

# IDF



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Maludam and Ulu Sebuyau National Parks

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## Previously unpublished Odonata records from Sarawak, Borneo, part X: Maludam and Ulu Sebuyau National Parks

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### Abstract

Previously unpublished records of Odonata collected during surveys at Maludam National Park (MNP) in 2018 and Ulu Sebuyau National Park (USNP) in 2015 are presented. Both protected areas are situated in the southwest of Sarawak and consist of peat swamp forest (PSF), a habitat that has declined dramatically in extent in southeast Asia in recent decades. Probably the most significant result of the surveys was the discovery of a population of the extremely poorly known *Pseudagrionoptera diotima* Ris, 1912 in MNP. Other significant records include *Podolestes chrysopus* Selys, 1889, *Podolestes parvus* Dow & Ngiam, 2019, *Pachycypha aurea* Lieftinck, 1950, *Elatoneura longispina* Lieftinck, 1937, *Ceriagrion* new sp., *Mortonagrion* sp. cf *aborensis* (Laidlaw, 1914), *Metaphya micans* Laidlaw, 1912 and *Raphismia inermis* Ris, 1910. With these records 62 species of Odonata are now known from MNP and 33 species are known from USNP. Checklists are given for the two areas in Appendix 1 and Appendix 2. The differences between numbers of species known from the two areas are partly explained by differences in sampling effort and a lack of running water habitats in the sampled part of USNP, but there is a somewhat surprising lack of swamp forest specialist or near specialist Libellulidae in the checklist for USNP. The proportion of species that are currently classified as Endangered, Vulnerable or Near Threatened on the IUCN Red List is high at both locations – ca. 29% at MNP, ca. 21% at USNP. Species that we consider to be specialists of low pH waters are listed.

**Key words:** Odonata, *Pseudagrionoptera diotima*, peat swamp forest, Borneo, Sarawak, threatened species, specialists of low pH waters.

### Introduction

Tropical peat swamp forest (PSF hereafter) in southeast Asia provides habitat for a number of specialist species of Odonata, but has been relatively little studied for the order. The lack of attention to this habitat type is especially concerning given its well documented rapid decline in extent (see for instance Miettinen et al. 2016). Here we report on surveys made in two protected areas of PSF in the southwest of Sarawak, Malaysian Borneo. Maludam National Park (MNP) is located in Betong Division. Dow, Ngiam & Ahmad (2015) reported on a survey made there in 2012, and larval records were published by Dosi et al. (2018).

RD has made two subsequent visits to the national park, in June 2015 and January/February 2018. Ulu Sebuyau National Park (USNP) is located slightly further west, on the other side of the Lupar River in Samarahan Division and is not yet open to the public. RD made a short survey at Ulu Sebuyau in January/February 2015 and a second survey, with GR, in July 2015 (results originating from the same trips, but from outside (away from the boundary) the NP were included in Dow et al. 2021). For both of these areas the hope/plan was to make additional visits, so the results were not written up until now (it is still hoped to visit both again, but RD has no concrete plans to do so in the near future). Some data from the surveys reported on here has, however, been published (e.g. Dow & Ngiam 2019).

## Locations

Fig. 1 shows the position of both national parks in Borneo.

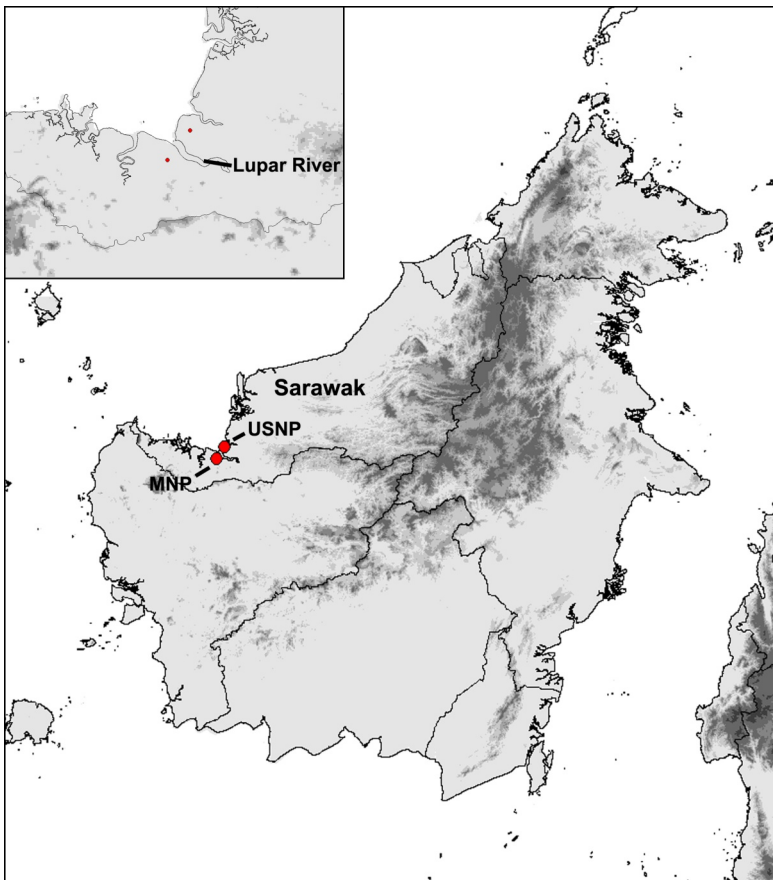


Figure 1. Map showing the positions of Maludam National Park (MNP) and Ulu Sebuyau National Park (USNP) in Borneo. The inset shows more detail of the position of the two protected areas on either side of the Lupar River.

