COMPOSITION AND ABUNDANCE OF ODONATES AT ALATORI STREAM SOUTH-WEST, NIGERIA

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Abstract
Dragonflies and damselflies (Odonata) are sensitive to human disturbance both as adults that are on wings and as larvae that are aquatic. This attribute suggests their usage as assessment tool for determination of human disturbance within the ecosystem. Alatori stream in Akure Forest Reserve was studied from May 2008 to April 2010 in order to determine the water quality and abundance of Odonata species of the stream. Adults and larvae specimens were sampled throughout the sampling period. A total of 767 adult specimens and 108 larvae were collected. Only 45.4% of the penultimate and ultimate larvae collected eclosed (emerged) to teneral adults. The composition of Odonata families occurring at the stream showed that Libellulidae was the highest (281) followed by Chlorocyphidae (158) while the lowest was Megapodagrionidae (5). The occurrence of members of the families Megapodagrionidae, Chlorocyphidae and Calopterigididae indicates that the stream ecosystem can sustain species with narrow niches. Seven physico-chemical variables: temperature (water and ambient), pH, turbidity, electrical conductivity, dissolved oxygen, water current velocity and depth of the stream were examined and analysed. Analysis of variance (ANOVA) result revealed that conductivity, temperature and water depth played a major role in determining the community structure of odonate assemblage in the stream. The mean (±) standard deviation of electrical conductivity (184.25 ± 6.37µS/cm) of the water was indicative of an unpolluted freshwater system with stable habitat structure. The study suggests that the water quality of Alatori stream is healthy and can sustain Odonata and other fauna within the ecosystem.

Keywords: Odonata, Abundance, Assemblage, Alatori stream

Introduction
Nigeria and many other tropical countries are facing problem of deforestation occasioned by increase in human activities and poor management of forest resources. This has resulted in loss of many endemic plants and animal species (Adu, 2012). Human activities such as felling of trees, damming and canalization of streams and rivers have resulted in opening up of forests and degradation of the water bodies (Kehinde *et al.*, 2014). For instance, canalization of rivers and streams affects the velocity of water leading to deposition of silt and consequently change the structure of the bottom

substrate. Some of these changes are hazardous to many benthic macro invertebrates such as dragonfly and damselfly larvae inhabiting water bodies. These unhealthy conditions usually result in habitat shift and or death of dragonflies and damselflies especially those with narrow niche (Adu and Ogunjobi, 2014).

Dragonflies and damselflies (Odonata) are sensitive to habitat disturbance such as pollution and can be used as indicators of environmental quality both in aquatic and terrestrial habitats Dijkstra (2007). Using species of dragonfly and damselfly order as bio-indicator is based on the fact that the ecology, distribution and taxonomy of the candidate taxa is well known (Brian, 2008). Dragonflies and damselflies as better indicator candidates than birds and butterflies because of their ability to exploit two different habitats (aquatic and terrestrial) during their lifetime.

Odonata have a range of preference for different biotopes, from permanent shaded sites to temporary pools (Corbet, 2004). The choice of different biotope by different species has been used as a means of determining the extent to which a landscape have been affected by anthropogenic activities which assist in the determination of the ecology integrity of an ecosystem (Samways, 1993). Many countries across the globe have used dragonflies as indicator species for determining health status of both aquatic and terrestrial habitats. Such countries include Japan, U.S.A, and Australia (Darwall *et al.*, 2005) and South Africa (Samways, 1993, Clark and Samways, 1994). It was hypothesized that Odonata composition, distribution and community assemblage have the tendency to disclose the fitness of stream ecosystem to sustain members of the community (Adu and Ogbogu, 2011). The objectives of this study are to determine the species composition i.e. to generate dragonflies and damselflies checklist for Alatori stream and using Odonata assemblage as tool to determine the water quality of the stream.

Materials and Methods

Description of the Study Site

Alatori stream is one of the water bodies located in Akure Forest Reserve South-West, Nigeria (07°12.24´ N - 07° 13.83´N and 005° 02.29´E - 005° 03.65´E). It is a permanent stream with the deepest part less than 0.9 m at the peak of rainy season. The flora community include aquatic plants such as *Oriza* spp, Hornwort, and arrowhead, other vegetation include shrubs, palm trees and crop tress. Some portions of the stream were opened. Figure 1 present the map of a portion of Akure Forest Reserve.

