Odonata (Dragonflies and Damselflies) of the Kwamalasamutu Region, Suriname

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Source: A Rapid Biological Assessment of the Kwamalasamutu region, Southwestern Suriname: 56

Published By: Conservation International

URL: https://doi.org/10.1896/054.063.0105

Chapter 3

Odonata (dragonflies and damselflies) of the Kwamalasamutu region, Suriname

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SUMMARY

Odonata were studied during a Rapid Assessment Program (RAP) survey of the Kwamalasamutu area in SW Suriname. Ninety-four species, representing one-third of the species known from Suriname, were registered at forest rivers, streams, and swamps; in particular 57 species were found at the Kutari River Site (Camp 1), 52 at the Sipaliwini River Site (Camp 2), and 65 at the Werehpai Site (Camp 3). Fourteen species represent new records for Suriname, of which four, belonging to the genus *Argia*, are new to science, and five represent first records of a species at a new locality since their original descriptions, increasing considerably their known extent of occurrence. The results indicate a healthy watershed and well preserved forest at all three sites; if forest cover and stream morphology are maintained in the area, the present odonate assemblages are expected to persist.

INTRODUCTION

Dragonflies and damselflies (Order Odonata) are widespread and abundant in all continents with the exception of Antarctica, with centers of species richness occurring in tropical forests. As larvae they live in aquatic habitats and use a wide range of terrestrial habitats as adults. Larvae are sensitive to water quality and habitat morphology such as bottom substrate and aquatic vegetation structure, and adult habitat selection is strongly dependent on aerial vegetation structure, including degrees of shading. As a consequence dragonflies show strong responses to habitat change such as thinning of forest and increased erosion. Common species prevail in disturbed or temporary waters, whereas pristine streams, seepage, and swamp forests house an array of more vulnerable, often localized species. Thus odonates are useful for monitoring the overall biodiversity of aquatic habitats and have been identified as good indicators of environmental health (Corbet 1999; Kalkman et al. 2008). Due to their low species numbers relative to other insects (about 5,700 species worldwide) they also constitute an ideal target group for a Rapid Assessment Program because it is feasible to fully document their species diversity for a particular area in a relatively short period of time. This is the first instance where odonates were included in a RAP survey in South America. The taxonomy of the odonates from Suriname is relatively well known in general compared to that of other South American countries, since two odonate specialists devoted over 60 years of continuous research to its study (Geijskes 1931, 1943, 1946, 1954, 1959, 1976, 1986; Belle 1963, 1966a, 1966b, 1970, 1984, 1992, 2002). However, no published data regarding regional distribution or particular ecological requirements of the odonates from Suriname exists at this moment, and the Kwamalasamutu area has never before been sampled for odonates.

METHODS AND STUDY SITES

Odonata species from the Kwamalasamutu area, in the Sipaliwini District of SW Suriname were studied by applying search-collecting methods. Odonates were surveyed from 19–24 August 2010 in the area surrounding the Kutari River (Camp 1: N 02°10'27", W 056°54'25", 263 m); from 28–31 August in the area adjacent to the Sipaliwini River (Camp 2: N 02°19'48", W 056°39'20", 264 m); and from 2–7 September in the surroundings of Werehpai (Camp 3: N 02°21'45", W 056°41'54", 252 m). Odonates were also recorded at Iwana Samu (N 02°21'46", W 056°45'18", 255 m) on 28 August, and at a vegetated ditch in Kwamalasamutu (N 02°21'17", W 056°47'11"W, 211 m) on 8 September. Searching, photographing, and collecting of adult odonates with an entomological aerial net was carried out around each camp, in terra firme forest along trails and in clearings, in forest swamps, along forest streams, and along rivers from a boat. All aquatic forest habitats were at least partially shady and usually devoid of aquatic plants, with an enclosed canopy cover, and only in the larger creeks and rivers did sun penetrate the forest canopy creating sunspots and larger continuous sunny areas at or near ground level during midday. The ditch at Kwamalasamutu was the only aquatic environment found which was fully exposed to the sun and provided with abundant aquatic and riparian vegetation. Presence/absence information of species was recorded and relative abundance for each species was noted as rare (1–3 individuals seen), frequent (4–20 individuals seen), or common (21–50 individuals seen). Collected specimens are deposited at the California State Collection of Arthropods and at the National Zoological Collection of Suriname.

Total species richness expected for the area was calculated using first-order jackknife and Chao 2 estimators. Composition of odonate communities from the three camps was compared using percentage complementarity (a measurement of distinctness or dissimilarity; Colwell & Coddington 1994).

RESULTS

Overall, 45 odonate genera belonging to 10 families were collected at the three sites, with a total of 94 species. These represent one-third of the total number of odonate species reported for Suriname (282 species according to Belle 2002). In particular, 10 families, 31 genera, and 57 species were collected at the Kutari site; 10 families, 28 genera, and 52 species at the Sipaliwini site; and 10 families, 34 genera, and 65 species at the Werehpai site. The odonates recorded at Kwamalasamutu and Iwana Samu represented 18 species in 13 genera and four families. Appendix A lists all species detected during the RAP survey and their relative abundances at each survey site.

The first-order jackknife estimator for the total number of odonates to be expected in this area was 120.3 species, and the Chao2 estimator was 137.23 species.

Werehpai was the richest site in odonate genera and species, and hosted 18 species not found at the other two camps: *Acanthagrion chacoense*, *Perilestes attenuatus*, *Brechmorrhoga praedatrix*, *Orthemis coracina* (along rivers), *Archaeogomphus nanus*, *Progomphus brachycnemis*, *Macrothemis ludia* (in forest creeks and streams), *Metaleptobasis quadricornis*, *M. mauritia* (at forest swamps), *Gynacantha gracilis*, *G. klagesi*, *G.* sp., *Misagria calverti*, *M. parana*, *Orthemis anthracina*, *Orthemis cultriformis*, *Uracis fastigiata*, and *U. siemensi* (along forest trails and in forest clearings). Twelve species were found only at the Kutari site: *Acanthagrion indefensum*, *Argia fumigata*, *Ebegomphus demerarae*, *Macrothemis delia* (at rivers), *Mnesarete cupraea, Macrothemis* sp. (in creeks and streams), *Argia* sp. 3, *Psaironeura tenuissima*, *Argyrothemis argentea* (in forest swamps), and *Mecistogaster ornata*, *Erythrodiplax castanea*, and *Gynothemis pumila* (along forest trails and clearings). Seven species were present only at the Sipaliwini site: *Phyllocycla ophis* (at rivers), *Neoneura mariana*, *Protoneura calverti*, *Elga leptostyla*, *Macrothemis hemichlora* (at forest creeks and streams), *Triacanthagyna ditzleri*, and *Macrothemis declivata* (along forest trails and clearings). Five of the species found at Kwamalasamutu (at a vegetated ditch) were unique to this site: *Miathyria simplex*, *Micrathyria artemis*, *Nephepeltia flavifrons*, *Oligoclada rhea*, and *Tauriphila argo*.

In terms of odonate community composition, the first and third camps were more dissimilar (complementarity of 51.8 %) than the second and third camps (complementarity of 48.6 %) or second and first camps (complementarity of 46.4 %; Table 1). Shared species usually showed different abundances at each one of the camps (i.e., many species common at one site were rare at another site; see Relative Abundance in Appendix A).

Four species of the genus *Argia* are new to science (*Argia* sp. 1, *A.* sp. 2, *A.* sp. 3, *A.* sp. 4). *Argia* is the most species-rich odonate genus in the New World, with 112 described species (Garrison et al. 2010). This genus shows its prevalence in all three sites being the richest in species (eight species total; four to eight species per camp). All of these new species are known also from collections outside of Suriname (Garrison pers. comm., Table 2), and are being described by Dr. Rosser W. Garrison (California Department of Food and

Table 1. Richness and percentage complementarity (number of species in common in parentheses) of odonate assemblages among Kutari, Sipaliwini, and Werehpai sites, Kwamalasamutu area, SW Suriname.

I	Kutari	Sipaliwini	Werehpai
Species richness	57	52	65
Camp 2	46.4 (38)		
Camp 3	51.8 (40)	48.6 (40)	

Agriculture) as part of his ongoing taxonomic revision of the genus.

Another nine species were recorded from Suriname for the first time, and the discovery of five of these species (Figs. 2–5) represents also the first published record in the literature of a new locality since their original descriptions, increasing considerably their known extent of occurrence:

Perilestes gracillimus (page 17): Recorded from creeks in lowland Amazon forest from Peru (Kennedy 1941) and Brazil (Lencioni 2005).

Epipleoneura pereirai (Fig. 2): Previously known from rivers in lowland Amazon forest in Amapá and Pará States in Brazil (Machado 1964).

Neoneura angelensis (Fig. 3): Recently described (Juillerat 2007) from French Guiana.

Neoneura denticulata: Widely distributed in the lowland Amazon forest, from Venezuela and Brazil to Peru and Ecuador.

Elasmothemis rufa (Fig. 4): Recently described (De Marmels 2008) from Amazonas State in Venezuela.

Gynothemis pumila: Widely distributed across South America, from Colombia and Trinidad to Brazil and Peru.

Macrothemis ludia (Fig. 5): Known so far from Bolívar State in Venezuela (Belle 1987).