### **Maludam National Park**

Habitats visited here include both PSF and a large stream (Sungai Maludam) flowing through the PSF. The PSF around the lower parts of Sungai Maludam is highly disturbed and there are many open and semi-open areas around the stream, with much tall, tree-like pandanus emerging from the water. As one progresses upstream the quality of the forest eventually rises and the canopy closes over the stream. Access to this part is only possible when water levels are sufficiently high (during the survey reported in Dow, Ngiam & Ahmad 2015 it was only possible to reach the very start of this part). In June 2015 it was possible to reach further into the closed canopy part and in January 2018 it was possible to reach even further upstream with some effort, where the channel is narrower on average, and that survey concentrated on the upper Sungai Maludam so that there are few results from the lower parts (except around the park HQ) from January 2018. Also, because of the time it took to reach and return from the upper Sungai Maludam, most sampling in January 2018 was on the stream itself with only limited time spent in the PSF away from the stream. Fig. 2 shows some more detail of the locations within MNP.

- M1.** On Sungai Maludam within the park boundary (1.6313N, 111.0533E) up to the end of the part where pandanus grows around the stream (at approximately 1.5847N, 111.0838E); representative coordinates in sampled part of Sungai Maludam: 1.6092N, 111.0665E.
- M2.** On Sungai Maludam beyond the pandanus, where the best quality forest is found. This area starts at approximately 1.5847N, 111.0838E and was sampled to beyond 1.5613N, 111.0987E (due to a malfunctioning GPS, coordinates could not be taken at the furthest points reached in 2018). Representative coordinates on Sungai Maludam in sampled part: 1.5665N, 111.0929E.
- M3.** In swamp or at small streams flowing out of the swamp before better quality forest is reached, accessed from M1.
- M4.** In swamp beyond the pandanus, where the best quality forest is found, accessed from M2.
- OM1.** Sungai Maludam outside the national park.
- OM2.** At MNP HQ (outside the park boundary, 1.6454N, 111.0433E): (a) areas around HQ (b) at lights at HQ.

Altitudes in the sample part of MNP are in the range 5-20m a.s.l.

### **Ulu Sebuyau National Park**

USNP was gazetted relatively recently (25th March 2010). It consists of 18,287 ha of PSF, disturbed by logging activities prior to becoming a protected area. There was no park infrastructure there in 2015 (and to our knowledge such infrastructure is still lacking) and it is not open to the public. With the assistance of the Sarawak Forestry Corporation (SFC) we were able to arrange to stay in the guest accommodation of an oil palm plantation at the park boundary and access the PSF by driving through the plantation to the head of a long transect made by the SFC for their own general survey some months before (not maintained but still usable with some effort) and from another point identified from satellite images. Ha-



**Figure 2.** Details of the locations at Maludam National Park, all marked locations are along Sungai Maludam.



**Figure 3.** Details of the locations at Ulu Sebuyau National Park.

bitat actually within the PSF surveyed at USNP did not include streams, although Sungai Sebuyau was reached at the end of the SFC transect in early 2015; the water was too deep to work there without a boat. In early 2015 conditions were wet in the PSF at USNP but by the second visit the PSF was mostly dry and few Odonata were found. Fig. 3 shows some more detail of the locations within USNP.



**US1.** Ditches and surrounding vegetation along park boundary in vicinity of **US3**.

**US2.** SFC Transect 1, inside PSF from 1.402N, 110.9163E to 1.4014N, 110.9474E; representative coordinates in around middle of transect: 1.4016N, 110.9325E.

**US3.** Peat swamp forest accessed from a small hill accessed from a path running along the park boundary, coordinates at the end of the path 1.3574N, 110.9428E.

Altitudes in the sampled part of USNP are in the range 10-25m a.s.l.

### Species recorded

Persons who collected specimens on each survey are listed in Table 1.

**Table 1: Collectors:** PD – Paya Dow, DE – D. Enchang, HH – H. Hasbi, JI – J. Indin, LS – Luke Southwell, LU – L. Ului; RD, GR – the authors.

Survey	Collectors
Maludam NP June 2015	RD, DE, JI, HH, LU
Maludam NP January/February 2018	RD, PD
Ulu Sebuyau NP January/February 2015	RD, LS
Ulu Sebuyau NP July 2015	RD, GR, LS

### Zygoptera

#### Lestidae

*Orolestes wallacei* (Kirby, 1889)

**US2** – ♂, 28.i.2015; ♂, 30.i.2015; ♂, 2.ii.2015; ♂ (teneral), 2.ii.2015. **US3** – ♂, 7.vii.2015.

#### Euphaeidae

*Dysphaea dimidiata* Selys, 1853

The Euphaeidae do not seem to be well represented at low pH waters, but *Dysphaea dimidiata* is present in good numbers in the upper, closed canopy, part of Sungai Maludam.