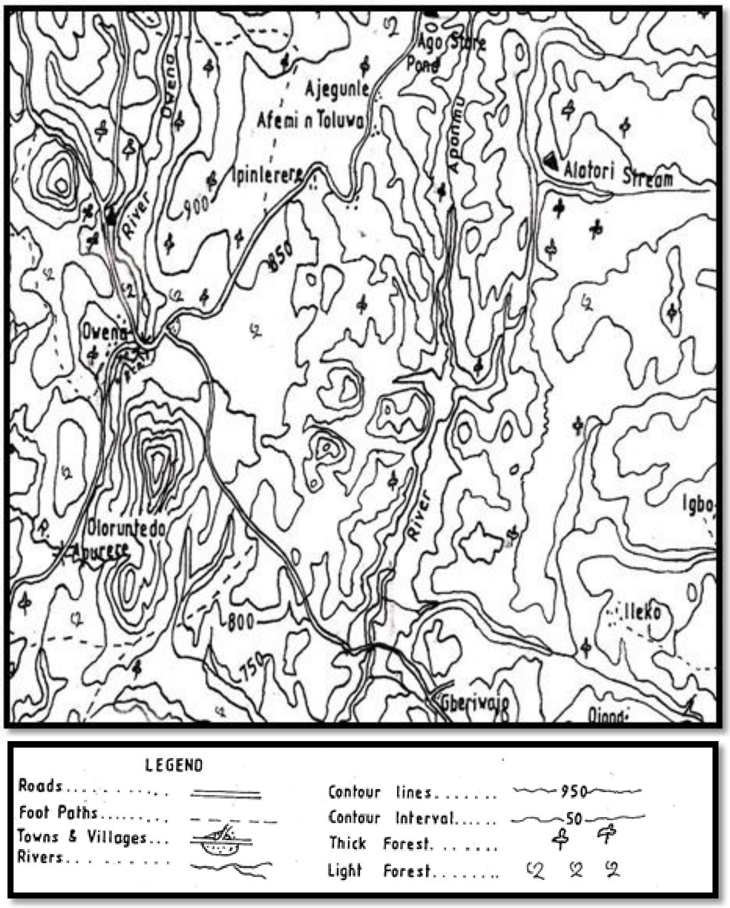

Figure 1: Map of a portion of Akure Forest Reserve. The star ( ) on the map indicates Alatori stream

Collection of samples

Both adults and larvae of dragonflies and damselflies specimens were sampled: the larvae were sampled once every two months for two years (May 2008 to April 2010). Specifically the sampling of the larvae is meant to be reared to adults so as to have specimens that are normally difficult to collect as adult. Therefore penultimate and ultimate larvae were sampled at the banks of the stream using a standard aquatic D-frame dip net with 600 micron width Nitex bag, white tray and small metal kitchen sieve. Sampling of specimens was between 9.00 am and 2.00 pm every sampling day. Stream banks are the best place to collect these larvae (penultimate and ultimate) since they seek after stems of semi-submerged and submerged riparian vegetation or boulders at the banks of the stream for support in preparation for eclosion (emergence) to teneral adults. On emergence, the adults begin migratory expedition to adjacent upland vegetation for the continuation of terrestrial phase of their life cycle (Chemick, 2007; Adu and Ogbogu, 2013).

Adult dragonflies and damselflies were collected once a month between 10.00am and 4.00pm for the two years study period (May 2008 to April 2010) using sweep net with 150cm long handle and 25cm in diameter. Each specimen caught was placed in a triangular envelope, while pairs of mating male and female caught in tandem were placed together in the same envelope. For further processing and preservation in the laboratory.

Preservation of specimens

All the specimens were then kept in acetone for a minimum of 12 hours so as to ensure absorption of sufficient acetone to enhance embalmment for proper preservation. Thereafter the specimens were removed from the acetone and air-dried on filter papers. Each of the specimens was then kept in a transparent small nylon bag, sealed and then placed inside a 3 x 5 cm envelope for keep in insect box. All specimens collected were identified to the lowest possible taxonomical level (species level) using relevant identification keys such as Dijkstra and Clausnitzer, (2015) and Vick, (2003).