Micrathyria paruensis: Known from lowland Amazon forest in Venezuela and French Guiana.

Orthemis anthracina: lowland Amazonian rainforest in Venezuela (De Marmels 1989).

Orthemis coracina (Fig. 6): Known from lowland Amazonian forest in Ecuador (von Ellenrieder 2009).

None of the species found are endemic either to the study area or to Suriname. No odonates are listed on the CITES appendices. The conservation status of about one-quarter of the Neotropical species was recently assessed by the IUCN Odonate Specialist Group (Claustnitzer et al. 2009) including approximately one-fifth of the species found in the present study (Table 2). From these, most were assessed as Least Concern and two species, *Epipleoneura pereirai* and *Perilestes gracillimus*, as Data Deficient. Notes on the biology of the recorded species are provided in Appendix B.

Table 2. Odonates found in SW Suriname, Kwamalasamutu region: Habitat where found, data on known larvae, distribution, and conservation status according to IUCN criteria. Distribution=US: United States of America, ME: Mexico, GU: Guatemala, BE: Belize, ES: El Salvador, HO: Honduras, NI: Nicaragua, CR: Costa Rica, PA: Panama, CO: Colombia, VE: Venezuela, TR: Trinidad/Tobago, GY: Guyana, SU: Surinam, FR: French Guyana, BR: Brazil, EC: Ecuador, PE: Peru, BO: Bolivia, PY: Paraguay, UR: Uruguay, AR: Argentina. IUCN category= LC: Least Concern, DD: Data Deficient.

Species	Habitat	Larva described	Distribution	IUCN
Hetaerina caja dominula	river/creek	Geijskes 1943	ME, NI, CR, PA, CO, VE, TR, FR, EC, PE	-
Hetaerina moribunda	creek/trail	Geijskes 1943 by supposition	VE, GY, SU, FR, BR	-
Hetaerina mortua	creek	-	VE, GY, SU, FR, BR, PE	-
Mnesarete cupraea	creek	-	VE, GY, SU, FR, PE, BO	-
Acanthagrion ascendens	creek/ditch	Geijskes 1943	CO, VE, TR, GY, SU, FR, BR, EC, PE, BO	-
Acanthagrion chacoense	river	-	VE, SU, BR, PE, BO	LC
Acanthagrion indefensum	river	Geijskes 1943	VE, GY, SU, FR, BR	-
Acanthagrion rubrifrons	swamp	-	VE, GY, SU, FR, BR	-
Argia fumigata	river	-	VE, GY, SU, FR, BR	-
Argia insipida	river	Geijskes 1943	CR, CO, VE, TR, GY, SU, FR, BR	-
Argia oculata	trail/swamp	Limongi 1983 (1985)	ME, GU, BE, ES, HO, NI, CR, PA, CO, VE, TR, BR, EC, PE	-
Argia translata	river	Geijskes 1946, von Ellenrieder 2007	US, ME, GU, BE, ES, HO, NI, CR, PA, CO, VE, TR, SU, FR, EC, PE, AR	-
Argia sp. 1	trail/swamp	-	VE, GY, SU, FR, BR	-
Argia sp. 2	swamp	-	SU, FR	-
Argia sp. 3	swamp	-	SU, FR	-
Argia sp. 4	swamp	-	VE, SU, FR, BR	-
Inpabasis rosea	swamp	-	VE, SU, FR, BR	-
Metaleptobasis mauritia	swamp	-	TR, GY, SU, FR, BR	-
Metaleptobasis quadricornis	swamp	-	GY, SU, BR	-
Heliocharis amazona	creek	Geijskes 1986, Santos & Costa 1988	CO, EC, PE, BO, VE, GU, SU, FR, BR, PY, AR	-

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Table 2. *continued*

Species	Habitat	Larva described	Distribution	IUCN
Heteragrion ictericum	trail/creek/river	-	VE, GY, SU, FR, BR	-
Heteragrion silvarum	trail/creek	-	GY, SU, FR, BR	LC
Oxystigma williamsoni	trail/creek/river	-	VE, GY, SU, FR, BR	-
Perilestes attenuatus	river	Neiss & Hamada 2010	VE, SU, FR, BR, PE, BO	LC
Perilestes gracillimus	creek	-	SU, BR, PE	DD
Perilestes solutus	creek	-	VE, SU, BR	LC
Epipleoneura fuscaenea	river/trail	-	VE, GY, SU, FR	LC
Epipleoneura pereirai	river	-	SU, FR, BR	DD
Neoneura angelensis	river	-	SU, FR, BR	-
Neoneura denticulata	river/creek	-	VE, SU, BR, EC, PE	-
Neoneura joana	river	Geijskes 1954	VE, GY, SU, FR, BR	-
Neoneura mariana	creek	-	VE, GY, SU, FR	-
Neoneura myrthea	river	-	VE, GY, SU, FR, BO	-
Phasmoneura exigua	swamp	-	VE, GY, SU, FR, BR, PE	-
Protoneura calverti	creek	-	VE, TR, GY, SU, FR, BR	LC
Protoneura tenuis	creek	-	VE, TR, GY, SU, FR, BR, PE, BO	LC
Psaironeura tenuissima	swamp	-	GY, FR, BR, EC, PE	-
Mecistogaster lucretia	trail	-	CO, VE, GY, SU, FR, BR, EC, PE, AR	-
Mecistogaster ornata	trail	Ramirez 1995	ME, GU, ES, HO, NI, CR, PA, CO, VE, TR, SU, FR, BR, EC, PE, AR	LC
Microstigma anomalum	trail	-	SU, FR, BR, PE, BO	-
Gynacantha auricularis	trail	-	BE, NI, CR, VE, GY, SU, FR, BR, EC, PE, BO	-
Gynacantha gracilis	trail	Santos 1973a	GU, CR, PA, VE, GY, SU, FR, EC, PE, BO, AR	-
Gynacantha klagesi	trail	-	?	-
Gynacantha sp.	trail	-	VE, SU, FR, PE	-
Staurophlebia reticulata	river	Geijskes 1959	GU, BE, HO, NI, CR, PA, CO, VE, TR, GY, SU, FR, BR, EC, PE, PY, UR, AR	-
Triacanthagyna ditzleri	trail	-	ME, GU, BE, CR, PA, CO, VE, TR, GY, SU, FR, BR, EC, PE, BO	-
Aphylla sp.	river/creek	-	?	-
Archaeogomphu nanus	creek	Belle 1970	VE, SU, FR, BR	-
Ebegomphus demerarae	river	Belle 1966a, 1970	GY, SU	-
Phyllocycla ophis	river	Belle 1970	VE, GY, SU, FR, BR	-
Phyllogomphoides major	creek	Belle 1970 as *P. fuliginosus*	VE, GY, SU, FR, BR	-
Phyllogomphoides undulatus	river	Belle 1970 by supposition	VE, SU, FR, BR	-
Progomphus brachycnemis	river/creek	Belle 1966b	VE, SU, BR	LC
Argyrothemis argentea	swamp	Fleck 2003a	VE, GY, SU, FR, BR, PE	LC
Brechmorrhoga praedatrix	river	Fleck 2004	VE, TR, GY, SU, FR, BR, AR	LC
Diastatops pullata	river	Fleck 2003b	VE, GY, SU, FR, BR, EC, PE, BO, AR	LC
Dythemis multipunctata	creek	De Marmels 1982, Westall 1988	ME, GU, BE, ES, HO, NI, CR, PA, VE, TR, GY, SU, FR, BR, EC, PE, PY, AR	-
Elasmothemis cannacrioides	river	Westall 1988	ME, GU, BE, HO, CR, PA, CO, VE, TR, SU, FR, BR, EC, PE, AR	-
Elasmothemis rufa	river	-	VE, SU	-

