IDF

Faunistic Studies in South-east Asian and Pacific Island Odonata

A Journal of the International Dragonfly Fund

1- 60

Milen Marinov, Sholeh Hanser, Ann Kitalong, Heather Ketebengang, Reagan Joseph Villanueva, Mamoru Terayama, Dan Polhemus, Coen Ruluked, Albert Naito Soaladaob, Niro Nobert, Crile Doscher, Lomalinda Gabriel, Rocky Orrakl Benedict, Hasinta Dil'Mesiich Idechong

A contribution to the study of the Odonata fauna of Palau (Insecta: Odonata)

published 19.02.2026

No. 50

ISSN 2195-4534

The International Dragonfly Fund (IDF) is a scientific society founded in 1996 for the improvement of odonatological knowledge and the protection of species.
Internet: http://www.dragonflyfund.org/

This series intends to contribute to the knowledge of the regional Odonata fauna of the Southeastern Asian and Pacific regions to facilitate cost-efficient and rapid dissemination of faunistic data.

Southeast Asia or Southeastern Asia is a subregion of Asia, consisting of the countries that are geographically south of China, east of India, west of New Guinea and north of Australia. Southeast Asia consists of two geographic regions: Mainland Southeast Asia (Indochina) and Maritime Southeast Asia.

Pacific Islands comprise of Micronesian, Melanesian and Polynesian Islands.

Editorial Work:	Martin Schorr, Milen Marinov, Holger Hunger and Rory Dow
Layout:	Martin Schorr
IDF-home page:	Holger Hunger
Printing:	Colour Connection GmbH, Frankfurt
Impressum:	Publisher: International Dragonfly Fund e.V., Schulstr. 7B, 54314 Zerf, Germany. E-mail: oestlap@online.de
Responsible editor:	Martin Schorr
Cover picture:	*Teinobasis palauensis*
Photographer:	Milen Marinov

Published 19.02.2026

A contribution to the study of the Odonata fauna of Palau (Insecta: Odonata)

Milen Marinov[1], Sholeh Hanser[2], Ann Kitalong[3], Heather Ketebengang[4], Reagan Joseph Villanueva[5], Mamoru Terayama[6], Dan Polhemus[7], Coen Ruluked[8], Albert Naito Soaladaob[9], Niro Nobert[10], Crile Doscher[11], Lomalinda Gabriel[12], Rocky Orrakl Benedict[13], Hasinta Dil'Mesiich Idechong[14]

[1] National Museum of Natural History, Bulgarian Academy of Sciences Tsar Osvoboditel Blvd. 1, 1000 Sofia, Bulgaria. Email: mg_marinov@yahoo.com

[2] Herbarium Manager, Natural History Section, Belau National Museum, P.O. Box 666, Koror, Republic of Palau. Email: shanser@gmail.com

[3] Natural History Manager, Natural History Section, Belau National Museum, P.O. Box 666, Koror, Republic of Palau. Email: kitalongann@gmail.com

[4] Program Manager, Palau Conservation Society, PO Box 1811, Koror, Republic of Palau. Email: hketebengang@palauconservation.org

[5] College of Medicine, Jose Maria College Foundation, Inc. Philippine-Japan Friendship Highway, Davao City, 8000 Davao del Sur, Philippines. Email: rjtvillanueva@gmail.com

[6] Graduate School of Science, Tokyo Metropolitan University, 1-1 Minami-osawa, Hachioji, Tokyo 192-0397, Japan. Email: terayama@fa2.so-net.ne.jp

[7] Department of Natural Sciences, Bishop Museum, Honolulu, HI 96817 USA. Email: bugman@bishopmuseum.org

[8] Environmental & Marine Science Major, Palau Community College, P.O. Box 9, Koror, Republic of Palau. Email: coconutcoen@gmail.com

[9] Local Plant Expert, Natural History Section, Belau National Museum, P.O. Box 666, Koror, Republic of Palau

[10] Research Assistant, Natural History Section, Belau National Museum, P.O Box 666, Koror, Republic of Palau. Email: nironobert@gmail.com

[11] Waterways Centre for Freshwater Management, Lincoln University, PO Box 84, Canterbury, New Zealand. Email: Crile.Doscher@lincoln.ac.nz

[12] lomalindg654@gmail.com

[13] Orraklben26@gmail.com

[14] Project Palau Center for Healthy Lifestyle. Email: idechongb@gmail.com

Abstract

The Odonata fauna of Palau is reviewed based on all published records and new data collected during the last 25 years. The list of scientific names of taxa is updated and analysed. At least two new taxa at generic level are added based on females which could not be associated with any of the males so far reported for Palau: *Pericnemis* (?) Selys, 1863 proposed as a provisional scientific name for two females which were found to be closer to congenors from the Philippines, and *Gynacantha* Rambur, 1842 based on one

female. The updated faunistic list is accompanied by photos of live individuals and diagnostic photos of specimens of all presently known members of the included taxa. Priorities in faunistic and taxonomic studies are suggested, with a focus on phenology and habitat requirements, especially of the Palau endemics *Pseudagrion palauense* Lieftinck, 1962; *Teinobasis palauensis* Lieftinck, 1962; *Drepanosticta palauensis* Lieftinck, 1962 and *Agrionoptera cardinalis* Lieftinck, 1962. The latter is discussed in the faunistic account, with description of the exuvia (by supposition) which is proposed for first time. The three other endemics are illustrated with detailed photos of diagnostic features. Short biogeographic notes are included as well, highlighting the significance of the islands within the Republic of Palau.

Abstract in Palauan

A Odonata, el chemaeong ma ikel ua teletelel el charm, ra chelsel Belau a ulecholt ra llechukl el babier ma beches el omesubel ra lluich ma eim el rak el mer chelechang. Ngultuil ra ikal mla mo merek el omesuub eng mla meteriter e mekedmokl el mukbeches a ngklel aikal charm luldimukl er ngii a dmolch el omesodel ma llecheklel. Kesengil eng teblo ra ikal chemaeong a mlodak lultuil ra ikel redil el chamaeong el dimlak el sebechel el mokesiu ra ikel sechal el chamaeong el mla meues ra chelsel Belau: *Pericnemis* (?) Selys, 1863, a mlodars ra diak lulterkokl el ngakl lultuil ra teblong el redil el chemaeong el mo kmeed el ua aikel chamaeong ra Phillipines, ma *Gynacantha* Rambur, 1842 el ultuil ra di chimol redil chemaeong.

A beches el llecheklel aikal charm a ulecholt lobengkel a siasing ra ngar el chemaeong ma siasing ra chedechedelel a omesubel aikal kakerous el chemaeong ma ikel rokui el mla mesuub el bebil ra bedengel a chemaeong. Sel kmal klou a ultutelel el kirel omesubel a charm ma bingel el mora kleblillel a bekbedengel a charm a ultuil ra sim ra charm ma dellomel, ma eolt, ma chull, ma temel a buil, ma lmuut el bebil ra kabekbuk el tekoi, el luldimukl ra ikel basio el lousbech el kiei e osiik a kelel er ngii, tokubets aikal mal di chermel Belau el *Pseudagrion palauense* Lieftinck, 1962; *Teinobasis palauensis* Lieftinck, 1962; *Drepanosticta palauensis* Lieftinck, 1962 ma *Agrionoptera cardinalis* Lieftinck, 1962. A mui el omesodel ngkel mlo ulebongel el chemaeong er tial babier, a mo uldimukl a teletelel a lolengui ma basio el de betik er ngii, el ngii a dirkak a tal lemesuub. Ea ikel keldei el chemaeong el kmal di de betik er Belau a mlucholt a llecheklel lokiu a dmolech el omesodel a chedechedelel.

A kedeb el omesodel a basio el de betik a charm ma dellomel er ngii ma telengtengil a uchul me ke de metik ra ikal basio a uldimukl er tial babier. Ng dirrek el mo smodii a uchul meng klou a ultutelel aikal iungs ra beluu ra Belau.

Key words: endemics, *Pseudagrion palauense, Teinobasis palauensis, Drepanosticta palauensis, Agrionoptera cardinalis*, description of exuvia, fauna, taxonomy.

Introduction

The Odonata of Palau have been targeted in several studies carried out mainly by Japanese researchers and also referred to in investigations on Micronesian islands as well (all reviewed below). Table 1 presents a checklist of the Odonata species currently known from Palau, with the newly recorded taxa marked with an "*" (for more on the methodology see Material and Methods).

Hagen (1867) erected the genus *Rhyothemis* for some taxa that at time had already been transferred from genus *Libellula* Linnaeus, 1758 to *Celithemis* Hagen, 1861. This taxonomic rearrangement is not discussed in here because of some nomenclatural uncertainties.

Table I. Chronological literature review of Odonata records from the Republic of Palau.

No	Verbatim species	Valid species name	Verbatim locality	Page	Reference
1	*Rhyothemis vitellina* Brau.	*Rhyothemis variegata* (Linnaeus, 1753)	Pelewinseln	184	Brauer (1868a)
2	*Neurothemis fluctuans*	*Neurothemis terminata* Ris, 1911	Pellew-Inseln	10	Brauer (1869)
3	*D. bipunctata*	*Diplacodes bipunctata* (Brauer, 1865)	Palau	471	Ris (1911)
4	*Anax guttatus* Burm.	*Anax guttatus* (Burmeister, 1839)	Palau	63	Ris (1916)
5	*Anaciaeschna jaspidea* Burmeister	*Anaciaeschna jaspidea* (Burmeister, 1839)	Palaus	2	Asahina (1940)
6	*Hemicordulia lulico* sp. nov.	*Hemicordulia lulico* Asahina, 1940	Palau	5	Asahina (1940)
7	*Agrionoptera insignis* Rambur	*Agrionoptera cardinalis* Lieftinck, 1962*	Palaus	13	Asahina (1940)
8	*Orthetrum sabina* Drury	*Orthetrum serapia* Watson, 1984	Tokobei, Palaus	15	Asahina (1940)
9	*Diplacodes trivialis* Rambur	*Diplacodes trivialis* (Rambur, 1842)	Tokobei, Palaus	16	Asahina (1940)
10	*Tholymis tillarga* Fabricius	*Tholymis tillarga* (Fabricius, 1798)	Koror, Palaus	18	Asahina (1940)
11	*Zyxomma petiolatum* Rambur	*Zyxomma petiolatum* Rambur, 1842	Koror, Palaus	19	Asahina (1940)
12	*Pantala flavescens* Fabricius	*Pantala flavescens* (Fabricius, 1798)	Tokobei, Palaus	19	Asahina (1940)
13	*Tramea limbata* Desjardins	*Tramea transmarina* Brauer, 1867	Peliliou, Babel-daob, Palaus	19	Asahina (1940)
14	*Drepanosticta palauensis* Lieftinck, n. sp.	*Drepanosticta palauensis* Lieftinck, 1962*	Ngiwal, Babel-thuap, Palau Is.	14	Lieftinck (1962)
15	*Teinobasis palauensis* Lieftinck, n. sp.	*Teinobasis palauensis* Lieftinck, 1962*	Koror I., Palau Is.	21	Lieftinck (1962)
16	*Pseudagrion palauense* Lieftinck, n. sp.	*Pseudagrion palauense* Lieftinck, 1962*	Melekeiok-Ngar-dok Lake, Babel-thuap, Palau	36	Lieftinck (1962)
17	*Ischnura torresiana* Tillyard	*Ischnura heterosticta* (Burmeister, 1839)	Babelthuap	41	Lieftinck (1962)
18	*Agriocnemis femina femina* Brauer	*Agriocnemis femina* (Brauer, 1868)	Palau	43	Lieftinck (1962)
19	*Macrodiplax cora* (Brauer)	*Macrodiplax cora* (Brauer, 1867)	Angaur	94	Lieftinck (1962)
20	*Ishnura senegalensis* (RAMBUR, 1842)	*Ischnura senegalensis* (Rambur, 1842)	Malakal	4	Katatani & Muraki (1997)

For example, one of the taxa was listed as "*R. chryseis* Hag. von den Pellew Inseln" and that should be considered as the first ever record for the country. However, it is not included in Table 1 because the origin of that scientific name and its nomenclatural availability could not be verified. Hagen (1867) cited it in a the way which inferred it was already introduced because there was an author given with it. Brauer (1868b) provided more clarity by citing

"*chryseis* Hg. litt. Pellew-Inseln (verw. m. *splendida*)", which means that Hagen may have mentioned this scientific name in a correspondence to Brauer, hence it was never introduced and should be considered nomen nudum (M. Schorr, per. comm.). Therefore, Brauer (1868a) should be considered the first official Odonata record for Palau (record in Table 1 follows Kosterin et al. 2025; see Material and Methods). He erected *Rhyothemis vitellina* as new to science based on a single female collected by Prof Karl Semper during his visit in the country from March 1862 to late January 1863 (see the translated version of Semper 1873).

Brauer (1868b) proposed five groups within genus *Rhyothemis* with three of the scientific names falling in two groups based on the wing colour pattern: Group (A) "*R. chryseis*" and *R. vitellina*, Group (C) *R. phyllis* (quotation marks to indicate that this is a nomen nudum which will not be used further below).

Brauer (1869) added *Neurothemis fluctuans* (Fabricius, 1793) to Palau based on specimens of both sexes supplied by Mr Custos Schmeltz.

Edmond de Selys Longchamps is the next important contributor to the Odonata fauna of Palau. Selys (1879) analysed members of *Neurothemis* Brauer, 1867 and included the scientific name *Polyneura apicalis* Rambur, 1842 in synonymy of *N. fluctuans*, proposing subspecies affiliation of Palau populations to *N. fluctuans apicalis*.

Selys (1882) reported members of three taxa under the locality name "Palan": *Agrionoptera insignis* (Rambur, 1842), *Diplacodes trivialis* (Rambur, 1842) and *Rhyothemis phyllis* (Sulzer, 1776). Most likely he referred to the island of Palawan in the Philippines, however, his spelling was misinterpreted by Ris (1909-1919) as "Palau" (see the discussion on this topic in Schmidt 1938: 323).

Selys (1891) discussed the members of the genus *Rhyothemis* distributed within SE Asia, New Guinea, the Philippines and some of the Pacific islands. He was the first to propose a possible conspecificity of the members of a range of taxa from within the region and suggested *R. phyllis* as the valid scientific name. *Rhyothemis vitellina*, previously listed for Palau, was also recorded as present in the Philippines. However, downgrading the various *Rhyothemis* taxa to subspecies level under *R. phyllis* was not supported in Kirby (1890), Ris (1900), or Krüger (1902) who regarded *R. vitellina* as a separate from *R. phyllis* (but see the discussion in Krüger 1902: 103). Semper (1905) included another scientific name for Palau, *Rhyothemis fluctuans*, however, its origin is uncertain. Note, that this study was dealing with Lepidoptera of the Caroline islands with *R. fluctuans* as one of the two Odonata collected by his brother (Prof Semper) and identified by F. Brauer (see above). The second odonatan taxon was given as "*Glenurus bicarunculattus*", which Brauer (1868a) included in the antlion family Myrmelionidae; it is not discussed any further here.

Krüger (1903) followed Selys (1879) regarding the affiliation of Palau *Neurothemis*, but referred to them as a separate species *N. apicalis* within the so called *sophronia*-group. This taxonomic discussion and proper nomenclature convention was elaborated further in Ris (1911), who proposed a replacement scientific name *N. terminata* Ris, 1911 (see Seehausen & Dow 2016 for more details).

Friedrich Ris' studies from the beginning of the 20th century were the next important milestone in Odonata studies, having a great impact not only on the Pacific dragonflies, but

also the world fauna. He analysed the collection of Selys and made very significant contributions. Those of particular interest to the fauna of Palau are summarised below.

Ris (1909-1919) referred to *A. insignis* and *D. trivialis* which he thought were collected from Palau and included in Selys (1882), but see the information above. Ris (1911: 471) reported male and female of *Diplacodes bipunctata* (Brauer, 1865) collected by Semper which were not reported in any of the earlier records (see above). Two significant contributions were published too dealing with the following genera: *Neurothemis* (mentioned above) and *Rhyothemis*. The later was analysed based on a large series of specimens and the author accepted the view expressed in Selys (1891) that members of *R. vitellina* should be subsumed as a subspecies of *R. phyllis* (Ris 1913: 941).

Ris (1916) also added *Anax guttatus* (Burmeister, 1839) as a new taxon for Palau.

Schmidt (1938) provided a checklist summarising the information published on the Pacific islands. He critically evaluated the records and included four scientific names in his account which were already reported at this time for Palau (cf. Table 1).

The next two studies in chronological order (Asahina 1940, Lieftinck 1962) are the most significant contributions for the Odonata fauna of Micronesia. They deserve very special treatment for the great attention to details which the authors included in these studies, which have resulted in erecting new taxa from the region. The contributions impress with the detailed morphological descriptions, keys, general distribution records and illustrations of adults and nymphs.

