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ODONATA OF MALUDAM NATIONAL PARK, SARAWAK, MALAYSIA

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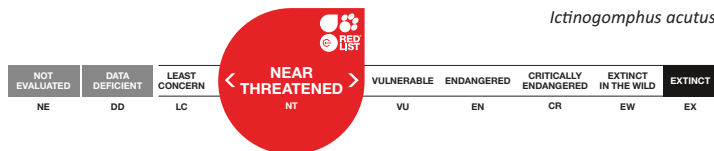
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Abstract: This paper presents records of Odonata collected in July 2012 in Maludam National Park, Sarawak, Malaysia. A total of 48 species from nine families were collected. Three species were new to science, one of which has already been described as *Prodasineura yulan* Dow & Ngiam, which may be endemic to Maludam. In addition, Maludam is only the second locality recorded in Sarawak for four poorly known species: *Pachycypha aurea*, *Macrogomphus decemlineatus*, *Brachygonia ophelia* and *Brachygonia puella*. Two of these species, *Macrogomphus decemlineatus* and *Brachygonia ophelia*, are recorded for the first time in Sarawak in more than 100 years

Keywords: Odonata, dragonflies, damselflies, Maludam, Betong, Sarawak, Malaysia, new species

Abstrak Bahasa Melayu: Kertas ini mengemukakan rekod Odonata yang dikumpul dalam bulan Julai di Taman Negara Maludam, Sarawak, Malaysia. Sejumlah 48 spesis daripada sembilan famili telah dikumpulkan. Tiga spesis adalah baharu kepada sains, satu daripadanya telah dihuraikan sebagai *Prodasineura yulan* Dow & Ngiam, yang mungkin endemik kepada Maludam. Tambahan pula, Maludam adalah tempat kedua di Sarawak yang merekodkan empat spesis yang kurang diketahui: *Pachycypha aurea*, *Macrogomphus decemlineatus*, *Brachygonia ophelia* and *Brachygonia puella*. Dua daripada spesis ini, *Macrogomphus decemlineatus* and *Brachygonia ophelia*, direkodkan untuk pertama kali di Sarawak dalam masa lebih daripada 100 tahun.



Ictinogomphus acutus



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Author Contribution: RAD identification and information on the Odonata collected, collection of specimens. RWJN collection of specimens and photography. RA background information and map in Figure 1.

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INTRODUCTION

Peat swamp forests are waterlogged wetland areas, with very low levels of nutrient and dissolved oxygen. Peat swamp forest is a unique ecosystem where special flora and fauna have evolved and adapted to the seemingly harsh environment. More than 60% of the world's tropical peat swamp forests are in Southeast Asia with the most extensive areas being in Borneo and Sumatra (UNDP 2006). Posa et al. (2011) demonstrated that a significant proportion of Southeast Asia's vertebrate fauna can be found in peat swamp forests and that preservation of these forests is crucial in conserving a number of threatened taxa, especially specialized fish species. Peat swamp forests, however, are often regarded as unproductive wastelands, and suffer from anthropogenic impacts such as logging and conversion to agricultural use while receiving little attention from conservationists. The degradation and habitat loss of peat swamps in Southeast Asia over the last few decades has been unprecedented; it is estimated that only ca. 37% of historical peat swamp forest remains in the region (Posa et al. 2011).

Historically Sarawak and Sabah had ca. 17,460 km² of peat swamp forest but only ca. 36% of it remains. Two of Sarawak's longer established national parks contain significant areas of peat swamp forest: Loagan Bunut National Park in Miri Division, gazetted in 1990, and Maludam National Park in Betong Division, gazetted in 2000. Maludam National Park is about 43,147 ha in size (Sarawak Forestry Corporation 2013). The park is located on the Maludam Peninsula and is part of the floodplain of the Lupar and Saribas rivers (Hazebroek & Morshidi 2000). Before the establishment of the park, the area was harvested for timber from 1955, mainly for ramin (*Gonystylus bancanus* - Thymelaeaceae) until logging concessions expired in 1999 (Wong 2003). Using remote sensing and GIS technology, Wong (2003) showed that natural undisturbed forests remaining in the national park constituted only about 3.29% of the total park area; much of the remaining area is still forested, with the forest in various states of disturbance.

Maludam National Park is a refuge for some of Sarawak's most important animal populations. Examples are the Red-banded Langur *Presbytis melalopus cruciger* which is probably limited entirely to Maludam, the Borneo endemic Proboscis Monkey *Nasalis larvatus* and the rare Storm's Stork *Ciconia stormi* (Hazebroek & Morshidi 2000). Odonata had not been surveyed in Maludam prior to 2012, indeed very little was known about the odonate fauna of Betong Division at all.