table continued on next page

Table 2. *continued*

Species	Habitat	Larva described	Distribution	IUCN
Elga leptostyla	creek	De Marmels 1990, Fleck 2003b	PA, CO, VE, TR, GU, SU, FR, BR, EC, PE	-
Erythrodiplax castanea	swamp/clearing	-	GU, BE, CR, CO, VE, TR, GY, SU, FR, BR, EC, PE, BO, PY, AR	-
Erythrodiplax famula	clearing	-	CR, VE, TR, GY, SU, FR, BR, PE, AR	-
Erythrodiplax fusca	river/clearing /ditch	Santos 1967	ME, GU, BE, ES, HO, NI, CR, PA, CO, VE, TR, GY, SU, FR, BR, EC, PE, BO,PY, UR, AR	-
Fylgia amazonica lychnitina	swamp	De Marmels 1992	VE, GY, SU, FR, BR, EC, PE	LC
Gynothemis pumila	clearing	Fleck 2004	CO, VE, TR, GY, SU, FR, BR, PE	LC
Macrothemis declivata	clearing	-	SU, BR, PE, BO, PY, AR	-
Macrothemis delia	river	-	ME, GU, CR, VE, SU	-
Macrothemis hemichlora	creek	-	ME, GU, BE, ES, HO, CR, PA, CO, VE, TR, SU, FR, EC, PE, PY, AR	LC
Macrothemis ludia	clearing/creek	-	VE, SU	-
Macrothemis sp.	creek	-	?	-
Miathyria simplex	ditch	Limongi 1991	ME, GU, BE, HO, CR, PA, VE, TR, GY, SU, FR, BR, EC, PE	-
Micrathyria artemis	ditch	Santos 1972	VE, GY, SU, FR, BR, EC, PE, AR	LC
Micrathyria paruensis	creek	-	VE, SU, FR	-
Micrathyria spinifera	creek	-	CO, VE, TR, GY, SU, FR, BR, EC, PE, BO	LC
Misagria calverti	clearing	-	SU, FR, BR, PE	-
Misagria parana	clearing	-	VE, GY, SU, FR, BR, EC, PE	-
Nephepeltia flavifrons	ditch	-	CO, VE, SU, FR, BR, PE, PY, AR	-
Oligoclada abbreviata	river	Fleck 2003a	VE, GY, SU, FR, BR, EC, PE	LC
Oligoclada amphinome	swamp	-	VE, GY, SU, FR, BR	-
Oligoclada rhea	ditch	-	SU, FR, BR, BO	-
Oligoclada walkeri	creek	-	VE, TR, GY, SU, FR, BR, EC, PE	-
Orthemis aequilibris	clearing/river	Fleck 2003b	CR, PA, CO, VE, GY, SU, FR, BR, PE, BO, PY, AR	-
Orthemis anthracina	clearing	-	VE, SU	-
Orthemis coracina	river	-	EC, SU	-
Orthemis cultriformis	clearing/creek	-	CR, PA, CO, VE, TR, GY, SU, FR, BR, EC, PE, BO, PY, AR	-
Perithemis cornelia	creek	-	VE, SU, FR, BR, EC, PE, BO	LC
Perithemis lais	creek	Costa & Regis 2005	CO, VE, GY, SU, FR, BR, EC, PE, BO, PY, AR	LC
Perithemis mooma	creek/ditch	Santos 1973b, von Ellenrieder & Muzón 1999	ME, GU, BE, ES, HO, NI, CR, PA, CO, VE, TR, SU, FR, BR, EC, PE, PY, UR, AR	-
Perithemis thais	swamp/creek	Spindola, Souza & Costa 2001	CR, VE, TR, GY, SU, FR, BR, EC, PE, BO, AR	-
Tauriphila argo	ditch	Fleck, Brenk & Misof 2006	ME, GU, BE, HO, NI, CR, PA, VE, TR, GY, SU, FR, BR, EC, PE, BO, PY, AR	-
Uracis fastigiata	trail	-	ME, GU, HO, NI, CR, PA, CO, VE, TR, GY, SU, FR, BR, EC, PE, BO	-
Uracis infumata	trail	-	VE, GY, SU, FR, BR, PE, BO	-
Uracis ovipositrix	trail	-	VE, GY, SU, FR, BR, EC, PE	-
Uracis siemensi	trail	-	VE, SU, FR, BR, EC, PE	-

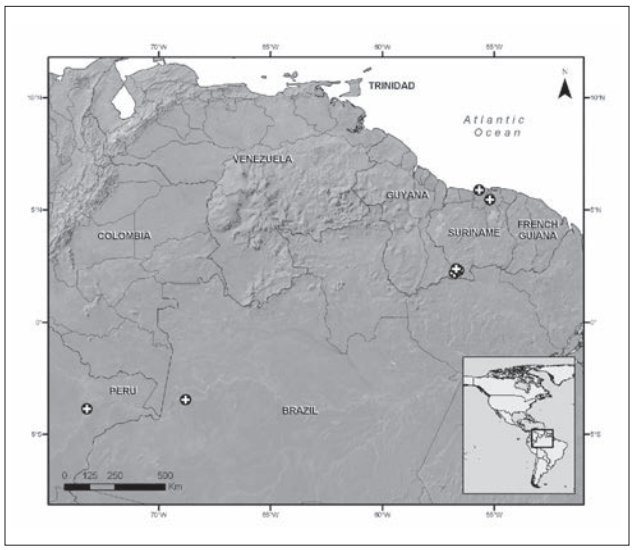

Figure 1. Known distribution of *Perilestes gracillimus* (Perilestidae).

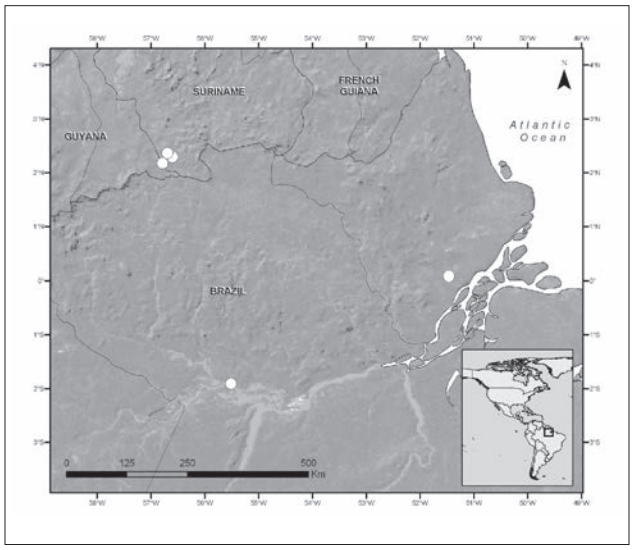

Figure 2. Known distribution of *Epipleoneura pereirai* (Protoneuridae).

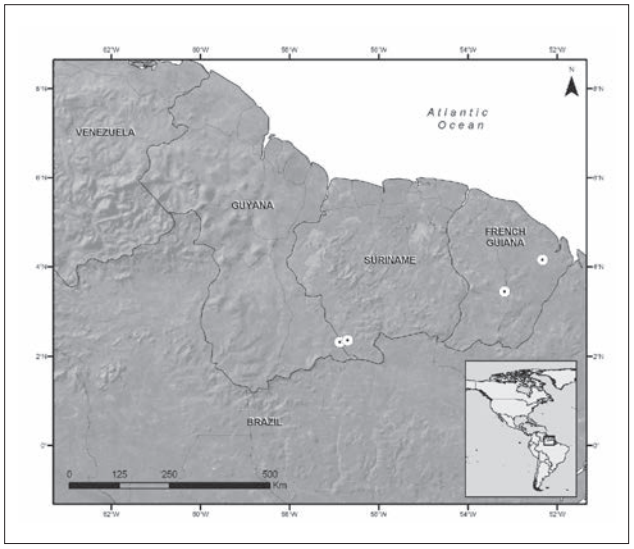

Figure 3. Known distribution of *Neoneura angelensis* (Protoneuridae).

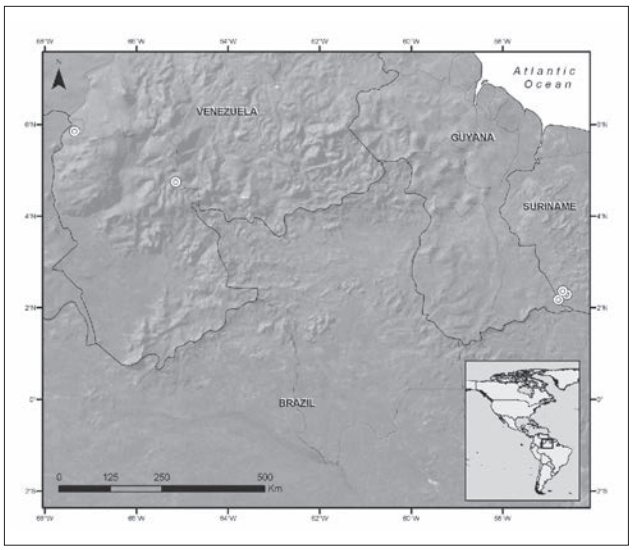

Figure 4. Known distribution of *Elasmothemis rufa* (Libellulidae).

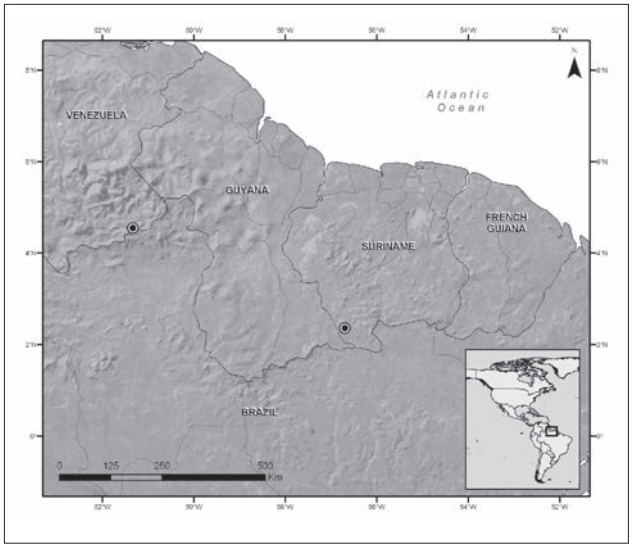

Figure 5. Known distribution of *Macrothemis ludia* (Libellulidae).