Rearing of Larvae

The aquaria (tanks) used for the rearing of the larvae were strategically placed at fairly shaded and airy part of the laboratory. Each of the tanks was equipped with five rearing cages. Each rearing cage was made up of metal mesh cylinder of 6 cm width and 15 cm height. The cage was covered at the top with an inverted plastic Petri dish. A larva was placed in each of the cage at a time to prevent cannibalism (Samways and Wilmot, 2003, Adu *et al*., 2014). Each of the tanks contained 2-3 cm deep of dechlorinated water and sand (from the stream). A stick was placed inside each cage to serve as support during eclosion. All the larvae were fed twice a day with maggots collected from poultry dropping (Adu, 2012 and Adu *et al*., 2014). Leftover food was removed from the aquaria every morning to avoid foul odour and contamination. Also water in the aquaria was replaced every two days to prevent contamination. Finally all emerged teneral adults (very fragile) were carefully removed from the cages and then kept inside cuticle hardening boxes for their cuticle to become hardened and subsequently prepared for identification (Adu *et al*., 2014).

Water sampling and Analysis

Samples of water from the stream (Alatori) were collected once every two months in 2 liters plastic bottles for the 24 months study period. The water sampled was analyzed to determine the temperature (water and ambient), pH, turbidity, electrical conductivity, dissolved oxygen, water current velocity and depth. The temperature was measured using a mercury-in glass thermometer while APHA (1998) methods were used for the determination of electrical conductivity, pH, dissolved Oxygen and turbidity. Float displacement method (which involved the use of float, meter rule and stop clock) was used in the estimation of the water current velocity (Schlosser, 1992; Adu, 2007). Water depth was measured using a calibrated staff gauge (Adu, 2007; Arimoro and Ikomi, 2008).

Data analysis

The data collected from analysis ofwater for the period of study were statistically analyzed using descriptive statistics and analysis of variance (ANOVA). The data of monthly occurrence of Odonata genera at the stream was subjected to multivariate analysis (Cluster Analysis) to show the community assemblage pattern.

Results

A total of 875 specimens of dragonflies and damselflies (767 Adults and 108 larvae) were collected at the stream, representing 76 species in 8 families of the Order Odonata. Only two families (Gomphidae and Libelullidae) of suborder Anisoptera (true dragonfly) were found in this stream. Libellulidae had 28 species while only one species (*Lestinogomphus angustus*) of Gomphidae was recorded at the stream throughout the duration of the study. Two hundred and eighty one (281) individual members of the family Libellulidae and thirteen individuals of Gomphidae were collected at the stream. The most abundant species recorded was *Congothemis dubia* (Table 1). This species (*Congothemis dubia*) occurred in most forested parts of tropical Africa: From Congo to West Africa (Dijkstra and Clausnitzer, 2015). The total number of individual true dragonflies collected at the stream was 294. The Family Libelullidae (281) had the largest number of individuals

Four hundred and seventy three (473) zygopteran (damselfly) in six families were represented at the stream environment. The families include Calopterygidae, Chlorocyphidae, Coenagrionidae Megapodagrionidae, Platycnemididae and Protoneuridae. The family Chlorocyphidae (158) had the highest number individuals followed by Coenagrionidae (132) and the lowest number of 5 was recorded for the family Megapodagrionidae (Table 1). The percentage composition of the families represented at Alatori stream and environment are presented in Table 2.

Out of twenty nine genera of Odonata sampled at the stream eleven are known to have narrow range of adaptability (stenotopic). The stenotopic genera include *Lestinogomphus, Neurolestes, Oreocnemis, Chlorocypha, Phaon, Saphon,* and *Umma.* Others are *Platycypha Elattoneura Chalcostephia,* and *Lokia*. These genera are sensitive to pollution and disturbed environment and are therefore not commonly found in disturbed environment and in highly polluted water. Occurrence of these genera is an evidence of a healthy water quality.

Out of the 108 larvae collected from the stream, 49 larvae emerged into teneral adults thus 55% mortality was recorded during the study; the cause of this high mortality rate could be attributed to the sensitivity of larvae to habitat change (Figure 2). All the larvae were reared outside the natural habitat a situation that led to high mortality rate. The month of March, 2009 and March 2010 were the two months with the highest percentage of survival, the month with the highest mortality rate was November, 2009 which was in dry season. The results of the physical and chemical factors of Alatori stream are shown in Table 3. There were positive significant relationships (P<0.05) in the conductivity, ambient temperature, water current velocity and water depth.

