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Chapter 12

Dragonflies and Damselflies of the Muller Range, Papua New Guinea

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SUMMARY

We conducted a survey of dragonflies at three elevations in the Muller Range of central-western Papua New Guinea (PNG) from 4-25 September 2009. Thirty-six species were documented, of which 31 were found only at the lowland site. Diversity at Camp 1 (Gugusu; ~500 m) was similar to that documented from the limited number of other sites studied in the central mountain range, and the dragonfly community conformed with a number of patterns previously observed at low elevations in the central ranges: (1) Higher level taxonomic diversity (number of families) is high in proportion to the number of species; (2) the majority of species are dependent on running water; (3) most of the species associated with running water are endemic to New Guinea while most species occupying standing water habitats are more widespread and often also occur outside New Guinea. At least six species new to science were found at Gugusu reinforcing the view that many species of dragonflies still await discovery in New Guinea. This is probably especially so for the southern slopes of the central mountain range in PNG because this area remains relatively unexplored. Diversity was extremely low at Camp 2 (Sawetau; 1,600-2,000 m; 1 species) and Camp 3 (Apalu Reke; 2,875 m; 4 species). The karst area at camp 2 is largely devoid of aquatic habitats and hence has a very poor dragonfly fauna. Camp 3 was above the altitudinal limit of all but a few species. However the discovery of the presumed larvae of *Papuagrion* at Camp 3 constitutes the first record of larvae of this genus. Its life-style (aboreal and semi-terrestrial) is unique among dragonflies and warrants more research.

We also report on a small collection of dragonflies assembled during the 2008 RAP survey at Tualapa near Wanakipa Village in the upper Strickland River catchment on the northern edge of the Muller Range. Opportunistic collecting at elevations between 845-1,422 m around Tualapa Camp documented 18 species of dragonflies including only the second records of the poorly known *Hylaeargia magnifica* and the recently described *Argiolestes verrucatus*.

INTRODUCTION

A short introduction to dragonflies and damselflies

Dragonflies (including damselflies) are well-known insects, due to their often striking colours and remarkable powers of flight. The larvae of most species live in running and standing freshwater environments, but some are tolerant of brackish and salty waters and a few even live in moist terrestrial habitats. Many species have small ranges, and are specific to certain habitats such as mountain bogs or seepages. Dragonflies are frequently used as indicators of environmental health and their sensitivity to habitat quality (e.g. forest cover, water chemistry), their amphibious life cycle, and the relative ease of their identification make them equally well suited for evaluating environmental changes in the long term (biogeography, climatology) and in the short term (water pollution, structural alteration of aquatic and riparian habitats). Dragonflies are recognized by their long and slender abdomen, their large globular eyes,

which often make up a large portion of the head, their short antennae and their long wings. They are divided into two suborders, namely Zygoptera or damselflies, and Anisoptera (Epiprocta) or true dragonflies. In this report the word 'dragonflies' is used for both suborders. Dragonfly larvae prey on all kinds of small animals up to the size of tadpoles and small fish. They take from a few weeks to several years to develop. Emergence takes place above the water on plants or on the shore, after which most species leave the water's edge to mature. The males return to the water to search for females or to establish territories, whereas the females often return only to mate and to lay their eggs. With about 5,680 species, the dragonflies constitute a relatively small insect order and most species are found in the tropics (Kalkman et al. 2008). A recent global conservation assessment of selected species indicated that about 10% of the world's dragonflies would probably be regarded as Threatened (CR, EN or VU) and 35% as Data Deficient (Clausnitzer et al. 2009).