Asahina (1940) considered the Palau Islands as five main islands given as Yap, Palaus s. str. [Babeldaob, Koror, Peleliu] and Tokobei. Records from Yap are not considered here because this island is out of the scope of the present study. Tokobei (or Hatohobei as is presently known) is included because it is the southernmost island within the Republic of Palau. A total of 12 scientific names were added to the list of Odonata taxa of Palau, with members of one of them (*Hemicordulia lulico* Asahina, 1940) endemic to Palau and Yap. A summary of the distribution was also given for the members of each taxon in the Palau fauna, as given below. Note that some of the scientific names in Table 1 have been modified based on the following assumptions:

- *Orthetrum sabina* (Drury, 1773) has been updated as *O. serapia* Watson, 1984
- *Tramea limbata* (Desjardins, 1835) is discussed under *T. transmarina* Brauer, 1867

Lieftinck (1962) added six new scientific names to the Palau fauna with four of them introduced as new to science. Three of the new taxa were proposed based on completely new material in that study, but one (*Agrionoptera cardinalis*) was based on specimens previously collected from the region and assigned to *A. insignis* in various earlier publications (e.g. Ris 1909, 1911; Asahina 1940). The morphological descriptions were illustrated with line drawings of microscopic details as well as habitus of nymphs of members of selected taxa some of which are represented in Palau as well. Keys to imaginal and preimaginal stages are important stepping stone for all who want to familiarise themselves with the Odonata fauna of Micronesia.

The Asahina (1964) study was published on a collection of Odonata made by Mr. Shozo Ishida from the Japanese islands of the Ryukyus. The author erected *Tramea transmarina yayeyamana*, a new taxon at the subspecific level, for the population from Yayeyama

island. He illustrated the wing markings, which were supposed to be the diagnostic character in comparison to other subspecies: *T. t. euryale* Selys, 1878 and *T. t. propinqua* Lieftinck, 1942. Palau is mentioned for the distribution of the former.

In his zoogeographic analysis of the world Odonata fauna, Belyshev (1969) commented on the checklist for Palau, which is almost identical to Table 1, for the taxa known at the time. *Orthetrum serapia* is the only species missing from that zoogeographic review, most likely because it was reported by Asahina (1940) from the small island of Hatohobei which is one of the most remote parts of the Republic of Palau.

Katatani & Muraki (1997, 1999) published results of their Odonata studies on the main Palau islands of Babeldaob, Koror, Malakal and Arakabesang (presently known as Ngerekebesang). They recorded members of 13 taxa, with *Ischnura senegalensis* (Rambur, 1842) reported for the first time for the country. The authors provided numerous illustrations showing the great variability of the posterior end of the abdominal segments of male *I. senegalensis* from Japan, Hong Kong, Thailand and Palau. These studies are important for illustrating the female of *T. palauensis* Lieftinck, 1962 for the first time (Katatani & Muraki.1997: 7, fig. 5), and for the numerous line drawings of thoracic patterns, wing colouration, male secondary genitalia and posterior abdominal appendages of members of genera represented in Palau in comparison to some of their congeners from other parts of the insular Pacific, including Japan.

In another study of Mr. Ishida he paid a special attention to the insects of Palau, focusing mainly on dragonflies and cicadas (Ishida 1998). It was published as a preliminary report of a very thorough investigation on the Odonata fauna as a result of the sampling efforts of several researchers acknowledged in the study. The report presented a list of 18 scientific names for Palau, omitting two (*I. senegalensis* and *O. serapia*) already given for the country (see Table 1). The field survey provided new information on the members of 15 taxa identified to species level from the islands of Babeldaob, Koror, and Ngerekebesang. Ishida (1998) restricted identification of some individuals that were visually sighted on Koror and Malakal to the genus level, such as *Tramea* sp. He also claimed that he may have found a female of a subspecies which is different from *R. p. vitellina* (see relevant sections in the faunistic list below). One final important comment – figure 3 shows a tandem pair of what is identified as *I. torresiana* Tillyard, 1913 (scientific name which is now considered as a junior synonym *I. heterosticta* (Burmeister, 1839)), but the markings on the second abdominal segment of the male resemble more the shape of *I. senegalensis*.

Jordan et al. (2003) included *Pseudagrion palauense* Lieftinck, 1962 from Palau with some other outgroup Coenagrionidae taxa from Fiji, Iran, and USA in their molecular analysis of Hawaiian endemic members of *Megalagrion* McLachlan, 1883.

Palau was included in the extralimital distribution records of representatives of some taxa (already included in Table 1) discussed in an analysis of fauna of the neighbouring island of Yap by Buden & Paulson (2007). This is the first study questioning the correct affiliation of the specimens collected from Hatohobei island and identified as *O. sabina* in Asahina (1940). This topic is discussed more in the faunistic list below.

Van Tol (2009) cited Lieftinck (1962) for the distribution of *Drepanosticta palauensis* Lieftinck, 1962.

Englund (2011) reported on the results from hydrobiological field studies in Palau and

Guam. Odonata were sampled from about 15 localities (some of them represented with multiple sites) on three islands in Palau: Babeldaob, Koror and Malakal. The author provided a very detailed account on the physical characteristics of the freshwater locations visited during the trip, richly illustrated with photos of the general appearance and *in situ* pictures of the live individuals, including so far the only known image of the Palau endemic *P. palauense*. No new scientific names were added to Table 1. However, it must be pointed out that Table 5 lists the members of the taxa recorded from Koror and Malakal and includes *Hemicordulia mindana* Needham & Gyger, 1937. However, it is not ticked off for any of the localities on both islands. Therefore, *H. mindana* is not considered as present in Palau. It is known instead from other Pacific islands in Japan, China, the Philippines and Marianas, including Guam (Ozono et al. 2012). *Orthetrum sabina* was recorded from a single locality on Babeldaob and is considered a probable *O. serapia*, but this supposition needs verification. Englund (2011: 13) also illustrates a male *Ischnura* sp. The text discusses members of this taxon as common in Malakal and also reported for Babeldaob, however, not keyed out in Lieftinck (1962). The body colour pattern of the male on the photo resembles *I. senegalensis* which has also been recorded from close localities during the present study (see faunistic part). Therefore, this observation is not included in Table 1.

Seehausen & Dow (2016) is so far the most comprehensive discussion on the taxonomy of genus *Neurothemis*. Palau and Yap are included within the range of *N. terminata*, marking the easternmost border of the distribution.

Terayama & Uesugi (2024) is an online resource which is updated regularly. This is a richly illustrated guide to the Odonata of Palau with images of live individuals and museum specimens for almost all members of the taxa included in this account.

Etymology of the Palauan names

Palauan is an Austronesian language with no close relatives (Blust 2009) because it has been evolving in a relative isolation for at least 3,000 years (Clark et al. 2006). Perhaps Yapese is the closest to it, which is as a result of the regular contacts of the inhabitants of these two islands from prehistoric times mainly due to the trade with the famous stone money (Blust 2009).

Malsol (1999) provides some hints how to properly pronounce the names on Palauan language. There are five vowels (a, e, i, o, u) and 10 consonants (b, ch, d, k, l, m, ng, r, s, t). Double vowels in the words indicate a long vowel and two same consonants are for a stronger sound. With a few exceptions they all are pronounced as their equivalents in English. The following consonants are of particular importance for the locality names below: “ch” is used as a single unit to represent a glottal stop (“chad” is pronounced “ad”); “ng” is a single unit pronounces with a nasal sound like the “ng” at the end of the English words such as “sing”. The colloquial name for all dragonflies and damselflies in Palauan is chamayong (uh-ma-yong).

Geography and geology

The information below is adopted from Michael & Jaensch (2014).

The Republic of Palau is located on the western most margins of the Micronesian group of

islands (Fig. 1). It consists of 586 islands (from Kayangel in the NE to Hatohobei in the SW) of which 12 are permanently inhabited. The islands include several high islands formed by Eocene volcanic activity, numerous low and raised coral and coralline limestone islands and islets, and atolls in the far north (Kayangell atoll) and the far south (Helen Reef).

With an area of 367 km^2 and length of 45 km, Babeldaob is by far the largest island in the archipelago, comprising about three quarters of the total land mass (see map below). Neighbouring islands to the south are much smaller: Koror (9.3 km^2), Peleliu (12.7 km^2) and Angaur (8.4 km^2). The four islands of Sonororol, Hatohobei and the Helen Reef atoll lie in the far south-west of Palau's territory, about 600 km from Babeldaob and only 200 km from Indonesian territory.

The Palau islands are near the southern end of the Palau-Kyushu submarine ridge system and lie between the Philippine and Pacific Plates. Babeldaob, parts of Koror and a few small islands in the vicinity of Koror (about 70% of the land area of Palau) are of volcanic origin, with highly acidic red soil, and are characterized by rolling, forested hills, coastal bottomlands and tidal flats. The maximum elevation on Babeldaob is 275 m. High rainfall has contributed to substantial erosion of Babeldaob, forming a thick layer of soil over the island and broad alluvial beds around the coast.

Much of Palau, from Babeldaob to Peleliu, is surrounded by a discontinuous barrier reef that is 260 km long and encompasses a lagoon with an area of about 1,450 km^2. The barrier reef is particularly well developed on the western side, where it is up to 2.5 km in width. The lagoon is considered to have northern, central and southern sections. Deeper sea separates the northern atoll of Kayangel, the southern island of Angaur, and the distant south-western islets from this barrier-lagoon system. The Palau Trench, a deep sea feature, lies close to the east of the Palau archipelago.

History and administration

Athens & Ward (2005) found out that the initial settlement of Palau may have occurred at least by c. 4,400 BP. That was indicated by the pollen analysis which showed that the pre-human environment on Babeldaob, represented by a diverse tropical forest, had changed and savanna/grasslands began to form. The authors supposed that this change was probably provoked by the humans clearing forested areas for introduced swamp taro, betel nut palm and other crops. Additional support for this hypothesis is provided by a significant increase in other anthropogenic disturbance indicators, such as charcoal, grass pollen, and *Lycopodium*. By about 3,000 BP, there was probably an extensive conversion of primary forest to swidden agriculture and other activities.

According to USDA (2009) in 1543 the Spanish explorer Ruiz Lopez de Villalobos was the first European to have sighted the islands of Palau. The Caroline Islands were nominally under Spanish control for several hundred years until the Spanish-American War of 1898. Spain then sold the islands to Germany in 1899. The German administration of the islands developed fisheries, established coconut plantations, introduced cassava, and possibly introduced mahogany. Germany governed the islands until 1914, when Japan acquired control of the Micronesian islands. The Japanese civilian population and trading increased during the 30-year Japanese period (1914-1944), and infrastructure, including roads and buildings, was expanded under Japanese control. By the start of World War II, the

Japanese civilian population in Palau increased to about 18,000, three times the Palauan population. The Japanese built fortifications on the main Palau islands during World War II. Slit trenches and gun emplacements remain open today, hidden by vegetation. Peleliu and Angaur Islands were the scenes of fierce battles between Japanese and American forces in 1944. Koror and Babeldaob were not invaded but were heavily bombed. After World War II, the United States took over administration of Palau.

Palau became an independent republic on October 1, 1994. Presently it is divided into 16 states that are largely defined by traditional clan-chieftain areas. Ten states cover Babeldaob; Koror State covers most of the Southern Lagoon; Kayangel (north of Babeldaob), Peleliu and Angaur islands are distinct States; the remote south-western islets are Sonsorol and Hatohobei States. The capital is a relatively new facility in Melekeok State, separate from the principal urban area in Koror.

Environment

The Palau Conservation Society (2016) recognises four distinct island types found in Palau: atoll islands, high limestone islands (the Rock Islands), low platform islands, and volcanic islands. Terrain varies from low coral islands fringed by large barrier reefs to the high mountainous main island of Babeldaob, which has rivers, wetlands, and 10 watersheds. Babeldaob is the largest island in Palau, and, after Guam, the second largest island in Micronesia. Distributed across the hundreds of islands that make up Palau are numerous habitats harbouring a wealth of biodiversity. Habitats include:

- Forests—upland forests, swamp forests, limestone forests, atoll forests, and mangrove forests;
- Savanna and grasslands;
- Freshwater habitats—rivers, streams, lakes, swamps, and taro patches;
- Brackish water habitats—wetlands and coastal lagoons;
- Marine lakes;
- Nearshore habitats—mudflats, seagrass beds, sandy beaches; and,
- Coral reefs—barrier reefs, patch reefs, and fringing reefs.

Naturally, freshwater habitats in Palau are of a particular importance for the present study. They have been reviewed and included in The Directory of the Wetlands of Palau (Michael & Jaensch 2014). NEPC (2019) assessed the state of the freshwater resources of Palau and provided a report on the conservation measures put on place. Palau's two natural freshwater lakes (Ngardok Lake and Ngerkall Pond) are contained within a Protected Areas Network (PAN). Of Palau's 621 km of freshwater streams and rivers, 16% of their length pass through a protected or managed area, but only 6% of freshwater streams pass through a PAN site. Perceived effectiveness for water variables was concluded to be Good.

Material and Methods

Table 1 represents the Odonata taxa currently known from Palau. The list of scientific names follows Kosterin et al. (2025) who proposed that *R. phyllis* was a junior subjective synonym of *R. variegata* (Linnaeus, 1753). Therefore, all records of *R. phyllis* from the chronological review

above have been transferred to *R. variegata* for the rest of the paper. Note, that the taxa have been considered at the species level only, with the same limitation kept for the faunistic part of the present study. By contrast, subspecific affiliations are not the subject of this publication. They need to be elaborated considering a larger base of material encompassing other parts of the Pacific as well. Comments have been included in relevant sections.

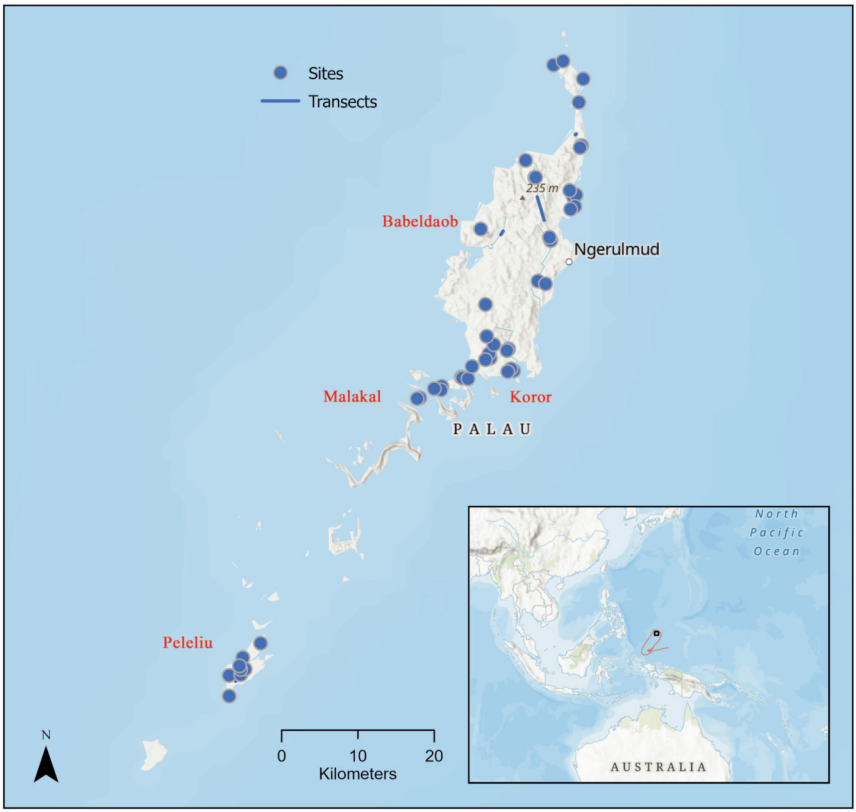
The records for the country have been arranged chronologically with the original scientific name and the combination which is considered valid at the moment. The nomenclatural conventions listed in Paulson et al. (2025) are followed as a source which is regularly updated with the most recently proposed novelties in taxonomy and nomenclature of this insect order. Locality data for multiple sites have been summarised for island or country level if many sample points have been included in the original publication. For new taxa proposed in some of the publications, only the locality of the name-bearing specimen is included. Verbatim locality is included as cited in the text. This is done for an easy tracing of the original resource with key words on digital copies of the original publications. The following updates are necessary to be considered:

- Pelew (or Pellew) is an archaic name for Palau islands.
- Tokobei (or Tobi) is presently known as Hatohobei Island.
- Babelthuap is the archaic name of Babeldaob Island, the largest island within the Palau archipelago.
- Peliliou is wrong spelling of Peleliu.
- Malakal Island and Arkebesang (Ngerkebesang) Island are connected to the main island of Koror by causeways.

The material for the present study was gathered mainly during a field study carried out by MM in the Republic of Palau between 16–28 March 2023 (Fig. 1). Four islands were visited (Babeldaob, Koror, Malakal, Peleliu) and data obtained from any suitable habitat, including passing by accidental individuals. Collection permits were obtained from the following states: Ngiwal, Ngardmau, Ngeremlengui, Ngaraard, Melekeok and Peleliu. From these states mainly adult odonates were sampled with an aerial net and killed in acetone, dried and transferred into paper envelopes. Exuviae were sampled in rare occasions when associated with the newly emerged adults or the predominant occupants of the locality spots. For all other states mentioned below in the *List of localities* only observations were made, with the adults identified visually and GPS coordinates recorded at the site. This list was expanded with localities sampled in another survey carried out by one of the authors (DP) between 5-13 August 1999 (added to Fig. 1 as well).