**M2** – ♂ ♂, 27.vi.2015; ♂, ♂ + ♀, 29.i.2018. **M4** – ♂, 31.i.2018.

#### Argiolestidae

*Podolestes chrysopus* Selys, 1889

This is a seldom recorded species, seemingly confined to the southwest of Sarawak and the northwest of Kalimantan, with few locations currently known. It is, however, very closely allied with *Podolestes buwaldai* Lieftinck, 1940 known from Peninsular Malaysia and Sumatra. It is fairly common at both MNP and USNP and appears to be confined to low pH swamp forest.

**M3** – ♂ ♂, ♀ ♀, 30.vi.2015; ♂ ♂, 1.vii.2015; ♂, 2.vii.2015. **US2** – ♀, 30.i.2015; ♂ ♂, 2.ii.2015; ♂, 8.vii.2015.

*Podolestes harrissoni* Lieftinck, 1953

A PSF specialist species, seemingly found almost universally where the habitat still exists in Sarawak and Brunei; common in both of the areas reported on here.

**M3** – ♂♂, 30.vi.2015; ♂, 1.vii.2015. **US2** – ♂, ♀, 28.i.2015; ♂♂, ♀, 30.i.2015, ♂♂, ♀, 2.ii.2015. **US3** – ♂♂, 29.i.2015.

*Podolestes orientalis* Selys, 1862

The most generalist species of *Podolestes*, in PSF generally occurring at lower densities than *P. harrissoni*.

**M3** – ♂, 1.vii.2015. **US3** – ♂, 7.vii.2015.

*Podolestes parvus* Dow & Ngiam, 2019

Material listed in Dow & Ngiam (2019). This species appears to have a very limited distribution in PSF around the Lupar River, with records only from the two national parks listed here and one small, non-protected site further inland.

**M3, US2.**

### Calopterygidae

*Vestalis amoena* Hagen in Selys, 1853

**M2** – ♂♂, ♀, 27.vi.2015. **M4** – ♂, 31.i.2018.

### Chlorocyphidae

*Libellago hyalina* (Selys, 1859)

**M1** – ♂♂, 27.vi.2015; ♂, ♀, 30.vi.2015; ♂♂, ♀♀, 29.i.2018. **M2** – ♂, ♀♀, 28.vi.2015; ♂, 31.i.2018. **M3** – ♂♂, 1.vii.2015. **M4** – ♂♂, 31.i.2018; ♂, ♀, 1.ii.2018. **US1** – ♂, 2.ii.2015.

*Pachycypha aurea* Lieftinck, 1950

Dow, Ngiam & Ahmad (2015) already reported this species from MNP. In 2018, when RD was able to reach further up Sungai Maludam than on any previous visit, the species was found again, but only females. A female was also seen at **M2** on 29.i.2018.

**M4** – ♀♀, 31.i.2018.

### Platycnemididae

*Elatoneura aurantiaca* (Selys, 1886)

Abundant on Sungai Maludam.

**M1** – ♂♂, 27.vi.2015; ♂♂, 29.i.2018; ♂♂, ♀, 31.i.2018. **M2** – ♂+♀, 29.i.2018. **M3** – ♀, 29.vi.2015; ♂, 30.vi.2015; ♂, 1.vii.2015; ♂♂, 2.vii.2015; ♂+♀, 31.i.2018. **M4** – ♂♂, 28.vi.2015.

*Elatoneura longispina* Lieftinck, 1937

Probably the most localised in occurrence of the species currently placed in *Elatoneura*, most records from Sarawak are from low pH waters; all are from swampy lowland forest habitats. A small population was found in flooded PSF around Sungai Maludam in 2018, in narrow channels with discernible flow. Although in PSF, the Maludam population (and other known populations in Sarawak) are the normal phenotype, rather than the smaller, darker phenotype found in PSF in Central Kalimantan and reported on in Dow & Silvius (2014).

**M2** – ♂, 29.i.2018. **M4** – ♂♂, 29.i.2018; ♀, 31.i.2018.



**Coenagrionidae***Agrioncnemis minima* Selys, 1877

Although certainly not confined to low pH waters, in Sarawak (at least) this species is far more often found at such waters than in other habitats.

**US1** – ♀, 29.i.2015.

*Amphicnemis annae* Lieftinck, 1940

Another apparent PSF specialist species, with a similar distribution to *Podolestes harrissoni*.

**M2** – ♂, 27.vi.2015. **M3** – ♂♂, ♀♀, 30.vi.2015; ♂♂, ♀♀, 1.vii.2015. **M4** – ♂♂, ♀, 8.vi.2015; ♂, ♀, 29.i.2018; ♂♂, 1.ii.2018. **US2** – ♂♂, ♀♀, 28.i.2015; ♂♂, ♀♀, 30.i.2015; ♂♂, ♀♀, 2.ii.2015; ♂, 8.vii.2015. **US3** – ♂, 1.ii.2015; ♀, 7.vii.2015.

*Amphicnemis* sp. *martini*-group

A difficult group taxonomically, but generally confined to low pH waters.

**M3** – ♂, 30.vi.2015; ♀, 1.vii.2015. **M4** – ♀, 28.vi.2015; ♂, 29.i.2018; ♂♂, ♀♀, 31.i.2018; ♂, 1.ii.2018. **US2** – ♂, ♀♀, 28.i.2015; ♂♂, 2.ii.2015. **US3** – ♂♂, ♀♀, 29.i.2015; ♂, ♀, 7.vii.2015.