Dragonflies of New Guinea

Nearly 420 species of dragonflies are currently known from New Guinea and adjacent islands, which is about seven percent of the world total. Almost 60 percent of these (238 species) were described by Maus Lieftinck in the period 1931-1987. Not only did he describe the majority of the known species but he also re-described and illustrated many of the previously described species. Lieftinck (1949) provides a summary of the fauna up to that date. A list of references published since 1949, together with an updated regional checklist, can be found at: www.papua-insects.nl. The high quality of Maus Lieftinck's work ensured that our knowledge of the basic taxonomy of New Guinean odonates is very good. However most of the material worked on by Lieftinck was collected by professional collectors or during expeditions in which he did not participate, and he visited the island of New Guinea only once. As a result information on the behavior, habitat and distribution of most species is very scant. It was not until 2003-2004 that the first serious study on habitat associations of New Guinean odonates was undertaken (Oppel 2005, 2006) and only a small number of faunistic papers have been published to date (Kalkman 2008, Kalkman et al. 2009, Kaize and Kalkman 2009, Polhemus 1995, Richards et al. 1998). The last decade has seen a surge of interest in the dragonflies of New Guinea, resulting in an increase in both fieldwork and in the number of species described from the region (e.g. Englund & Polhemus 2007, Kalkman 2008, Michalski and Oppel 2007, Theischinger and Richards 2006, 2007, 2008).

About 3500 dragonfly records (comprising a species record on a specific date at a specific location) have been published from mainland New Guinea, of which less than a third originate from Papua New Guinea (Figure 12.1). Two areas in the central mountain range have been especially well explored. These are an elevational cross-section of the mountains near the Baliem Valley in Indonesia's Papua Province which was visited during the Third Archbold Expedition, and Crater Mountain Wildlife Management Area (CMBRS) in PNG which was explored in 2003-2004 (Oppel 2005, 2006). Records from other sites in the central mountain range are generally based on small numbers of specimens and give an incomplete impression of the local fauna.

Over half of the dragonfly species and more than a quarter of the genera reported from New Guinea are endemic to mainland New Guinea and adjacent islands. Most of the endemic species and genera are present in, and many are restricted to, the central mountain range. In contrast the southern lowlands of New Guinea seem to be comparably species poor with relatively few endemics, but more fieldwork in this area is needed. Although it is clear that there are differences at the species level between the faunas on the northern and southern slopes of the central mountain range, it is not yet clear whether the composition of the fauna at