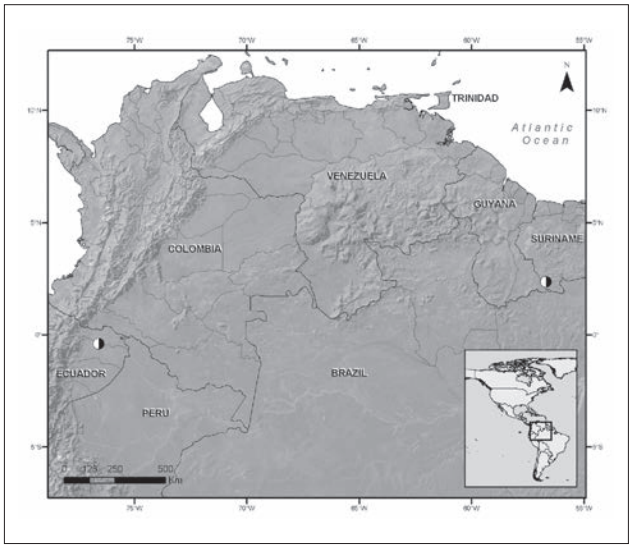

Figure 6. Known distribution of *Orthemis coracina* (Libellulidae).

DISCUSSION

The differences in odonate species composition among the three camps are probably due to slightly different qualities of the aquatic habitats sampled at each site, as a consequence of the different kinds of soils and vegetation which characterize the three camps (i.e., Kutari river and creeks were lower in oxygen content and pH; Kutari soils included loamy sands; soils were sandy and rocky at Werehpai).

Stagnant water bodies are comparatively scarce in the forest, and the presence of a vegetated ditch in Kwamalasamutu (a type of habitat not found at the camps) contributed five species restricted to lentic habitats. These species are all widespread, vagile species that inhabit open vegetated ponds throughout the lowland Amazon region (Table 2). A more thorough and extended study around Kwamalamasutu and Iwaana Saamu would most likely have recorded additional taxa characteristic of this type of environment in the Neotropics, and which are expected to occur in the area; i.e. species of *Lestes* (Lestidae), *Ischnura*, *Telebasis* (Coenagrionidae), *Erythemis*, *Tramea* (Libellulidae), and others. Diversity estimators corroborate this, indicating that another twenty to forty species are to be expected in this area.

Gynacantha sp. and *Macrothemis* sp. were represented by a single female each, and due to the poor taxonomic knowledge of the female sex in these two genera — unknown for many species — the specimens cannot presently be reliably assigned a specific name.

Aphylla sp. was represented by a larval exuviae. Although several species of this genus are known to occur in Suriname and adjacent lowland forests in the Guiana Shield, their larvae remain undescribed, and therefore it is not possible at this moment to identify the specimen to species.

Inpabasis rosea and *Metaleptobasis quadricornis* have been erroneously mentioned from Suriname in the literature as *I. eliasi* and *M. weibezahni*, respectively (Belle 2002). Belle (2002) also listed *Heteragrion melanurum* and *Microstigma maculatum* as present in Suriname (see Appendix A). According to De Marmels (1987), *H. melanurum* is a probable junior synonym of *Heteragrion silvarum*, an opinion which is shared in this study. Based on observed morphological variability of the diagnostic characters traditionally used to identify species of *Microstigma*, the three specific names currently used might represent only intraspecific variability. This was already suggested by Neiss et al. (2008) based on the apparent absence of diagnostic differences between the larvae of *M. maculatum* and *M. rotundatum*, and it is supported by the specimens studied here, which show an intergradation of characters attributed to *M. anomalum* and *M. maculatum*; thus the older of the two names (*M. anomalum*) is applied in this study.

CONSERVATION RECOMMENDATIONS

The diversity of odonate genera and species found in this study is typical of well preserved sites; most of the species found in the forest understory, creeks, and swamps in the three camps would not be present if the forest were disturbed.

Unlike birds, mammals, or butterflies, Odonata are largely unaffected by hunting or trade. However, many odonate species require closed canopy forest to maintain the appropriate vegetation structure they need as adults. Human activities such as deforestation and mining would most likely affect their occurrence in the area and produce a marked decrease in their diversity, since deforestation affects the vegetation structure needed by the adults, and subsequent alteration of water bodies by erosion and siltation would be detrimental for their larvae. Mining would lead to increased turbidity and siltation of streams, changing the substrate and reducing the habitat quality needed by odonate larvae. Claustnitzer et al. (2009) found that the threats are greater for forest species restricted to forest fragments, mountaintops, and island localities, whereas species inhabiting large forest blocks are usually at lower risk.

Therefore, the main conservation recommendation is to include an area as large as possible, encompassing at a minimum the three visited sites and intervening areas, as a legally protected nature preserve to prevent mining and logging activities and thus conserve the high diversity of odonate species found in this study. Species of particular conservation concern are the seldom-encountered lowland Amazon species including *Neoneura angelensis, Epipleoneura pereirai, Elasmothemis rufa, Macrothemis ludia*, and *Orthemis coracina*, all of which occur here (Figs. 2–6). If a nature preserve is not created and development activities do take place within the Kwamalasamutu region, it is recommended to establish broad buffer zones of undisturbed vegetation along rivers and creeks, in order to minimize the damage to the watershed and consequently to the odonate community.

Further biodiversity studies in the area are recommended to increase the knowledge of several poorly known and rare species that occur in these pristine forests (the larval stage of 61 % of species and habitat preferences of several of the species recorded are still unknown; see Table 2), and to gain knowledge about the possible seasonality (dry–rainy season species assemblages) of the odonate community of southwest Suriname. If further surveys are conducted, it is suggested to include some sites close to human settlements to provide the framework needed to assess which species are most affected by human disturbance and thus possibly identify indicator species of pristine environments for this area. Initial involvement of local communities in dragonfly and damselfly observation is encouraged, by providing them with educational color picture guides to the most common species in order to increase their appreciation and knowledge of this group, which could eventually be used for ecotourism and monitoring programs in the future.

REFERENCES

Bede, L.C., W. Piper, G. Peters, and A.B.M. Machado, 2000. Phenology and oviposition behaviour of *Gynacantha bifida* Rambur (Anisoptera: Aeshnidae). Odonatologica 29(4): 317–324.

Belle, J. 1963. Dragonflies of the Genus *Zonophora* with Special Reference to its Surinam Representatives. Stud. Fau. Surin. Guyan. 5(16): 60–69.

Belle, J., 1966a. Surinam dragon-files of the *Agriogomphus* complex of genera. Stud. Fau. Surin. Guyan. 8(29): 29–60.

Belle, J., 1966b. Surinam dragon-flies of the genus *Progomphus*. Stud. Fau. Surin. Guyan. 8(28): 1–28.

Belle, J., 1970. Studies on South American Gomphidae (Odonata) with special reference to the species from Surinam. Stud. Fau. Surin. Guyan. 11(43): 1–158

Belle, J., 1984. A synopsis of the South American species of *Phyllogomphoides*, with a key and descriptions of three new taxa (Odonata, Gomphidae). Tijdschr. v. Entomol. 127(4): 79–100.

Belle, J., 1987. Three new species of *Macrothemis* from northern South America (Odonata: Libellulidae). Zool. Med. Leiden 61(19): 287–294.

Belle, J., 1992. A revision of the South American species of *Aphylla* Selys, 1854 (Odonata: Gomphidae). Zool. Med. Leiden 66(12): 239–264.

Belle, J. 2002. Commented Checklist of the Odonata of Suriname. Odonatologica 31(1): 1–8.

Clausnitzer, V., V.J. Kalkman, M. Ram, B. Collen, J.E.M. Baillie, M. Bedjanic, W.R.T. Darwall, K.-D.B. Dijkstra, R. Dow, J. Hawking, H. Karube, E. Malikova, D. Paulson, K. Schütte, F. Suhling, R. Villanueva, N. von Ellenrieder, and K. Wilson. 2009. Odonata Enter the Biodiversity Crisis Debate: The First Global Assessment of an Insect Group. Biol. Conserv. 142: 1864–1869.

Colwell, R.K. and J.A. Codington. 1994. Estimating Terrestrial Biodiversity through Extrapolation. Phil. Trans. R. Soc. Lond. (B) 345: 101–118.

Corbet, P.S. 1999. Dragonflies - Behavior and Ecology of Odonata. Comstock Publishing Associates, Cornell University Press, Ithaca, NY.

Costa , J.M. and L.P.R.B. Regis. 2005. Description of the last instar larva of *Perithemis lais* (Perty) and comparison with other species of the genus (Anisoptera: Libellulidae). Odonatologica 34(1): 51–57.

De Marmels, J. 1982. Cuatro náyades nuevas de la familia Libellulidae (Odonata: Anisoptera). Bol. Entomol. Venez., N. S. 2(11): 94–101.

De Marmels, J. 1987. On the type specimens of some neotropical Megapodagrionidae, with a description of *Heteragrion pemon* spec. nov. and *Oxystigma caerulans* spec. nov. from Venezuela (Zygoptera). Odonatologica 16(3): 225–238.

De Marmels, J. 1989. Odonata or dragonflies from Cerro de la Neblina. Academia de las Ciencias Físicas, Matemáticas y Naturales, Caracas, Venezuela 25: 1–78.

De Marmels, J. 1990. Nine new Anisoptera larvae from Venezuela (Gomphidae, Aeshnidae, Corduliidae, Libelulidae). Odonatologica 19(1): 1–15.