*Amphicnemis wallacii* Selys, 1863

The most generalist of the *Amphicnemis* species, always found in PSF in southwest Sarawak but also occurring in other habitats. Populations from further east in Sarawak might (or might not) represent one or more separate species, but those from MNP and USNP are unequivocally *A. wallacii*.

**US2** – ♂♂, ♀, 28.i.2015; ♂♂, ♀, 30.i.2015; ♂♂, ♀♀, 8.vii.2015. **US3** – ♂♂, ♀♀, 29.i.2015, RD; ♂, ♀♀, 1.ii.2015; ♂, ♀, 7.vii.2015.

*Archibasis melanocyana* (Selys, 1877)

Very common on Sungai Maludam, as it is generally on low pH forest streams in Borneo.

**M1** – ♂♂, ♂+♀, 27.vi.2015; ♂♂, ♀♀, 30.vi.2015; ♂♂, 29.i.2018; ♂, 31.i.2018; ♂, 1.ii.2018. **M2** – ♂♂, ♀, ♂+♀, 29.i.2018. **M3** – ♂, 1.vii.2015. **M4** – ♂♂, ♀♀, 28.vi.2015; ♂♂, 31.i.2018. **US2** – ♂, ♂ (teneral), 30.i.2015. **US3** – ♀, 7.vii.2015.

*Archibasis viola* Lieftinck, 1948

**M3** – ♂♂, ♀♀, 1.vii.2015; ♂, 2.vii.2015. **OM2b** – ♂ (in morning), 29.i.2018. **US1** – ♀, 29.i.2015. **US2** – ♂♂, 28.i.2015; ♂, 30.i.2015; ♂♂, ♀, 2.ii.2015. **US3** – ♂, 29.i.2015.

*Ceriagrion cerinorubellum* (Brauer, 1865)

**M3** – ♀, 29.vi.2015; ♂, 1.vi.2015. **US1** – ♂, 29.i.2015. **US2** – ♂, 30.i.2015.

*Ceriagrion* new sp.

This new species was first recorded (from MNP) by Dow, Ngiam & Ahmad (2015) and subsequently found at a few other locations in Sarawak and Brunei. Material to be listed in the description of the species (in preparation). **M2, M3, M4.**

*Ischnura senegalensis* (Rambur, 1842)

**US1** – ♀♀, 29.i.2015.

*Mortonagrion* sp. cf *aborensis* (Laidlaw, 1914)

This taxon has only been found at one other location in Sarawak (Dow 2016), it also occurs in Central Kalimantan and Sumatra.

**US2** – ♂, 28.i.2015.

*Mortonagrion indraneil* Dow, 2011

Another PSF specialist species, known from Brunei, Sarawak and the northwest of Kalimantan.

**M3** – ♂♂, ♀, 2.vii.2015. **US2** – ♂, 2.ii.2015; ♂, ♀, 8.vii.2015.

*Pseudagrion coomansi* Lieftinck, 1937

Common on Sungai Maludam.

**M1** – ♂, 27.vi.2015; ♂♂, ♀♀, 29.i.2018; ♂♂, ♂+♀, 31.i.2018. **M2** – ♂♂, 1.ii.2018.

**OM1** – ♂, 26.i.2018.

*Pseudagrion microcephalum* (Rambur, 1842)

**US1** – ♂♂, ♀, 29.i.2015.

## Anisoptera

### Aeshnidae

A few additional records, of females of uncertain identity beyond genus, are listed separately after the main list, to avoid unnecessary inflation of the number of species recorded.

*Gynacantha basiguttata* Selys, 1882

**US2** – ♂, 2.ii.2015.

*Gynacantha dohrni* Krüger, 1899

**US1** – ♂ (hawking during rain at ca 1 pm), 1.ii.2015.

*Gynacantha* sp.

Not either of the two previous species, quite likely to be *G. maclachlani* Krüger, 1899 but identification of females in this group remains problematic unless associated with males.

**US2** – ♀, 30.i.2015.

*Heliaeschna crassa* Krüger, 1899

Note that Dow, Ngiam & Ahmad (2015) listed *Heliaeschna idae* from MNP, however after examining the type of *H. crassa* RD reidentified specimens collected within the park boundary in 2012 as that species.

**M3** – ♂, 1.vii.2015. **OM2b** – ♂, 26.vi.2015; ♂, 28.vi.2015; ♂♂, 2.ii.2018.

*Heliaeschna idae* (Brauer, 1865)

**OM2a** – ♂♂ (at dusk), 1.ii.2018. **OM2b** – ♂, 28.vi.2015; ♂♂, 28.i.2018; ♂♂, 29.i.2018; ♂, 30.i.2018; ♂, 31.i.2018; ♂♂, 2.ii.2018.

*Heliaeschna simplicia* (Karsch, 1891)

**OM2a** – ♀ (at dusk), 31.i.2018.

*Oligoaeschna foliacea* Lieftinck, 1968

A female, identified as this species with some reservations, collected on 2.ii.2015 in USNP was flying low around shallow pools in PSF, seemingly investigating possible oviposition sites. *Oligoaeschna* are normally collected whilst hawking or perched in the forest. Their larvae are not known and little is known about their ecology, so any observations of other behaviour have some significance.

