

RAPID SURVEY OF DRAGONFLIES (INSECTA: ODONATA) OF KRIBI FOREST AND CAMPO MA'AM NATIONAL PARK, SOUTHERN CAMEROON

*ADU, B.W.,¹ OGBOGU S.S.² AND AKINDELE, E.O.²

¹Department of Biology, Federal University of Technology Akure, Ondo State, Nigeria

²Department of Zoology, Obafemi Awolowo University, Ile-Ife

Abstract

A five day survey was carried out to assess the odonate fauna associated with the riverine sections of two forests (Kribi Forest and Campo Ma'am National Park) of southern Cameroon. The primary objective of the study was to determine the species composition and community structure of the odonate fauna occurring in the forests. The goal is to infer the health status of the two forests. Three study sites were selected, one in each of the main water bodies in the forests (Rivers Kienke and Linde in Kribi forest, and River Bitande in Campo Ma'am National Park). All the specimens collected were identified to the lowest taxonomic level. A total of one hundred and ninety four (194) individuals of Odonata were collected in the forests comprising 10 families, 24 species of Anisoptera and 30 species of Zygoptera. Anthropogenic activities were less prevalent at Campo Ma'am National Park, an area in which all the 10 families were incidentally recorded. The community structure of the southern forest revealed that only River Bitande with Shannon-Wiener diversity index (H') of 3.80 was having a stable environmental condition. Others were close to stable condition (River Kienke H' 2.99 and River Linde H' 2.95) with mild disturbance caused by human activity. Simpson index range (0.94 – 0.98) at the three study sites revealed that the vegetation was matured and stable. The distribution of dragonflies and damselflies revealed a stable environment (Evenness 0.90 – 0.95). Kribi Forest appears to be more impacted by anthropogenic activities as fewer (six) families were recorded there. The relative distribution of the species in the two forest ecosystems seemed to have some relationship with human interference therein.

Key Words: Damselfly, Dragonfly, Diversity, Forest, River

Introduction

Tropical countries especially in sub-Saharan Africa are facing problem of deforestation occasioned by increased human activities and poor management of forest resources (Smith *et al.*, 2009). This has resulted in loss of some flora and fauna that are endemic to tropical forest ecosystems. Practices such as

felling of trees, point source discharge, damming and channelization of streams and rivers have resulted in the opening up of forests and degradation of the water bodies (Smith *et al.*, 2009).

Channelization of rivers and streams affects the velocity of water leading to deposition of silt and consequently change in their substrate composition

(Adu, *et al.*, 2014). This change is hazardous to the wellbeing of odonate fauna both in water and within riparian forest vegetation. These unhealthy conditions usually result in habitat shift or death of dragonflies and damselflies, especially those with narrow niche (Adu and Ogunjobi, 2014). Odonate fauna with broad niche and mostly the ubiquitous can cope considerably in disturbed habitat (Clausnitzer, 2006). They are also good colonizers of temporary environment and some are known to be good indicators of polluted freshwater and terrestrial environments (Corbet, 1999).

Vegetation architecture plays important role in regulating the distribution and assemblage of Odonata species (Korkeamaki and Suhonen, 2002). Therefore, a depleted forest will be too open for shade-lovers, who might have been killed or migrated out of the environment. River ecosystems especially the adjacent riparian vegetation usually have a high assemblage of Odonate fauna. Streams, freshwater swamps and peat swamps are known to be rich in dragonflies and damselflies (Che Salmah *et al.*, 2005). Although Odonata occurs in almost every form of freshwater ecosystem, microhabitats with high heterogeneity of vegetation are believed to be the primary factor determining their composition, diversity and distribution (Watanabe *et al.*, 2004).

Dragonflies and damselflies are sensitive to anthropogenic activity (Clark and Samways, 1996; Stewart and Samways, 1998). The two areas selected for this study (Kribi Forest and Campo Ma'am National Park) have heterogeneous vegetation, although they are of different status (unprotected and

protected forests respectively). It was hypothesized that the two forests would have diverse forms of anthropogenic activities which could influence their local flora and fauna. It was further hypothesized that, since the two forests were experiencing different levels of human disturbance, they would differ in terms of Odonata species composition and community structure. This study was thus aimed at describing the health status of the two forest ecosystems based on the species composition and community structure of dragonflies and damselflies in the forests.

