura dorsalis*. (5) Bako National Park, Kuching Division. (6) Ulu Mujok, Sarikei Division. (7) Sungai Tapang Rumput, Sri Aman Division. (8) Sungai Kumpang, Sri Aman Division.**

*Prodasineura dorsalis* was described from a male specimen from Sarawak attributed to Wallace (Selys 1860); since Wallace did not collect north or east of the Lupar it is safe to say that the holotype is from southwest Sarawak. The holotype is in the Institut

royal des Sciences naturelles de Belgique and has a pair of dull orange subtriangular marks on the dorsum of the head behind the antennae (the "un triangle roux" of the original description). Many populations in southwest Sarawak actually lack these marks entirely or have them reduced to faint patches. On the other hand populations from east of the LL typically have a complete or almost complete band between the eyes at the same position and I had wondered in the past if there was a sudden division in this character at the LL. However I had already seen some significant variation that demonstrated that this was not the case before the sampling reported here and specimens reported here merely provide additional evidence, showing a spectrum of conditions. Figs. 5–8 shows some of the variation in these markings, with Fig. 5 the most western specimen shown, Figs 7 and 8 from the surveys reported here but Fig. 6 actually from further to the east. The colour of the markings on the dorsum of the head, prothorax and synthorax varies from bright yellow to orange. Lieftinck (1948) described *P. flammula* Lieftinck, 1948 from Batu Besi in East Kalimantan from a single male collected in 1937, it is very similar in appearance to *P. dorsalis* but differs in having the pale colour on thorax and parts of the head "flame scarlet" (Lieftinck 1948: 227) rather than yellow, and in details of the anal appendages. I have not yet examined the holotype of *P. flammula* in detail but the colour of the "flame scarlet" markings is better described as orange and falls within the colour variation seen in *P. dorsalis*. The cerci of *P. flammula* as illustrated by Lieftinck do look rather different from those of *P. dorsalis* but I suspect that this will ultimately prove to be due to rotation rather than real differences. The only other record of *P. flammula* that I am aware of is in Tsuda & Kitagawa (1989), who record a male and a female from Tenom in Sabah; I suspect that this is a misidentification of *P. dorsalis* based on Lieftinck's misleading description of colouration. I have seen a number of *P. dorsalis* specimens in old, unsorted material from East Kalimantan in the Naturalis Biodiversity Center. However it is not safe to declare *P. flammula* a junior synonym of *P. dorsalis* until the anal appendages of the holotype of the former have been examined in detail, so this, along with a re-description of *P. dorsalis*, is left to a future publication.

*Prodasineura haematosoma* and *P. hyperythra* are another species pair that appear to be divided by the LL. The two differ only in details of colouration and *P. hyperythra* is rather variable across its range east of the LL, so that it is likely that the two are synonyms. The same comments as made for the *Vestalis amnicola* and *V.* species cf *amnicola* pair apply here, except that one typical *P. haematosoma* was collected at the western end of the Kelingkang Range.

*Stenagrion dubium* was described from Mount Batu Lawi in the Tama Abu Range in the northeast of Sarawak (Laidlaw 1912b). It is widespread in Brunei, Sabah and Sarawak and although there is no published record from Kalimantan, there are a pair of specimens in a box of unidentified specimens from Central Kalimantan in the Naturalis Biodiversity Center (♂, ♀, Murung River upstream from junction with Barito River, Central Kalimantan, 25.vii.1992, leg. C. Jiggins). It will be extremely surprising if the species does not prove to be widespread at least in the north of Kalimantan. The species exhibits rather a lot of variation in its markings as well as in size (the latter appears correlated with altitude) but the most obvious and consistent difference is that populations from the southwest of Sarawak have the labrum, genae, mandible bases,