Table 1: Number of individuals' per species of Odonata recorded in Alatori Stream in Akure Forest Reserve

TAXA	**No. of individual**	**Sub total**
Family: Gomphidae		
Lestinogomphusangustus Martins, 1911	13	13
Family: Libellulidae		
Atoconeura luxata Dijkstra,2006	15	
Brachythemis lacustris (Kirby,1889)	12	
Brachythemis leucosticte (Burmeister,1839)	14	
Congothemis dubia (Frazer,1954)	18	
Congothemis leakeyi (Pinhey, 1955)	6	
Congothemis erythraea (Brulle,1832)	8	
Congothemis sanguinolenta (Burmeister,1839)	8	
Lokiaery thromelas (Ris,1910)	10	
Neodythemis klingi (Karsch,1890)	6	
Hadrothemis infesta (Karsch,1891)	12	
Nesciothemis nigeriensis Gambles,1966)	8	
Nesciothemis farinose (Forster,1898)	8	
Nesciothemis pujoli Pinhey,1971	10	
Orthetrum africanum (Selys,1887)	6	
Orthetrum brachiale (Palisot de Beauvois,1817)	8	
Orthetrum caffrum (Burmeister,1839)	8	
Orthetrum chrysostigma (Burmeister,1839)	13	
*Orthetrum hintzi*Schmidt,1951	9	
*Orthetrum julia*Kirby,1900	16	
Orthetrum machadoi Longfield,1955	6	
Orthetrum stemmale (Burmeister,1839)	8	
Chalcostephia flavifrons Kirby,1889	12	

Palpopleura lucia(Drury,1773)	14	
Palpopleura portia (Drury,1773)	17	
Sympetrum fronscolmobii (Selys,1840)	6	
Sympetrum navasi Lacroix,1921	8	
*Trithemis dichroa*Karsch, 1893	5	
*Trithemis imitate*Pinhey 1961	10	281
Family: Calopterygidae		
*Phaoncame runensis*Sjöstedt, 1900	12	
Phaoniri dipennis(Burmeister, 1839)	15	
Saphonciliata (Burmeister, 1839)	9	
Ummacincta (Hagen in Sélys, 1853)	6	
Ummadeclivium Förster, 1906	5	
Umma mesostigma(Selys, 1879)	11	
*Umma saphirina*Förster, 1916	11	
*Umma mesumbei*Vick, 2003	13	82
Family: Chlorocyphidae		
Chlorocypha cancellata(Selys, 1879)	12	
Chlorocyphacentripunctata Gambles, 1975	12	
Chlorocypha consueta (Karsch, 1899)	14	
Chlorocypha dahlia Fraser, 1956	10	
Chlorocypha autorea	9	
Chlorocyph aluminosa (Karsch, 1893)	10	
Chlorocypha victorae (Förster, 1914)	9	
Chlorocypha dispar (Palisot de Beauvois, 1807)	12	
Chlorocypha glauca (Selys, 1879)	7	
Chlorocypha curta (Hagen in Selys, 1853)	17	
Chlorocypha radix Longfield, 1959	13	
*Chlorocypha flammea*Dijkstra,2009	9	
Chlorocypha trifaria(Karsch, 1899)	8	
*Chlorocypha pyriformosa*Fraser, 1947	7	
Platycypha auripes (Förster, 1906)	5	
Platycypha eliseva Dijkstra, 2008	4	158
Family: Coenagrionidae		
Aciagrion heterostica Fraser, 1955	9	
Aciagrion hamoni Fraser, 1955	9	

Africallagma vaginale Sjostedt,1917	12	
Ceriagrion glabrum (Burmeister, 1839)	9	
Ceriagrion suave Ris, 1921	9	
Ischnura senegalensis (Rambur, 1842)	10	
Pseudagrion kersteni (Gerstäcker, 1869)	18	
*Pseudagrion melanicterum*Selys, 1876	13	
Pseudagrion risi Schmidt, 1936	15	
Pseudagrion sublacteum (Karsch, 1893)	12	
Pseudagrion torridum Selys, 1876	8	
Teinobasi salluaudi (Martin, 1896)	8	132
Family: Megapodagrionidae		
Neurolestes trinervis Selys, 1885	5	5
Family: Platycnemididae		
Mesocnemis saralisa Dijkstra, 2008	8	
Mesocnemis singularis Karsch, 1891	10	
Oreocnemis phoenix Pinhey, 1971	8	26
Family: Protoneuridae		
Chlorocnemis nigripesi Selys, 1886	10	
Chlorocnemis superb Schmidt, 1951	8	
Elattoneuracentr Africana Lindley, 1976	8	
Elattoneura incerta Pinhey, 1962	12	
Elattoneura nigra Kimmins, 1938	14	
Elattoneura lliba Legrand, 1985	10	
Elattoneura pasquinii Consiglio,1978	8	70
Total	**767**	**767**