Studying Odonata of southern Cameroon dates back to 1884 (Vick 2003) when the Germans took over the coastal part of Duala territory (Mbuagbaw *et al.*, 1987). Series of research works on Odonata have been carried out in the country ever since. Contributions of odonatologists like Karsch (1890) laid the foundation of the study of dragonflies in Cameroon. Pinhey (1962, 1964, and 1974) gave detailed records of Odonata from Fernando Po, Malende, Koto Barombi and Nyasoso. Recent works on dragonflies of southern Cameroon include that of Vick (2003), which provided a checklist of the Odonata of the southwestern Province of Cameroon and biodiversity assessment of the Odonate fauna of the Takamanda Forest Reserve. Other scholarly works include Chelmick (1999, 2001) who worked on the larvae of a member of Aeshnidae. The contributions of these scholars have revealed that southern Cameroon forests are very rich in Odonata. This particular study was a quick and brief assessment of two forests in southern Cameroon, viz Kribi Forest and Campo Ma'am National Park. According to Dijkstra (2007), a rapid

survey of a forest is able to give a fair picture of the local diversity of Odonata within a short period of time. Although previous scholars agreed that the forests are hotspots of Odonate fauna, data on the local faunal composition of Odonata in the forests are lacking.

This paper is a product of the fieldwork carried out during a brief visit to the forests. Although it was a rapid assessment of Odonate fauna in the forests, it was meant to supplement already known information on Odonata of Cameroon in general and of the forests in particular. Besides, the effect of climate change and human activities prevailing in sub-Saharan forests, which could have altered composition, distribution and species diversity of odonate fauna in the forest, necessitated the need for an assessment of the current status forests.

Materials and Methods

Study Site

Two forests in Southern Cameroon were surveyed with the intention of identifying odonate species inhabiting the forests. These two forests, like most forests in sub-Saharan Africa, are subjected to degradation owing to anthropogenic activities. Human activities in the two forests include farming; logging and construction work especially in Kribi forest. These activities were however minimal at the Campo Ma'am National Park due to strict compliance with government forest conservation and management policies. Nevertheless, limited logging was allowed in some part of the park. Subsistence farming was observed at the camps adjacent to the forest. Three study sites were established in the two forests: two in Kribi forest and one site at Campo-Ma'am National Park. Table 1 presents the Geo-reference coordinate of the three study sites while Figure 1 presents the map of south Cameroon forest.

Table 1: Geo-reference coordinates of the three study sites at Kienke, Linde, and Bitande Rivers.

Study Site	Location	Geo-Reference Coordinate
River Kienke	Kribi Forest	02° 28`12 - 02° 28` 56 N, 09° 51`28 -09° 51` 47` E
River Linde	Kribi Forest	02°25`33 - 02° 26`08 N, 09° 51`48-09° 52`06`E
River Bitande	Campo Ma'am National Park	02° 21`42- 02° 21`58 N, 09° 55`58-09° 56`10`E