De Marmels, J. 1992. Caballitos del Diablo (Odonata) de las Sierras de Tapirapecó y Unturán, en el extremo sur de Venezuela. Acta Biol. Venez. 14(1): 57–78.

De Marmels, J. 2007. Thirteen new Zygoptera larvae from Venezuela (Calopterygidae, Polythoridae, Pseudostigmatidae, Platystictidae, Protoneuridae, Coenagrionidae). Odonatologica 36(1): 27–51.

De Marmels, J. 2008. Three new libelluline dragonflies from southern Venezuela, with new records of other species (Odonata: Libellulidae). Int. J. Odonatol. 11(1): 1–13.

Fleck G. 2003a. Contribution à la connaissance des Odonates de Guyane française. Les larves des genres *Argyrothemis* Ris, 1911 et *Oligoclada* Karsch, 1889 (Insecta, Odonata, Anisoptera, Libellulidae). Ann. Naturhist. Mus. Wien, S. B 104: 341–352.

Fleck, G. 2003b. Contribution à la connaissance des Odonates de Guyane française: Notes sur des larves des genres *Orthemis*, *Diastatops* et *Elga* (Anisoptera: Libellulidae). Odonatologica 32(4): 335–344.

Fleck G. 2004. Contribution à la connaissance des Odonates de Guyane française: les larves des *Macrothemis pumilla* Karsch, 1889 et de *Brechmorhoga praedatrix* Calvert, 1909. Notes biologiques et conséquences taxonomiques (Anisoptera: Libellulidae). Ann. Soc. Entom. Fr. 40(2): 177–184.

Fleck G., M. Brenk, and B. Misof. 2006. DNA taxonomy and the identification of immature insect stages: the true larva of *Tauriphila argo* (Hagen 1869) (Odonata: Anisoptera: Libellulidae). Annales de la Société Entomologique de France (Nouvelle série) 42(1): 91–98.

Garrison, R.W., N. von Ellenrieder, and J.A. Louton. 2010. Damselfly genera of the New World. An Illustrated and Annotated Key to the Zygoptera. The Johns Hopkins University Press, Baltimore, xiv + 490 pp, + 24 color plates.

Geijskes, D.C. 1931. A New Species of *Oligoclada* (Odonata) from Trinidad B.W.Z. Ent. Berich. 8(178): 209–214.

Geijskes, D.C. 1943. Notes on Odonata of Surinam. IV. Nine new or little known zygopterous nymphs from the inland waters. Ann. Entomol. Soc. Amer. 36(2): 165–184.

Geijskes, D.C. 1946. Observations on the Odonata of Tobago, B.W.I.. Trans. Roy. Entomol. Soc. London 97(9): 213–235.

Geijskes, D.C. 1954. Notes on Odonata of Surinam VI. The nymph of *Neoneura joana* Will.. Entomol. News. 65(6): 141–144.

Geijskes, D.C. 1959. The aeschnine genus *Staurophlebia*. Stud. Fau. Surin. Guyan. 3(9): 147–172.

Geijskes, D.C. 1976. The genus *Oxystigma* Selys, 1862 (Zygoptera: Megapodagrionidae). Notes on Odonata of Surinam XIII. Odonatologica 5(3): 213–230.

Geijskes, D.C. 1986. The Larva of *Dicterias cothurnata* (Förster, 1906) (Zygoptera: Dicteriastidae). Odonatologica 15(1): 77–80.

González-Soriano, E. 1987. *Dythemis cannacrioides* Calvert, a libellulid with unusual ovipositing behaviour (Anisoptera). Odonatologica 16(2): 175–182.

IUCN 2001. IUCN Red List Categories: Version 3.1. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

Juillerat, L. 2007. *Neoneura angelensis* sp. nov. from French Guyana (Odonata: Protoneuridae). Int. J. Odonatol. 10(2): 203–208.

Kalkman, V.J., V. Clausnitzer, K.-D. Dijkstra, A. G. Orr, D.R. Paulson, and J. van Tol. 2008. Global Diversity of Dragonflies (Odonata) in Freshwater. Hydrobiologia 595: 351–363.

Kennedy, C.H. 1941. Perilestinae in Ecuador and Peru: revisional notes and descriptions (Lestidae: Odonata). Ann. Entomol. Soc. Amer. 34(3): 658–688.

Lencioni, F.A.A. 2005. Damselflies of Brazil. An illustrated identification guide. 1 - The non-Coenagrionidae families. All Print Editora iv + 324 pp.

Limongi, J. 1983 (1985). Estudio morfo-taxonómico de nayades en algunas especies de Odonata (Insecta) en Venezuela (I). Mem. Soc. Cs. Ns. "La Salle" 43(119): 95–117.

Limongi, J. 1991. Estudio morfo-taxonómico de náyades de algunas especies de Odonata (Insecta) en Venezuela (II). Memorias de la Sociedad de ciencias naturales "La Salle" 50(133–134): 405–420.

Louton, J.A., R.W. Garrison and O.S. Flint, 1996. The Odonata of Parque Nacional Manu, Madre de Dios, Peru: natural history, species richness and comparisons with other Peruvian sites, pp. 431–449. In: Wilson, D.E. and A. Sandoval (eds.), Manu, the biodiversity of southeastern Peru. Smithsonian Institution.

Machado, A.B.M. 1964. Duas novas Epipleoneuras dos Rios Paru de oeste e Amapari (Odonata- Protoneuridae). Bol. Mus. Paraense Emilio Goeldi, Zool. 51: 1–13.

Neiss, U.G., F.A.A. Lencioni, N. Hamada, and R.L. Ferreira-Keppler. 2008. Larval redescription of *Microstigma maculatum* Hagen in Selys, 1860 (Odonata: Pseudostigmatidae) from Manaus, Amazonas, Brazil. Zootaxa 1696: 57–62.

Neiss, U.G. and N. Hamada. 2010. The larva of *Perilestes attenuatus* Selys, 1886 (Odonata: Perilestidae) from Amazonas, Brazil. Zootaxa 2614: 53–58.

Ramírez, A., 1995. Descripción e historia natural de las larvas de odonatos de Costa Rica. IV. *Mecistogaster ornata* (Rambur, 1842) (Zygoptera, Pseudostigmatidae). Bull. Amer. Odonatol. 3(2): 43–47.

Santos, N.D. 1967. Notas sôbre a ninfa de *Erythrodiplax connata fusca* (Rambur, 1842) Brauer, 1868 (Odonata, Libellulidae). Atas Soc. Biol. Rio de Janeiro 10(6): 145–147.

Santos, N.D. 1969. Contribuição ao conhecimento da fauna do estado da Guanabara. 70--Descrição da ninfa de *Perilestes fragilis* Hagen in Selys, 1862 e notas sobre o imago (Odonata: Perilestidae). Atas Soc. Biol. Rio de Janeiro 12(5–6): 303–304.

Santos, N.D. 1972. Contribuição ao conhecimento fauna do estado da Guanabara e arredores. 80 - Descrição da ninfa de *Micrathyria artemis* (Selys ms.) Ris, 1911 (Odonata: Libellulidae). Atas Soc. Biol. Rio de Janeiro 15(3): 141–143.

Santos, N.D. 1973a. Contribuição ao conhecimento da fauna da Guanabara e arredores 82 - Descrição da ninfa de *Gynacantha gracilis* (Burmeister, 1839) Kolbe, 1888 (Aeshnidae: Odonata). Atas Soc. Biol. Rio de Janeiro 16(2–3): 55–57.

Santos, N.D. 1973b. Contribuição ao conhecimento da fauna do estado da Guanabara e arredores. 84 - Descrição da ninfa de *Perithemis mooma* Kirby, 1889 (Odonata: Libellulidae). Atas Soc. Biol. Rio de Janeiro 16(2–3): 71–72.

Santos, N.D. and J.M. Costa. 1988. The larva of *Heliocharis amazona* Selys, 1853 (Zygoptera: Heliocharitidae). Odonatologica 17(2): 135–139.

Spindola, L.A., L.O.I. Souza, and J.M. Costa. 2001. Descrição da larva de *Perithemis thais* Kirby, 1889, com chave para identificação das larvas conhecidas do gênero citadas para o Brasil (Odonata, Libellulidae). Bol. Mus. Nac., Rio de Janeiro, N.S. 442: 1–8.

von Ellenrieder, N. 2007. The larva of *Argia joergenseni* Ris (Zygoptera: Coenagrionidae). Odonatologica 36(1): 89–94.

von Ellenrieder, N. 2009. Five new species of *Orthemis* from South America (Odonata: Libellulidae). Int. J. Odonatol. 12(2): 347–381, pl. VII.

von Ellenrieder, N. & J. Muzón. 1999. The Argentinean species of the genus *Perithemis* Hagen (Anisoptera: Libellulidae). Odonatologica 28(4): 385–398.

Wasscher, M.T. 1990. Reproduction behaviour during heavy rainfall of *Oxystigma williamsoni* Geijskes in Surinam (Zygoptera: Megapodagrionidae). Notul. odonatol. 3(5): 79–80.

Westall, Jr., M.J. 1988. *Elasmothemis* gen. nov., a new genus related to *Dythemis* (Anisoptera: Libellulidae). Odonatologica 17(4): 419–428.