There are only published records of eight species of Odonata that can be traced to Betong Division that we are aware of, all in Laidlaw (1914, 1920) and all from Saribas: *Libellago hyalina* (Selys, 1859); *Rhinocypha cucullata* Selys, 1873; *Euphaea subcostalis* Selys, 1873; *Euphaea tricolor* Selys, 1859; *Elattonneura analis* (Selys, 1860); *Heliaeschna idae* (Brauer, 1865); *Gynacantha dohrni* Krüger, 1899; and *Microgomphus chelifer* (Selys, 1858). It was against this background that a survey of the odonate fauna of Maludam National Park was conducted in July 2012 by the first two authors with assistance from the Protected Areas and Biodiversity Conservation Unit of the SFC.

MATERIALS AND METHODS

Adult Odonata were collected using handheld nets on six days from 6 to 11 July 2012. The main areas of collection were: Sungai Maludam near Rumah Tanjong Baru (outside the national park boundary); Sungai Maludam inside the national park, this is referred to below as Ulu (upriver) Maludam; in swamp adjacent to, and small streams flowing into Ulu Maludam (Images 1–3). On the Sungai Maludam, sampling was conducted from a boat. Sampling in swamp and small streams flowing into Sungai Maludam was conducted on foot. The sampling sites are shown in Fig. 1.

Specimens were preserved either by treatment with acetone or immersion in ethanol. The specimens are currently held in either the Naturalis Biodiversity Centre in Leiden, the Raffles Museum of Biodiversity Research at National University of Singapore, or the working collections of the first two authors.



Image 1. Sungai Maludam.



Image 2. Small tributary stream of Sungai Maludam.



Image 3. A forest trail in Ulu Maludam.

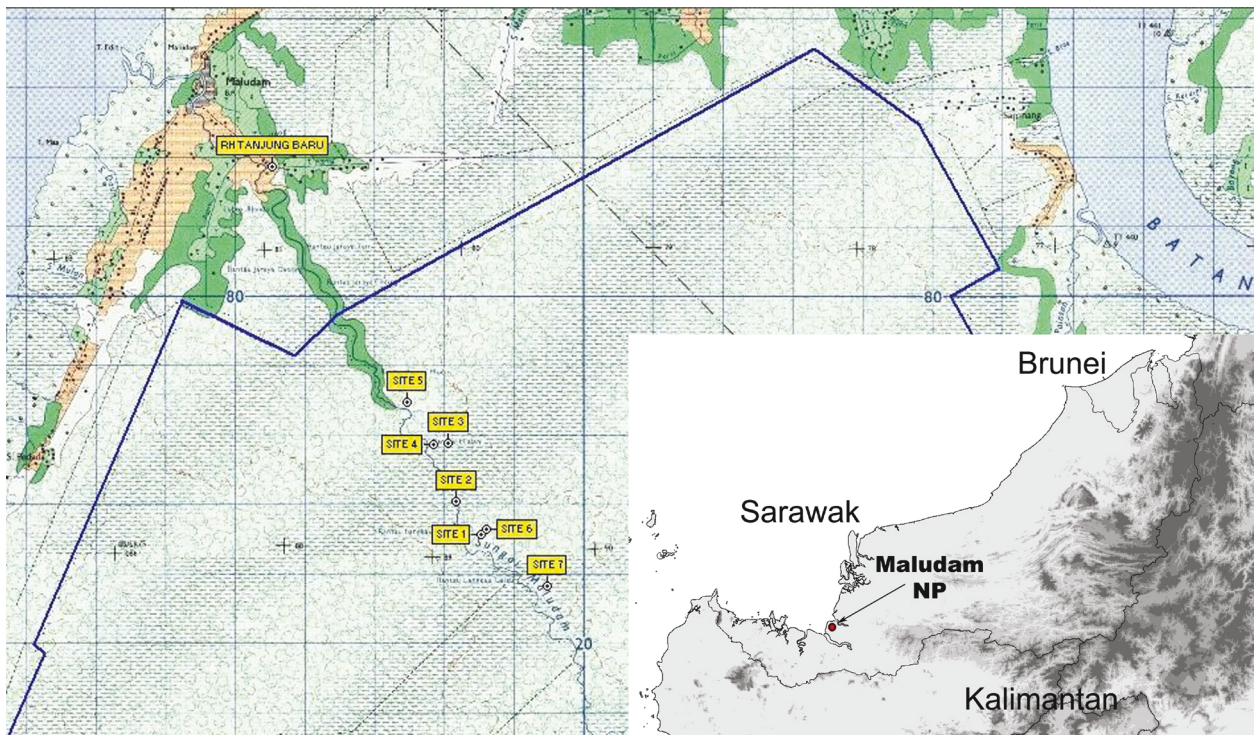


Figure 1. Location of Rumah Tanjong Baru and sampling sites in Maludam National Park.