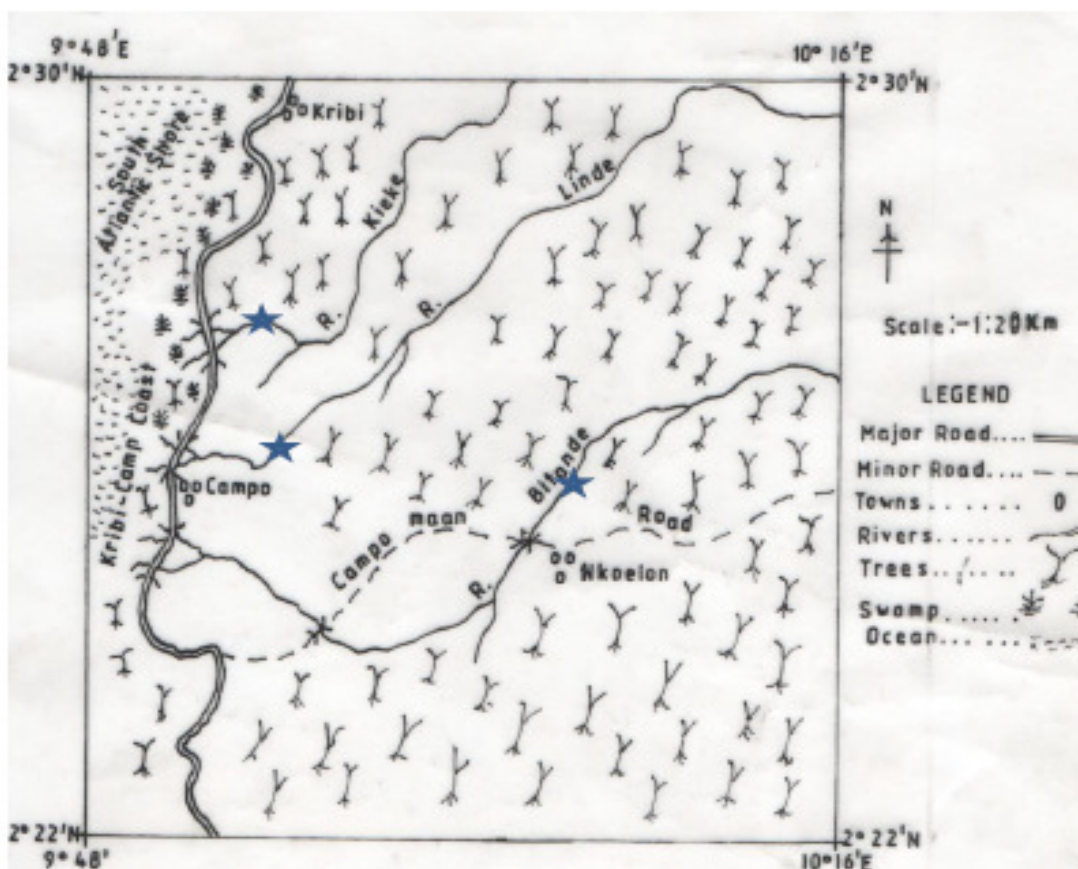


Figure 1: Map of Southern Cameroon Forest Reserve. The Stars (★) on the map indicate the three study sites

Collection, Preservation and Identification of Specimens

Samples of adult dragonflies and damselflies were caught using a sweep net. The sampling was carried out in the two forests between 9.00 am and 4.00 pm. The survey lasted for 5 days (10th-14th June, 2008). Kribi Forest was surveyed from 10th to 12th of June and Campo-Ma'am forest surveyed on 13th and 14th of June. All the specimens collected were kept in small triangular envelopes. Males and females caught in tandem were placed together inside one envelope and then labeled. Adult specimens were preserved by placing each catch in a triangular envelope and then immersing them in acetone. The specimens were allowed to remain inside

acetone for a minimum of 12 hours, after which they were dried on tissue paper in open air and then kept in cellophane envelopes. All specimens collected were deposited in the National Museum of Natural History Naturalis, Leiden, Netherlands. Identification of all the samples collected was carried out by an odonatological expert in Cameroon.

Data Analysis

Species richness of the three study sites was determined using diversity indices which include Shannon-Wiener index (H') Margalef index *d* Simpson's Dominion index (C) and Evenness E. Simple descriptive statistic like percentage was also used in the analysis of the data collected in the study.

Results

Table 2 presents the relative distribution of odonate species recorded in the three study sites during the five-day survey. A total of 194 individuals of dragonflies and damselflies were collected at the sites during the period. The collected samples belonged to 54 species in ten families. Six out of the ten families were zygopterans (Lestidae, Platycnemididae, Protoneuridae, Coenagrionidae, Chlorocyphidae and Calopterygidae) while the rest were anisopterans (Libellulidae, Gomphidae, Corduliidae and Aeshnidae). Only one species each of Aeshnidae (*Gynacantha bullata*) and Lestidae (*Lestes uncifer*) were collected in this study. Zygoptera was the dominant sub-order with 30 species represented, while Anisoptera had 24 species.

Figures 2 and 3 show the qualitative and quantitative contributions of each odonate family in the three study sites. A

total of six families each were recorded in Rivers Kienke and Linde, while all the ten families were recorded in River Bitande. Libellulidae (Anisoptera) was the family with the largest number of species in the three sites, while Lestidae and Aeshnidae were both represented by only one species each. All species of *Chlorocypha* sampled in this study were represented in all the study sites except *Chlorocypha neptunus* which was not found in Kribi forest (Rivers Kienke and Linde). Two species of *Pseudagrion* (*P. camerunensis* and *P. serrlatun*) were also found present in all the sites. Other dragonflies and damselflies found common in all the sites were *Elattonneura pruinosa*, *Othetrum brachiale*, *Othetrum stemmale* and *Trithemis arteriosa*. Quantitatively, the most dominant families in the three study sites were Libellulidae, Chlorocyphidae and Coenagrionidae.