Field notes on the biology and ecology of the individuals were also recorded, however, no specific investigations on these two topics have been carried out. Therefore, the results from the field visit should be considered preliminary.

The faunistic list is illustrated with photos of live individuals for almost all taxa. These photos are expected to facilitate identification in the field. Most of them have been taken in the field by two of us (HK, MM). For odonates not photographed during the present study we included images from other parts of their ranges and acknowledge the photographers in the figure captions with their initials as follows: Daniel Grand (DG), Haomiao Zhang (HZ), Taku Kitayama (TK), Toshiharu Mita (TM). Members of two more taxa not recorded during the present study



Esri, TomTom, FAO, NOAA, USGS, Esri, NASA, NGA, USGS, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS, Esri, USGS

Figure 1. Map of the Republic of Palau with sampling localities.

are included at the end of the paper. These are: *D. trivialis*, reported for Palau by Asahina (1940) and *Ischnura aurora* (Brauer, 1865), commented below.

Almost all microscopic pictures of diagnostic characters were produced using the equipment of the Plant Health and Environment Laboratory, Christchurch, Ministry for Primary Industries, in New Zealand. A series of images were taken under high power Nikon AZ100M microscope and stacked with Helicon Focus 6.7.1 software. Photos of *Gynacantha* sp. were taken by Mamoru Terayama before the specimen was deposited in the Belau National Museum, Republic of Palau. Figures supplied by DP were taken at the Bishop Museum, Honolulu using a Leica digital imaging system consisting of a MC170 HD digital camera coupled to a Leica M165-C dissecting stereomicroscope, with post-processing using Photoshop CS software.

Morphological description follows Garrison et al. (2010).

Abbreviations: AL – abdomen length (appendages excluded); Ce – cerci; Ep – epiproct; Fig. – figures used as illustrations in the present study; fig. – figures used as illustrations in

previous studies and cited in here; FW – fore wing; HW – hind wing; HfL – hind femur; MWh – maximum width of head; MWa – maximum width of abdomen; Pp – paraproct; TL – total length; S1–10 – abdominal segments 1 to 10.

All measurements in millimetres (mm).

Specimens sampled during the present study will be split in between three collections: Belau National Museum, Republic of Palau (BNM); New Zealand Arthropod Collection, New Zealand (NZAC); Bean Life Science Museum, Brigham Young University, USA (MLBM). All specimens from the 1999 Polhemus study are deposited at the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM). Specimens from the Englund surveys of 2011 are deposited in the Bishop Museum, Honolulu, Hawaii, USA (BPBM)..

Table 1 includes the list of species known from the country. This list will be reviewed for the final publication and modified accordingly considering the contemporary taxonomy and nomenclature.

List of localities is presented below as they were visited in chronological order during both main sampling periods outlined above in the following year:

2023

1. Taro field, Koror State, Koror Island (7.3403N, 134.4769E; 6 m a.s.l.): 16 March
2. Stream by taro field, Koror State, Koror Island (7.3407N, 134.4769E; 8 m a.s.l.): 16 March
3. Belau National Museum, Koror State, Koror Island (7.3367N, 134.4759E; 30 m a.s.l.): 16 March
4. Roadside puddle, Koror State, Koror Island (7.3518N, 134.4998E; 2 m a.s.l.): 17 March
5. Taro field, Koror State, Koror Island (7.3507N, 134.5012E; 3 m a.s.l.): 17 March
6. End of the road, Koror State, Koror Island (7.3499N, 134.5074E; 1 m a.s.l.): 17 March
7. Stream E of Airai, Airai State, Babeldaob Island (7.3606N, 134.5576E; 1 m a.s.l.): 17 March
8. End of the road, Airai State, Babeldaob Island (7.3592N, 134.5612E; 8 m a.s.l.): 17 March
9. Roadside puddle, Airai State, Babeldaob Island (7.3613N, 134.5580E; 4 m a.s.l.): 17 March
10. End of the road, Airai State, Babeldaob Island (7.3581N, 134.5546E; 45 m a.s.l.): 17 March
11. Roadside puddle, Airai State, Babeldaob Island (7.3741N, 134.5339E; 46 m a.s.l.): 17 March
12. Roadside puddle, Ngchesar State, Babeldaob Island (7.4651N, 134.5898E; 11 m a.s.l.): 17 March
13. End point of observation, Ngchesar State, Babeldaob Island (7.4616N, 134.5988E; 87 m a.s.l.): 17 March
14. Ngardmau waterfall car park, Ngardmau State, Babeldaob Island (7.5868N, 134.5862E; 128 m a.s.l.): 17 March
15. Ridge walk along the border between Ngiwal and Ngeremlengui States, Babeldaob Island (7.5643N, 134.5890E to 7.5364N, 134.5973E; 158 to 132 m a.s.l.): 17 March
16. End point of observations, Ngeremlengui State, Babeldaob Island (7.5264N, 134.5224E; 12 m a.s.l.): 17 March

17. Sewage pond at the southmost end of Koror State, Malakal island (7.3275N, 134.4511E; 4 m a.s.l.): 18 March
18. Stream and floods at Ngiwal, Ngiwal State, Babeldaob Island (7.5659N, 134.6338E; 1 m a.s.l.): 18, 19, 21 March
19. Source of the stream by Ngiwal above the dam, Ngiwal State, Babeldaob Island (7.5639N, 134.6317E; 22 m a.s.l.): 18 March
20. Dims bungalow, Ngiwal, Ngiwal State, Babeldaob Island (7.5666N, 134.6347E; 1 m a.sl.): 18 March
21. Floods at the end of the road where the secondary road meets the main road W-NW from Ngiwal, Ngiwal State, Babeldaob Island (7.5715N, 134.6272E; 23 m a.s.l.): 19 March
22. Secondary road between Ngiwal and Locality 21, Ngiwal State, Babeldaob Island (7.5666N, 134.6347E to 7.5715N, 134.6272E; 1 to 23 m a.s.l.): 19 March
23. Canals in taro field above Ngiwal, Ngiwal State, Babeldaob Island (7.5527N, 134.6337E; 4 m a.s.l.): 19 March
24. Top of the ridge, Ngiwal State, Babeldaob Island (7.5498N, 134.6284E; 34 m a.s.l.): 19 March
25. Forest section below the pump station, Ngiwal State, Babeldaob Island (7.5508N, 134.6298E to 7.5506N, 134.6306E; 48 to 27 m a.s.l.): 19 March
26. Top of Babeldaob Island, Ngarchelong State, Babeldaob Island (7.7192N, 134.6083E; 2 m a.s.l.): 20 March
27. Top of a ridge, Ngarchelong State, Babeldaob Island (7.7243,N 134.6192E; 89 m a.s.l.): 20 March
28. Section in a river in Ollei, Ngarchelong State, Babeldaob Island (7.7179N, 134.6155E to 7.7192N, 134.6181E; 13 to 18 m a.s.l.): 20 March
29. End of the road in Imetang, Ngarchelong State, Babeldaob Island (7.7032N, 134.6431E; 8 m a.s.l.): 20 March
30. Grass areas in Ngaraard, Ngaraard State, Babeldaob Island (7.6245N, 134.6412E; 2 m a.s.l.): 20 March
31. Waterfall in Ngaraard, Ngaraard State, Babeldaob Island (7.6223N, 134.6394E; 3 m a.s.l.): 20 March
32. Lake Ngardok, Melekeok State, Babeldaob Island (7.5124N, 134.6047E; 40 m a.s.l.): 21, 22 March
33. Small stream close to Lake Ngardok, Melekeok State, Babeldaob Island (7.5165N, 134.6033E; 40 m a.s.l.): 21 March
34. Floods by a stream E of Airai Dam, Airai State, Babeldaob Island (7.3850N, 134.5552E; 8 m a.s.l.): 21 March
35. Section of a track N of Katuu Camp, Airai State, Babeldaob Island (7.3827N, 134.5375E to 7.3882N, 134.5382E; 101 to 99 m a.s.l.): 21 March
36. Taro fields, Ngaraard State, Babeldaob Island (7.6754N, 134.6381E; 2 m a.s.l.): 22 March
37. Section of a stream above grave yard, Ngaraard State, Babeldaob Island (7.6245N, 134.6375E to 7.6243N, 134.6356E; 11 to 42 m a.s.l.): 22 March

38. Section of a stream, Ngaraard State, Babeldaob Island (7.6384N, 134.6352E to 7.6371N, 134.6339E; 8 to 17 m a.sl.): 22 March
39. Floods and puddles close to the Palau Aquarium, Koror State, Koror Island (7.3383N, 134.4677E; 1 m a.s.l.): 23 March
40. Pond in Imelchol Village, Peleliu State, Peleliu Island (7.0384N, 134.2635E; 1 m a.s.l.): 24, 26 March
41. Main road close to a junction to Amber beach, Peleliu State, Peleliu Island (7.0212N, 134.2422E; 1 m a.s.l.): 25 March
42. Grass area by War Museum, Peleliu State, Peleliu Island (7.0004N, 134.2265E; 3 m a.s.l.): 25 March
43. Pond at the S end of the island, Peleliu State, Peleliu Island (6.9759N, 134.2265E; 1 m a.s.l.): 25 March
44. Section of a road along E part of the island, Peleliu State, Peleliu Island (6.9934N, 134.2341E to 7.0017N, 134.2397E; 1 to 1 m a.s.l.): 25 March
45. Grass area roadside, Peleliu State, Peleliu Island (7.0014N, 134.2400E; 39 m a.s.l.): 25 March
46. Swampy area overgrown-1, Peleliu State, Peleliu Island (7.0077N, 134.2453E; 1 m a.s.l.): 25 March
47. Swampy area overgrown-2, Peleliu State, Peleliu Island (7.0073N, 134.2398E; 1 m a.s.l.): 25 March
48. Pond (limestone?) roadside on Crocodile Rd, Peleliu State, Peleliu Island (7.0113N, 134.2388E; 10 m a.s.l.): 25 March
49. Floods in Bird Sanctuary, Ngeremlengui State, Babeldaob Island (7.5194N, 134.5461E to 7.5238N, 134.5491E; 9 to 6 m a.s.l.): 27 March
50. Floods in Ngardmau village, Ngardmau State, Babeldaob Island (7.6124N, 134.5802E to 7.6082N, 134.5801E; 18 to 3 m a.s.l.): 28 March
51. River SE from Ngardmau village, Ngardmau State, Babeldaob Island (7.6072N, 134.5755E; 2 m a.s.l.): 28 March
52. Puddle right hand-side on the track down to the Ngardmau falls, Ngardmau State, Babeldaob Island (7.5869N 134.5872E; 105 m a.s.l.): 28 March
53. Section of the river above Ngardmau falls, Ngardmau State, Babeldaob Island (7.5874N, 134.5918E to 7.5911N, 134.5932E; 41 to 30 m a.s.l.): 28 March

1999

54. Tributary to upper Tabecheding River on road to Melekeok, Ngatpang State, Babeldaob Island (7.4375N, 134.5283E; 30 m a.s.l.): 5 August
55. Lower Ngerikill River at pump station, N. of Palau airport, Airai State, Babeldaob Island (7.3828N, 134.5533E; 5 m a.s.l.): 6 August
56. Upper Ngerimel River, above reservoir, Airai State, Babeldaob Island (7.3794N, 134.5322E; 30 m a.s.l.): 6, 12 August
57. Falls on upper Kmekumer River, Airai State, Babeldaob Island (7.3900N, 134.5378E; 50 m a.s.l.): 7 August

58. Pond at giant clam farm, sea level, Koror State, Malakal Island (7.3264N, 134.4478E; 0 m a.s.l.): 9 August
59. Ngerimel River, below reservoir, Airai State, Babeldaob Island (7.3722N, 134.5281E; 10 m a.s.l.): 10 August
60. Small rocky stream above Ngetkib, W. of Palau airport, Airai State, Babeldaob Island (7.3644N, 134.5125E; 50 m a.s.l.): 10-11 August
61. Flowing spring on N. slope of Mt. Ngetkum (Mt. Dabadora), Airai State, Babeldaob Island (7.3997N, 134.5294E; 200 m a.s.l.): 13 August

Results

Species check list

The list below includes the scientific names of the taxa, photos of live individuals, localities where the representatives were collected from, comments following the field observations as well as illustrations of morphological features which are found be important diagnostic for selected insects.

Family Coenagrionidae Kirby, 1890

Agriocnemis femina (Brauer, 1868) (Fig. 2)

Localities: **2, 11, 18, 22-23, 31-32, 36-39, 48-50, 53, 55, 58-59**

Very common in variety of habitats except in lotic environments. Adults were still recorded alongside some streams and irrigation canals, but mainly at the flooded areas close to the main source or around sections with no obvious streamflow.
Agriocnemis femina was previously reported for Babeldaob, Koror and Malakal (Lieftinck 1962; Katatani & Muraki 1997; Ishida 1998; Englund 2011; Terayama & Uesugi 2024). First record for Peleliu.

Ischnura heterosticta (Burmeister, 1839) (Fig. 3)

Localities: **32** (22 March)

Individuals of *I. heterosticta* are close in colour to their congenerics of *I. senegalensis*. During the present research both were confused in the field. Males were properly affiliated to the respective hypotheses only in the laboratory. Therefore, it is possible that some of the previous records on *I. heterosticta* (especially from Malakal) to be actually of *I. senegalensis*. Males of both species are illustrated on Figures 4 and 6 for *I. heterosticta* and *I. senegalensis* respectively. For key diagnostic details of live individuals see the pattern of the second abdominal segments in both males.
Ischnura heterosticta was previously reported for Babeldaob, Koror and Malakal (Lieftinck 1962; Ishida 1998; Terayama & Uesugi 2024).

Ischnura senegalensis (Rambur, 1842) (Fig. 5)

Localities: **39-40** (26 March)

It is possible that these damselflies are distributed more widely than we presently know. The habitats where the individuals were found were in modified environments with strong

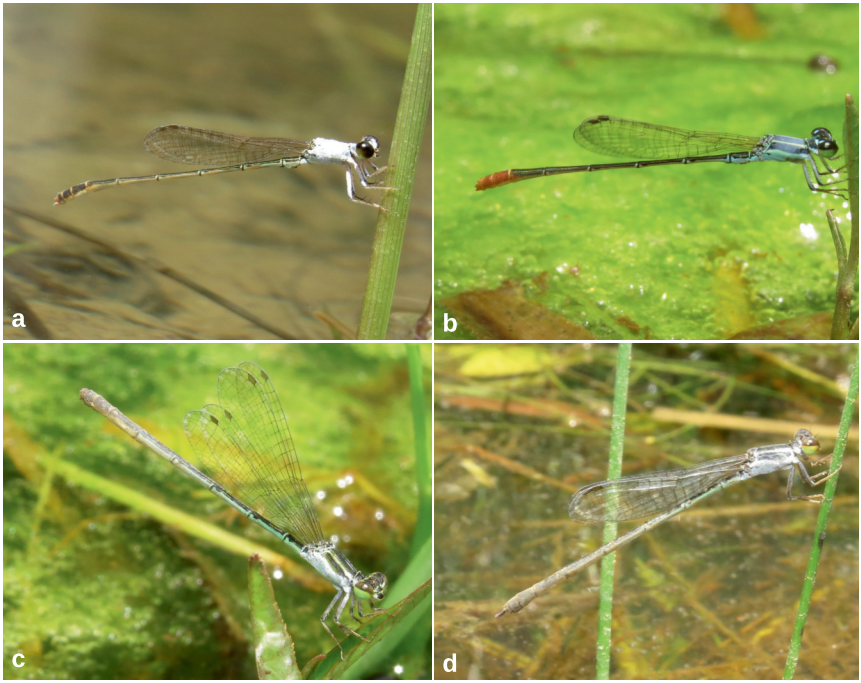


Figure 2. ***Agriocnemis femina*****: a) adult male; b) immature male; c-d) females at different stages of maturity (MM).**