RESULTS

A total of 48 species from nine families were collected. Material listed is by date then in alphabetical order by collectors' surname. Collectors: WA - Watson anak Asai; RD - Rory Dow; RN - Robin Ngiam. Classification follows Dijkstra et al. (2013) except that the Argiolestidae are recognized following Kalkman & Theischinger (2013) and Dijkstra et al. (2014).

Zygoptera

Argiolestidae

(i) *Podolestes chrysopus* Selys, 1889 (Image 4) — The only recent records of this species are from western Sarawak (Dow & Reels 2011; Dow 2012). It is otherwise known from locations in northwestern Kalimantan (Selys 1889; Lieftinck 1935); a record from Brunei (Thompson & van Tol 1993) in fact refers to misidentified *P. harrissoni* and that from Labuan in Selys (1889) is likely to be one



Image 4. *Podolestes chrysopus* (male). This is a peat swamp specialist and is found at only two other unprotected sites in Sarawak.



Image 5. *Podolestes* new species (female).

of many cases where specimens were labelled according to the port from which they were sent back to Europe rather than collecting site. 4 males, 6.vii.2012, RD; 5 males, 7.vii.2012, RD; 1 male, 7.vii.2012, RN; 1 male, 1 female, 8.vii.2012, WA; 3 males, 1 female, 8.vii.2012, RN; 1 female, 9.vii.2012, WA; 1 male, 9.vii.2012, RD; 1 male, 9.vii.2012, RN; 1 female, 10.vii.2012, WA; 1 male, 1 female, 10.vii.2012, RD; 1 female, 10.vii.2012, RN; 1 male, 11.vii.2012, RD; 2 males, 11.vii.2012, RN.

(ii) *Podolestes harrissoni* Lieftinck, 1953 — Widely distributed across Sarawak and Brunei, but confined to peat swamp forest. 1 male, 6.vii.2012, RD; 9 males, 1 female, 7.vii.2012, RD; 3 males, 7.vii.2012, RN; 1 male, 9.vii.2012, WA; 1 male, 1 female, 9.vii.2012, RN; 1 male, 10.vii.2012, RD.

(iii) *Podolestes orientalis* Selys, 1862 — The most eurytopic and widespread of the *Podolestes* species, found in a variety of swampy situations. 1 female, 6.vii.2012, RN; 1 female, 7.vii.2012, RD; 2 males, 7.vii.2012, RN; 1 male, 10.vii.2012, RD.

(iv) *Podolestes* new species (Image 5) — Possibly the smallest *Podolestes* species known. Females were found perched at waist height in closed canopy forest without nearby free water. The sole male found was perched in a small hole dug into the damp peat, presumably by a Bearded Pig *Sus barbatus*, without free water; when disturbed it flew away but returned a few minutes later, and acted as if it was holding a territory at the hole. Water was only found ca. 15cm below the bottom of the hole. 2 females, 7.vii.2012, RD; 1 male, 10.vii.2012, RD.

Chlorocyphidae

(i) *Libellago hyalina* (Selys, 1859) — 2 males, 1 female, 6.vii.2012, RD; 1 male, 6.vii.2012, RN; 1 male, 1

female, 7.vii.2012, RD; 1 male, 7.vii.2012, RN; 1 female, 8.vii.2012, WA; 2 males, 9.vii.2012, WA; 2 males, 9.vii.2012, RD; 1 female, 10.vii.2012, WA; 1 male, 1 female, 11.vii.2012, RN.

(ii) *Pachycypha aurea* Lieftinck, 1950 — Maludam National Park is the second site in Sarawak where this poorly known species has been found, the other is a non-protected site near Kuching (Dow & Reels 2011); it is otherwise known from central Kalimantan. 1 male, 7.vii.2012, RN.

Platycnemididae

(i) *Coeliccia* species — The status of the *Coeliccia* species found at Maludam is still under investigation; it may merely be the widespread *C. nigrohamata* Laidlaw, 1918, which it closely resembles, but *C. nigrohamata* is not normally found in peat swamp forest. 1 male, 7.vii.2012, RD; 1 male, 9.vii.2012, RN; 1 male, 1 female, 10.vii.2012, RD.