**US2** – ♂, 28.i.2015; ?♀, 2.ii.2015; ♀, 8.vii.2015.

### Gomphidae

*Gomphidia maclachlani* Selys, 1873

Common in the closed canopy part of Sungai Maludam during sunny weather.

**M2** – ♂♂, 28.vi.2015; ♂♂, 29.i.2018; ♂, 1.ii.2018.

*Ictinogomphus acutus* (Laidlaw, 1914)

A low pH specialist species, common on parts of Sungai Maludam.

**M1** – ♂♂, 27.vi.2015; ♂♂, 31.i.2018; ♂, 1.ii.2018. **M2** – ♂, ♀, 29.i.2018.

### Macromiidae

*Epopthalmia vittigera* (Rambur, 1842)

**M1** – ♂, 31.i.2018; ♀, 1.ii.2018.

*Macromia cincta* Rambur, 1842

This species, although found in a wider variety of habitats, thrives at low pH forest streams.

**M1** – ♂♂, 27.vi.2015; ♂, 31.i.2018; ♂♂, 1.ii.2018. **M2** – ♂♂, 29.i.2018.

### Corduliidae

*Hemicordulia tenera* Lieftinck, 1930

Dow, Ngiam & Ahmad (2015) reported good numbers of this species from MNP, but on later visits only a single male has been recorded.

**M3** – ♂, 1.vii.2015.

*Metaphya micans* Laidlaw, 1912

A rarely recorded species, seemingly a PSF specialist. The teneral male listed below was collected deep inside PSF in USNP, with only pools, rather than flowing water, anywhere near to where it was found.

**US2** – ♂ (teneral), 30.i.2015; ♀, 2.ii.2015.

### Libellulidae

*Brachydiplax chalybea* Brauer, 1868

**US1** – ♂♂, 29.i.2015, RD.

*Brachygonia oculata* (Brauer, 1878)

Generally common in swamp forest in Sarawak.

**M3** – ♂♂, 29.vi.2015; ♂♂, ♀, 30.vi.2015; ♂♂, ♀, 1.vii.2015. **M4** – ♂, 28.vi.2015; ♂, 29.i.2018; ♂, 1.ii.2018. **US2** – ♂♂, 28.i.2015; ♂♂, ♀, 30.i.2015; ♂, ♀, 2.ii.2015.

**US3** – ♂♂, ♀, 7.vii.2015.

*Brachygonia puella* Lieftinck, 1937

Scarce and localised in Sarawak, although sometimes common where it does occur.

**M3** – ♂, 2.vii.2015. **M4** – ♂, 28.vi.2015.

*Chalybeothemis fluviatilis* Lieftinck, 1933

**M1** – ♂♂, 27.vi.2015; ♂♂, 29.i.2018; ♂♂, 31.i.2018; ♂, 1.ii.2018. **M2** – ♂, 29.i.2018.

*Hydrobasileus croceus* (Brauer, 1867)

This is a species of standing and slowly flowing, open waters. At USNP single males were collected on two occasions while perched at chest height deep within PSF (not in clearings). Perhaps individuals forage over the canopy and descend to the shaded understorey when they need to perch for longer periods.

**M1** – ♂, 27.vi.2015. **US2** – ♂, 30.i.2015; ♂, 2.ii.2015.

*Nannophya pygmaea* Rambur, 1842

**M1** – ♂, 29.i.2018. **M4** – ♂, 28.vi.2015. **US2** – ♂, 2.ii.2015.

*Neurothemis fluctuans* (Fabricius, 1793)

**M3** – ♂♂, 29.vi.2015; ♂, 2.vii.2015. **US1** – ♂♂, ♀, 29.i.2015. **US2** – ♂, 30.i.2015; ♀, 2.ii.2015.

*Onychothemis culminicola* Förster, 1904

**M1** – ♂, 27.vi.2015.

*Orchithemis pruinans* (Selys, 1878)

**M4** – ♂, 28.vi.2015; ♂♂, 31.i.2018.

*Orchithemis pulcherrima* Brauer, 1878

**M3** – ♀, 1.vii.2015; ♂, 2.vii.2015.

*Orchithemis xanthosoma* Laidlaw, 1911

Another PSF specialist.

**M3** – ♂♂, ♀, 30.vi.2015; ♂♂, 1.vii.2015; ♂, ♀, 2.vii.2015.

*Orthetrum chrysis* (Selys, 1891)

**US1** – ♂♂, 29.i.2015.

*Orthetrum sabina* (Drury, 1773)

**US1** – ♂♂, ♀, 29.i.2015. **US2** – ♀, 30.i.2015; ♂, 2.ii.2015.

*Pantala flavescens* (Fabricius, 1798)

**US1** – ♀, 29.i.2015.

*Pseudagrionoptera diotima* Ris, 1912

This is probably the most significant result reported here. *Pseudagrionoptera diotima* is a very seldom recorded species and virtually nothing has been known about its habitats, although Orr (2001: 209) reported a female “ovipositing in an open swampy area close to peat swamp forest”. At MNP males were found in the uppermost part of Sungai Maludam reached in 2018, where the channel is narrow and the canopy closed. They occurred individually at well-spaced intervals, perched on vegetation at the side of the channel. Many more were seen than were collected. A single female was collected while flying over an open part of Sungai Maludam much further downstream than where the males were found. Judged from the males the preferred habitat of the species is closed canopy streams in PSF, nowadays a rare habitat. Fig. 4 shows a male specimen, the female specimen is shown on the cover. Ris (1912) states the forewing triangle is crossed but the series from MNP reveals that this is a variable character, with the forewing triangle free in two of the males.