Westfall, Jr., M.J. and M.L. May. 2006. Damselflies of North America. Revised edition. Scientific Publishers, Inc. xii + 502 pp.

Williamson, E.B. 1918. A collecting trip to Colombia, South America. Univ. Mich. Mus. Zool., Misc. Pub. 3: 1–24.

Plate I. a: Male of *Hetaerina caja dominula* (Odonata, Calopterygidae) along a forest trail in Sipaliwini Camp. **b**: Male of *Hetaerina moribunda* (Odonata, Calopterygidae) at a forest stream in Werehpai Camp. Both photographed by N. von Ellenrieder.

Plate II. a: Male of *Acanthagrion ascendens* (Odonata, Coenagrionidae) at a forest stream. **b**: Male, and **c**: Female, of *Acanthagrion rubrifrons* (Odonata, Coenagrionidae) at a forest swamp. All photographed at Sipaliwini Camp by N. von Ellenrieder.

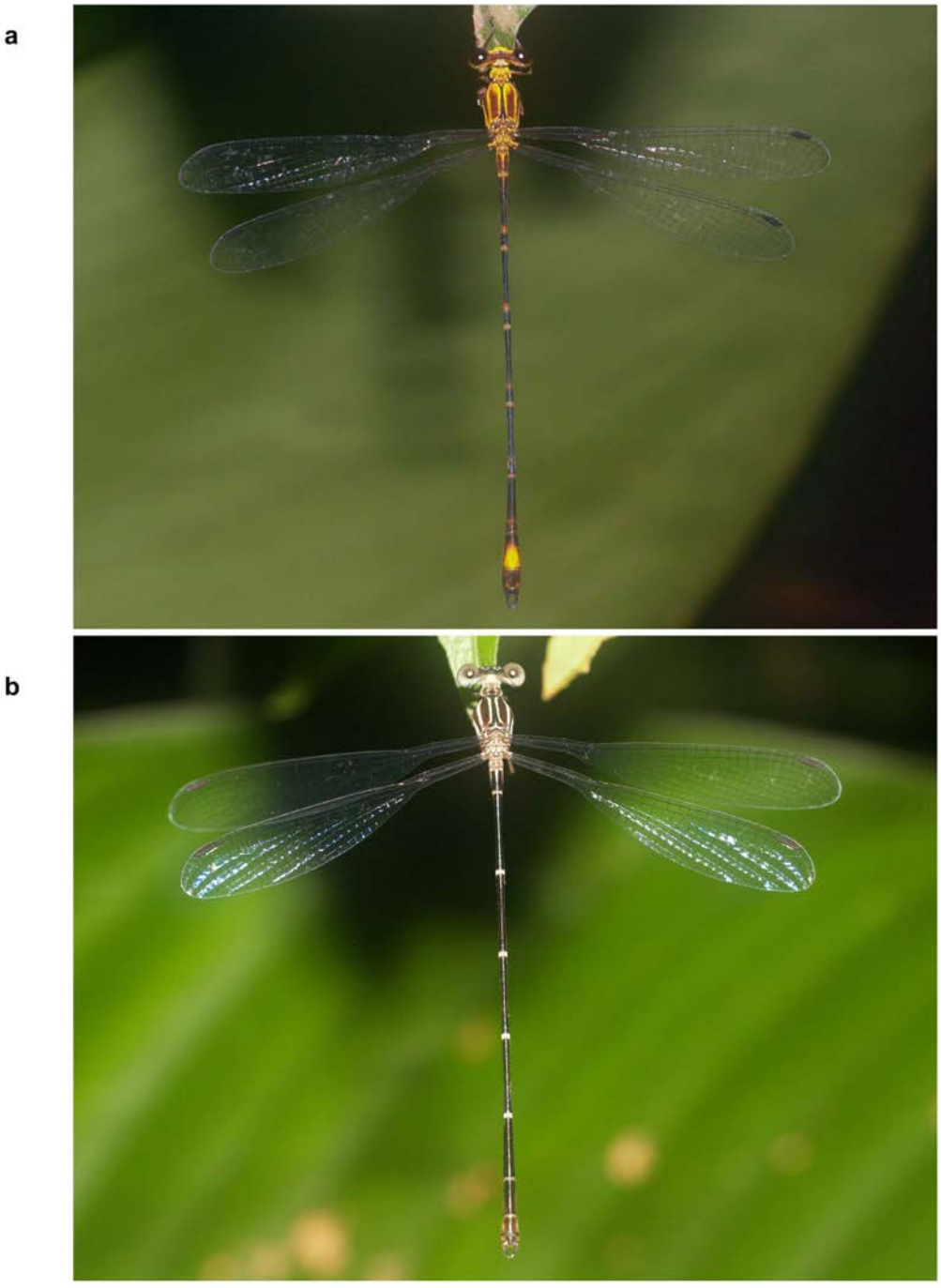

Plate III. a: Male of *Heteragrion ictericum* (Odonata, Megapodagrionidae). **b**: Male of *Oxystigma williamsoni* (Odonata, Megapodagrionidae). Both photographed at a forest creek in Werehpai Camp by N. von Ellenrieder.

Plate IV. a: Male of *Protoneura tenuis* (Odonata, Protoneuridae) at a forest stream in Kutari Camp. **b**: Male of *Mecistogaster lucretia* (Odonata, Pseudostigmatidae) at a forest trail in Werehpai Camp. Both photographed by N. von Ellenrieder.

Plate V. a: Male of *Phyllogomphoides major* (Odonata, Gomphidae). **b**: Male of *Diastatops pullata* (Odonata, Libellulidae). Both photographed at Sipaliwini River, near Sipaliwini Camp, by N. von Ellenrieder.

Males of the clubtail dragonfly *Phyllogomphoides major* swiftly patrolled rivers and major creeks surrounding the Camps, and could be seen perching on tip of branches of low vegetation on the banks. Females only visit the water for oviposition, and larvae burrow on the muddy river beds.

Plate VI. a: Female of *Erythrodiplax castanea* (Odonata, Libellulidae) at a forest clearing in Sipaliwini Camp. **b**: Male of *Fylgia amazonica lychnitina* (Odonata, Libellulidae) at a forest swamp in Werehpai Camp. **c**: Male of *Macrothemis hemichlora* (Odonata, Libellulidae) at a forest stream in Sipaliwini Camp. All photographed by N. von Ellenrieder.

Plate VII. a: Male of *Misagria parana* (Odonata, Libellulidae) at a forest clearing in Werehpai Camp.
b: Male of *Oligoclada walkeri* (Odonata, Libellulidae) at a forest stream in Sipaliwini Camp. Both photographed by N. von Ellenrieder.

Plate VIII. a: Male of *Perithemis cornelia* (Odonata, Libellulidae) at a forest stream in Sipaliwini Camp. **b**: Male of *Perithemis thais* (Odonata, Libellulidae) at a forest swamp in Werehpai Camp. **c**: Female of *Uracis oviposi-trix* (Odonata, Libellulidae) at a forest trail in Kutari Camp. All photographed by N. von Ellenrieder.

Dragonflies of the genus *Perithemis*, commonly known as 'Amber wings' due to their golden-orange wings, are believed to mimic wasps in their flight. Four species of this genus were encountered during this RAP; the pictures below show a male of *Perithemis cornelia* at a forest stream in Sipaliwini Camp and a male of *Perithemis thais* at a forest swamp in Werehpai Camp. Adults fly close over water in sunshine or in partially shaded areas. They perch on small branches or reeds usually close to water's surface, often with fore and hind wings slowly moving alternatively. Larvae crawl on substrate and among submerged vegetation.

Appendix A. List of Odonates from SW Suriname, Sipaliwini District, Kwamalasamutu region. Relative abundance: R (rare = 1–3 individuals seen); F (frequent = 4–20 individuals seen); C (common = 21–50 individuals seen). * = new record for Suriname; # = misidentified in the literature.