(ii) “*Elattoneura*” *aurantiaca* (Selys, 1886) (Image 6) — See Dijkstra et al. (2014) for a discussion of Asian “*Elattoneura*”. 6 males, 1 female, 6.vii.2012, RD; 2 males, 6.vii.2012, RN; 1 male, 1 female, 7.vii.2012, RD; 2 males, 1 female, 7.vii.2012, RN; 1 female, 8.vii.2012, WA; 2 males, 1 female, 9.vii.2012, WA; 3 males, 1 female, 9.vii.2012, RD; 2 males, 9.vii.2012, RN; 1 male, 10.vii.2012, RN; 2 males, 1 female, 11.vii.2012, WA; 1 male, 2 females, 11.vi.2012, RN.

(iii) *Onychargia atrocyana* (Selys, 1865) — *Onychargia* was formerly placed in the Coenagrionidae, see Dijkstra et al. (2014). 1 male, 9.vii.2012, RD.

(iv) *Prodasineura yulan* Dow & Ngiam, 2013 — See Dow & Ngiam (2013).



Image 6. "*Elattoneura*" *aurantiaca* (male).

Coenagrionidae

(i) *Amphicnemis annae* Lieftinck, 1940 — A peat swamp forest specialist, widely distributed in north-western Kalimantan, Sarawak and Brunei. 3 males, 1 female, 6.vii.2012, RD; 1 male, 3 females, 7.vii.2012, RD; 1 female, 9.vii.2012, RN; 3 males, 2 females, 10.vii.2012, RD; 1 male, 1 female, 10.vii.2012, RN; 1 male, 11.vii.2012, RD.

(ii) *Amphicnemis wallacii* Selys, 1863 — 1 male, 6.vii.2012, RD; 1 male, 9.vii.2012, WA; 1 male, 2 females, 9.vii.2012, RD; 1 male, 1 female, 9.vii.2012, RN; 3 males, 1 female, 10.vii.2012, RD; 1 male, 10.vii.2012, RN.

(iii) *Amphicnemis* species cf *dactylostyla* Lieftinck, 1953 — The status of forms allied to *A. dactylostyla* and *A. martini* Ris, 1911 in Sarawak is the subject of an ongoing investigation. 3 males, 7.vii.2012, RD.

(iv) *Archibasis melanocyana* (Selys, 1877) — Abundant on stretches of Ulu Maludam. 1 male, 6.vii.2012, RD; 1 male, 6.vii.2012, RN; 3 males, 10.vii.2012, RD; 5 males, 1 female, 11.vii.2012, WA; 11 males, 11.vii.2012, RN.

(v) *Archibasis viola* Lieftinck, 1949 — 1 male, 6.vii.2012, RD; 1 male, 7.vii.2012, RD; 2 males, 1 female, 10.vii.2012, RD; 1 male, 10.vii.2012, RN.

(vi) *Ceriagrion cerinorubellum* (Brauer, 1865) — 1 male, 6.vii.2012, RN; 1 female, 8.vii.2012, RN; 1 male, 9.vii.2012, RD; 1 male, 1 female, 9.vii.2012, RN; 2 males, 10.vii.2012, WA; 1 male, 1 female (in tandem), 10.vii.2012, RN.

(vii) *Ceriagrion* new species — A species that closely resembles *C. cerinorubellum*, differing in the almost entirely red abdomen and details of the anal appendages. Since its discovery at Maludam it has also been found at two sites in Brunei (Ngiam, Dow & Choong in preparation). It appears to be a specialist of peat swamp and kerapas (intermediate between peat

swamp and kerangas) forest. 1 male, 6.vii.2012, RD; 3 males, 7.vii.2012, RN; 2 males, 1 female(?), 8.vii.2012, RN; 1 male, 9.vii.2012, RD; 1 male, 10.vii.2012, WA; 2 males, 10.vii.2012, RD; 1 male, 10.vii.2012, RN.

(viii) *Ischnura senegalensis* (Rambur, 1842) — 1 male, 10.vii.2012, RD.

(ix) *Mortonagrion indraneil* Dow, 2011 — Like *Podolestes harrisoni*, this species is widely distributed in Sarawak and Brunei, but is confined to peat swamp forest. 1 male, 6.vii.2012, RD; 3 males, 2 females, 7.vii.2012, RD; 1 male, 7.vii.2012, RN; 1 male, 8.vii.2012, WA; 1 male, 9.vii.2012, RD; 1 female, 9.vii.2012, RN; 2 males, 1 female, 10.vii.2012, RD; 1 female, 10.vii.2012, RN.