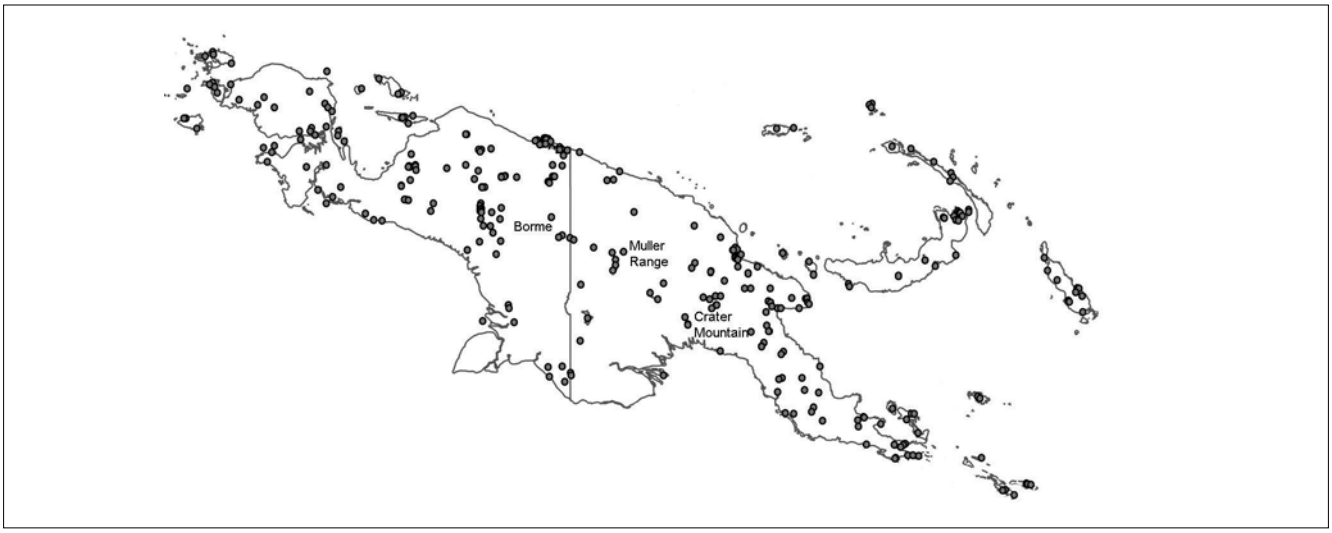

Figure 12.1. Collection localities for odonates on mainland New Guinea and nearby islands

higher taxonomic levels is different. Attempts to understand biogeographical patterns in the New Guinea dragonfly fauna are currently compromised by the scarcity of comprehensive data on regional faunas. For example current rates of species discovery in the region indicate that more than 100 additional New Guinean species still await discovery and description.

To address this issue several students from the Universitas Cenderawasih, Jayapura (UNCEN) have been trained in techniques for collecting dragonflies. However identification of material by students in the field remains a major obstacle and for this reason a field guide to the dragonflies of northern New Guinea is currently being prepared. This chapter reports findings of two surveys that documented diversity and endemicity of odonate fauna in the upper Strickland basin in southern Papua New Guinea.

METHODS

Adult and larval dragonflies were collected with a hand net during daylight from all available freshwater habitats at the three camp sites visited during the 2009 Muller Range expedition. Larvae were not sampled during the 2008 RAP survey. Identifications were based mainly on the papers by Lieftinck (see above); taxonomy follows Van Tol (2006). Alternative higher-level classifications that affect some PNG taxa have recently been proposed (see e.g. Theischinger and Endersby (2009)) but these do not alter the species- and genus-level names presented here. Voucher specimens from the 2009 survey are deposited in the collection of the National Museum of Natural History (Leiden, The Netherlands); those from the 2008 survey will be deposited in the South Australian Museum. A selection of duplicates will be returned to Papua New Guinea.

Sites

2008 RAP survey

Tualapa – (5°17.003'S, 142°29.849'E; 1,115 m).
The main camp at Tualapa is in medium-crowned upland (hill) forest (Takeuchi, Chapter 9 this volume) that has been adversely impacted by the 1997-1998 El Nino event. Collections were made in the camp clearing, along trails near camp, and at the following streams: Ate Weti, a large stream adjacent to Tualapa camp (05°17.080S, 142°29.756E; 1,075 m), Ate Pukhali (05°16.402S, 142°30.352E; 845 m); Ate Tautwa (05°17.284S, 142°30.047E; 1,135 m) and Ate Kokopa (05°18.342S, 142°30.654E; 1,422 m). All of the streams were clear and flowed over rocky substrates. All were located in mature forest habitats except Ate Pukhali, which was broadly exposed due to a series of land-slips. Sunny periods were encountered on most days of the survey but collecting was opportunistic and the results should not be considered a comprehensive inventory of the local dragonfly fauna.

2009 RAP survey

Camp 1: Gugusu – (05°43.751S, 142°15.797E; 515 m).
The habitats for dragonflies at camp one consisted of a series of runnels and small brooks in primary forest, most of which were followed for a few kilometers. The width of the brooks varied from a few decimeters to about five meters. The brooks were mostly shallow (a few centimeter to ~ 50 cm), steep and partly running over bare rock. A few seeps were present on top of the ridge at the starting point of the brooks. The only standing (non-flowing) water was a small pond of one square meter dug at the campsite to provide a waste dump and a small pool adjacent to the helipad. Most of the brooks were shaded for large parts of the day due to surrounding forest. The weather at this site was generally sunny for at least part of the day.

