Dragonflies and damselflies of a montane tropical rainforest in Papua New Guinea

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Introduction

The odonate fauna of Papua New Guinea (PNG) is poorly studied and distribution and habitat requirements of many species are unknown. The human population in PNG is growing rapidly, which potentially results in habitat degradation and a loss of biodiversity.

In this study I surveyed odonates for several months in an aseasonal rainforest in order to compare the odonate communities of a pristine forest and a modified garden landscape. The principal aim of this investigation was to examine which assemblages are at the highest risk from human induced habitat modification.

I trained local assistants from the village of Herowana to assist me in capturing dragonflies.

This resulted in an increase of awareness for dragonflies in the local community.

Study Area

The study area was located in the Crater Mountain Wildlife Management Area (CMWMA), a 2700 km^2 tract of continuous rainforest in Papua New Guinea (Fig. 1). The climate is equal throughout the year, and both rainfall and temperatures do not exhibit distinctive seasons. I carried out studies at two research stations within the CMWMA, one situated in primary forest, and one in a typical village. The primary study site (Crater Mountain Biological Research Station - CMBRS) is in the centre of the CMWMA, ranging from 850 m to 1300 m a.s.l. Rainfall is abundant (6.5m, Wright et al. 1997), numerous streams and creeks are present, and the area has never been logged. The village of Herowana lies 10 km to the east of CMBRS at an elevation of 1300 m, and consists of mostly subsistence gardens, small coffee plantations and scattered huts. Native forest is still present, but has been degraded by cutting, and there are more open habitats than at CMBRS.

Methods

Dragonflies were sampled between November 2003 and October 2004 on 112 days at CMBRS and on 36 days in Herowana. Specimens were collected with a net and later identified by J. Michalski (Morristown, USA) and N. Donnelly (Binghampton, USA). I used rank-abundance curves, Simpson`s diversity index and evenness to describe the community composition at each site. The similarity of both communities was compared with a new Jaccard-type abundance index, calculated in the program EstimateS 7.5 (Colwell 2004, Chao et al. 2005).
At CMBRS, I recorded the following habitat variables at every point where an adult odonate was observed: stream order, nature of water body, shading, substrate, presence of boulders > 1m, presence of standing pools, presence of floating vegetation, and distance to the nearest sunny patch. The habitat variables recorded were used to classify the odonate assemblage into several groups, representing distinct communities per habitat type. I used a hierarchical cluster analysis to group species into clusters with similar environmental characteristics.
I then recorded the use of habitat types in Herowana and at CMBRS, and calculated the percentages of shared and locally endemic species that preferred and occurred in each habitat type.

Procordulia leopoldi, the most common dragonfly at a pond in the pristine rainforest at CMBRS.

Results

Community comparison

I recorded a total of 78 species from 13 families in both study areas together, with 21 species occurring both in Herowana and at CMBRS (Table 1). The natural rainforest site had a higher number of species, and a higher diversity and evenness (Fig. 1). The Jaccard abundance index for both communities was 0.477, and differed widely between families.

Ordination of odonate assemblages at CMBRS

The hierarchical cluster analysis identified seven ecologically significant groups (Fig. 2). The position of cluster centroids in relation to environmental variables is presented in Table 2. The group including species associated with rivers contained the highest number of species (20), followed by the assemblage of smaller and shadier temporary creeks with 13 species. Taken together, the assemblages of temporary water sources and the forest interior comprised 39% of all species present at CMBRS. Anisopterans occurred only in four of the assemblages, and only two species occurred in temporary water sources.

Comparison of habitat use and preference

In Herowana, the most species-rich habitat types were ditches, small permanent creeks, and open sunny areas. These three habitats also served as preferred habitat for 68% of all species (Fig. 3). At CMBRS the distribution of preferred habitats was more equal than in Herowana, with five habitat types being equally important (Fig. 3). They served as preferred habitat for 79% of all species.
At CMBRS, only one (13%) of those species preferring the forest interior, and three of the nine species preferring small temporary creeks (33%) also occurred in Herowana. In Herowana, more than half of the species preferring open sunny areas, the forest interior, sunny puddles, small permanent creeks and ditches occurred also at CMBRS.

Table 1. Community statistics of the two odonate communities in Crater Mountain Wildlife Management Area, Papua New Guinea, in 2004.

	Herowana	CMBRS
Number species	38	61
Number families	10	13
Anisoptera	9 (24%)	16 (27%)
Zygoptera	29 (76%)	45 (73%)
species total	78	
species co-occurring	21	
species only at that site	17	40
Jaccard-Abd Index (Chao et al.2005)	0.447	
Simpson	8.59	11.48
Evenness	0.715	0.804

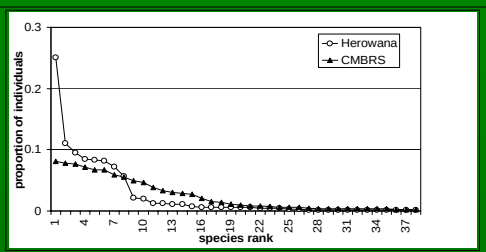

Figure 1: Rank-abundance curves for the odonate communities at CMBRS and in Herowana, Crater Mountain Wildlife Management Area, Papua New Guinea, in 2004.
Note that for simplicity only 38 species are shown at CMBRS.