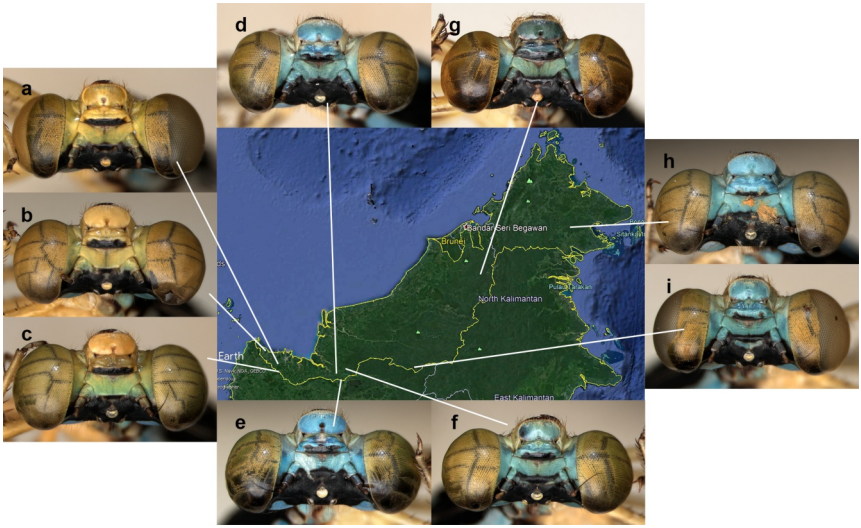



**Figure 9. Heads of *Stenagrion dubium* males from different parts of Borneo. (a-c) Yellow-faced males from southwest Sarawak: (a) Tasik Kunyit, Bau, Kuching Division; (b) Gunung Gading, Lundu, Kuching Division; (c) Gunung Penrissen, Kuching Division. (d-f) Blue-faced males from the surveys reported here: (d) Sungai Tapang Rumput, central Kelingkang Range, Sri Aman Division; (e) Ulu Unggar, Kumpang Langgir, Engkilili, Sri Aman Division; (f) Bukit Baya, Kumpang Langgir, Engkilili, Sri Aman Division. (g-i) Blue-faced males from further afield: (g) Pa'Gelawat, Pulong Tau National Park, Miri Division, Sarawak; (h) Maliau Basin, Sandakan Division, Sabah; (i) Gunung Melatai, Kapit Division, Sarawak.**

anteclypeus and much of the frons and antenna bases yellow or yellow green (see Fig. 9) but the same areas are blue in other populations, however the mandible bases are at best bluish in some populations in Sarawak. Interestingly the population south and west of, but near to, the LL have these parts of the head blue as in the more eastern and northern populations, except that the mandible bases and parts of the anteclypeus are cream rather than blue (not very evident in Fig. 9). The metepimeron is generally yellow or yellow green in life in yellow-faced specimens (see Fig. 10) but it is also yellow in some other populations but blue in others, for instance see Fig. 11 (note that it is often difficult to be sure of the life colour of the metepimeron in preserved material). Unfortunately I viewed the pair from Central Kalimantan about a decade ago and did not make notes beyond the identification and what was on the labels, so can make no further comment on those specimens at this time.

*Stenagrion dubium* also shows considerable variation in the COI marker (see Fig. 12, and see the Appendix for "material and methods" for the production of this gene tree) but there is no obvious correlation between differences in COI and other characters. In particular (see Fig. 12) the yellow-faced south western population is mixed with blue-faced specimens from Mount Dulit, Tubau and Usun Apau in COI. When just a



**Figures 10-11. Male *Stenagrion dubium* in life (photographs by G.T. Reels). (10) South-western yellow-faced form, Kubah National Park, Sarawak. (11) Blue-faced form, Lambir Hills National Park, Sarawak.**

few specimens (or sequences) are looked at patterns appear present that vanish when more are specimens are considered. A subset of the specimens analysed for COI, including all the major groupings seen in Fig. 12, have been analysed for ITS but with that marker very little variation is seen and the groupings seen in Fig. 12 are not reproduced. The variation (in markings and COI) in this species is a subject of ongoing investigation, but at present I am doubtful that there is actually more than one species involved. It is a source of frustration that the species, often relatively common in suitable habitat, was not found in the one day so far spent at the western end of the