Table 2: Relative distribution of species of Odonata in Kribi Forest and Campo Ma'am National Park, Southern Cameroon (June, 2008)

Taxa	Study Sites		
	Kribi Forest		Campo-Ma'am National Park
	R. Kienke	R. Linde	R. Bitande
Aeshnidae			
<i>Gynacantha bullata</i> Karsch, 1891	0	0	1
Calopterygidae			
<i>Phaon camerunensis</i> Sjostedt 1900	1	0	0
<i>Phaon iridipensis</i> (Burmeister, 1839)	1	0	3
<i>Sapho orichalcea</i> McLachlan 1969	0	1	2
<i>Sapho gloriosa</i> McLachlan in Selys, 1873	0	0	2
<i>Saphon ciliate</i> (Fabricius, 1781)	0	0	2
<i>Umma longistigma</i> (Selys, 1869)	1	2	3
Chlorocyphidae			
<i>Chlorocypha centripunctata</i> Gambles, 1975	1	2	3
<i>Chlorocypha cancellata</i> (Selys, 1879)	1	3	2
<i>Chlorocypha curta</i> (Hagen in Selys, 1853)	2	2	3
<i>Chlorocypha cyanifrons</i> (Selys, 1873)	2	3	3
<i>Chlorocypha glauca</i> (Selys, 1879)	2	2	3
<i>Chlorocypha neptunus</i> (Sjostedt, 1899)	0	0	2
Coenagrionidae			
<i>Africallagma vaginale</i> (Sjostedt, 1917)	2	0	2

<i>Agriocnemis maclachlani</i> Sjostedt, 1877	0	2	2
<i>Agriocnemis forcipata</i> Le Roi 1915	0	0	3
<i>Pseudagrion kersteni</i> (Gerstaecker, 1869)	5	0	4
<i>Pseudagrion camerunense</i> Karsch, 1899	2	1	2
<i>Pseudagrion melanicterum</i> Selys, 1876	0	0	3
<i>Pseudagrion rissi</i> Schmidt in Ris, 1936	0	0	3
<i>Pseudagrion serrulatum</i> Karsch, 1894	2	2	3
Corduliidae			
<i>Phyllomacromia contumax</i> Selys, 1879	0	0	2
<i>Phyllomacromia overlaeti</i> (Schouteden, 1934)	0	0	2
<i>Phyllomacromia paula</i> (Karsch 1892)	0	0	1
Gomphidae			
<i>Diastatomma tricolour</i> (Palisot de Beauvois, 1805)	0	0	1
<i>Neurogomphus agilis</i> (Martins, 1908)	0	0	2
<i>Microgomphus camerunensis</i> Longfield, 1951	1	0	0
Protoneuridae			
<i>Chlorocnemis eisentrauti</i> Pinhey, 1974	2	0	0
<i>Chlorocnemis abbotti</i> (Calvert, 1896)	0	0	2
<i>Chlorocnemis nigripes</i> Selys, 1886	0	3	0
<i>Elatoneura balli</i> Kimmins, 1938	0	0	2
<i>Elatoneura lliba</i> Legrand, 1985	0	0	2
<i>Elatoneura josemorai</i> Compte Sart, 1964	0	0	3
<i>Elatoneura pruinosa</i> (Selys, 1886)	2	3	3
Platycnemididae			
<i>Platycnemis rufipes</i> (Selys 1886)	0	0	3
<i>Mesocnemis singularis</i> Karsch, 1891	0	2	2
Lestidae			
<i>Lestes uncifer</i> (Karsch, 1899)	0	0	2
Libellulidae			
<i>Orthetrum abbotti</i> Calvert, 1892	2	0	2
<i>Orthetrum brachiale</i> (Palisot de Beauvois, 1805)	1	4	3
<i>Ortherum julia</i> Kirby, 1900	0	2	3
<i>Orthetrum microstigma</i> Ris, 1911	0	2	3
<i>Orthetrum stemmale</i> (Burmeister, 1839)	1	3	2
<i>Neodythemis gorilla</i> Pinhey, 1961	0	3	2
<i>Pantala flauescens</i> (Fabricius, 1798)	1	0	3
<i>Palpopleura ivera</i>	0	0	2
<i>Palpopleura lucia</i> (Drury, 1773)	2	0	0
<i>Palpopleura portia</i> (Drury, 1773)	0	3	0
<i>Trithemis aenea</i> Pinhey, 1961	0	0	2
<i>Trithemis annulata</i> (Palisot de Beauvois, 1805)	0	0	1
<i>Trithemis arteriosa</i> (Burmeister, 1839)	2	3	2
<i>Trithemis dichroa</i> Karsch, 1893	2	0	0
<i>Trithemis grouti</i> Pinhey, 1961	0	0	1
<i>Trithemis hartwig</i> Pinhey, 1970	0	0	2
<i>Trithemis tropicana</i> Fraser, 1953	0	0	2
Number of species	22	20	47
Total Individuals	38	48	108