Camp 2: Sawetau – (05°39.397S, 142°18.277E; 1,587 m).
Very little surface water was present at this site due to the karst geology. Only one small brook occurred in the primary forest that covered this site. It ran at the surface for only about 20 m before continuing underground, and was shaded for most of the day. At 2016 m on a ridge above camp a small depression was present containing several small sphagnum pools. This location was visited with good weather on at least three occasions but no dragonflies were observed. Based on the knowledge of the local people no other surface water is present in the broad surroundings. The two sites with water are connected by a path going to the village of Tobi and are used as resting places by the local community indicating that water is indeed a limited resource in this area. Most days at this site were largely cloudy with little sunshine penetrating to the forest floor.

Camp 3: Apalu Reke – (05°29.174S, 142°18.117E; 2,875 m).
The open areas at this campsite in montane grassland with patches of montane forest contained a large number of small, and a few larger, pools. All of these pools were remarkably similar in being very shallow (5-10 cm), with a solid bottom on which a layer of 1-2 cm of detritus was present. The banks of these pools consisted of ferns and grasses. Although several brooks were seen in the area during our arrival by helicopter most were too remote to reach on foot and the only running water accessed was a small brook in shaded forest which ran at the surface for several hundreds meters adjacent to the camp. Most days were largely cloudy but there were some periods with sun, during which the temperature in open areas increased quickly.

RESULTS AND DISCUSSION

2008 RAP Survey

A total of 18 species were documented during this survey (Table 12.1). Five species of Libellulids (*Agrionoptera longitudinalis, Neurothemis stigmatizans, Orthetrum glaucum, Orthetrum villosovittatum,* and *Tramea* sp.) and the large

Table 12.1. Odonate (Dragonfly and damselfly) species documented in the upper Strickland Basin (2008) and Muller Range (2009).

Species	Gugusu (~515 m)	Sawetau (1,600-2,000 m)	Apalu Reke (2,875 m)	Tualapa (2008) (850-1,400 m)
CALOPTERYGIDAE				
Neurobasis ianthinipennis Lieftinck, 1949	X			
CHLOROCYPHIDAE				
Rhinocypha tincta Rambur, 1842	X			
MEGAPODAGRIONIDAE				
Argiolestes ornatus group sp1	X			
Argiolestes ornatus group sp2	X			
Argiolestes muller Kalkman et al. 2010	X			
Argiolestes tuberculiferus Michalski & Oppel, 2010	X			
Argiolestes verrucosus Michalski & Oppel, 2010				X
PLATYSTICTIDAE				
Drepanosticta lepyricollis Lieftinck, 1949	X			
Drepanosticta cf. *dendrolagina* Lieftinck, 1938	X			
ISOSTICTIDAE				
Selysioneura cervicornu Förster, 1900				X
Selysioneura sp.	X			
COENAGRIONIDAE				
Ischnura acuticauda Lieftinck, 1959			X	
Papuagrion sp.			X	
Papuagrion sp.	X			X
Pseudagrion civicum Lieftinck, 1932	X			
Teinobasis scintillans Lieftinck, 1932				X
Teinobasis sp. nov.	X			
PLATYCNEMIDIDAE				
Hylaeargia magnifica Michalski 1995				X
Idiocnemis australis Gassmann, 1999	X			
Idiocnemis dagnyae Lieftinck, 1958	X			
Palaiargia sp.	X			X?
Papuargia sp. nov.	X			
Paramecocnemis sp. nov.	X			
Arrhenocnemis parvibullis Orr & Kalkman, 2010	X			
PROTONEURIDAE				
Nosoticta finisterrae (Förster, 1897)	X			X
AESHNIDAE				
Anax selysi Förster, 1900				X
Aeshnidae unid		X		
Gynacantha kirbyi? Krüger, 1899				X
MACROMIIDAE				
Macromia sp.	X			
CORDULIIDAE				
Cordulidae			X	
Hemicordulia silvarum Ris, 1913	X			