**M1** – ♀, 31.i.2018. **M2** – ♂♂, 29.i.2018; ♂, 31.i.2018.



Figure 4. Male of *Pseudagrionoptera diotima* (SA-R18\_LIB44) collected at Mauldam National Park. Photograph by Chien Lee.

*Raphismia inermis* Ris, 1910

Another scarce and local low pH specialist species.

**M4** – ♀, 1.ii.2018.

*Rhodothemis rufa* (Rambur, 1842)

**M1** – ♀, 27.vi.2015; ♂, 29.i.2018; ♀, 31.i.2018.

*Rhyothemis aterrima* Selys, 1891

**M1** – ♂, 31.i.2018.

*Rhyothemis fulgens* Kirby, 1889

**M1** – ♀, 1.ii.2018. **M3** – ♂♂, ♀, 30.vi.2015; ♂, ♀, 1.vii.2015; ♂, ♀, 2.vii.2015.

*Rhyothemis phyllis* (Sulzer, 1776)

**M3** – ♂, 29.vi.2015. **OM2a** – ♀, 26.vi.2015. **US1** – ♂, 29.i.2015.

*Risiophlebia dohrni* (Krüger, 1902)

**US3** – ♀, 29.i.2015.

*Tyriobapta kuekenthali* (Karsch, 1900)

Incorrectly listed as *T. laidlawi* Ris, 1919 in Dow, Ngiam & Ahmad (2015), see Dow & Orr (2021).

**M3** – ♂, 30.vi.2015; ♂♂, 1.vii.2015; ♂, 2.vii.2015. **M4** – ♂, 28.vi.2015.

*Urothemis signata insignata* (Selys, 1872)

**M1** – ♂, 27.vi.2015; ♂, 31.i.2018; ♂, 1.ii.2018. **M2** – ♂, 29.i.2018. **US1** – ♂, 29.i.2015.

*Zyxomma petiolatum* Rambur, 1842

**OM2a** – ♂ (at dusk), 31.i.2018.

**Additional****Aeshnidae**

*Heliaeschna* sp. (*crassa* or *idaea*)

**OM2a** – ♀ (at dusk), 31.i.2018. **OM2b** – ♀, 30.i.2018. **US2** – ♀, 8.vii.2015.

*Oligoaeschna* sp.

**OM2a** – ♀ (hawking over path beside river at dusk, close to completely dark), 28.vi.2015.

**M3** – ♀, 30.vi.2015.

**Discussion**

With the records given here 62 species of Odonata are now known from MNP and 33 species are known from USNP. Checklists are given for the two areas in Appendix 1 and Appendix 2. The discrepancy in the numbers of species from the two areas is partly explained by (a) greater sampling effort at MNP and (b) lack of stream habitats in the sampled part of USNP. There is however a surprising lack of swamp forest Libellulidae in the USNP, with only *Brachygonia oculata* and *Risioephlebia dohrni* falling into this category. The fact that species such as *Orchithemis xanthosoma* and *Tyriobapta kuekenthali* were apparently absent from the sampled part of USNP even in wet conditions in early 2015 is strange, since these species are generally common in PSF in Sarawak and apparently suitable habitat for them was present.

Both protected areas have high proportions of species currently classified as either Endangered, Vulnerable or Near Threatened on the IUCN Red List (Table 2): MNP has 18 (ca. 29%) such species and USNP has 7 (ca. 21%) such species. For context, Gunong Mulu National Park and the Lanjak Entimau Wildlife Sanctuary, both relatively well sampled for Odonata, have only 5 (ca. 3%) and 10 (ca. 8.8%) such species respectively. All of the species listed in Table 2 are specialists of or largely confined to low pH waters in the lowlands and all are forest-dependent (with the possible exception of *Brachygonia puella*) and their threat statuses reflect the diminishing extent and fragmented state of such habitats.

**Table 2: Endangered, Vulnerable and Near Threatened species of Odonata recorded from Maludam and Ulu Sebauau National Parks.**

IUCN category	MNP	USNP
<b>Endangered</b>	<i>Podolestes chrysopus</i> , <i>Podolestes parvus</i> , <i>Pachycypha aurea</i> , <i>Prodasineura yulan</i> , <i>Brachygonia ophelia</i> , <i>Pseudagrionoptera diotima</i> , <i>Raphismia inermis</i>	<i>Podolestes chrysopus</i> , <i>Podolestes parvus</i> , <i>Metaphya micans</i>
<b>Vulnerable</b>	<i>Ictinogomphus acutus</i> , <i>Brachygonia puella</i>	
<b>Near Threatened</b>	<i>Podolestes harrissoni</i> , <i>Elattoneura aurantiaca</i> , <i>Elattoneura longispina</i> , <i>Amphicnemis annae</i> , <i>Mortonagrion indraneil</i> , <i>Oligoaeschna foliacea</i> , <i>Orchithemis xanthosoma</i> , <i>Rhyothemis fulgens</i> , <i>Tyriobapta kuekenthali</i>	<i>Podolestes harrissoni</i> , <i>Amphicnemis annae</i> , <i>Mortonagrion indraneil</i> , <i>Oligoaeschna foliacea</i>
<b>Total</b>	<b>18</b>	<b>7</b>