(x) *Pseudagrion coomansi* Lieftinck, 1937 — 1 male, 6.vii.2012, RD; 1 male, 7.vii.2012, RD; 1 male, 10.vii.2012, RD; 1 female, 11.vii.2012, WA; 4 males, 1 female, 11.vii.2012, RN.

(xi) *Pseudagrion microcephalum* (Rambur, 1842) — 1 male, 6.vii.2012, RD; 1 male, 6.vii.2012, RN; 1 male, 10.vii.2012, RD.

Anisoptera

Aeshnidae

(i) *Gynacantha dohrni* Krüger, 1899 — 1 male, 7.vii.2012, RD.

(ii) *Heliaeschna idae* (Brauer, 1865) — This large species was abundant during the sampling period. It is typically regarded as a crepuscular species, but at Maludam it was observed flying all day, even in bright sunlight in parts of the forest where the canopy had been opened extensively by past logging activities. 1 male, 7.vii.2012, RD; 1 male, 7.vii.2012, RN; 1 male, 8.vii.2012, RN; 1 male, 9.vii.2012, RD; 1 male, 1 female, 10.vii.2012, WA; 1 male, 1 female (in tandem), 10.vii.2012, RD; 1 male, 10.vii.2012, RN.

(iii) *Oligoaeschna foliacea* Lieftinck, 1968 — 1 male, 2 females, 11.vii.2012, RD.

(iv) *Tetracanthagyna plagiata* (Waterhouse, 1877) — 1 female, 9.vii.2012, RD.

Gomphidae

(i) *Ictinogomphus acutus* (Laidlaw, 1914) (Image 7) — 4 males, 2 females, 6.vii.2012, RD; 2 males, 6.vii.2012, RN; 1 male, 7.vii.2012, RD; 2 males, 7.vii.2012, RN; 1 female, 9.vii.2012, RN; 1 male, 11.vii.2012, WA; 2 males, 11.vii.2012, RN.

(ii) *Ictinogomphus decoratus melaenops* (Selys, 1858) — 1 male, 7.vii.2012, RN; 1 male, 9.vii.2010, RD.

(iii) *Macrogomphus decemlineatus* (Selys, 1878) — We are not aware of any published record of this



Image 7. *Ictinogomphus acutus* (male). It was very abundant along Sungai Maludam.



Image 8. *Brachygonia ophelia* (female). This is the first record of the species in Sarawak since 1910.

species having been collected in Sarawak since that in Laidlaw (1914) of two males collected from “Kuching” in May 1896. The species is known from Borneo, Sumatra, Belitung and peninsular Malaysia, but is seldom recorded. 2 males, 6.vii.2012, RD.

Macromiidae

(i) *Macromia cincta* Rambur, 1842 — 1 male, 9.vii.2012, RN; 1 male, 10.vii.2012, WA; 1 male, 10.vii.2012, RD.

Corduliidae

(i) *Hemicordulia tenera* Lieftinck, 1930 — 1 male, 6.vii.2012, RD; 2 males, 7.vii.2012, RD; 5 males, 1 female (in tandem), 7.vii.2012, RN; 1 male, 8.vii.2012, WA; 1 male, 9.vii.2012, RN; 6 males, 10.vii.2012, WA; 1 male, 10.vii.2012, RN; 1 male, 11.vii.2012, RD.

Libellulidae

(i) *Brachygonia oculata* (Brauer, 1878) — 1 male, 6.vii.2012, RD; 1 male, 1 female, 6.vii.2012, RN; 1 male, 7.vii.2012, RD; 1 male, 1 female, 7.vii.2012, RN; 2 males, 2 females, 8.vii.2012, WA; 1 male, 8.vii.2012, RN; 3 females, 9.vii.2012, WA; 1 male, 9.vii.2012, WA; 1 female, 9.vii.2012, RN; 1 male, 2 females, 10.vii.2012, WA; 1 male, 10.vii.2012, RN; 1 female, 11.vii.2012, WA.

(ii) *Brachygonia ophelia* Ris, 1910 (Image 8) — The last published record of this species from Sarawak was made in Kuching Division in 1910 (Laidlaw 1920), making this the first record of the species from the state for more than 100 years. It is a locally occurring specialist of low pH swamp forest, known to occur across Borneo and in peninsular Malaysia, but with very few records. 1 male, 9.vii.2012, RN; 1 female, 11.vii.2012, RN.