table continued on next page

Table 12.1. *continued*

Species	Gugusu (~515 m)	Sawetau (1,600-2,000 m)	Apalu Reke (2,875 m)	Tualapa (2008) (850-1,400 m)
LIBELLULIDAE				
Agrionoptera longitudinalis Selys, 1878	X			X
Bironides/Microtrigonia	X			
Diplacina ismene Lieftinck, 1933	X			X?
Diplacina paula? Ris, 1919				X
Diplacodes trivialis Rambur, 1842	X			
Huonia arborophila Lieftinck, 1942				X
Lanthanusa lamberti Lieftinck, 1942			X	
Nannophlebia sp.	X			X?
Nannophlebia sp. nov.	X			
Neurothemis stigmatizans (Fabricius, 1775)				X
Orthetrum glaucum Brauer, 1865	X			X
Orthetrum villosovittatum Brauer, 1868	X			X
Protorthemis coronata Brauer, 1866	X			
Tramea sp.	X			X
Totals	**31**	**1**	**4**	**18**

aeshnid *Anax selysi* were abundant in the camp clearing. All are species with wide distributions in New Guinea and most of them also occur outside New Guinea. The small, widespread coenagrionid *Teinobasis scintillans* was also extremely abundant along the forest verge around the camp clearing. The remaining species were found along small forest trails in dappled sunlight, and in or adjacent to rocky streams. The most significant species documented during this survey were *Hylaeargia magnifica*, a species previously known only from the type series collected near Oksapmin in 1994 and classified as Data Deficient by the IUCN (Kalkman 2007) and *Argiolestes verrucatus*, a species recently described from Mt Stolle (Michalski and Oppel 2010). The former species was represented by two individuals found in moderately disturbed forest near Tualapa Camp along a trail that connects the Camp with Wanakipa Village. *Argiolestes verrucatus* was found at several small shady streams between about 1,000-1,450 m.

2009 RAP survey

In total 36 species of dragonflies were collected at the three campsites. This low number is mainly due to camp 2 and 3 being largely unsuitable for dragonflies. At camp one 31 species were recorded while at Camp 2 and 3 only one and four species respectively were found (Table 12.1). The dragonfly fauna around the village of Borme was explored during six days in 2006 (Kalkman 2008) and as this is relatively close to the Muller Range serves as comparison.

Camp 1: Gugusu – The number of species found at the first campsite is comparable to the 37 species found during six days of fieldwork at Borme (1,000-1,100m) and the 24 species found during three days of fieldwork at Lelambo (Kalkman, 2008 & unpublished). This indicates that diversity at Camp 1 one is not extremely low or extremely rich compared to the few other sites for which information is available. The only long-term study on dragonflies in New Guinea at CMBRS documented a very slow accumulation curve of species. In that study a total of 61 species was found during 112 days of fieldwork but it took 45 days to find the first 75% of species and even after 100 days of fieldwork additional species for the area were being found (Oppel, 2005). Based on these results it is likely that the present study found less than half of the species present in the area of Camp 1.

The 31 species found at Camp 1 belong to 12 families, which is a surprisingly high family-level diversity in proportion to the number of species. However this pattern seems to be normal for most sites in New Guinea with the exception of the southern lowlands, where the fauna is dominated by the families Coenagrionidae and Libellulidae. Twenty five of the 31 species are probably dependent on seepages or brooks. The exceptions are *Papuagrion* sp., which probably breeds in phytothelmata (arboreal water-holes) and six species of Libellulidae (Agr*ionoptera longitudinalis, Diplacodes trivialis, Orthetrum glaucum, Orthetrum villosovittatum, Prothorthemis coronata* and *Tramea* sp.). The latter were all found at the helicopter-pad or at the man-made pond in the camp. These species are all widespread and common on New Guinea but are normally rare in virgin forest, occurring in natural situations only at marshes or at pools at landslides or tree falls.