Concerning species specialised to low pH waters, there is some room for debate over what exactly constitutes a specialist species. Here we consider a species to be a specialist of low pH waters if it is either entirely confined to such waters or is largely confined to such waters so that the removal of all such habitat would result in a catastrophic drop in its overall population. The habitat requirements of a species can shift over its range, or potentially with altitude or the presence or absence of competing species. These factors complicate discussions of specialisation. Water within (and flowing out from) true PSF is always low pH, with a distinctive black appearance when not turbid. Low pH waters can however occur outside of PSF in Southeast Asia, in other forest formations. Not all forest-dependent low pH specialist species are confined or largely confined to PSF; PSF specialists are a proper subset of low pH specialists. Here we focus on low pH specialisation rather than PSF specialisation, but some of the species listed below certainly belong to the more restricted category.

**Table 3: Species recorded from MNP and USNP and considered to be specialists of low pH waters.**

MNP	USNP
<i>Podolestes chrysopus</i> , <i>Podolestes harrissoni</i> , <i>Podolestes parvus</i> , <i>Elattoneura aurantiaca</i> , <i>Amphicnemis annae</i> , <i>Amphicnemis</i> sp. <i>martini</i> -group, <i>Archibasis melanocyana</i> , <i>Ceriagrion new</i> sp., <i>Mortonagrion indraneil</i> , <i>Ictinogomphus acutus</i> , <i>Brachygonia ophelia</i> , <i>Brachygonia puella</i> , <i>Orchithemis xanthosoma</i> , <i>Pornothemis</i> sp. A, <i>Pseudagrionoptera diotima</i> , <i>Raphismia inermis</i> , <i>Rhyothemis fulgens</i> , <i>Tyriobapta kuekenthali</i>	<i>Podolestes chrysopus</i> , <i>Podolestes harrissoni</i> , <i>Podolestes parvus</i> , <i>Amphicnemis annae</i> , <i>Amphicnemis</i> sp. <i>martini</i> -group, <i>Mortonagrion indraneil</i> , <i>Metaphya micans</i>
MNP	USNP

In Table 3 we have listed the species recorded from MNP and USNP that in our view are low pH specialists. We have left out the *Coeliccia* sp. recorded from MNP by Dow et al. (2015) but not found during the latter surveys. This might be a low pH specialist but its status is not clear: it might just be a form of the common *Coeliccia nigrohamata* Laidlaw, 1918. Note that *Prodasineura yulan* Dow & Ngiam, 2013, described from MNP, is also omitted from Table 3, since it has now been found in non-PSF habitat in West Kalimantan (Silvius & Dow 2024) where the pH of the water can only be guessed at. When more is known about *P. yulan* it might prove to be a low pH specialist. Other species are borderline or their inclusion in Table 3 would require considerable qualification, for instance *Agriocnemis minima* would qualify as a low pH specialist within Sarawak but probably not across its entire range. As with Table 2 all species included in Table 3 are forest-dependent and all of the named species in Table 3 are also included in Table 2.

### Acknowledgements

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## Appendix 1: Concise checklist of Odonata from Maludam NP

First records made during the surveys reported on here are indicated by an \*. Updates to identifications in Dow, Ngiam & Ahmad (2015) are given in []. This list only includes species found within or at the national park boundary (e.g. not locations OM1 and OM2 listed above). Most of the records are either from Dow, Ngiam & Ahmad (2015) or the present report but Dosi et al. (2018) added two species to the checklist (these are also indicated in []).

### Zygoptera

#### Euphaeidae

*Dysphaea dimidiata* Selys, 1853

#### Argiolestidae

*Podolestes chrysopus* Selys, 1889

*Podolestes harrissoni* Lieftinck, 1953

*Podolestes orientalis* Selys, 1862

*Podolestes parvus* Dow & Ngiam, 2019 [listed as *Podolestes* new species in Dow, Ngiam & Ahmad (2015)]

#### Calopterygidae

*Vestalis amoena* Hagen in Selys, 1853

#### Chlorocyphidae

*Libellago hyalina* (Selys, 1859)

*Pachycypha aurea* Lieftinck, 1950

#### Platycnemididae

*Coeliccia* sp.

*Elattoneura aurantiaca* (Selys, 1886)

*Elattoneura longispina* Lieftinck, 1937\*

*Onychargia atrocyana* Selys, 1865

*Prodasineura yulan* Dow & Ngiam, 2013

#### Coenagrionidae

*Amphicnemis annae* Lieftinck, 1940

*Amphicnemis martini*–group [listed as *A.* species of *dactylostyla* Lieftinck, 1953 in Dow, Ngiam & Ahmad (2015)]

*Amphicnemis wallacii* Selys, 1863

*Archibasis melanocyana* (Selys, 1877)

*Archibasis viola* Lieftinck, 1948

*Ceriagrion cerinorubellum* (Brauer, 1865)

*Ceriagrion* new sp.