		Site			
		Kutari	Sipaliwini	Werehpai	Kwamalasamutu/ Iwana Samu
Family	Species	Relative abundance of species per site			
Calopterygidae (2 gen., 4 spp.)	*Hetaerina caja dominula* Hagen in Selys, 1853	C	C	C	F
	Hetaerina moribunda Hagen in Selys, 1853	R	F	F	-
	Hetaerina mortua Hagen in Selys, 1853	R	R	-	-
	Mnesarete cupraea (Selys, 1853)	R	-	-	-
Coenagrionidae (4 gen., 15 spp.)	*Acanthagrion ascendens* Calvert, 1909	-	R	F	F
	Acanthagrion chacoense Calvert, 1909	-	-	R	-
	Acanthagrion indefensum Williamson, 1916	R	-	-	-
	Acanthagrion rubrifrons Leonard, 1977	F	F	F	-
	Argia fumigata Hagen in Selys, 1865	R	-	-	-
	Argia insipida Hagen in Selys, 1865	F	R	-	-
	Argia oculata Hagen in Selys, 1865	F	C	F	C
	Argia translata Hagen in Selys, 1865	F	F	C	F
	* *Argia* sp. 1	R	C	C	F
	* *Argia* sp. 2	C	R	R	-
	* *Argia* sp. 3	F	-	-	-
	* *Argia* sp. 4	F	R	-	-
	# *Inpabasis rosea* (Selys, 1877)	F	F	F	-
	Metaleptobasis mauritia Williamson, 1915	-	-	R	-
	#*Metaleptobasis quadricornis* (Selys, 1877)	-	-	R	-
Dicteriadidae (1 gen., 1 sp.)	*Heliocharis amazona* Selys, 1853	R	R	R	-
Megapodagrionidae (2 gen., 3 spp.)	*Heteragrion ictericum* Williamson, 1919	F	R	F	-
	# *Heteragrion silvarum* Sjöstedt, 1918	R	R	R	-
	Oxystigma williamsoni Geijskes, 1976	-	-	F	-
Perilestidae (1 gen., 1 sp.)	*Perilestes attenuatus* Selys, 1886	-	-	R	-
	* *Perilestes gracillimus* Kennedy, 1941	R	R	F	-
	Perilestes solutus Williamson & Williamson, 1924	-	R	R	-
Protoneuridae (5 gen., 11 spp.)	*Epipleoneura fuscaenea* Williamson, 1915	R	F	F	-
	* *Epipleoneura pereirai* Machado, 1964	F	R	F	-
	* *Neoneura angelensis* Juillerat, 2007	R	-	R	-
	* *Neoneura denticulata* Williamson, 1917	R	R	R	-
	Neoneura joana Williamson, 1917	F	F	F	-
	Neoneura mariana Williamson, 1917	-	R	-	-
	Neoneura myrthea Williamson, 1917	F	F	F	R
	Phasmoneura exigua (Selys, 1886)	F	R	F	-
	Protoneura calverti Williamson, 1915	-	F	-	-
	Protoneura tenuis Selys, 1860	F	F	F	-
	Psaironeura tenuissima (Selys, 1886)	R	-	-	-
Pseudostigmatidae (2 gen., 3 spp.)	*Mecistogaster lucretia* (Drury, 1773)	R	F	F	F
	Mecistogaster ornata Rambur, 1842	R	-	-	-
	Microstigma anomalum Rambur, 1842	F	R	R	-

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Family	Species	Site			
		Kutari	Sipaliwini	Werehpai	Kwamalasamutu/ Iwana Samu
		Relative abundance of species per site			
Aeshnidae (3 gen., 6 spp.)	*Gynacantha auricularis* Martin, 1909	-	R	R	-
	Gynacantha gracilis (Burmeister, 1839)	-	-	R	-
	Gynacantha klagesi Williamson, 1923	-	-	R	-
	Gynacantha sp.	-	R	R	-
	Staurophlebia reticulata (Burmeister, 1839)	R	R	F	-
	Triacanthagyna ditzleri Williamson, 1923	-	R	-	-
Gomphidae (6 gen., 7 spp.)	*Aphylla* sp.	R	-	R	-
	Archaeogomphu nanus Needham, 1944	-	-	R	-
	Ebegomphus demerarae (Selys, 1894)	R	-	-	-
	Phyllocycla ophis (Selys, 1869)	-	R	-	-
	Phyllogomphoides major Belle, 1984	-	-	R	-
	Phyllogomphoides undulatus (Needham, 1944)	F	F	R	-
	Progomphus brachycnemis Needham, 1944	-	-	R	-
Libellulidae (19 gen., 40 spp.)	*Argyrothemis argentea* Ris, 1909	F	-	-	-
	Brechmorrhoga praedatrix Calvert, 1909	-	-	R	-
	Diastatops pullata (Burmeister, 1839)	R	F	R	-
	Dythemis multipunctata Kirby, 1894	-	R	F	-
	Elasmothemis cannacrioides (Calvert, 1906)	F	F	F	-
	* *Elasmothemis rufa* De Marmels, 2008	R	R	F	-
	Elga leptostyla Ris, 1909	-	R	-	-
	Erythrodiplax castanea (Burmeister, 1839)	R	-	-	-
	Erythrodiplax famula (Erichson, 1848)	R	F	F	C
	Erythrodiplax fusca (Rambur, 1842)	R	R	R	R
	Fylgia amazonica lychnitina De Marmels, 1989	R	-	R	-
	* *Gynothemis pumila* (Karsch, 1890)	R	-	-	-
	Macrothemis declivata Calvert, 1909	-	F	-	-
	Macrothemis delia Ris, 1913	R	-	-	-
	Macrothemis hemichlora (Burmeister, 1839)	-	F	-	-
	* *Macrothemis ludia* Belle, 1987	-	-	R	-
	Macrothemis sp.	R	-	-	-
	Miathyria simplex (Rambur, 1842)	-	-	-	C
	Micrathyria artemis Ris, 1911	-	-	-	R
	* *Micrathyria paruensis* Geijskes, 1963	R	-	R	-
	Micrathyria spinifera Calvert, 1909	R	R	-	-
	Misagria calverti Geijskes, 1951	-	-	R	-
	Misagria parana Kirby, 1889	-	-	F	-
	Nephepeltia flavifrons (Karsch, 1889)	-	-	-	F
	Oligoclada abbreviata (Rambur, 1842)	C	F	F	F
	Oligoclada amphinome (Ris, 1919)	F	-	F	-
	Oligoclada rhea (Ris, 1911)	-	-	-	R

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Family	Species	Site			
		Kutari	Sipaliwini	Werehpai	Kwamalasamutu/ Iwana Samu
		Relative abundance of species per site			
Libellulidae *(continued)* (19 gen., 40 spp.)	*Oligoclada walkeri* Geijskes, 1931	-	F	R	-
	Orthemis aequilibris Calvert, 1909	R	F	F	-
	* *Orthemis anthracina* De Marmels, 1989	-	-	R	-
	* *Orthemis coracina* von Ellenrieder, 2009	-	-	R	-
	Orthemis cultriformis Calvert, 1899	-	-	F	-
	Perithemis cornelia Ris, 1910	F	C	F	-
	Perithemis lais (Perty, 1834)	R	R	-	-
	Perithemis mooma Kirby, 1889	-	R	R	F
	Perithemis thais Kirby, 1889	C	C	C	F
	Tauriphila argo (Hagen, 1869)	-	-	-	F
	Uracis fastigiata (Burmeister, 1839)	-	-	F	F
	Uracis infumata (Burmeister, 1839)	F	-	R	-
	Uracis ovipositrix Calvert, 1909	F	R	R	-
	Uracis siemensi Kirby, 1897	-	-	R	-
10 families	**94 spp.; 45 genera**	**57 spp.; 31 genera**	**52 spp.; 28 genera**	**65 spp.; 34 genera**	**18 spp.; 13 genera**

Appendix B. Biology notes on odonates found during the Kwamalasamutu RAP survey.

Genus	Biology notes
Hetaerina	Adults perch on tips of branches and on leaves overhanging water of forest streams (Pl. I b, page 65) and rivers, where they wait for potential mates. More than one species usually occupies the same stream, or species assemblages partition different microhabitats (e.g. sunny versus shaded) of the same stream. Adults commonly found along forest trails perching on leaves and twigs on sunny spots (Pl. I a, page 65). Larvae live in submerged vegetation in aerated portion of streams.
Mnesarete	Adults perch on top of leaves overhanging water of forested streams, and larvae live among submerged aquatic vegetation.
Acanthagrion	Slow backwaters of forest streams and rivers (*A. ascendens*, Pl. II a [page 66], *A. chacoense*, *A. indefensum*), small pools in forest swamps (*A. rubrifrons,* Pl. II b, c [page 66]), and vegetated ditches and ponds in open areas (*A. ascendens*). Females oviposit inside stems of floating plants or masses of algae while in tandem with males, which often remain upright. Larvae live among submerged aquatic vegetation.
Argia	Some species inhabit forest rivers and streams (*A. fumigata, A. insipida, A. translata*), while others breed in forest swamps (*A. oculata, A*. sp. 1, *A*. sp. 2, *A*. sp 3. *A*. sp 4), where larvae live under stones and on sediment. Adults perch on rocks, logs, and twigs close to water surface, on overhanging leaves at streams, or on leaves, twigs and on the ground along forest trails near swamps (page 17), usually in sunny and bare substrates. After landing, adults open and close their wings two or three times. Females oviposit in masses of floating algae or aquatic plants, alone or while still in tandem, with males often standing vertically.
Inpabasis	Adults perch on leaves of bushes at sunny spots in forest swamps. Males where observed guarding little muddy depressions (page 17) where *I. rosea* is likely to breed. Larvae still unknown.
Metaleptobasis	Small sluggish streams and swampy areas within shaded forest zones; adults difficult to detect because they seldom fly and remain near ground, perching still on twigs and bushes. Larvae still unknown.
Heliocharis	Adults wary, perch on sunlight spots on vegetation overhanging water along forest streams with wings outspread. All adult odonates usually have spiny legs, which form a functional 'cage-net' to trap insects caught in flight. *Heliocharis* (and *Dicterias*) present an exception, as they have only minute spines on their legs, and presumably use their unusually large mouthparts instead to catch and hold their prey. Larvae inhabit stream pools with litter substrate and marginal areas of creeks and small slow-flowing rivers bordered by abundant riparian vegetation.
Heteragrion	Adults localized along shaded forest streams and rivers, perching by hanging with outspread wings on twig or leaf tips (Pl. III, page 67). Also commonly found on more open places along creeks and trails, where they catch prey from advantageous perches, usually returning to the same spots. Larvae live among leafy detritus and on lime and gravel beds of streams, and dwelling among organic matter and plant detritus where there is little or no water flow in primary and secondary forest streams.
Oxystigma	Forest streams, where adults perch on tips of twigs in the shade near creeks with wings outspread (Pl. III b, page 67), and can be active during heavy rain (Wasscher 1990), unique among odonates. Oviposition occurs in tandem, and males remain upright while holding females, which insert eggs into fallen palm leaves (Geijskes 1976). Emergence occurs on rocks along margins of creeks (De Marmels 1987).
Perilestes	Adults perch with partially open wings hanging vertically from vegetation in the shaded understory surrounding forest creeks (page 17), where they are rendered inconspicuous by their dark and dull colors. Female ovipositor is strong and likely used to lay eggs in hard substrates, including bark of twigs. Known larvae live among dead leaf litter accumulated in beds of quiet areas of small forest streams (Santos 1969, Neiss & Hamada 2010).
Epipleoneura	Small and dark inconspicuous adults hover very close to water surface and perch in shade under overhanging bushes along forest rivers. Tenerals perch on forest bushes in sunny spots away from water. Known larvae for other species of the genus live in rapidly flowing streams within primary forest (De Marmels 2007).
Neoneura	Adults hover just above water surface in forest streams and rivers, in bright or dappled sunshine, perching on twigs overhanging banks. Females oviposit in tandem in masses of small floating sticks, in dead grassy debris, sticks, and branches, or in muddy banks (Williamson 1918, De Marmels 1992, 2007). Larvae cling to stones in stream beds or are associated with vegetation or coarse detritus in river and creek pools (Westfall & May 2006).
Phasmoneura	Adults found in forest swamps, perching on tips of twigs and leaves (page 17). Larvae still unknown.
Protoneura	Small muddy or sandy streams within forest. Adults fly in shaded areas along banks, hover almost motionless near water surface, and perch on tip of small branches and twigs (Pl. IV a, page 68). They feed on small insects and some species are known to glean small spiders and flies from vegetation (Louton et al. 1996). Females oviposit alone or still in tandem, in leaves or pieces of wood floating in the water, debris, mosses, stems of aquatic plants, or roots, in areas of slow or standing waters, and several pairs can aggregate to oviposit.