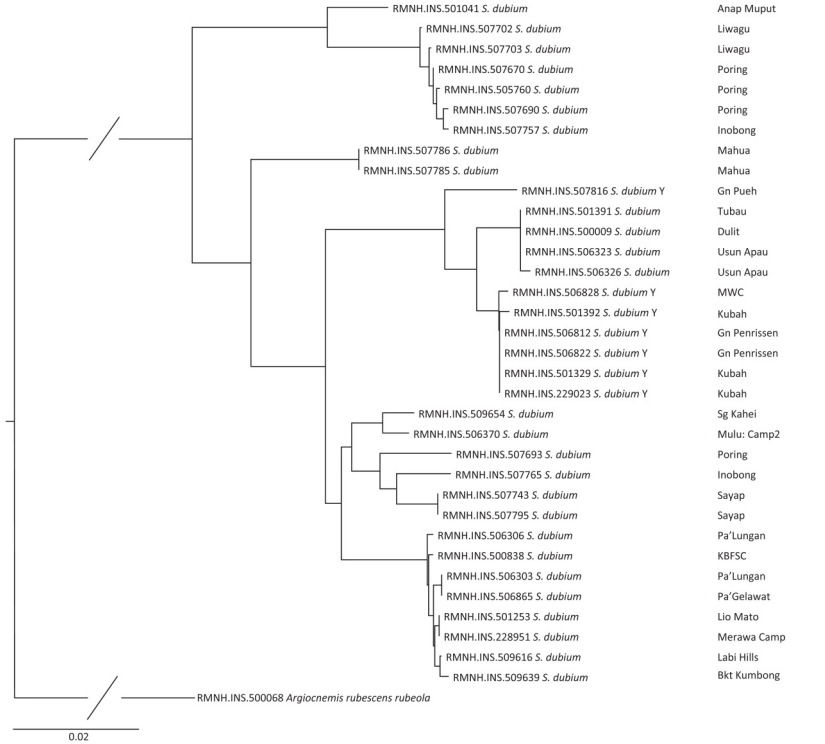



**Figure 12. Neighbour joining COI gene tree for *Stenagrion dubium* using the uncorrected p-distance model. All specimens included are male. Yellow-faced specimens are indicated by a Y after the species name. Abbreviations used: Bkt: Bukit; Gn: Gunung; KBFSC: Kuala Belalong Field Studies Centre; MWC: Matang Wildlife Centre; Sg: Sungai.**

Kelingklang Range, since specimens from that area might have been informative. When molecular data are available from Kalimantan perhaps population geneticists and evolutionary biologists will be able to use it to tell an interesting story about this species.

I note in passing that Lieftinck (1954: 62) gives the habitat of this species as "Swampy forests." This is a very misleading statement. In fact this species occurs at high gradient forest streams, usually rocky. On larger streams it is often associated with waterfalls but it is certainly not confined to them. It is sometimes found in seepages which have muddy sections, but this is as close to "swampy forest" as it gets.

*Leptogomphus williamsoni*. Dow et al. (2017) noted that females from Gunung Penrissen and the Matang Range differ from *L. williamsoni* females from elsewhere, listing them as *L.* sp. cf *williamsoni*. At the time all other populations known were north and east of the LL. Since then a semi-teneral male seemingly conforming to typical *L. williamsoni* has been collected at a location in Serian Division (Dow et al. in preparation for IDF Reports) so that it is less likely that the LL is significant in this case, or differences are confined to females.