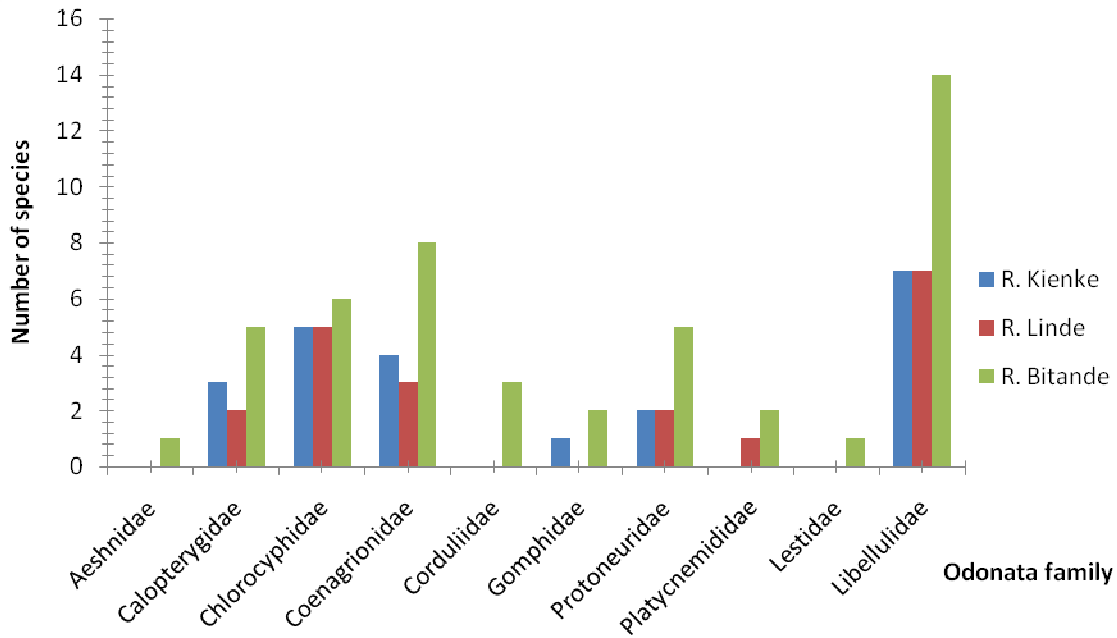


Figure 2: Abundance of Odonata species in Kribi Forest and Campo-Ma'am National Park, Southern Cameroon