Figure 3. ***Ischnura heterosticta*****, mating pair, New Caledonia (DG).**

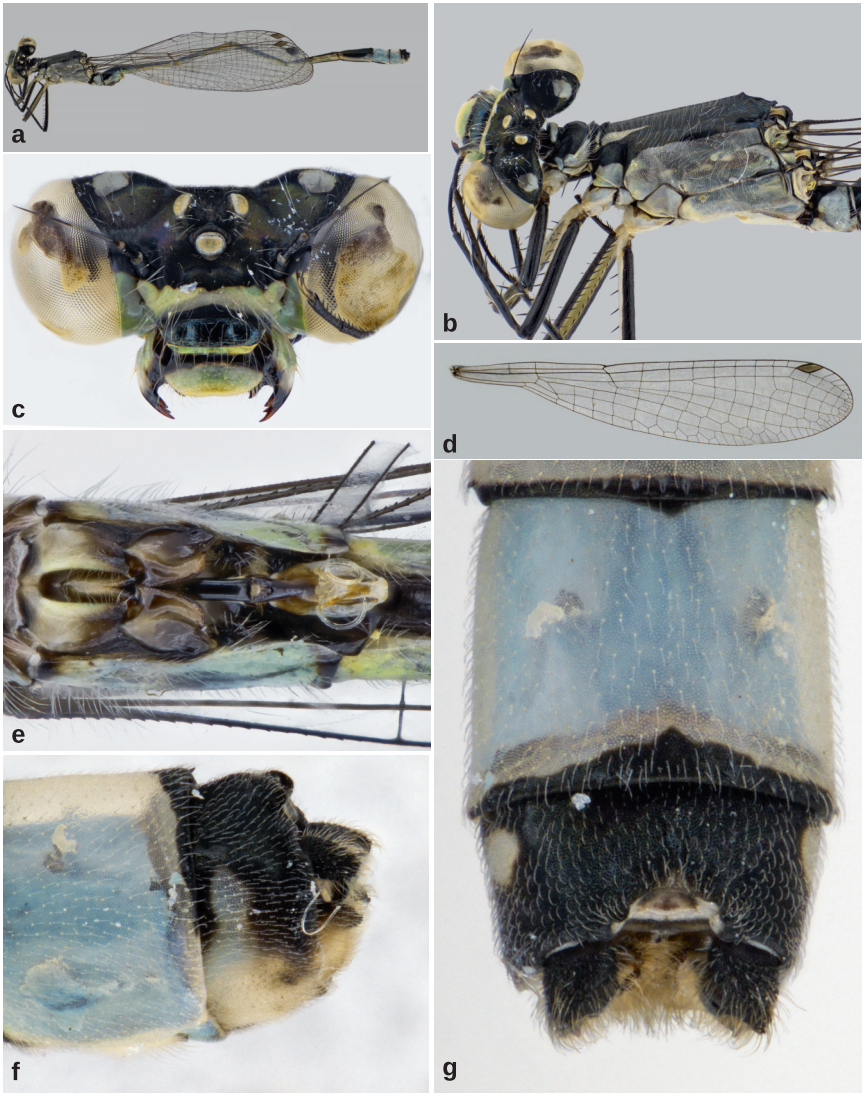


Figure 4. *Ischnura heterosticta*, male: a) habitus; b) head and thorax, dorsal and lateral views; c) head, frontal view; d) HW; e) penis, ventral view; f-g) terminal abdominal appendages, lateral and dorsal views.

anthropogenic influence. It is possible that habitats on Koror may have *I. senegalensis* as well. Figure 6 illustrate the morphology and colour of a male. For comparison with *I. heterosticta* see Figure 4.

Figure 5. ***Ischnura senegalensis*****, male (MM).**

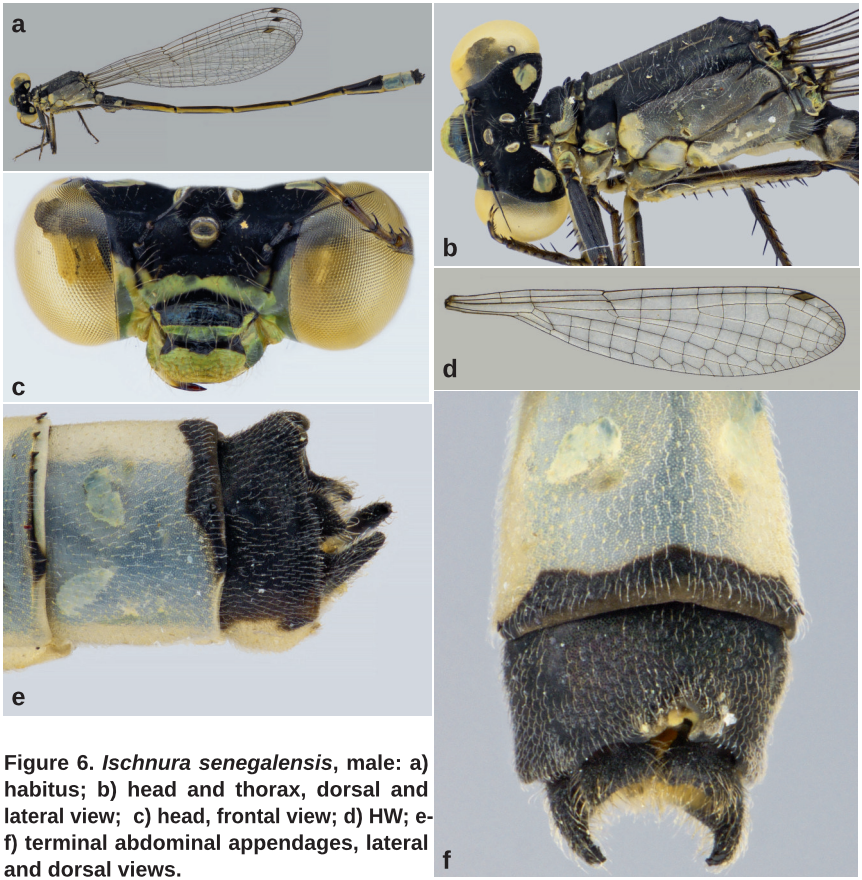


Figure 6. ***Ischnura senegalensis*****, male: a) habitus; b) head and thorax, dorsal and lateral view; c) head, frontal view; d) HW; e-f) terminal abdominal appendages, lateral and dorsal views.**

Ischnura senegalensis was previously reported for Malakal (Katatani & Muraki 1997). First record for Peleliu.

Pericnemis (?) sp. (Fig. 7)

Locality: **53**

Two females were sampled from a single locality only. Their affiliation with the genus *Pericnemis* is provisional. No males were found at the locality to validate the proposed taxonomic position. To facilitate future taxonomic studies, one of the specimens is illustrated in here (Fig. 7). If this genus is confirmed, this is an additional taxon for Palauan Odonata fauna.

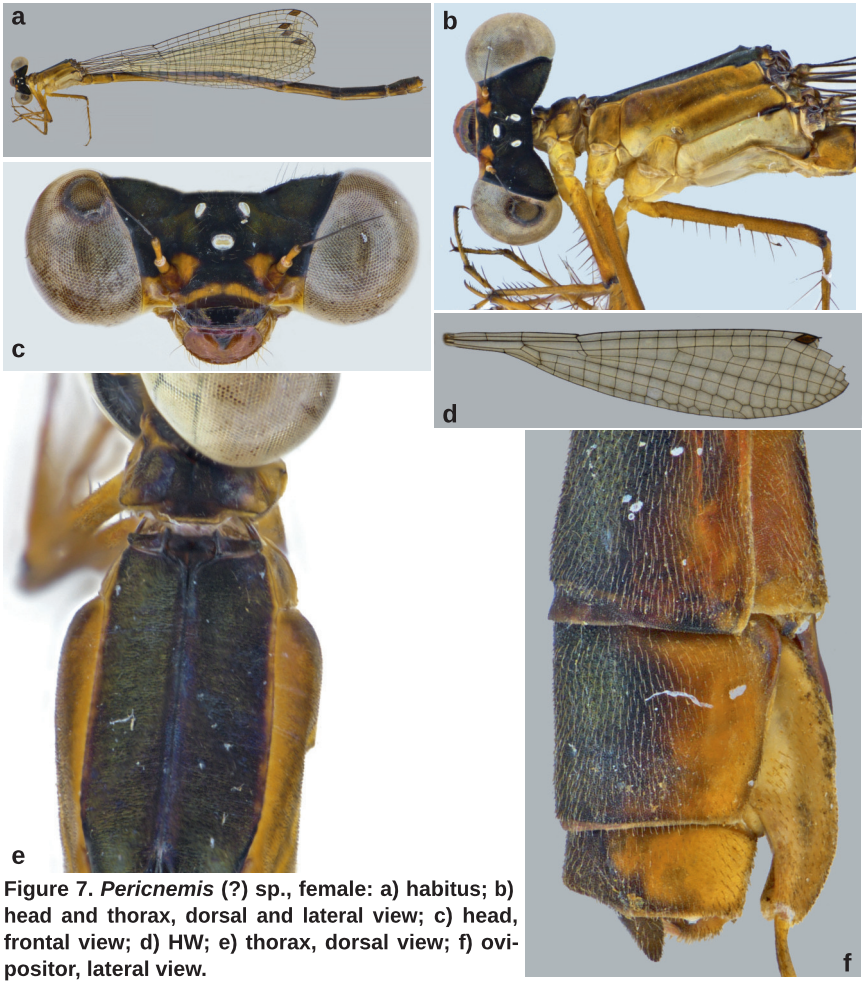


Figure 7. *Pericnemis* (?) sp., female: a) habitus; b) head and thorax, dorsal and lateral view; c) head, frontal view; d) HW; e) thorax, dorsal view; f) ovipositor, lateral view.

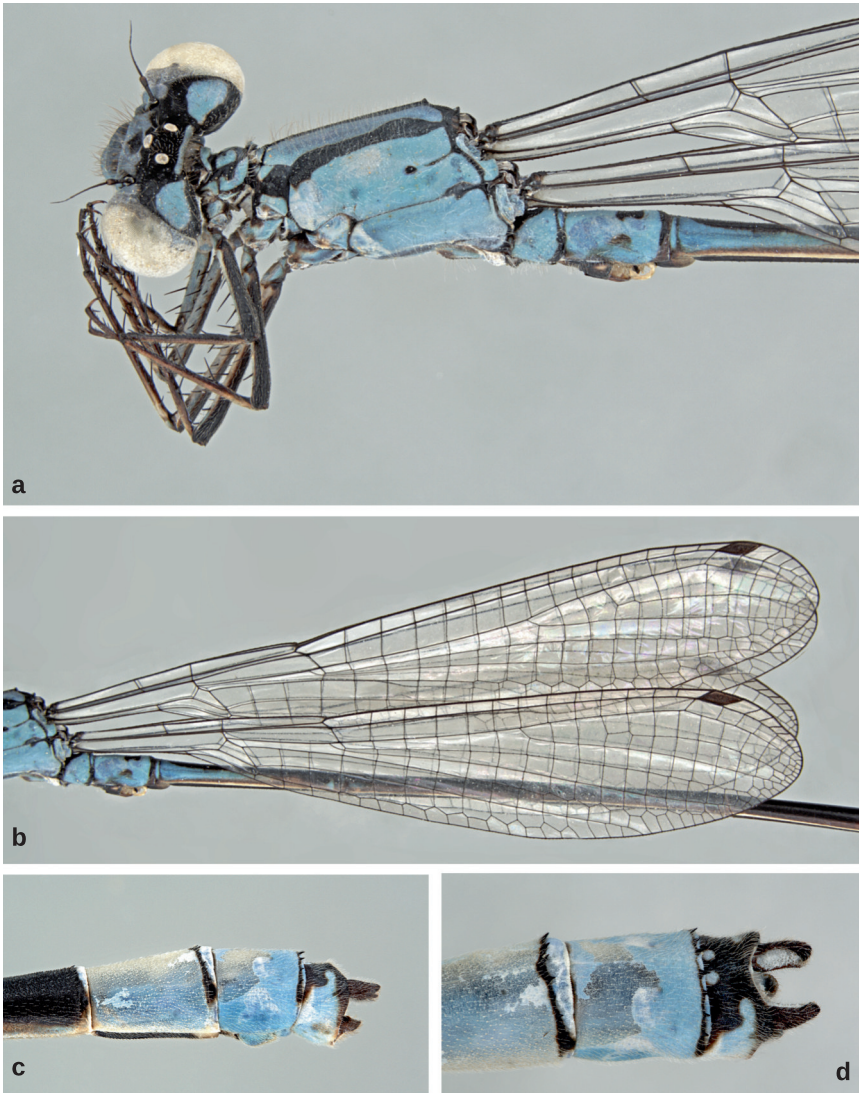


Figure 8. *Pseudagrion palauense*, male.

Pseudagrion palauense Lieftinck, 1962 (no image of live individuals available)

Localities: **54-57**

Not observed in any of the habitats investigated in 2023, but reported from the 1999 field survey (cf. Fig. 8 for diagnostic of the male). At the time when it was erected as a new to science taxon in Lieftinck (1962), the female was unknown.

Figure 9. *Teinobasis palauensis*, male (MM).

Pseudagrion palauense was previously reported for Babeldaob (Lieftinck 1962; Ishida 1998; Jordan et al. 2003; Englund 2011; Terayama & Uesugi 2024).

Teinobasis palauensis Lieftinck, 1962 (Fig. 9)

Localities: **18, 21, 28, 32** (22 March), **37-38, 49-51, 53-57, 60**

Adults were found along the banks of a wide range of flowing waters – trickles, small streams and rivers up to 7-10 m wide. They were observed close to human dwellings in what appeared to be waste water near the villages with tandem pairs discovered, but no evidences for breeding. Single males were encountered close to a lake, but away from the banks and deep into the vegetation. All adults selected plants as their perching substrate.

Apart of Katatani & Muraki (1997) previous investigations reported this damselfly as single individuals, however, during the present study individuals of *T. palauensis* were found to be very wide spread across Babeldaob island. They are well camouflaged in their environment and easy to be missed unless the dense vegetation (especially Locality 18, Fig. 10) is inspected thoroughly.

Lieftinck (1962: 22-23, figs 4c-3, 5a) illustrated the male appendages and wing venation respectively. Katatani & Muraki (1997: 7, fig. 5) illustrated the posterior end of the fe-

Figure 10. Habitat of *Teinobasis palauensis*, mating and concentration of adults observed at this site (Locality 18).

Figure 11. *Teinobasis palauensis*, immature male (MM).

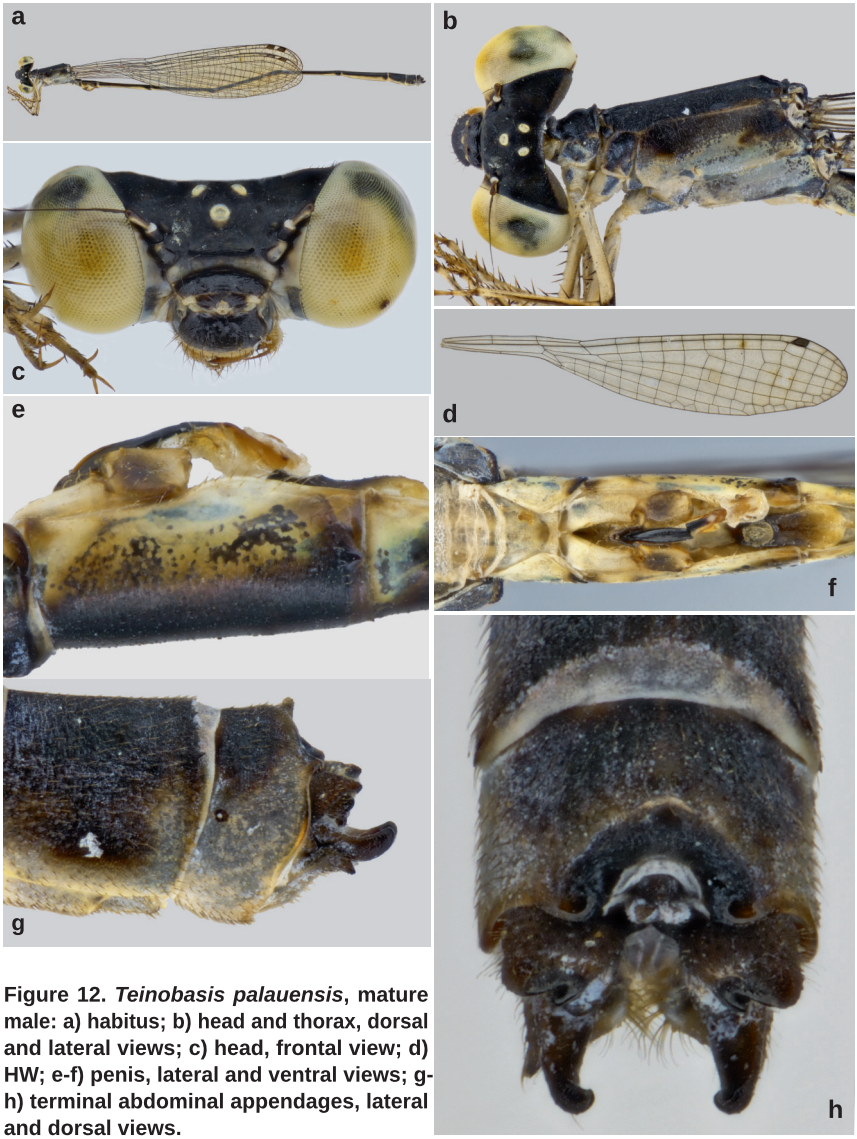


Figure 12. *Teinobasis palauensis*, mature male: a) habitus; b) head and thorax, dorsal and lateral views; c) head, frontal view; d) HW; e-f) penis, lateral and ventral views; g-h) terminal abdominal appendages, lateral and dorsal views.