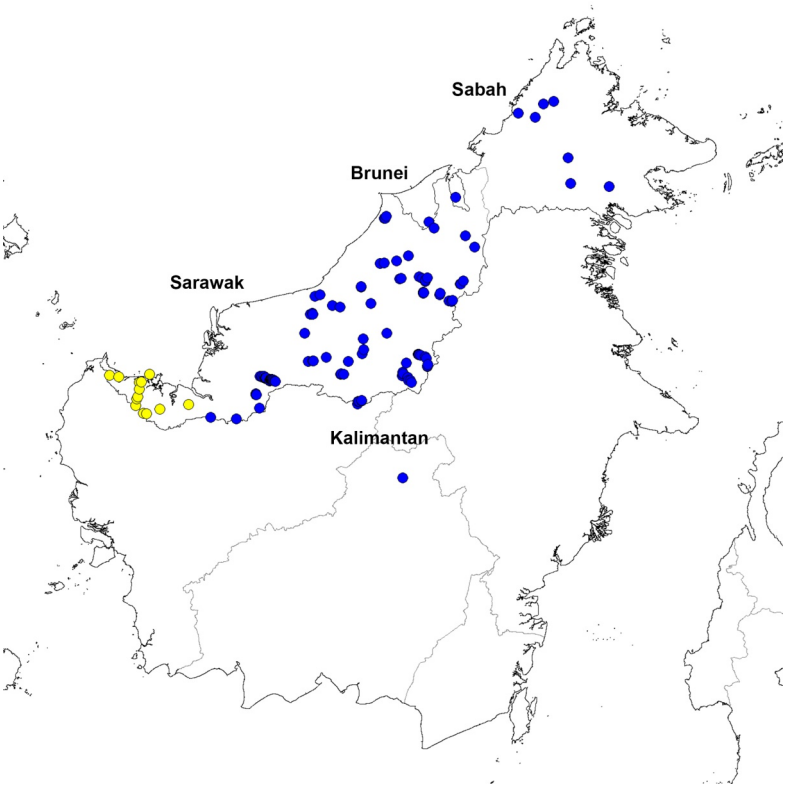



**Figure 13. Distribution of *Stenagrion dubium*. Yellow circles: yellow-faced south-western Sarawak form; blue circles: all other populations. Map made using DIVA-GIS.**

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## Appendix: Materials and methods for the COI gene tree in Fig. 12.

### Specimens

The dataset used for *Stenagrion* includes 34 specimens, from Brunei, Sabah and Sarawak plus a specimen of *Argiocnemis rubescens rubeola* Selys, 1877 from Peninsular Malaysia used as an outgroup (see Table 1). All of these specimens are in the Naturalis Biodiversity Center except the two from Usun Apau National Park. Although legs had been removed from the two Usun Apau specimens for later DNA extraction, these were stored separately to the voucher specimens which unfortunately were among material lost in transport back to Europe (see Dow, Reels & Ngiam 2015b). The mitochondrial marker COI was amplified from all of these specimens.

The gene trees resulting from a simple Neighbour Joining analysis is shown in Fig. 12. All sequences have been uploaded to the BOLD website and can be found there using the collection codes or BOLD Process IDs listed in Table 1.

### Methods

DNA extraction and amplification and analysis. This was carried out as detailed in Dow & Stokvis (2018) and the reader is referred to the relevant section in that publications for details.

**Table 1: Collection codes and BOLD Process IDs for *Stenagrion dubium* and *Argiocnemis rubescens rubeola* outgroup used in the molecular analysis. All specimens are adult males. Abbreviations used: Gn: Gunung; KBFSC: Kuala Belalong Field Studies Centre; NP: National Park; UKM: Universiti Kebangsaan Malaysia. Specimens with BOLD process IDs beginning with ODOPH were published previously (see Dijkstra et al. 2014). The collection codes (and BOLD process IDs) can be used to locate the COI sequences on the BOLD website, and also appear as BOLD Sample IDs there.**