At least seven of the recorded species were new to science, although descriptions of three of them have been published in 2010 (Kalkman et al. 2010, Michalski and Oppel, 2010, Orr and Kalkman 2010). This high portion of species new to science shows that, especially in the eastern part of New Guinea, many species still await discovery. This is probably especially true for the southern slopes of the central mountain range as these are particularly poorly explored.

Camp 2: Sawetau – No adult dragonflies were documented at Camp 2. This site was situated at an altitude (~1,600 m) which is above the upper limit of distribution for most New Guinean dragonflies. The seemingly cold local climate in this area due to persistently cloudy conditions and extensive canopy cover, coupled with the virtual absence of surface water, probably also contributed to the low number of dragonflies documented. The two aquatic habitats accessible from the camp were visited several times without any dragonflies being seen and the only record of a dragonfly is a larva collected at night at the bog-pools above camp. This larva belongs to a species in the family Aeshnidae but cannot be identified further at present.

Camp 3: Apalu Reke – Four species of dragonflies were documented at this site. Given the high altitude of Camp 3 (2,875 m) the low number of species encountered was not unexpected. Only five genera with a total of 12 species are known to occur above 2,500 m on mainland New Guinea (2 *Ischnura*, 5 *Oreagrion*, 2 *Lanthanusa*, 2 *Hemicordulia*, 1 *Papuagrion*). All four species recorded at Camp 3 belong to these genera. Two of these, *Ischnura acuticauda* and *Lanthanusa lamberti*, are known to be confined to higher altitudes and it is likely that the same is true for the other two species. Only one male of *Lanthanusa* was found and the *Hemicordulia* is represented by an emerging larva that was found at the brook adjacent to Camp. *Ischnura acuticauda* was the only species observed in large numbers. By far the most interesting discovery at this site was the larvae of a damselfly living in Screw pines (*Pandanus*) that were initially found during a search for katydids. These larvae probably belong to the genus *Papuagrion* for which the larvae were previously unknown. It has already been suggested that larval *Papuagrion* might live in Screw Pines because adults are often found a long way from water in the vicinity of these trees (Kalkman 2008, Oppel 2005). Despite intensive searching no adults of this species were seen. In tropical habitats worldwide at least 24 genera and 47 species of dragonflies are known to breed in waters-holes in plants (phytothelmata) (Corbet 1999). However in the Screw Pines water available in the leaf-axils for the larvae is very limited or absent and all larvae were found walking on the wet leaves suggesting that they might be aboreal and 'semi-terrestrial', a life-style unknown for dragonflies thus far.

CONSERVATION ISSUES AND RECOMMENDATIONS

Results of the 2008 and 2009 surveys indicate that the upper Strickland Basin, including the Muller Range, supports a rich but poorly-known odonate fauna. We documented one species listed as Data Deficient by the IUCN, and numerous undescribed species. Most of these are species known or expected to be restricted to small forested streams and species with these habitat requirements in New Guinea are also more likely to have restricted distributions. Limiting damage to vegetation in and adjacent to small, clear streams in forest is the most practical way to ensure the long-term survival of these species. This is unlikely to be a problem in the foreseeable future around Gugusu, which has both a high odonate diversity and a large proportion of undescribed species, because the site is remote from large human population centres and pressure on the forest there is low. However around Wanakipa Village slash and burn agriculture and impacts from the most recent El Nino event have severely modified vegetation on some of the hill slopes. These impacts are evident around Tualapa Camp; the camp itself was located in an old garden. Fortunately the Hewa community in this area are part of a Forest Stewards initiative being guided by Dr William Thomas (see Chapter 8, this volume) and are extremely receptive to conserving the forests on their land.

We recommend that the local community be encouraged to actively protect the freshwater habitats and riparian corridors on their land, as a way of not only ensuring survival of the many species reliant on these habitats, but also of ensuring the continued ecosystem services (including clean water) provided by these streams. This could be initiated through existing programs established by the Forest Stewards initiative.

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