male abdomen with the ovipositor. Englund (2011: 21) provided a photo of an adult male. During the present study more than 20 individuals of both sexes were observed and some collected from Locality 51. They were characterised by yellow bodies (Fig. 11), which is in contrast to the general drab colour of the mature adults (Figs 9, 12). They are illustrated on

Figure 13. ***Teinobasis palauensis*****, immature male: a) habitus; b) head and thorax, dorsal and lateral view; c) head, frontal view; d) HW; e-f) penis, lateral and ventral views; g-h) terminal abdominal appendages, lateral and dorsal views.**

Figure 13 for comparison with the mature males. The female is illustrated in Figure 14. *Teinobasis palauensis* was previously reported for Babeldaob and Koror (Lieftinck

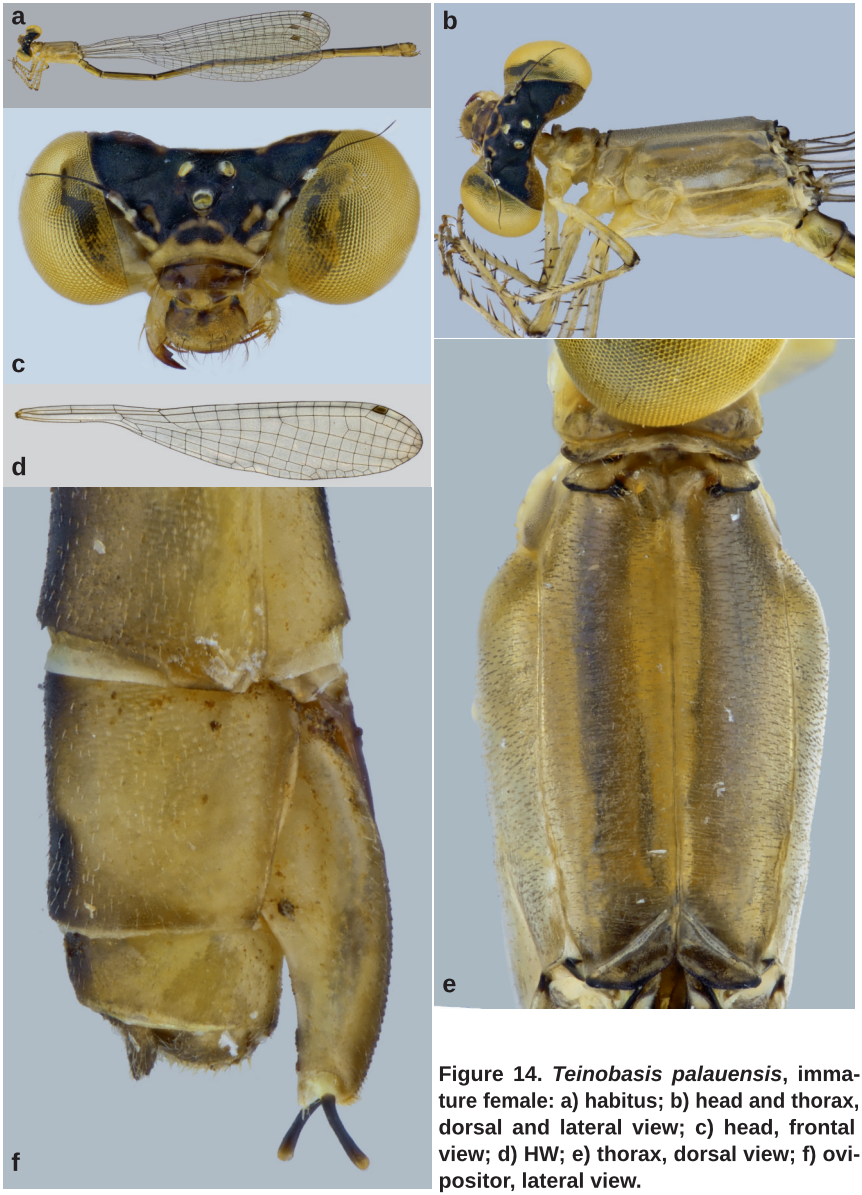


Figure 14. *Teinobasis palauensis*, immature female: a) habitus; b) head and thorax, dorsal and lateral view; c) head, frontal view; d) HW; e) thorax, dorsal view; f) ovipositor, lateral view.

1962; Katatani & Muraki 1997; Ishida 1998; Englund 2011; Terayama & Uesugi 2024).

Family Platystictidae Kennedy, 1920

Drepanosticta palauensis Lieftinck, 1962 (Fig. 15)

Localities: **19, 37**

Locality 19 was found to be the best for *D. palauensis* and deserves a special attention. Following the stream at the southern end of Ngiwal (Fig. 16) up to the source in the forest leads to a swampy area fed by a number of tributaries and their floods amongst the

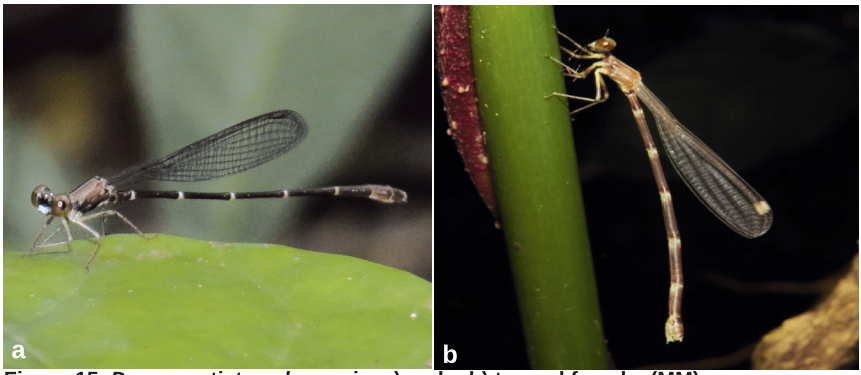


Figure 15. *Drepanosticta palauensis*: a) male; b) teneral female. (MM).

Figure 16. Stream at the southern end of Ngiwal. Source of this stream was found to be a very suitable habitat for *D. palauensis*.

bases of the tree trunks (Fig. 17). The latter were found to be favoured by adults from both sexes which mainly perched on the leaves of epiphytes and were rarely observed directly on the bark of the trees (Fig. 18). The narrow forested stretch corresponding to this general description is very limited above the settlement and is within the zone bordered by a main road and the area free of human dwellings. A similar situation was recorded along

Figure 17. Habitats of *D. palauensis*.

Figure 18. Tree trunk were recorded as suitable perching sites for *D. palauensis*.

the reach investigated in the second locality reported in here. All adults were found along the upper section of the stream away from the anthropogenically influenced sections of the locality.

Both sexes of *D. palauensis* were described at the time when the species was erected, with illustrations of the male abdominal appendages (Lieftinck 1962: 15, fig. 3). More morphological features and colouration are presented in here in Figures 19-20.

Drepanosticta palauensis was previously reported for Babeldaob (Lieftinck 1962; Englund 2011; Terayama & Uesugi 2024).

Family Aeshnidae Rambur, 1842

Anaciaeschna jaspidea (Burmeister, 1839) (Fig. 21)

Localities: **28**

Only one male individual was observed in the field, but not collected. It was chased from the tall grass at the locality reported here. *Anaciaeschna jaspidea* is probably more common within the country, but difficult to spot due to the known increased flight activity at twilight recorded in many studies (e.g. Lieftinck 1962, Marinov et al. 2019 and others).

Anaciaeschna jaspidea was previously reported for Babeldaob and Koror (Lieftinck 1962; Katatani & Muraki 1997; Ishida 1998; Terayama & Uesugi 2024).

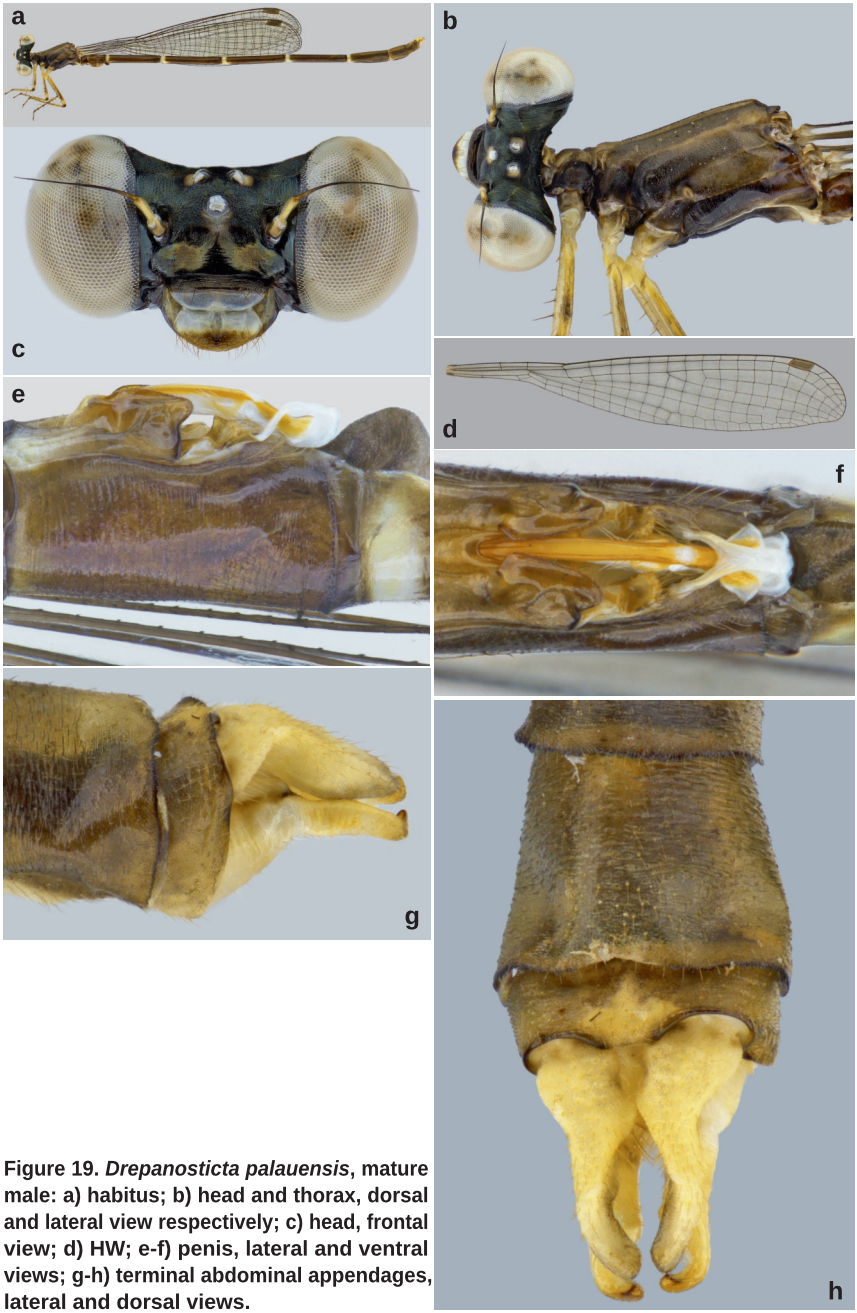


Figure 19. ***Drepanosticta palauensis*****, mature male: a) habitus; b) head and thorax, dorsal and lateral view respectively; c) head, frontal view; d) HW; e-f) penis, lateral and ventral views; g-h) terminal abdominal appendages, lateral and dorsal views.**

Figure 20. ***Drepanosticta palauensis*****, immature female: a) habitus; b) head and thorax, dorsal and lateral view; c) head, frontal view; d) HW; e) thorax, dorsal view; f) ovipositor, lateral view.**

Anax sp.

Localities: **32** (22 March)

A single individual observed, but not collected. Therefore, it's species affiliation is not possible to establish. *Anax guttatus* (Burmeister, 1839) is the most likely candidate because it was previously reported for Babeldaob, Koror and Malakal (Ris 1916; Ishida 1998; Englund 2011; Terayama & Uesugi 2024). Figure 22 illustrates it for future reference in comparison to previously sampled congeneric specimens from Palau.

Figure 21. *Anaciaeschna jaspidea*, male, (HZ).

Figure 22. *Anax guttatus*, male, New Caledonia (DG).

Gynacantha sp. (no image of live individuals available)

Localities: **22**

One adult visually sighted at a single locality at dusk is the only observation made during the field study. The locality was revisited several times but no flying individuals were observed. Figure 23 illustrates a female specimen collected by one of us (MT) who found it when the individual entered the hotel room on Koror Island. At the moment this female is not affiliated with any hypothesis at the species level because an association with a male specimen was not possible to be establish.

No *Gynacantha* spp. have been reported before for Palau.

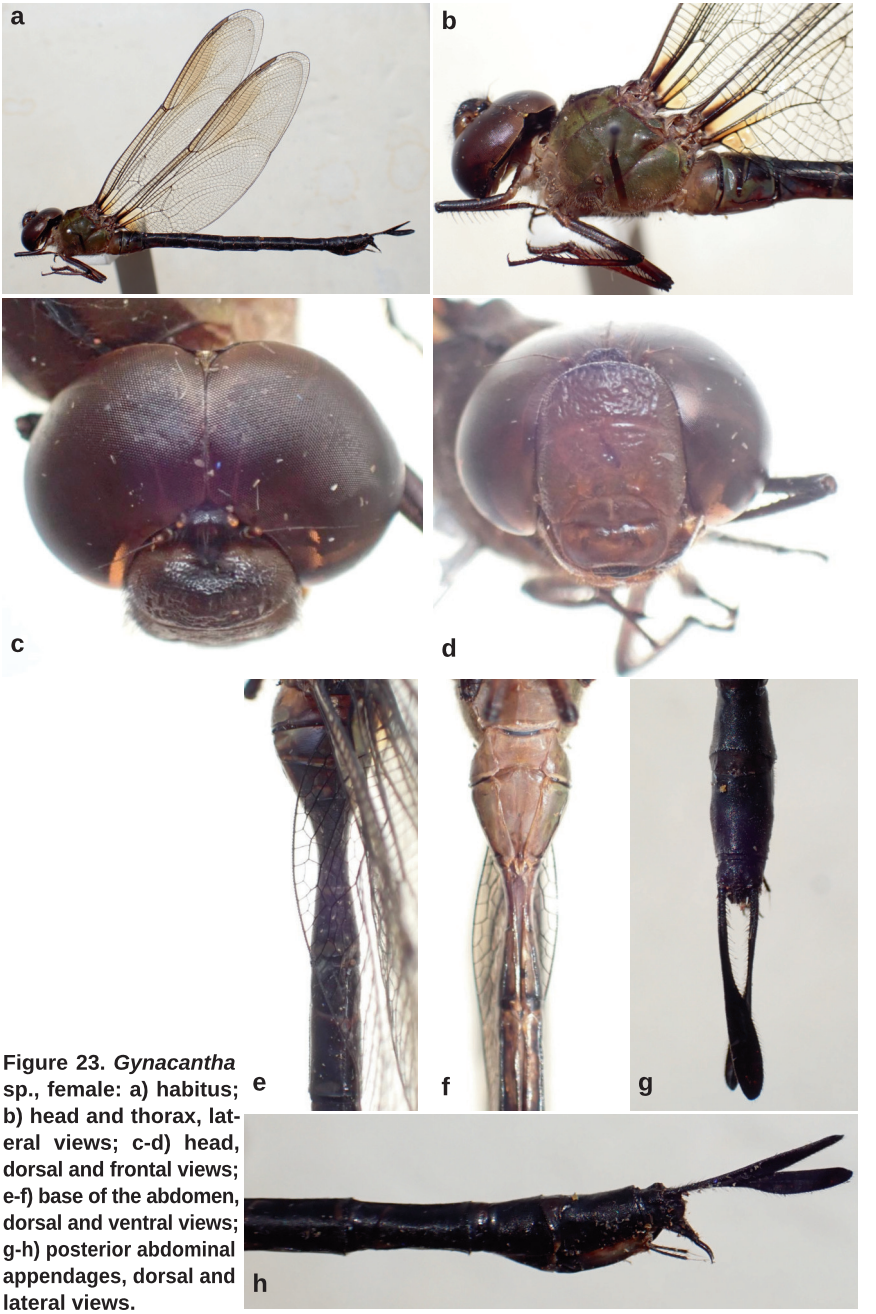


Figure 23. ***Gynacantha*** **sp., female: a) habitus; b) head and thorax, lateral views; c-d) head, dorsal and frontal views; e-f) base of the abdomen, dorsal and ventral views; g-h) posterior abdominal appendages, dorsal and lateral views.**

Family Corduliidae Kirby, 1890

Hemicordulia lulico Asahina, 1940 (Fig. 24)

Localities: **32, 45-47, 49**

Hemicordulia lulico was erected as a new species to science based on holotype and allotype from Yap and nine paratypes (3 ♂♂, 6 ♀♀) from Palau around Ngiwal. No data outside these two island groups have been recorded so far. Asahina (1940: 6, figs 7–12) illustrated important diagnostic features of both sexes. Katatani & Muraki (1997: 9, fig. 7) added an important comparison between the colour pattern of the thorax of the females of *H. lulico* and *H. mindana nipponica* Asahina, 1980. Updated illustrations of male *H. lulico* are presented in here in Figure 25.