| RMNH number | Country: State | Division/District | Location | BOLD process ID |
|---|---|---|---|---|
| ***Stenagrion dubium*** | | | | |
| RMNH.INS.228951 | Malaysia: Sarawak | Miri | Near Merewa Camp | ODOPH144-13 |
| RMNH.INS.229023 | Malaysia: Sarawak | Kuching | Kubah NP | ODOBP7514-16 |
| RMNH.INS.500009 | Malaysia: Sarawak | Miri | Mount Dulit | ODOBP7694-16 |
| RMNH.INS.500838 | Brunei | Temburong | KBFSC | ODOBP8102-16 |
| RMNH.INS.501041 | Malaysia: Sarawak | Bintulu | Anap Muput | ODOBP8219-16 |
| RMNH.INS.501253 | Malaysia: Sarawak | Miri | Lio Mato | ODOBP8394-16 |
| RMNH.INS.501329 | Malaysia: Sarawak | Kuching | Kubah NP | ODOBP8461-16 |
| RMNH.INS.501391 | Malaysia: Sarawak | Bintulu | Tubau | ODOBP8518-16 |
| RMNH.INS.501392 | Malaysia: Sarawak | Kuching | Kubah NP | ODOBP8519-16 |
| RMNH.INS.505760 | Malaysia: Sabah | West Coast | Poring Hot Springs | ODOPH145-13 |
| RMNH.INS.506303 | Malaysia: Sarawak | Miri | Pulong Tau NP: Pa'Lungan | ODOBP3727-16 |
| RMNH.INS.506306 | Malaysia: Sarawak | Miri | Pulong Tau NP: Pa'Lungan | ODOBP3728-16 |
| RMNH.INS.506323 | Malaysia: Sarawak | Miri | Usun Apau NP | ODOBP3741-16 |
| RMNH.INS.506326 | Malaysia: Sarawak | Miri | Usun Apau NP | ODOBP3744-16 |
| RMNH.INS.506370 | Malaysia: Sarawak | Miri | Gn Mulu NP: camp 2 | ODOBP3786-16 |
| RMNH.INS.506812 | Malaysia: Sarawak | Kuching | Gn Penrissen | ODOBP5158-16 |
| RMNH.INS.506822 | Malaysia: Sarawak | Kuching | Gn Penrissen | ODOBP5168-16 |
| RMNH.INS.506828 | Malaysia: Sarawak | Kuching | Matang Wildlife Centre | ODOBP5174-16 |
| RMNH.INS.506865 | Malaysia: Sarawak | Miri | Pulong Tau NP: Pa'Gelawat | ODOBP5207-16 |
| RMNH.INS.507670 | Malaysia: Sabah | West Coast | Mt Kinabalu: Poring | ODOBP5568-16 |
| RMNH.INS.507690 | Malaysia: Sabah | West Coast | Mt Kinabalu: Poring | ODOBP5583-16 |
| RMNH.INS.507693 | Malaysia: Sabah | West Coast | Mt Kinabalu: Poring | ODOBP5586-16 |
| RMNH.INS.507702 | Malaysia: Sabah | West Coast | Mt Kinabalu: Sg Liwagu | ODOBP5595-16 |
| RMNH.INS.507703 | Malaysia: Sabah | West Coast | Mt Kinabalu: Sg Liwagu | ODOBP5596-16 |
| RMNH.INS.507743 | Malaysia: Sabah | West Coast | Mt Kinabalu: Sayap | ODOBP5625-16 |
| RMNH.INS.507757 | Malaysia: Sabah | West Coast | Crocker Range NP: Inobong | ODOBP5637-16 |
| RMNH.INS.507765 | Malaysia: Sabah | West Coast | Crocker Range NP: Inobong | ODOBP5645-16 |
| RMNH.INS.507785 | Malaysia: Sabah | Interior | Crocker Range NP: Mahua | ODOBP5659-16 |
| RMNH.INS.507786 | Malaysia: Sabah | Interior | Crocker Range NP: Mahua | ODOBP5660-16 |
| RMNH.INS.507795 | Malaysia: Sabah | West Coast | Mt Kinabalu: Sayap | ODOBP5667-16 |
| RMNH.INS.507816 | Malaysia: Sarawak | Kuching | Gn Pueh | ODOBP5687-16 |
| RMNH.INS.509616 | Brunei | Belait | Labi Hills | ODOBP7073-16 |
| RMNH.INS.509639 | Malaysia: Sarawak | Kapit | Bukit Kumbong | ODOBP7094-16 |
| RMNH.INS.509654 | Malaysia: Sarawak | Kapit | Sungai Kahei | ODOBP7108-16 |
| ***Argiocnemis rubescens rubeola*** | | | | |
| RMNH.INS.500068 | Malaysia: Selangor | | UKM campus | ODOBP3727-16 |

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