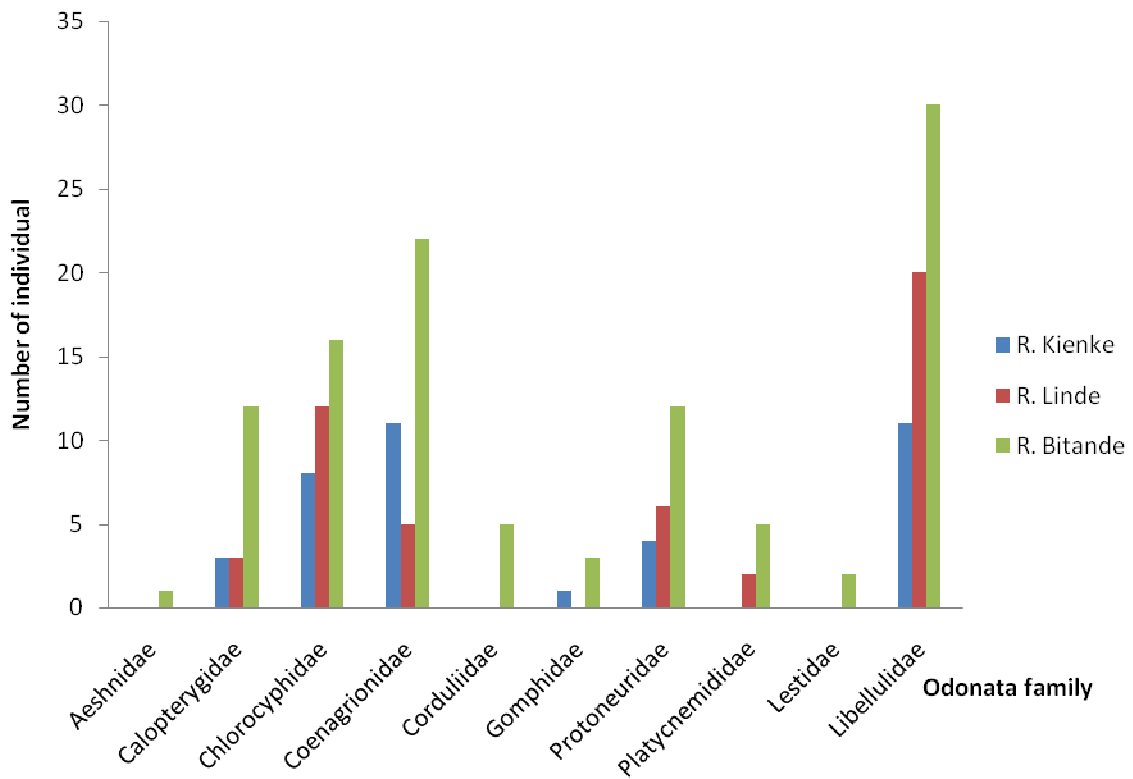


Figure 3: Number of individuals of Odonata families sampled in Kribi Forest and Campo-Ma'am National Park, southern Cameroon

The community structures of Odonata fauna in the forests are presented in Table 2. River Bitande had the highest number of species (47) followed by River Kienke (22 species) and River Linde (20 species). The highest abundance of Odonata was recorded at Campo Ma'am National Park (River Bitande), and this was significantly higher ($p < 0.001$) than the other two sites. Shannon-Weiner (H'), Simpson (1-D) and Margalef (d) indices indicated that Campo-Ma'am National Park (River Bitande) recorded the highest diversity of Odonata, while River Linde (Kribi Forest site) recorded the lowest. Evenness of species was lowest at River Kienke (Kribi Forest site) and highest at River Bitande (Campo-

Ma'am National Park site). Species richness of the three study sites was quite healthy since all of the study site have Shannon-Wiener diversity index of closer 3.00, which is above 2.00 (a value characterized with moderate polluted condition). Shannon-Wiener index of 3.00 signifies stable environmental condition (Sarmistha *et al.*, 2009).

Simpson dominance index is also very close to 1.0 which shows the two forests is matured and in stable environmental condition (see table 3). The evenness values were close to 1.0 in the entire study site which shows that the species in the forest were evenly distributed (Table 3).

Table 3: Community structure of Odonate fauna in Kribi Forest and Campo-Ma'am National Park, Southern Cameroun (June 2008)

Parameter	Kribi Forest		Campo-Ma'am National Park
	R. Kienke	R. Linde	R. Bitande
Species richness	22	20	47
No. of Individuals	38	48	108
Shannon-Weiner H'	2.99	2.95	3.80
Simpson (1-D)	0.94	0.95	0.98
Evenness E	0.90	0.95	0.95

Six species of Calopterygidae were recorded in this study. Five out the six species were collected at River Bitande (*Phaon iridipennis*, *Sapho orichalea*, *S. gloriosa*, *S. ciliata* and *Umma longistigma*), three species at River Kienke (*Phaon cameroonensis*, *P. iridipennis* and *Umma longistigma*) and two at River Linde (*Sapho orichalea* and *Umma longistigma*). All the six species of Chlorocyphidae collected were found at the study sites except *Chlorocypha neptuna* which only occurred at River Bitande. Eight species of Coenagrionidae were recorded in this study, five of which belonged to genus

Pseudagrion while two species belonged to *Agriocnemis* and one to *Africallagma*.