Because of its biogeographic importance *H. lulico* was specially targeted in the present study at all investigated localities. At the moment only flying individuals have been observed with no records of possible breeding at the habitats. A concentration of mature males along the road next to a wetland completely overgrown with vegetation at locality 45 (Fig. 26) was the only indication of a suspect habitat affiliation. This falls on lower scores of the classification scheme proposed in Marinov & Doscher (2011) for POSSIBLY AUTOCHTHONOUS SPECIES. A similar situation was observed at Locality 49 (Fig. 27). The photo presents the main water course in the same locality which was contemplated as a possible breeding place for *H. lulico*. Single passing individuals were observed at Lake Ngardok as well (Locality 32). Unfortunately, none of these observations were considered as enough to provide any specific habitat association at this stage. Our field results are in concordance with other studies where mainly accidental individuals have been observed flying among the trees on the edge of a road (Katatani & Muraki 1997) and in a suburban area around the Belau Museum (Ishida 1998). The actual habitat of *H. lulico* remains to be described in future studies, however, we suspect that members of this species probably inhabit a wider range of sites than initially inferred from previous publications.

Figure 24. *Hemicordulia lulico*, female (HK).

Hemicordulia lulico was previously reported for Babeldaob and Koror (Asahina 1940; Lieftinck 1962; Katatani & Muraki 1997; Ishida 1998; Englund 2011; Terayama & Uesugi 2024). First record for Peleliu.

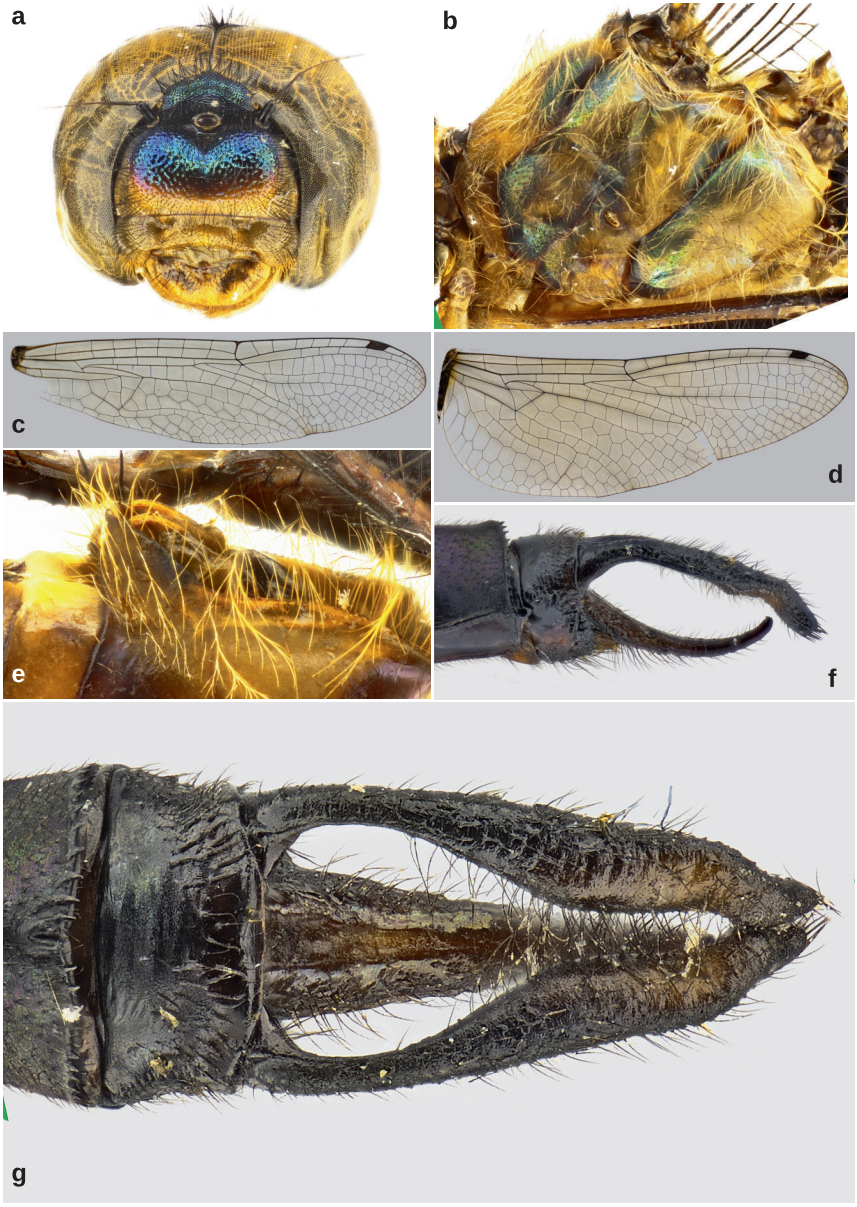


Figure 25. ***Hemicordulia lulico*****, male: a) head, frontal view; b) thorax, lateral view; c) FW; d) HW; e) secondary genitalia; f) posterior abdominal appendages, lateral view; g) posterior abdominal appendages, dorsal view.**

Figure 26. Locality 45, importance for adults of *H. lulico*: a) roadside vegetation with concentration of hunting males; b) overgrown wet meadow where occasional adults were observed as well.

Family Libellulidae Leach, 1815

Agrionoptera cardinalis Lieftinck, 1962 (Fig. 28)

Localities: **2, 3, 12, 18, 22-23, 35, 42, 46, 49-52, 58, 61**

Lieftinck (1962) and Katatani & Muraki (1999) provide rich illustrations of various morphological structures and colour pattern of *A. cardinalis* in comparison with various congeners. Therefore, no more figures are provided in here.

During the present study, *A. cardinalis* was found to be one of the commonest dragonflies in the field. Adults were frequently observed on the roadside bush vegetation, under

Figure 27. Locality 49, the main water course within the area where adults of *H. lulico* were observed. Note, no insects were found associated with this open water, but at the terrestrial vegetation along the banks. Being the major freshwater habitat (apart of what appeared to be temporary floods), this site was contemplated as another possible *H. lulico* habitat.

the tree canopies of densely overgrown sections close to taro fields with adults showing what appeared to be a strong affinity to forested pools under the 100% vegetation cover. Four exuviae were collected from a locality within Locality 50 (Fig. 29). No tenerals were found associated with these exuviae, however, the exuviae keyed out (with some assumptions, see the *Note* below) at the congeneric *A. sanguinolenta* Lieftinck, 1962 in the "Key to known larvae of Micronesian Libellulidae" provided in Lieftinck (1962: 58-61). As *A. cardinalis* is the sole representative of the genus in Palau and is considered as endemic to these islands, the sampled exuviae were associated with that species and described below.

Description of the nymph of *A. cardinalis* (*by supposition*) (Fig. 30)
Material: 4 ♀♀; all collected from a pond (coordinates not recorded) situated within the vicinity of Ngardmau village, Babeldaob Island; the pond is one of the multiple sites sampled within Locality 50 (7.6124, 134.5802 to 7.6082, 134.5801; 18 to 3 m a.s.l.); 28 March 2023; M. Marinov, S. Hanser, H. Ketebengang leg.
Exuviae were collected above the water surface (0.5–0.9 m) or on a tree about 1.70 m from the pond and 1.40 m high. The description below based mainly on a single exuvia. Its head was destroyed while detaching the labium for illustration.
General appearance dark brown with almost no marks except obscure bands on legs and wing sheaths (Fig. 30a-b).
Head. Wider than long, wider than thorax, slightly narrower than maximum width of the abdomen (measured from the ventral side); antenna 7-segmented (Fig. 30c), measurements:

0.23, 0.29, 0.55, 0.35, 0.43, 0.52, 0.52; eyes slightly protruding laterally with distal end rounded, eye length subequal to occiput; occipital lobes not conspicuous, slanting posteriorly from the eyes forming a widely round occiput, setae developed at the posterior surfaces; labrum (Fig. 30d) with long hairs anteriorly and a large, central, creamy pale spot; mandibles (Fig. 30e-j) without molar crest, formula: L 1234 y- ab / R 1234 y abd, b>a in left mandible, b=d >a in right mandible; maxillae: galeolacinia (Fig. 30k-l) with seven spines clustered at the tip, almost all spines straight or slightly inwardly curved at the tips, maxillary palp enlarged and stouter than galeolacinia; labium (Fig. 30m-n): prementum-postmentum articulation slightly surpassing the anterior corners of mesocoxae, prementum deeply concave dorsally with labial palps roughly triangular in shape, their dorsal margins almost reaching antennal bases, inner margins crenulated with each crenation (Fig. 30o) possessing 2-4 setae at the posterior half increasing in size, the last one at least 2x the length of the preceding setae, setae continue along the posterior margin not grouped but almost evenly spaced out alternating in sizes, movable hooks dark red, 10 marginal setae on both palps, ligula roughly triangular W/L ratio 1:0.13, its margin finely serrulate, with six submarginal small setae dorsally, no setae at the mere tip, premental setae in two opposing groups of 14 at both sides arranged as follows: nine long setae along the margin and five short entering the surface in an oblique line.
Thorax. Prothorax shorter than head with widely rounded posterior margin; pterothorax glabrous almost squarish from dorsal view, mesospiracles large, black; sternum (Fig. 30p) mostly bare, hairy around the joints of the mesocoxae and along the sutures between meso- and metasterna; legs (when fully extended, hind legs will reach and slightly surpass posterior end of S10), mostly bare small hairs on the ventral surfaces of procoxae, legs with dark bands (two on femora, three on tibiae), tarsal formula cannot be established because most are destroyed, tarsal claws simple, paler than rest of the tarsi except for the dark tips; wing sheaths reaching at least mid-section to of S5.
Abdomen. Roundly expanded reaching its widest point at articulation between S5-6; lacking dorsal protuberances (Fig. 30q) on almost all segments except short spine on the middle of posterior margin of S9; lateral spines at posterior corners of S8-9 (Fig. 30r); dorsum almost glabrous very short sparce hairs on the disks, rows of setae along the posterior edges increasing at density especially from S7-9; sternum mostly glabrous (hairy on S9-10); anal pyramid (Fig. 30s-u): wider than long with all five appendages sharply pointed, epiproct subequal to paraprocts hairy with a round ridge at the posterior 2/3, cerci twice shorter.
Measurements: TL(N=1) 15.5; AL(N=2) (ventral, excl. terminal abdominal app.) 8.7-8.8; MWh(N=1) 4.6; HfL (lateral; N=4) 4.2-4.7; MWa (ventral; N=1) 5.4; Ep (N=4) 1.0-1.2; Ce (N=4) 0.5-0.7; Pp (N=4) 1.2-1.3; lateral spine on S8 (N=4) 0.1; lateral spine on (N=4) S9 0.2-0.3.
Note. The Lieftinck (1962) key to the nymphs of Micronesian Libellulidae goes directly to species level and does not give characters at generic level. Therefore, the exuvia described in here does not completely fit the couplet 10(9) which is for *A. sanguinolenta*. Features such as the number of palpal setae and ratio between the cerci and epiproct do not match the description presented here and could be species specific. *Agrionoptera cardinalis* exuvia (described by supposition) was associated to the genus mainly due to the shape of the distal margin of the labial palpi (Fig. 30o). It appears to be reliable for distin-

Figure 28. ***Agrionoptera cardinalis*****: a) male (MM); b) female (HK).**

Figure 29. Locality 50, four exuviae identified as *A. cardinalis* (by supposition) were sampled from this site.

guishing between members of *Agrionoptera* Brauer, 1864 (crenulated with each crenation bearing tuft of spiniform setae) and *Neurothemis* (almost entire, very slightly undulated, obsolete teeth represented by single spiniform setae) and as illustrated in Lieftinck (1962: 79; fig. 25). However, using crenulation alone as a distinguishing character for *Agrionoptera* nymphs is not recommended for other regions where members of morphologically similar genera may co-exist.
Agrionoptera cardinalis was previously reported for Babeldaob and Koror (Asahina 1940; Lieftinck 1962; Ishida 1998; Katatani & Muraki 1999; Terayama & Uesugi 2024). First record for Peleliu.

Diplacodes bipunctata (Brauer, 1865) (Fig. 31)

Localities: **3, 4, 23, 28, 32, 40** (26 March), **47-48, 58**

Our field studies show that the members of this species are widespread, but not abundant at the localities sampled, at least for the period of observation.
Diplacodes bipunctata was previously reported for Babeldaob, Koror, Malakal, Ngergoi, Peleliu, Angaur (Ris 1911; Asahina 1940; Lieftinck 1962; Ishida 1998; Katatani & Muraki 1999; Englund 2011; Terayama & Uesugi 2024).

Macrodiplax cora (Brauer, 1867) (Fig. 32)

Localities: **32** (21 March)

One female was caught, identified by hand and released at the single locality reported here.
Macrodiplax cora was previously reported for Angaur (Lieftinck 1962; Terayama & Uesugi 2024). First record for Babeldaob.

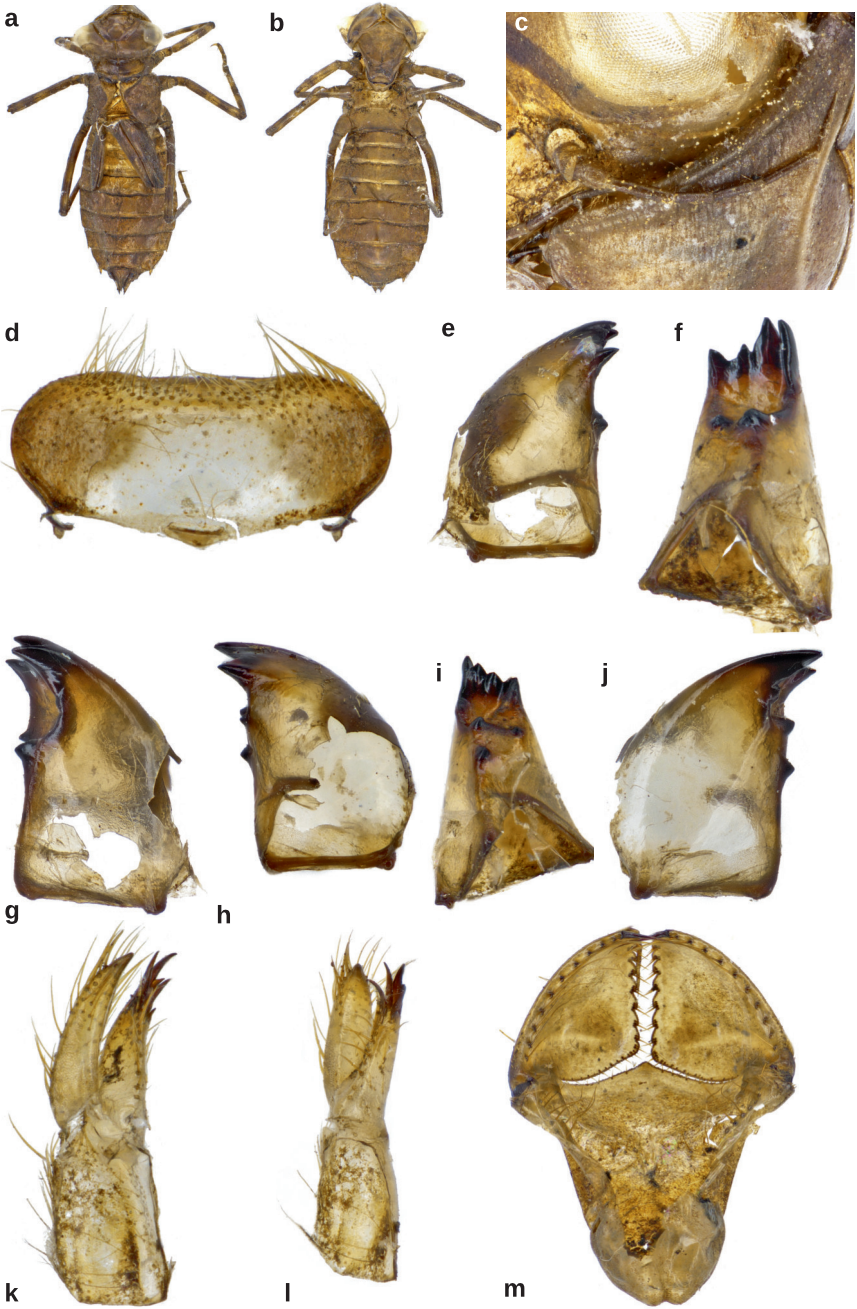

a
b
c
d
e
f
g
h
i
j
k
l
m

Figure 30. ***Agrionoptera cardinalis*****, exuvia (by supposition): a-b) habitus, dorsal and ventral views; c) antenna; d) labrum; e-g) left mandible, dorsal, inner and ventral views; h-j) right mandible, dorsal, inner and ventral views; k-l) left maxilla, dorsal and inner views; m-n) labium, dorsal and ventral views; o) crenulation of right labial palp, ventral view; p) pterothoracic sternum; q-r) abdomen, lateral and ventral views; s-u) anal pyramid, dorsal, ventral and lateral views.**

Figure 31. ***Diplacodes bipunctata*****: a) male, Wallis Island (MM); b) female (MM).**

Figure 32. *Macrodiplax cora*, male, Wallis Island (MM).