(iii) *Brachygonia puella* Lieftinck, 1937 — Maludam

National Park is the second site in Sarawak where this poorly known species has been found; the other site is Binyo Penyilam proposed national park in Bintulu Division (Dow & Unggang 2010). It is also known from Kalimantan Tengah and Belitung. 3 males, 6.vii.2012, RD; 2 males, 6.vii.2012, RN; 2 males, 8.vii.2012, WA; 2 males, 8.vii.2012, RN; 1 male, 9.vii.2012, WA; 2 males, 10.vii.2012, WA; 1 male, 10.vii.2012, RD.

(iv) *Chalybeothemis fluviatilis* Lieftinck, 1933 — 2 males, 6.vii.2012, RD; 2 males, 6.vii.2012, RN; 1 male, 10.vii.2012, RD; 1 male, 11.vii.2012, RD; 3 males, 11.vii.2012, RN.

(v) *Nannophya pygmaea* Rambur, 1842 — 1 male, 6.vii.2012, RD; 1 male, 6.vii.2012, RN; 2 males, 10.vii.2012, WA.

(vi) *Neurothemis fluctuans* (Fabricius, 1793) — 1 male, 11.vii.2012, RD.

(vii) *Orchithemis pruinans* (Selys, 1878) — 1 male, 10.vii.2012, RN.

(viii) *Orchithemis pulcherrima* Brauer, 1878 — 1 male, 10.vii.2012, RN.

(ix) *Orchithemis xanthosoma* Laidlaw, 1911 — 2 males, 1 female, 7.vii.2012, RD; 3 males, 7.vii.2012, RN; 1 male, 8.vii.2012, WA; 1 male, 9.vii.2012, RD; 1 male, 9.vii.2012, RN; 1 male, 10.vii.2012, RD; 1 male, 11.vii.2012, RN.

(x) *Orthetrum chrysis* (Selys, 1891) — 1 male, 8.vii.2012, WA;

(xi) *Orthetrum sabina* (Drury, 1773) — 1 male, 6.vii.2012, RN.

(xii) *Pornothemis serrata* Krüger, 1902 — 1 male, 6.vii.2012, RD; 2 males, 6.vii.2012, RN; 1 female, 7.vii.2012, RD; 1 male, 9.vii.2012, RD; 1 male, 10.vii.2012, RD.

(xiii) *Rhodothemis rufa* (Rambur, 1842) — 1 male,

7.vii.2012, RN.

(xiv) *Rhyothemis fulgens* Kirby, 1889 — This species was treated as a junior synonym of *R. pygmaea* (Brauer, 1867) by Ris (1913), a course followed by almost all subsequent authors, but is clearly distinct from true *R. pygmaea*, differing substantially in the male anal appendages; it appears that *R. pygmaea* occurs east of the Wallace line and that all records from west of the Wallace line actually refer to *R. fulgens*. This subject will be treated in detail elsewhere (Dow in preparation). 1 male, 6.vii.2012, RN; 1 male, 1 female (in tandem), 7.vii.2012, RN; 1 male, 10.vii.2012, RN.

(xv) *Rhyothemis obsolescens* Kirby, 1889 — 1 male, 6.vii.2012, RD.

(xvi) *Tyriobapta laidlawi* Ris, 1919 — 3 males, 6.vii.2012, RD; 1 male, 6.vii.2012, RN; 1 male, 7.vii.2012, RD; 1 male, 7.vii.2012, RN; 2 males, 8.vii.2012, WA; 1 male, 9.vii.2012, WA; 2 males, 1 female, 9.vii.2012, RD; 1 male, 9.vii.2012, RN; 1 male, 1 female, 10.vii.2012, WA; 2 males, 10.vii.2012, RD; 1 male, 10.vii.2012, RN; 2 males, 11.vii.2012, WA.

(xvii) *Urothemis signata insignata* (Selys, 1872) — 2 males, 1 female, 6.vii.2012, RD; 1 female, 6.vii.2012, RN; 1 male, 8.vii.2012, WA; 1 male, 11.vii.2012, WA; 1 male, 11.vii.2012, RN.

(xviii) *Zygomma petiolatum* Rambur, 1842 — 1 male, 9.vii.2012, RN; 1 male, 10.vii.2012, RD.

DISCUSSION

The results from this first Odonata collection in Maludam National Park are very encouraging, the 48 species recorded offer a snapshot of the diversity present in the park; further surveys will surely uncover additional species. With a number of rare and specialist species, including three previously unknown to science, it is already clear that Maludam National Park is an important area for odonate conservation and research in northern Borneo. One of the new species has already been described in Dow & Ngiam (2013). Only a single male specimen of this species, *Prodasineura yulan*, was collected. Description of the other two new species (*Podolestes* new species cf. *atomarius* and *Ceriagrion* new species) is in preparation. Besides the new species found, other important records were also made, including only the second record in Sarawak for *Pachycypha aurea* and *Brachygonia puella*, and the first record in Sarawak for over 100 years for *Macrogomphus decemlineatus* and *Brachygonia ophelia*. Due to time constraints and low water levels, the upper reaches of Ulu Maludam, where there are more pristine forest areas, were not explored; this is a priority area for future work.