Discussion

Rapid assessment programme has been a usual exercise conducted by International Union for the Conservation of Nature and Natural Resources (IUCN). In 2005 and 2007, rapid assessment programme on Odonata of Liberia and Ghana (respectively) was carried out by the organization (IUCN). The product of the assessment programme includes the discovery of *Atoconeura luxata* for the first time in Ghana and was listed among the regional threatened species by

IUCN. Also a total of 93 species of Odonata were sampled in Liberia during a similar assessment programme at Gola and Grebo National, Forest Liberia. Dijkstra (2007a) concluded that rapid assessment programmes have the tendency to measure indirect anthropogenic disturbance.

The study area for this assessment programme (i.e. Southern Cameroon forests) may be considered rich in Odonata. It is important to mention here that more species of Odonata as well as high number of individuals could have been recorded, but for the short duration of survey. Also the visits to the forests were during the wet season, a period characterized by cloudy day and torrential rainfall. During this period, some riparian vegetation which could provide oviposition sites for mature reproductive females were submerged. Also this period is usually too dangerous for emerging teneral adults which could easily be flushed away by allochthonous run-off. The two monospecific families Aeshnidae and Lestidae (*Gynacantha bullata* and *Lestes uncifer* respectively) are forest species. Collecting them at Campo Ma'am National Park showed that anthropogenic activity in the forest was minimal, since Aeshnidae are generally shade lovers. It was not unexpected that *G. bullata* was collected at the river side since the species is generally known to inhabit streams and swamps in dense forests. *G. bullata* has a wide geographical distribution and has been reported to occur in forests of West Kenya, North Malawi and all over West Africa (Clausnitzer and Dijkstra, 2009).

All the species of Calopterygidae collected in this study are forest insects (Samways, 2008) whose range extends

from Cote d'Ivoire to Cameroon Dijkstra and Clausnitzer, 2015). Vick (2009) had earlier reported that *Chlorocypha neptuna* is a rare species which only occurs in Cameroon in the whole of tropical Africa. The species was the only chlorocyphid species recorded in this study at one site, thus confirming its endemism in Cameroon and rarity in the whole of tropical Africa. Generally, *Chlorocypha* is endemic to tropical Africa with over 30 species. They are forest Odonata found to inhabit all manner of running waters from West Africa to Central Africa). *Pseudagrion*, which recorded the highest number of species among the coenagrionids in this study, is the largest genus in the family with almost a hundred species (Dijkstra, 2003). The five *Pseudagrion* species are widespread across West Africa and have been reported from Republic of Benin to Cameroon (Gambles, 1980) as well as East Africa (Clausnitzer and Dijkstra, 2005).

The three species of Corduliidae collected in this study belonged to genus *Phyllomacromia* (*P. contumax*, *P. overlaiet* and *P. paula*) and they were recorded only in Campo Ma'am National Park, at some distance from the river. *Phyllomacromia* is not new to Cameroon and its larvae have been part of the delicacy of people living around Mount Kupe (Vick, 1999). Only two species (*Platycnemis rufipe* and *Mesocnemis singularis*) of the Platycnemididae were recorded in this study. They have earlier been reported in Cameroon (Vick, 1999). Their distribution range includes Senegal, Ghana, Republic of Benin, Nigeria and Upper Guinean forests (Vick, 1998; Adu and Ogbogu, 2011).

Many of the libellulids collected are well known across West Africa.

Orthetrum stemmale, *O. brachiale* and *Trithemis arteriosa* were well represented in all the study sites. *Orthetrum stemmale* had been reported in Guinea, Ivory Coast, Nigeria, Ghana and Ethiopia (Clausnitzer and Dijkstra, 2005; Adu and Ogbogu, 2011). *Patala flavescens*, *Orthetrum julia* and *Trithemis arteriosa* have also been recorded in Takamanda Forest Reserve, Cameroon (Vick, 2003).

Conclusion

In conclusion, it is obvious that the two forests are rich in odonate fauna, although Campo Ma'am National Park appears richer. Findings from this study have provided baseline information for odonatologists who may want to carry out research on dragonflies and damselflies of Kribi Forest and Campo Ma'am National Park. It is believed that a more elaborate study on the odonate fauna of the forests would record higher taxa richness. It is therefore recommended that a thorough survey be carried out in the two forests which should extend beyond the three rivers (R. Kienke, R. Linde and R. Bitande). Priority should be given to other natural water bodies such as streams, springs and swamps so that restricted and localized Odonata species hidden in the forests can be fully accounted for.

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