Neurothemis terminata Ris, 1911 (Fig. 33)

Localities: **1, 4-5, 9, 11, 15, 17-18, 21-23, 28-32, 34-39, 40 (26 March), 41, 45-47, 49-50, 54-55, 58**

The most commonly observed dragonfly for the investigation period. The large number of previous records infer that perhaps *N. terminata* could be observed at high density all year round.

Neurothemis terminata was previously reported for Babeldaob, Koror, Ngergoi, Peleliu, Angaur (Brauer 1869; Selys 1879; Krüger 1903; Ris 1911; Asahina 1940; Lieftinck 1962; Ishida 1998; Katatani & Muraki 1999; Englund 2011; Seehausen & Dow 2016; Terayama & Uesugi 2024).

Orthetrum serapia Watson, 1984 (Fig. 34)

Localities: **1, 3-5, 9, 11, 18, 22-23, 28, 32, 35-36, 38-39, 42, 48-50**

Recorded as very common across a wide range of habitats on the islands investigated during the present study. Field observations were carried out with great caution for validating the taxonomic identity of all *Orthetrum*-like individuals encountered. This was done because all previous records reported below were on *O. sabina*. Some of them were published prior to Watson (1984) who updated the hypothesis of *O. sabina* at the time and erected *O. serapia* (for more on the subject check Grand et al. 2019; Marinov et al. 2019). During the present study we also checked old material deposited at the Belau Museum and validated them all as affiliated to *O. serapia*. Therefore, we propose to transfer all previous records of *O. sabina* to *O. serapia* until proved otherwise. The co-existence of the members of the two species is not to be excluded for the moment.

Figure 33. ***Neurothemis terminata*****, male (MM).**

Figure 34. ***Orthetrum serapia*****, female (MM).**

Orthetrum serapia was previously reported for Babeldaob, Koror, Malakal, Hatohobei (Asahina 1940; Lieftinck 1962; Ishida 1998; Katatani & Muraki 1999; Englund 2011; Terayama & Uesugi 2024). First record for Peleliu.

Pantala flavescens (Fabricius, 1798) (Fig. 35)

Localities: **15, 22, 36, 44**

All observations were on flying individuals recorded as accidental at the localities. Due to its wide distribution within the Pacific and around the world, no particular attention was paid on the members of this species during the present field studies.
Pantala flavescens was previously reported for Babeldaob, Koror, Malakal, Angaur, Hatohobei (Asahina 1940; Lieftinck 1962; Ishida 1998; Katatani & Muraki 1999; Englund 2011; Terayama & Uesugi 2024). First record for Peleliu.

Figure 35. *Pantala flavescens*, male, New Caledonia (DG).

Rhyothemis variegata (Linnaeus, 1763) (Fig. 36)

Localities: **4, 9, 18, 22-23, 30-36, 40** (26 March), **44, 48-49**

We follow Kosterin et al. (2025) who abstained from commenting on the subspecific affiliation of *R. variegata* from the large area enclosed in between Indian subcontinent, Australia, Japan and Pacific islands up to Wallis. Other studies (e.g. Marinov et al. 2019; Marinov 2021) suggested the need of a revision of the Pacific members of the genus to explore if the wing colouration along could be used as a diagnostic character at the subspecific level as proposed so far. The complicated nature of this question has been demonstrated by comparing the colour patterns in some of the above mentioned studies. For consistency with other studies the wing colour of both sexes are presented here as well (Fig. 37),

Figure 36. *Rhyothemis variegata*, male (MM).

Figure 37. *Rhyothemis variegata*, wing patterns: a-b) male, FW and HW; c-d) female, FW and HW.

however, we will not discuss this point further before more detailed taxonomic work has been carried out For comparison with the illustration in Figure 37, check Marinov et al. (2019: 27, fig. 23) and Marinov (2021: 57, fig. 21).

Rhyothemis variegata was previously reported for Babeldaob, Koror, Malakal, Ngergoi, Peleliu, Angaur (Hagen 1867; Brauer 1868a, b; Selys 1882, 1891; Ris 1900, 1913; Krüger 1902; Semper 1905; Asahina 1940; Lieftinck 1962; Ishida 1998; Katatani & Muraki 1999; Englund 2011; Terayama & Uesugi 2024).

Tholymis tillarga (Fabricius, 1798) (Fig. 38)

Localities: **23, 40** (24 March)

Our expectations are that the two locations reported here are not representative of the actual distribution within the studied area. Most likely this species has a much wider distribution across the islands. The preference of the imagines to fly during late afternoon or at dusk has been reported in other studies across the Pacific (e.g. Lieftinck 1962) as well as in other parts of its range (e.g. Theischinger et al. 2021). This behavioural trait was observed in both localities reported here. Irrigation canals at Locality 23 were explored continuously during the daylight hours, with the first *T. tillarga* individuals coming to water at around 3pm. Those were males patrolling very intensively along the banks at a time when the activities of the other dragonflies noticeably decreased. *Tholymis tillarga* was previously reported for Babeldaob, Koror, Malakal, Angaur (Asahina 1940; Lieftinck 1962; Ishida 1998; Katatani & Muraki 1999; Englund 2011; Terayama & Uesugi 2024). First record for Peleliu.

Figure 38. *Tholymis tillarga*: a) male; b) female. All from Japan (TK).

Tramea transmarina Brauer, 1867 (Fig. 39)

Localities: **9, 15, 23, 32, 35-36, 39, 42, 44, 47-48**

Lieftinck (1962) commented that all previous records in the literature reported as *T. limbata* (Desjardins, 1835) for Micronesia (e.g. Ris 1913; Schmidt 1938; Asahina 1940) should be transferred to *T. transmarina* (a view proposed in earlier studies, see Lieftinck 1942). He presented the subspecific affinities and distribution of the Micronesian populations of *T. transmarina* as follows: *T. t. euryale* Selys, 1878 (north and west: Palau, Yap, South Mariana, Bonin) and *T. t. propinqua* Lieftinck, 1942 (east: Chuuk, Pohnpei, Kosrae, Marshall, Kiribati). This view has been questioned in consequent studies variously elevating them to species level (proposed at the time when they were erected as taxa new to science). As this division was mainly based on wing venation. which was demonstrated to be highly variable in other studies from Pacific islands (e.g. Marinov 2013; Marinov et al. 2015; Marinov et al. 2019), we prefer to leave this taxonomic discussion for the future. when more material is available across the rest of the insular Pacific region. Figure 40 demonstrates the variation in the extent of dark area at the bases of the hind wings in some selected specimens collected during the present study. It shows that this maculation alone is not enough for differentiation at the subspecific level. The shape in the male specimen (Fig. 40a) is almost identical to what illustrated in Marinov (2013: 9, fig. 5c) for a specimen from Tonga (reproduced on Fig. 40d).

Tramea transmarina was previously reported for Babeldaob, Koror, Malakal, Peleliu, Angaur (Asahina 1940; Lieftinck 1962; Asahina 1964; Ishida 1998; Katatani & Muraki 1999; Englund 2011; Terayama & Uesugi 2024).

Figure 39. *Tramea transmarina*, male, Wallis Island (MM).

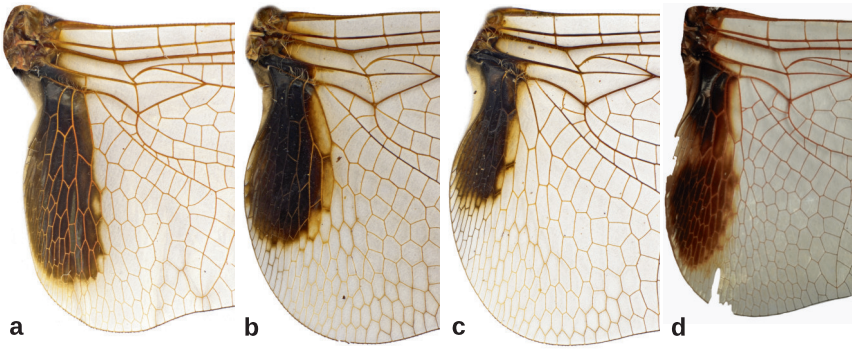


Figure 40. ***Tramea transmarina,*** **HW basal spot: a) male; b-c) females; d) male, Tongatapu Island, Tonga (Marinov 2013: 9, fig. 5c).**

Tramea sp.

Locality: **48**

One male individual was observed close to the locality reported in here (Fig. 41), but was flying too high to catch. The overall body shape, intensity of the red colour and size of the hind wing basal spot were found to be generally more intense than what usually observed in members of *T. transmarina*. Ishida (1998) also reported some *Tramea* sp. individuals (found on Koror and Malakal) which expressed similar characteristics. He commented on the possible affiliation with *T. t. propinqua* (discussed as a separate species as originally erected), but preferred not to make any specific identification.

Figure 41. Locality 48.

Zyxomma petiolatum Rambur, 1842 (Fig. 42)

Localities: **21, 53**

One record of a single specimen is all that has been published about this species from Palau (Asahina 1940). Lieftinck (1962) suggested that it was probably more widely distributed, but due to its crepuscular lifestyle is difficult to observe in nature. Three males from two localities (Figs 43-44) were collected during the present study.

Zyxomma petiolatum was previously reported for Koror (Asahina 1940; Lieftinck 1962; Terayama & Uesugi 2024). First record for Babeldaob.

Figure 42. *Zyxomma petiolatum*, mating pair in flight, Japan (TK).

Figure 43. Habitat for *Z. petiolatum* (Locality 21).

Figure 44. Habitat for *Z. petiolatum* (Locality 53).

Discussion

The present study confirmed the members of 19 taxa (*Anax* sp. to genus level only) out of the 20 included in Table 1 as so far reported for Palau. *Diplacodes trivialis* was the only one not sampled from the investigated area. Members of this species are widespread across SE Asia and the Pacific islands, with Wallis Island as the easternmost point so far reported (Marinov et al. 2021). This species is very common at the localities where it occurs, and has been reported from a wide range of habitats (Marinov & Waqa-Sakiti 2013) including roadside ditches which appear to be under high anthropogenetic pressure (M. Marinov, per. obs.). Therefore, the absence from the main islands of Babeldaob, Koror, Malakal and Peleliu was considered unusual. The literature review of the *D. trivialis* records for Palau showed that Ris (1911: 468) reported it for the first time. He cited Selys (1882), but Ris most likely misread the original source where the locality was given as “Palan”, which is probably a spelling of the island of Palawan in the Philippines. This mistake was commented on by Schmidt (1938) who did not include *D. trivialis* in his catalogue of the Odonata of the Pacific. Ris (1911) did not provide any additional records of *D. trivialis* from Palau. Therefore, Asahina (1940) is included in Table 1 as the first official record of *D. trivialis* for Palau. He reported 1♂, 3♀♀ found only on Hatohobei Island, which has never been resampled after that study. The specimens were deposited at the Kyushu University, Japan (Fig. 45) and rechecked during the present study to validate the identification. *Diplacodes trivialis* (Fig. 46) is found across the Philippines (Hämäläinen & Müller 1997), the Ryukyus, Japan (Ozono et al.

Figure 45. *Diplacodes trivialis* specimen collected from Hatohobei Island. Asahina collection deposited at Kyushu University, Japan (TM).

2012), the Solomon Islands (Marinov & Pikacha 2013), Vanuatu (Marinov et al. 2019), Fiji (Marinov & Waqa-Sakiti 2013), and Wallis (Marinov et al. 2021), but not yet found on Yap (Buden & Paulson 2007) or any other Micronesian islands.

Our results show that at least three more taxa should be added in the future when the association with males has been confirmed or more field sampling carried out. These are: *Pericnemis* (?) sp. (generic affiliation provisional for the moment), *Gynacantha* sp. and *Tramea* sp.

The faunistic analysis in comparison to previous studies shows that there is probably a seasonality of the Odonata of Palau. No specific phenological pattern can be proposed at the moment, however, our results seem to not completely agree with the earlier observations. For example, Ishida (1998) reported *A. cardinalis* specimens collected by Mr. Hajimu Ichi-

Figure 46. *Diplacodes trivialis*: a) male; b) immature male; c) female. All from Wallis Island (MM).

hashi, but he did not see these dragonflies in the field. Similar results are found in Englund (2011) where no *A. cardinalis* was included in his report. However, these dragonflies were found to be very common during the present investigation period. Individuals were mostly found in forested areas, from which records of successful development have been collected (Locality 50), but there were numerous males perched on the roadside vegetation. Their bright red bodies made them easy to spot.

On the other hand, during the 2023 investigation we failed to sample any *P. palauense*. Being one of the Palau endemic damselflies, they were specifically targeted during the field sampling. Literature search produced a list of previous localities which were revisited in 2023, however, no *P. palauense* observed. Ishida (1998) reported "many adults in a gently flowing stream" in November. Englund (2011) collected it "at Ngertebechel River around riffle/chute habitat in shaded areas", but found it uncommon in March. Lieftinck (1962) too had limited material to work on erecting the hypothesis of the new species, which was based on the holotype male taken in February. Probably the adult activity decreases around second half of March and resumes some weeks later. A full comparison with the congener *P. microcephalum* (Rambur, 1842) from other places in the Pacific cannot be made, but some interesting facts could be pointed out in here. Marinov et al. (2021) found *P. microcephalum* around Wallis Island at the end of February–first half of March; Marinov (2012, 2013) reported it to be active in the field during visits to Tonga in April and July respectively; and Marinov et al. (2019) recorded it as common on Efate and Malekula, Vanuatu. Whether there is a short window in the decrease of the activity for the Pacific *Pseudagrion* spp., or the absence of *P. palauense* from the 2023 investigated areas is related to some specificity of the phenology of the latter, remains to be established by future studies.

Speaking about the absence of certain species, Lieftinck (1962) listed *I. aurora* for all major Micronesian groups of islands except Palau. This fact was also emphasised in Buden & Paulson (2007), who found *I. aurora* on Yap. *Ischnura aurora* was not reported for Palau in any of the subsequent studies, including the present one. These small and delicate damselflies have often been given as examples of an air-borne dispersalist which is blown the wind and spread across the entire Pacific (Armstrong 1958, 1973; Belyshev 1969; Donnelly 2005; Fraser 1925, 1927; Lieftinck 1962; Tillyard 1924). If this is really a "wind-borne and highly adaptive species" (according to Lieftinck 1962) why has not been reported from Palau so far? The answer to this question could be as simple as that *I. aurora* (Fig. 47) has been so far omitted because of its small size. However, there may be other explanations related to the specific biogeographic situation of Palau.

Discussing the biogeography of Palau, Heads (2014) stressed the fact that these islands lie at the eastern limits of the distribution for members of various groups (e.g. ferns, birds), including the family Platystictidae. The latter is otherwise very common in SE Asia and a comprehensive list of species found in the neighbouring Philippines contains more than 30 species in two genera: *Drepanosticta* Laidlaw, 1917 and *Protosticta* Selys, 1885 (Hämäläinen & Müller 1997). Van Tol (2009) commented that the occurrence of a single "species of *Drepanosticta* on Palau presently ca. 800 km east of Mindanao, presumably the nearest founder population, is another enigma". The present field studies demonstrated what we call a "secretive life" for *D. palauensis*. Members of this species were discovered in a narrow range of habitats along the upper sections of streams, in areas subjected to floods

Figure 47. *Ischnura aurora*: a) tandem with teneral female; b) mature female. All from Wallis Island (MM).

inside forested areas at the source or dense bank vegetation under 100% tree cover. The nature of the terrain on the largest island of Babeldaob serves to restrict the number of such suitable habitats. Unlike other islands in Palau, Babeldaob is mountainous, but the highest peak of Ngerchelchuus is only 242 m a.s.l. The main road cuts along the ridge tops with a few side roads reaching down to the ocean. This leaves only short sections of the tributaries to the main rivers unaffected by the anthropogenic activities as locations where *D. palauensis* may survive. The sheltered places deep inside the forest seem to protect individuals well enough that they are rarely exposed to an eventual transport across the ocean blown by the wind. Therefore, Heads' (2014) suggestion of the seafloor spreading (not long distance dispersal) may be the answer to question about the distribution of the members of Platystictidae.

Long distance dispersal from SE Asia seems to be improbable scenario for the pattern so far observed in the lack of the members of some taxa. For example, *I. aurora*, otherwise very common across the Pacific, was never reported from any of the Palauan islands, but is found on Yap, about 450 km to the NE. *Diplacodes trivialis* on the other hand occurs on the small island of Hatohobei (0.85 km^2), but has never been recorded from any of the other much larger islands in Palau. These appear to be examples of the so-called by Marinov (2015) "selective distribution". Random aerial transport would be expected to result in a more or less uniform, but not disjunct set of distributions where the members seem to somehow "avoid" some islands which are aligned with the wind direction and "select" others in order to settle in. More studies are needed to demonstrate if these two species are really absent from Palau or so far overlooked. Human mediated transport, mentioned by Marinov (2015), should also be given more attention in future studies as a possible explanation of the records of occasional specimens in some island groups which are absent from neighbouring islands.