Species collected at Maludam National Park and considered to be worthy of special attention from a conservation viewpoint, at least in Sarawak, are summarised in Table 1. For explanation of terms such as Data Deficient, Area of Occurrence etc., see

Table 1. Species collected in Maludam National Park in 2012 and potentially of conservation concern either within Sarawak, or globally.

Species	Conservation concern
<i>Pachycypha aurea</i>	Only one other, non-protected, site is known in Sarawak for this species. Outside of Sarawak it is only currently known from a few sites in Kalimantan Tengah.
<i>Podolestes</i> new species cf. <i>atomarius</i>	Only known from Maludam National Park.
<i>Podolestes harrissoni</i>	A peat swamp forest specialist species whose Extent of Occurrence has been seriously reduced.
<i>Podolestes chrysopus</i>	Only two other sites in Sarawak are known for this species; both are non-protected. Outside of Sarawak it is only known from old records from north-western Kalimantan.
<i>Amphicnemis annae</i>	A peat swamp forest specialist species whose Extent of Occurrence has been seriously reduced.
<i>Ceriagrion</i> new species	Only known from Maludam National Park and two sites in Brunei.
<i>Mortonagrion indraneil</i>	A peat swamp forest specialist species whose Extent of Occurrence has been seriously reduced.
<i>Prodasineura yulan</i>	Only known from Maludam National Park.
<i>Ictinogomphus acutus</i>	Currently listed as Near Threatened on the IUCN Red List, because of specialized habitat and a declining extent of occurrence
<i>Macrogomphus decemlineatus</i>	Maludam National Park is the only location in Sarawak from which this species is currently known.
<i>Brachygonia ophelia</i>	Currently assessed as Data Deficient for the IUCN Red List, but likely to be re-assessed in a higher threat category as an extremely local low pH swamp forest specialist species. In Sarawak only currently known from Maludam National Park.
<i>Brachygonia puella</i>	Within Sarawak only one other site in is currently known for this species.

IUCN (2012). There is still insufficient data to make concrete statements about the rarity or otherwise of many odonate species in Sarawak. However, any peat swamp forest specialist species confined to Borneo can be reasonably assumed to be of serious conservation concern, as peat swamp forest is undoubtedly an extremely threatened forest type in South-east Asia, known to have undergone a serious and continuing decline in its extent, and in the quality of what remains (e.g. Wong 2013, Posa et al. 2011); probably the only truly pristine peat swamp habitats remaining on the island are in Brunei. Moreover, as very little peat swamp forest is protected in Sarawak, peat swamp specialist species occurring in the state have few secure refuges and are of significant conservation concern.

There are relatively few publications dealing specifically with the Odonata of peat swamp forest and other low pH swamp forest formations in Borneo. Orr (2001) includes records from peat swamp forest in Belait district of western Brunei, as do Thompson & van Tol (1993). Considerable extra data from peat swamp forest in northern Belait District was generated in 2013 as part of the Belait Biodiversity Action Plan project (Dow & Choong unpublished); this data will be published in due course. Dow & Silvius (2014) deals with the peat swamp forests of Central Kalimantan, Indonesian Borneo; many records in Lieftinck (1953a,b) must actually be from similar habitat, but details are lacking. Yagi & Kitagawa (2001) presented records from degraded peat swamp forest in the Klias peninsula on the west coast of Sabah. For Sarawak, Dow & Unggang (2010) discussed the odonate fauna of low pH swamp forest at Binyo Penyilam in Bintulu Division, Dow & Reels (2011) presented records from a peat swamp forest remnant in Kuching Division, and Dow & Reels (2013) includes records from Sama Jaya Nature Reserve in Kuching Division (where the habitat may be best characterized as *kerapa* – intermediate between peat swamp and *kerangas* forest), from peat swamp forest at the Universiti Malaysia Sarawak campus in Samarahan Division, and a few records from extremely disturbed peat swamp forest from the Simunjan area further west in the same administrative division. As-yet-unpublished data is also available from Loagan Bunut National Park in Miri Division, and from highly disturbed peat swamp forest habitats in the vicinity of Marudi in the lower Baram area of the same division. In Sundaland outside of Borneo substantial areas of peat swamp forest occur in Sumatra and, to a lesser extent, in peninsular Malaysia; for these areas even less data is available. We are not aware of any publications dealing specifically

with peat swamp forest Odonata from Sumatra or its satellite islands; although some records from Sumatra and Belitung must be from peat swamp forest, but details of habitat are lacking from most records. From peninsular Malaysia data from peat swamp forest can be found in Choong & Cheah (2013: Ayer Hitam in Johor), Dow et al. (2010, 2012: the Sungai Bebar area in Pahang) and Norma Rashid et al. (2001: Tasek Bera in Pahang; most records in this publication appear to be from open habitats around the margin of the lake Tasek Bera rather than from within the peat swamp forest that borders part of the lake).