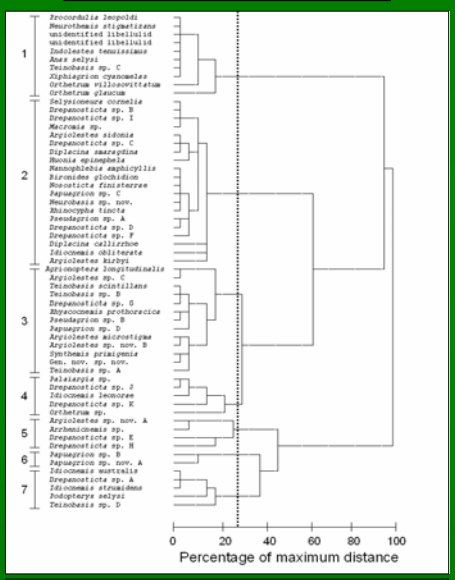

Figure 2: Dendrogram of the hierarchical cluster analysis of odonate species at CMBRS, Papua New Guinea, in 2004. The dashed vertical line indicates the 25% cut-off of the maximum squared Euclidian distance used to determine clusters. Cluster number is indicated on the left. See Table 2 for environmental characteristics of clusters.

Table 2: Central values of environmental variables for the seven odonate assemblages identified by the cluster analysis in a lower montane tropical rainforest in Papua New Guinea.

Cluster	number species	class	water speed	nature of water source		shade (%)	substrate	boulder	pools	floating vegetation	mean dist. to sun (m)
1	10	pond	0	permanent	standing	42	mud	no	yes	yes	0.00
2	20	river	> 1 m/s	permanent	running	58	gravel	yes	yes	no	2.00
3	13	stream	0.3 m/s	temporary	running	88	mud	no	yes	no	7.80
4	5	creek	0.7 m/s	permanent	running	64	sand	no	yes	no	3.60
5	4	stream	0.1 m/s	temporary	running	86	sand	no	no	no	11.40
6	2	no water	0	none	no water	68	mud	no	no	no	0.00
7	5	puddle	0	temporary	standing	79	mud	no	no	no	6.20

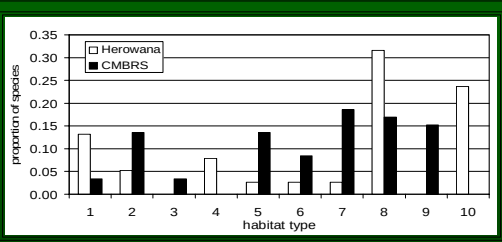

Figure 3: Proportion of all species preferring a particular habitat type at CMBRS (black columns) and in Herowana (white columns), Crater Mountain Wildlife Management Area, Papua New Guinea, in 2004. Habitat types: (1) open sunny areas without water, (2) forest interior without water, (3) temporary puddles in the forest interior, (4) temporary puddles in open sunny areas, (5) fish-free permanent pond, (6) large open river, (7) small partially shaded river, (8) small, permanent, mostly shaded creek, (9) small temporary creek in the forest, and (10) artificial ditch.

Discussion

The odonate fauna of the Crater Mountain Wildlife Management Area is species rich, and distinctly different from lowland areas in PNG (Mack 1998). This indicates a high level of local endemism on New Guinea, similar to other areas in South East Asia (Orr 2004). Since local endemism renders odonates vulnerable to extinction (Korkeamäki & Suhonen 2002), the conservation of primary habitats in all parts of the island is an essential prerequisite for the preservation of odonate diversity on New Guinea.

The modified forest in Herowana had less species and a more skewed community composition than the natural rainforest at CMBRS. This indicates that the modification of the rainforest results in an unbalanced species assemblage, where a few generalist species benefit from large open areas and dominate the odonate community (Samways & Steytler 1996, Stewart & Samways 1998, Clausnitzer 2003). These generalist species were mostly associated with open and artificial habitats, and were much less common or absent in the natural rainforest.

Species associated with temporary puddles in the forest, small temporary creeks, and the forest interior comprised 39% of the total odonate community at CMBRS. Most of the forest interior and small temporary water species at CMBRS did not occur in Herowana, which suggests that species depending on a closed canopy and temporary water sources are most susceptible to forest modification (Clausnitzer 2003). Therefore, modification of the forest caused by human subsistence gardening may lead to a loss of c. 25% of the species associated with closed canopy rainforest habitats. This highlights the urgent need for the conservation of natural rainforests.

Nosoticta finisterrae (Protoneuridae, left) and Rhinocypha tincta (Chlorocyphidae, right) were common representatives of both the village and the natural forest communities.
Photos courtesy of Stuart Wilson.

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