*Ischnura senegalensis* (Rambur, 1842)

*Mortonagrion indraneil* Dow, 2011

*Pseudagrion coomansi* Lieftinck, 1937

*Pseudagrion microcephalum* (Rambur, 1842)

**Anisoptera****Aeshnidae**

*Anax guttatus* (Burmeister, 1839) [recorded by Dosi et al. 2018]

*Gynacantha dohrni* Krüger, 1899

*Heliaeschna crassa* Krüger, 1899 [listed as *H. ida* (Brauer, 1865) in Dow, Ngiam & Ahmad (2015)]

*Oligoaeschna foliacea* Lieftinck, 1968

*Tetracanthagyna plagiata* (Waterhouse, 1877)

**Gomphidae**

*Gomphidia maclachlani* Selys, 1873\*

*Ictinogomphus acutus* (Laidlaw, 1914)

*Ictinogomphus decoratus melaenops* (Selys in Selys & Hagen, 1858)

*Macrogomphus decemlineatus* Selys, 1878

**Macromiidae**

*Epopthalmia vittigera* (Rambur, 1842)\*

*Macromia cincta* Rambur, 1842

**Corduliidae**

*Hemicordulia tenera* Lieftinck, 1930

**Libellulidae**

*Brachydiplax chalybea* Brauer, 1868

*Brachygonia oculata* (Brauer, 1878)

*Brachygonia ophelia* Ris, 1910

*Brachygonia puella* Lieftinck, 1937

*Chalybeothemis fluviatilis* Lieftinck, 1933

*Hydrobasileus croceus* (Brauer, 1867)\*

*Nannophya pygmaea* Rambur, 1842

*Neurothemis fluctuans* (Fabricius, 1793)

*Neurothemis ramburii* (Brauer, 1866) [recorded by Dosi et al. 2018]

*Onychothemis culminicola* Förster, 1904\*

*Orchithemis pruinans* (Selys, 1878)

*Orchithemis pulcherrima* Brauer, 1878

*Orchithemis xanthosoma* Laidlaw, 1911

*Orthetrum chrysis* (Selys, 1891)

*Orthetrum sabina* (Drury, 1773)

*Pornothemis* sp. A [listed as *P. serrata* Krüger, 1902 in Dow, Ngiam & Ahmad (2015)]

*Pseudagrionoptera diotima* Ris, 1912\*

*Raphismia inermis* Ris, 1910\*

*Rhodothemis rufa* (Rambur, 1842)

*Rhyothemis aterrima* Selys, 1891\*

*Rhyothemis fulgens* Kirby, 1889

*Rhyothemis obsolescens* Kirby, 1889

*Rhyothemis phyllis* (Sulzer, 1776)\*

*Tyriobapta kuekenthali* (Karsch, 1900) [listed as *T. laidlawi* Ris, 1919 in Dow, Ngiam & Ahmad (2015)]

*Urothemis signata insignata* (Selys, 1872)

*Zyxomma petiolatum* Rambur, 1842

## Appendix II: Concise checklist of Odonata known from Ulu Sebuyau National Park

### Zygoptera

#### Lestidae

*Orolestes wallacei* (Kirby, 1889)

#### Argiolestidae

*Podolestes chrysopus* Selys, 1889

*Podolestes harrissoni* Lieftinck, 1953

*Podolestes orientalis* Selys, 1862

*Podolestes parvus* Dow & Ngiam, 2019

#### Chlorocyphidae

*Libellago hyalina* (Selys, 1859)

#### Coenagrionidae

*Agriocnemis minima* Selys, 1877

*Amphicnemis annae* Lieftinck, 1940

*Amphicnemis* sp. *martini*-group

*Amphicnemis wallacii* Selys, 1863

*Archibasis melanocyana* (Selys, 1877)

*Archibasis viola* Lieftinck, 1948

*Ceriagrion cerinorubellum* (Brauer, 1865)

*Ischnura senegalensis* (Rambur, 1842)

*Mortonagrion* sp. cf. *aborense* (Laidlaw, 1914)

*Mortonagrion indraneil* Dow, 2011

*Pseudagrion microcephalum* (Rambur, 1842)

### Anisoptera

#### Aeshnidae

*Gynacantha basiguttata* Selys, 1882

*Gynacantha dohrni* Krüger, 1899

*Gynacantha* sp.

*Oligoaeschna foliacea* Lieftinck, 1968

### **Corduliidae**

*Metaphya micans* Laidlaw, 1912

### **Libellulidae**

*Brachydiplax chalybea* Brauer, 1868

*Brachygonia oculata* (Brauer, 1878)

*Hydrobasileus croceus* (Brauer, 1867)

*Nannophya pygmaea* Rambur, 1842

*Neurothemis fluctuans* (Fabricius, 1793)

*Orthetrum chrysis* (Selys, 1891)

*Orthetrum sabina* (Drury, 1773)

*Pantala flavescens* (Fabricius, 1798)

*Rhyothemis phyllis* (Sulzer, 1776)

*Risiophlebia dohrni* (Krüger, 1902)

*Urothemis signata insignata* (Selys, 1872)

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