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Genus	Biology notes
Psaironeura	Forest swamps, where adults fly among low vegetation in the shade, and perch on stems or leaf tips close to the ground. Larvae still unknown.
Mecistogaster	Adults perch on trees and bushes along forest trails (Pl. IV b, page 68) and clearings, and fly across forest understory in a slow wavy fashion, which combined with their unusually large size makes them very conspicuous. They glean spiders or wrapped spider prey items from spider webs, and females oviposit in species-specific phytotelmatha; larvae of *M. ornata* live in water accumulated in tree holes, other species breed in water filled tree holes (*M. jocaste, M. linearis*), bromeliad bracts (*M. modesta*), or bamboo holes (*M. asticta, M. jocaste*; Garrison et al. 2010). Larvae and breeding habitat of *M. lucretia*, the most common species in this study, are still unknown.
Microstigma	Appearance and habits as in *Mecistogaster*. Larvae live in water-filled tree holes and fallen fruit or nut husks (Neiss et al. 2008).
Gynacantha	Adults inconspicuous, due to their olive-brown ground color and crepuscular habits flying seldom through dense forest understory. They can be found perching on vegetation along margins of forest trails. Larvae inhabit mud bottomed pools, phytotelmatha, and streams (Bede et al. 2000).
Staurophlebia	Large size and bright contrasting green and red colors render adults conspicuous when they patrol forest rivers. Occasionally attracted to light at night. Larvae live in forest rivers (Geijskes 1959).
Triacanthagyna	Crepuscular habits in forests, where they breed in temporary pools and phytotelmatha. Adults can be found perching on vegetation along margins of forest trails.
Aphylla	Adults found along forest trails or at margins of streams where they alight on ground or snags with horizontally spread wings. Larvae are borrowers in soft muddy bottom zones in slowly flowing streams or still water areas (Belle 1992).
Archaeogomphus	Adults perch on overhanging leaves or twigs in dappled shade along forest stream banks, in which larvae live in pools with sand and detritus.
Ebegomphus	Forest rivers, where adults hover over sunny spots, low over the surface of quietly flowing water, and perch on twigs and dry branches. Larvae inhabit leafy trash in pools and eddies of creeks, and have been reported to emerge on large floating leaves at midday (Belle 1970).
Phyllocycla	Adults perch occasionally on dry twigs in the sun along forest rivers and streams, which males patrol flying swiftly close to water. Larvae probably inhabit silt-covered backwaters.
Phyllogomphoides	Males perch on stones or tip of branches of low vegetation on forest river banks (Pl. V a, page 69), and females visit the water only for oviposition. Larvae burrow on muddy river beds (Belle 1984).
Progomphus	Adults perch on rocks or low vegetation along forest river and stream banks. Larvae burrow in sand beds (Belle 1966b).
Argyrothemis	Adults found in forest swamps, where males are striking by flashing their bright pruinose-white thoracic dorsum when flying through a sun-patch, and disappearing as they move into the shade. Larvae camouflage themselves with detritus (Fleck 2003a).
Brechmorrhoga	Adults course up and down sections of forest rivers, and perch in pendent position in forest clearings or in brush on river banks. Larvae commonly found in areas of rocky substrate, shallow water, and rapid flow. The larva of *B. praedatrix* is apparently associated with the aquatic plant *Mourera fluviatilis* (Podostemaceae), which grows only in fast moving currents (Fleck 2004).
Diastatops	Marshy areas along forest rivers, where adults perch on vegetation along banks (Pl. V b, page 69), often with conspicuous black and red wings asymmetrically set, and larvae live among submerged vegetation.
Dythemis	Forest streams in sunny or shaded areas.
Elasmothemis	Forest rivers; adults perch on twigs with wings set. Females of *E. cannacrioides* deposit egg strands on floating roots of a liana (González-Soriano 1987).
Elga	Forests streams, where adults perch in sunny patches on leaves of trees bordering banks and fly down to water only for short periods at a time. Larvae live on stream bed.
Erythrodiplax	Forest stream pools and swamps, where larvae live. Adults perch with wings set on tips of grass, low stems, and twigs in open areas (Pl. V a, page 70).
Fylgia	Forest swamps; males land on leaves overhanging water in dappled sunlight, where their white face and red abdomen strike out in the mosaic of twilight and sunspot-shade (Pl. VI b, page 70). Larvae inhabit small, clear, stagnant pools with leaf litter (De Marmels 1992).
Gynothemis	Adults glide over clearings in little mini-swarms at head height and above, and perch on twigs on small creeks within forest where they breed.

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Genus	Biology notes
Macrothemis	Adults hover or course up and down sections of moderate to fast forest creeks, and often land on banks or vegetation bordering streams (Pl. VI c, page 70) or forest clearings; also found sometimes in swarms with one or more other species over glades in forest. Larvae burrow in areas of slow or still water, muddy substrate, and closed canopy.
Miathyria	Lentic environments with floating vegetation, among which roots the larvae live. Adults usually fly in swarms about 3 m over fields, in company with individuals of *Tauriphila*.
Micrathyria	Forest streams (*M. paruensis* and *M. spinifera*) and vegetated ditches (*M. artemis*). Males perch on tips of reeds and grass on shore vegetation with wings set. Females commonly found perching away from water on tips of twigs of bushes and trees.
Misagria	Adults perch on tips of branches and snags with wings set in partially shaded forest areas, and are commonly found in forest clearings and along trails (Pl. VII a, page 71). Larvae unknown.
Nephepeltia	Adults perch with wings set on tips of stems along marshy environments, in which they breed.
Oligoclada	Adults found along forest rivers (*O. abbreviata*), streams (*O. walkeri*, Pl. VII b, page 71), swamps (*O. amphinome*), and ditches (*O. rhea*) where they alight on ground or on surfaces of leaves. Known larva (*O. abbreviata*) collected in an artificial reservoir with strongly fluctuating water levels (Fleck 2003a).
Orthemis	Adults at slow moving forest streams, where males defend territories from a perch on reed, branch, or snag. Females oviposit guarded by the hovering males. Often also found perching in high sunny branches in forest clearings.
Perithemis	Forest streams (*P. cornelia, P. mooma, P. lais, P. thais*), swamps (*P. thais*), and vegetated ditches (*P. mooma*), where adults fly close over water in sunshine or in partially shaded areas. They perch on small branches or reeds usually close to water surface (Pls. VIII a, b, page 72) often with fore and hind wings slowly moving alternatively. Larvae crawl on substrate and among submerged vegetation.
Tauriphila	Adults engage in sustained gliding flights over open fields often in company with individuals of *Miathyria*; larvae live in temporary ponds and ditches among submerged vegetation.
Uracis	Adults perch on small twigs and vegetation near the ground in shaded forest understory or along partially shaded forest trails (Pl. VIII c, page 72). Females of *Uracis ovipositrix* lay eggs in damp earth and in the muddy bottom of small rain puddles. Males of *U. siemensi* hold territories at small water holes in the forest, close to creeks. Larvae unknown.