Acknowledgements

The field sampling in 2023 was funded by the International Dragonfly Fund. We thank Martin Schorr for the continued support for the studies of the Pacific Odonata. Belau National Museum is thanked for the logistic in the field and coordination with the collection permits obtained from the respective states. State authorities were very helpful in providing us with assistance needed for the field studies. Toshiharu Mita assisted with images of *Diplacodes trivialis* deposited at the Kyushu University. Rodolfo Novelo Gutiérrez provided valuable comments and guided us on the description of the *Agrionoptera cardinalis*. Various photographers (acknowledged in the relevant sections) shared with us images of live individuals.

Our final gratitude goes to all people in Palau who were curious to learn about the field studies on Odonata, shared some folk stories related to these insects and joining us for some of the field days.

References

Armstrong, J., 1958. Notes on *Ischnura aurora* (Brauer), Odonata. New Zealand Entomologist 2(2): 2-3.

Armstrong, J., 1973. Odonata of the Kermadec Islands. New Zealand Entomologist 5(3): 277-283.

Asahina, S., 1940. Odonata-Anisoptera of Micronesia. Tenthredo 3: 1-23.

Asahina, S., 1964. Descriptions of new and little known dragonflies from the Ryukyus (Odonata). Kontyû 32(2): 299-310.

Athens, S. & J. Ward, 2005. Palau compact road archaeological investigations, Babeldaob island, Republic of Palau. Phase 1: Intensive Archaeological Survey. Volume IV: Holocene Paleoenviroment and Landscape Change. International Archaeological Research Institute, Inc.: 159 pp.

Belyshev, B., 1969. Frangemti k zoogeographii strekoz (Odonata) mira. I. (Contribution to the zoogeography of dragonflies (Odonata) of the world). I. Annales zoologici Warszawa 27(1): 1-27. [in Russian with summaries in Polish and English]

Blust, R., 2009. Palauan historical phonology: whence the intrusive velar nasal? Oceanic Linguistics 48(2): 307-336.

Brauer, F. 1868a. Neue und wenig bekannte vom Herrn Doct. Semper gesammelte Odonaten. Verhandlungen der kaiserlichköniglichen zoologischbotanischen Geselschaft Wien 18: 167-188.

Brauer, F. 1868b. Verzeichniss der bis jetzt bekannten Neuropteren im Sinne Linné's. Zweiter Abschnitt. Verhandlungen der kaiserlichköniglichen zoologischbotanischen Gesellschaft Wien 18: 711-742.

Brauer, F. 1869. Beschreibung neuer Neuropteren aus dem Museum Godeffroy in Hamburg. Verhandlungen der kaiserlichköniglichen zoologischbotanischen Geselschaft Wien 19: 9-18.

Buden, D. & D. Paulson, 2007. Odonata of Yap, Western Caroline Islands, Micronesia. Pacific Science 61 (2): 267-277.

Clark, G., A. Anderson & D. Wright, 2006. Human colonization of the Palau islands, western Micronesia. Journal of Island and Coastal Archaeology, 1: 215-232.

Donnelly, T., 2005. Oceanic islands in the news – or – Parthenogenesis means never having to remember Valentine's Day. Argia 17 (3): 31-32.

Fraser, F., 1925. A preliminary report on the Dragonflies (Order Odonata) of Samoa. Transactions of the Entomological Society London 1924 IIIIV: 429-438.

Fraser, F., 1927. Insects of Samoa and other Samoan terrestrial Arthropoda. Odonata. London, British Museum (Nat. Hist.), Part VII, Fasc. I: 19-44.

Englund, R., 2011. 2010 trip report: Guam and Palau aquatic insect surveys. Bishop Museum, Pacific Biological Survey: 21 pp.

Garrison, R., N. von Ellenrieder & J. Louton, 2010. Damselfly Genera of the New World: An Illustrated and Annotated Key to the Zygoptera. The Johns Hopkins University Press: 490 pp.

Grand, D., M. Marinov, H. Jourdan, C. Cook, S. Rouys, C. Mille & J. Theuerkauf, 2019. Distribution, habitats, phenology and conservation of New Caledonian Odonata. Zootaxa 4640: 1-112.

Hagen, H., 1867. Die Neuroptera der Insel Cuba. Stettiner Entomologische Zeitung 28: 215-232.

Hämäläinen, M. & R. Müller, 1997. Synopsis of the Philippine Odonata, with lists of species recorded from forty islands. Odonatologica 26(3): 249-315.

Heads, M., 2014. Biogeography of Australasia: a molecular analysis. Cambridge University Press: 493 pp.

Ishida, S., 1998. Insect fauna in Palau (mainly dragonflies and cicadas). Preliminary report on the Mie-Palau Environmental Conservation Research, Mie higher education system liaison Conference, Mie Prefecture, March 1998: 97-113.

Jordan, S., C. Simon, D. Foote & R. Englund, 2003. Phylogeographic patterns of Hawaiian *Megalagrion* damselflies (Odonata: Coenagrionidae) correlate with Pleistocene island boundaries. Molecular Ecology 14: 3457-3470.

Katatani, N. & A. Muraki, 1997. Records of the Odonata taken in Palau, Part I. Aeschna 33: 1-10.

Katatani, N. & A. Muraki, 1999. Records of the Odonata taken in Palau, Part II. Aeschna 35: 9-22.

Kirby, W.F., 1890. A synonymic catalogue of Neuroptera Odonata or dragonflies. With an appendix of fossil species. Gumey & Jackson, London: 202 pp.

Kosterin, O., E. Vshivtseva & A. Blinov, 2025. What was known as *Rhyothemis variegata* (Linnaeus, 1763) and *R. phyllis* (Sulzer, 1776) (Odonata, Libellulidae) are the same species. Zootaxa, 5725 (4): 567-582.

Krüger, L., 1902. Die Odonaten von Sumatra. III. Theil. b. Familie Libeluliden. Stettiner entomologische Zeitung 63: 58-193.

Krüger, L., 1903. Die Arten der Odonatengattung *Neurothemis*. Stettiner entomologische Zeitung 64: 248-291.

Lieftinck, M., 1942. The Dragonflies (Odonata) of New Guinea and neighbouring Islands. Part VI. Treubia 18: 441-608.

Lieftinck, M.A., 1962. Insects of Micronesia. Odonata. Insects of Micronesia 5(1): 1–95.

Malsol, Y., 1999. Palauan language Workbook. Koror, Palau: 85 pp.

Marinov, M., 2012. Odonata from the Kingdom of Tonga, with a description of *Pseudagrion microcephalum stainbergerorum* ssp. nov. (Zygoptera: Coenagrionidae). Odonatologica 41(3): 225-243.

Marinov, M., 2013. Contribution to the Odonata of the Kingdom of Tonga. Faunistic Studies in South-East Asian and Pacific Island Odonata 1: 1-18.

Marinov, M., 2015. The seven “oddities” of Pacific Odonata biogeography. Faunistic Studies in South-East Asian and Pacific Island Odonata 11: 1-58.

Marinov, M., 2021. A taxonomic and biogeographic discussion on *Rhyothemis regia* (Brauer, 1867) from Samoa and neighbouring islands with introduction of *Rhyothemis regia uveae* subsp. nov. (Odonata: Libellulidae). Faunistic Studies in Southeast Asian and Pacific Island Odonata 35: 1-33.

Marinov, M., S. Bybee, C. Doscher & D. Kalfatakmolis, 2019. Faunistic studies on Odonata of the Republic of Vanuatu (Insecta: Odonata). Faunistic Studies in South-East Asian and Pacific Island Odonata 26: 1-46.

Marinov, M. & C. Doscher, 2011. Spatial modelling of Odonata habitats in the Pacific, 1: Introduction to the techniques in spatial modelling. Odonatologica 40(4): 287-304.

Marinov, M., R. Krieg-Jacquier, J.-M. Duvernay, G. Fleck, J. Vincent-Gorlier, N. Mary, C. Doscher, F. Le Bail, H. Jourdan & J. Theuerkauf, 2021. An update of the Odonata fauna of Wallis & Futuna (Insecta: Odonata). Faunistic Studies in South-East Asian and Pacific Island Odonata 35: 35-67.

Marinov, M. & P. Pikacha, 2013. On a dragonfly collection from the Solomon Islands with overview of fauna from this Pacific archipelago (Insecta: Odonata). Faunistic Studies in South-East Asian and Pacific Island Odonata 4: 1-48.

Marinov, M., M. Schmaedick, D. Polhemus, R. Stirnemann, F. Enoka, P. Siaifoi Fa'aumu & M. Uili, 2015. Faunistic and taxonomic investigations on the Odonata fauna of the Samoan archipelago with particular focus on taxonomic ambiguities in the “Ischnurine complex”. International Dragonfly Fund Report 91: 1-56.

Marinov, M. & H. Waqa-Sakiti, 2013. An illustrated guide to dragonflies of Viti Levu, Fiji. The University of South Pacific Press: 148 pp.

Michael, P. & R. Jaensch, 2014. Directory of Wetlands of Palau - 2014. Report to the Secretariat of the Pacific Regional Environment Program: 87 pp.

NEPC, 2019. 2019 State of the Environment Report, Republic of Palau. National Environmental Protection Council (NEPC), Government of Palau: Koror, Palau: 100 pp.

Ozono, A., I. Kawashima & R. Futahiashi, 2012. Dragonflies of Japan, Revised edition. Bunichi-Sogo Syuppan: 532 pp.

Palau Conservation Society, 2016. The Republic of Palau, Revised National Biodiversity Strategy and Action Plan 2015-2025. Promoting Wise Development to Achieve Conservation and Sustainable Use of Biodiversity. Prepared For: Ministry of Natural Resources, Environment and Tourism National Government of the Republic of Palau November 2016: 177 pp.

Paulson, D., M. Schorr, J. Abbott, C. Bota-Sierra, C. Deliry, K.-D. Dijkstra & F. Lozano (Coordinators), 2025. World Odonata List. OdonataCentral, University of Alabama. Available at: https://www.odonatacentral.org/app/#/wol/. (Accessed: 10 April 2024).

Ris, F., 1900. Libellen vom Bismarck-Archipel, gesammelt durch Prof. Friedrich Dahl. Archiv für Naturgeschichte 66 (1): 175-204.

Ris, F., 1909-1919. Collections Zoologiques du Baron Edm. de Selys Longchamps, Catalogue Systematique et descriptif. Libellulinen monographisch bearbeitet. Vol. 1, Fascicule IX (1909): 1-120, Fascicule X (1910): 121-244, Fascicule XI (1910): 245-384; Vol. 2, Fascicule XII (1911): 385-528, Fascicule XIII (1911): 529-700, Fascicule XIV (1912): 701-830; Vol. 3 Fascicule XV (1913): 837-964, Fascicule XVI, part 1 (1913): 965-1042, Fascicule NVI, part 2 (1919): 1043-1278.

Ris, F., 1916. H. Sauter's Formosa-Ausbeute. Odonata. Supplementa Entomologica 5: 1-81.

Seehausen, M. & R. Dow, 2016. Morphological studies and taxonomic considerations on the ‘reddish-brown-winged’ group of *Neurothemis* Brauer, 1867 with the description of *N. taiwanensis* sp. nov. (Odonata: Libellulidae). International Dragonfly Fund Report 93: 101 pp.

Selys-Longchamps, E. de, 1879. Nouvelles observations sur les odonates de la région de la Nouvelle Guinée. Annali del Museo Civico di Storia Naturale Genova 14: 287-324.

Selys-Longchamps, E. de, 1882. Odonates des Philippines. Anales de Historia Natural 11: 1-32.

Selys Longchamps, E. de, 1891. Viaggio di Leonardo Fea in Birmanie e regioni vicine, XXXII, Odonates. Annali del museo civico de storia naturale di Genova 10: 433-511.

Semper, G., 1905. Beitrag zur Lepidopterenfauna des Karolinen-Archipels. Deutsche Entomologische Zeitschrift 18: 245-267.

Semper, K., 1873. Die Palau-Inseln im Stillen Ocean / translated by M.L. Berg, 1980 Palau Islands in the Pacific Ocean. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://evols.library.manoa.hawaii.edu/server/api/core/bitstreams/b0113b09-7830-480a-92c4-44c7471fbf5a/content.

Schmidt, E., 1938. Check-list of Odonata of Oceania. Annals of the Entomological Society of America 31 (3): 322-344.

Terayama, M. & M. Uesugi, 2024. Odonata (Insecta) of Palau. Identification guide to the insects of Palau, 3. Odonata, 29 pp. Available from: https://jimdofree.com/app/download/1417146980/

Theischinger, G., J. Hawking & A. Orr, 2021. The complete field guide to dragonflies of Australia. 2nd edn. CSIRO Publishing, Melbourne: 406 pp.

Tillyard, R., 1924. The dragonflies (Order Odonata) of Fiji, with special reference to a collection made by Mr. H.W. Simmonds, F.E.S., on the Island of Viti Levu. Transactions of the Entomological Society London 1923 IIIIV: 305-346.

USDA (United States Department of Agriculture), Natural Resources Conservation Service, 2009. Soil survey of the Islands of Palau, Republic of Palau: 403 pp. Accessible online at: http://soils.usda.gov/survey/printed_surveys/

Van Tol, J., 2009. Phylogeny and biogeography of the Platystictidae (Odonata). Ph.D. thesis, University of Leiden: p. i-x + 1-294.

Watson, J., 1984. A second Australian species in the *Orthetrum sabina* complex (Odonata: Libellulidae). Journal of the Australian Entomological Society 23: 1-10.

INSTRUCTION TO AUTHORS

Faunistic studies of South-East Asian and Pacific islands Odonata is a journal of the International Dragonfly Fund (IDF). It is referred to as the journal in the remainder of these instructions. Transfer of copyright to IDF is considered to have taken place implicitly once a paper has been published in the journal.

The journal publishes original papers only. By original is meant papers that: a) have not been published elsewhere before, and b) the scientific results of the paper have not been published in their entirety under a different title and/ or with different wording elsewhere. The republishing of any part of a paper published in the journal must be negotiated with the Editorial Board and can only proceed after mutual agreement.

Papers reporting studies financially supported by the IDF will be reviewed with priority, however, authors working with Odonata from the focal area (as defined on the back page of the front cover) are encouraged to submit their manuscripts even if they have not received any funds from IDF.

Manuscripts submitted to the journal should preferably be in English; alternatively German or French will also be accepted. Every manuscript should be checked by a native speaker of the language in which it is written; if it is not possible for the authors to arrange this, they must inform the Editorial Board on submission of the paper. Authors are encouraged, if possible, to include a version of the abstract in the primary language of the country in which their study was made.

Authors can choose the best way for them to submit their manuscripts between these options: a) via e-mail to the publisher, or b) on a CD, DVD or any other IBM-compatible device. Manuscripts should be prepared in Microsoft Word for Windows.
While preparing the manuscript authors should consider that, although the journal gives some freedom in the style and arrangements of the sections, the editors would like to see the following clearly defined sections: Title (with authors names, physical and e-mail addresses), Abstract, Introduction, Material & Methods, Results, Discussion, Acknowledgments and References. This is a widely used scheme by scientists that everyone should be familiar with. No further instructions are given here, but every author should check the style of the journal.

Authors are advised to avoid any formatting of the text. The manuscripts will be stylised according to the font type and size adopted by the journal. However, check for: a) all species names must be given in italic, b) the authority and year of publication are required on the first appearance of a species name in the text, but not thereafter, and c) citations and reference list must be arranged following the format below.

Reference cited in the text should read as follows: Tillyard (1924), (Tillyard 1924), Swezey & Williams (1942).

The reference list should be prepared according to the following standard:
Swezey, O. & F. Williams, 1942. Dragonflies of Guam. Bernice P. Bishop Museum Bulletin 172: 3-6.
Tillyard, R., 1924. The dragonflies (Order Odonata) of Fiji, with special reference to a collection made by Mr. H.W. Simmonds, F.E.S., on the Island of Viti Levu. Transactions of the Entomological Society London 1923 III-IV: 305-346.

Citations of internet sources should include the date of access.

The manuscript should end with a list of captions to the figures and tables. The latter should be submitted separately from the text preferably as graphics made using one of the Microsoft Office products or as a high resolution picture saved as a .jpg .tif or .ps file. Pictures should be at least 11 cm wide and with a minimum 300 dpi resolution, better 360 dpi. Line drawings and graphics could have 1200 dpi for better details. If you compose many pictures to one figure, please submit the original files as well. Please leave some space in the upper left corner of each picture, to insert a letter (a, b, c...) later. Hand-made drawings should be scanned and submitted electronically. Printed figures sent by the post could be damaged, in which case authors will be asked to resubmit them.

Manuscripts not arranged according to these instructions may also be accepted, but in that case their publication will be delayed until the journal's standards are achieved.