Although there is an urgent need for far more data from the remaining peat swamp forest areas of Borneo, sufficient data is now available to make some preliminary observations about the specialist odonate fauna of peat swamp forest of different parts of the island.

For Anisoptera the available data suggests that many of the specialist species have relatively large ranges, some even extending beyond Borneo. However some of the more widely distributed species, perhaps most notably *Brachygonia ophelia*, are extremely local in occurrence. We are not aware of any specialist anisopteran species confined to peat swamp forest in just one part of Borneo. However it should be noted that many species from the families Aeshnidae, Gomphidae, Macromiidae and Corduliidae are so difficult to sample in Borneo that it is entirely possible that some restricted range peat swamp specialists have not yet been detected.

For the more weakly flying Zygoptera the situation is very different. In genera generally recognized as having many swamp forest specialist species, e.g., *Podolestes*, *Amphicnemis* and *Mortonagrion*, all the peat swamp specialist species found in Borneo are endemic to the island. Additionally the available evidence suggests that a number of the Bornean Platycnemididae formerly placed in Protoneuridae, e.g., members of *Elattoneura* sensu lato and *Prodasineura*, are specialists of low pH streams; of these only "*Elattoneura*" (sic) *aurantiaca* and "*Elattoneura*" (sic) *coomansi* Lieftinck, 1937 are known to occur outside of Borneo.

Within Borneo many of the peat swamp specialist Zygoptera appear to have restricted ranges. Most of the Zygoptera known or believed likely to be peat swamp or other low pH swamp forest specialists occurring in Central Kalimantan appear to be confined to the peat lands of southern Borneo (See Dow & Silvius (2014) and Dow (2014): *Podolestes atomarius* Lieftinck, 1950; *P. furcifer* Lieftinck, 1950; *Coeliccia* new species; "*Elattoneura*" *erythromma* Lieftinck, 1953; *Prodasineura abbreviata* Lieftinck, 1951; *P. quadristigma* Lieftinck,

1951; *Prodasineura* new species; *Amphicnemis erminea* Lieftinck, 1953; *A. pandanicola* Lieftinck, 1953; *A. platystyla* Lieftinck, 1953; *Amphicnemis triplex* Dow, 2014 and an as-yet-un-named *Amphicnemis* species). As these low lying areas are almost isolated from similar habitats in other parts of the island by extensive mountain ranges, the high degree of endemism to the region may not be surprising. However even in northern Borneo, many peat swamp specialist species appear to have small ranges. *Amphicnemis madelena* Laidlaw, 1913 is only known from northwestern Kalimantan (Lieftinck 1954) and Kuching Division in Sarawak (e.g., Dow & Reels 2011, 2013). The status of a number of forms allied to *A. martini* Ris, 1911 is unclear, but some may be distinct species with small ranges; at least one of these is a peat swamp specialist. An unnamed peat swamp species of *Coeliccia* known from two sites in Kuching and Samarahan divisions (Dow & Reels 2011, 2013) has not been found at Maludam or further east, while *Coeliccia macrostigma* Laidlaw, 1918 is a peat swamp forest specialist only known from the lower Baram area (where virtually no suitable habitat remains) and Belait District in Brunei. Two of the new species found at Maludam (*Podolestes* new species and *Prodasineura yulan*) have not been found anywhere else. *Podolestes chrysopus* is only reliably known from north-west Kalimantan and Sarawak as far east as Maludam. However, *Pachycypha aurea*, which is a peat swamp forest specialist, appears to have a wide distribution from Kalimantan Tengah to western Sarawak. We can tentatively conclude that there is a “hot spot” for peat swamp Zygoptera endemism and diversity in southern Kalimantan and possibly another in northwestern Kalimantan and southwestern Sarawak. What appears certain is that additional peat swamp specialist species remain undiscovered in the many poorly sampled parts of the lowlands of Borneo. As very little peat swamp forest has totally protected status in Borneo, many of the peat swamp specialist Odonata face an uncertain future.

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