Table 2 : Percentage composition of families of Odonata occurring in Alatori Stream

Family	No. of individual	Percentage composition (%)
Gomphidae	13	1.7
Libellulidae	281	36.54
Calopterygidae	82	10.7
Chlorocyphidae	158	20.6
Coenagrionidae	132	17.21

Megapodagrionidae	5	0.65
Platycnemididae	26	3.39
Protoneuridae	70	9.13

Table 3: Descriptive statistics and ANOVA result of water quality of Alatori stream

	DESCRIPTIVE		ANOVA	
Parameter	Data Range	Mean ± SD	F	Sig
pH	6.8 - 8.27	7.23 ± 0.13	13.37	0.071
Conductivity* (µmho/cm)	150 – 202	184.25 ± 6.37	0.43	0.84
Turbidity (NTU)	0.01 - 0.06	0.02 ± 0.00	3.7	0.23
Ambient Temperature*(°C)	28 – 31	28.13± 0.28	0.34	0.9
Water Temperature *(°C)	22 – 27	24.13 ± 0.44	2.56	0.31
Dissolved Oxygen (mg/L)	7.6 - 10.86	10.15 ± 0.37	2.18	0.35
Water Current Velocity*(m/s)	0.24 – 0.45	0.28 ± 0.02	0.21	0.96
Water Depth* (cm)	6.9 - 8.6	3.84 ± 0.2	0.4	0.86

* Significant at P>0.05

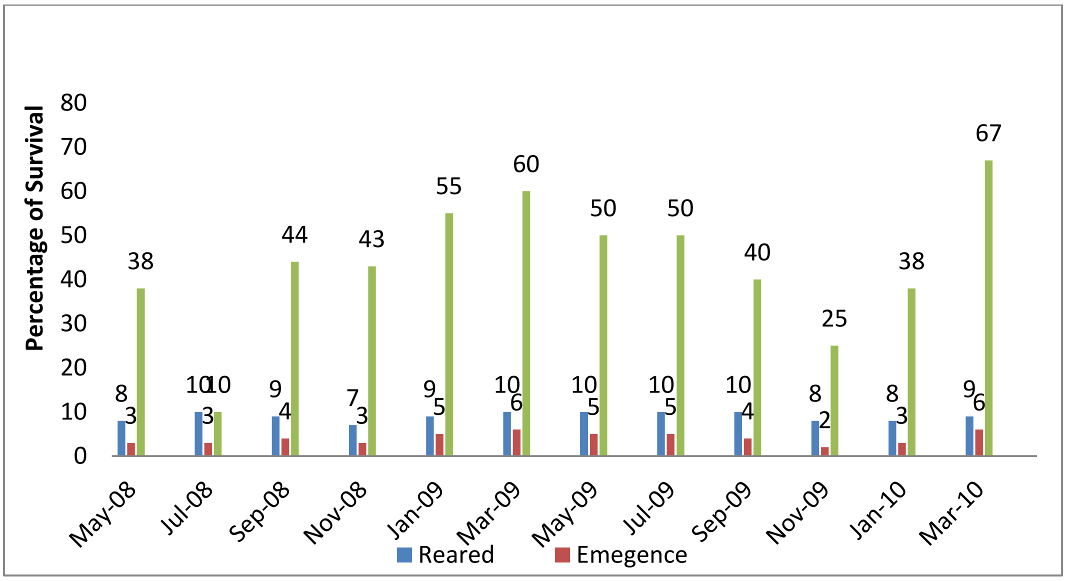

Figure 3: Survival % of Odonata reared in the laboratory

Odonata assemblage in Alatori stream

The assemblage of various genera of Odonata at Alatori stream is presented in multivariate analysis (cluster analysis) in Figure 3. Twenty-nine genera of Odonata occurred at the stream. The assemblage of genera are in three major clusters, with a chunk 'simplicifolious' that is dissimilar from the three clusters. The chunk case (simplicifolious) is genus *Chlorocypha*. Fourteen (14) species out of over thirty (30) species of (*Chlorocypha*) found existing in Africa (Dijksra and Clausnitzer, 2015) occurred at the stream. The first cluster (Cluster next to chunk-case *Chlorocypha*) is the next in distance to chunk-case *Chlorocypha*. The cluster has the largest number of cases (genera; 15) arrayed in three bunches. The next two clusters have the same clade which shows that the occurrence of the genera in the two clusters is similar to each other than the first cluster. The second cluster has 8 genera while the third has 5 genera.

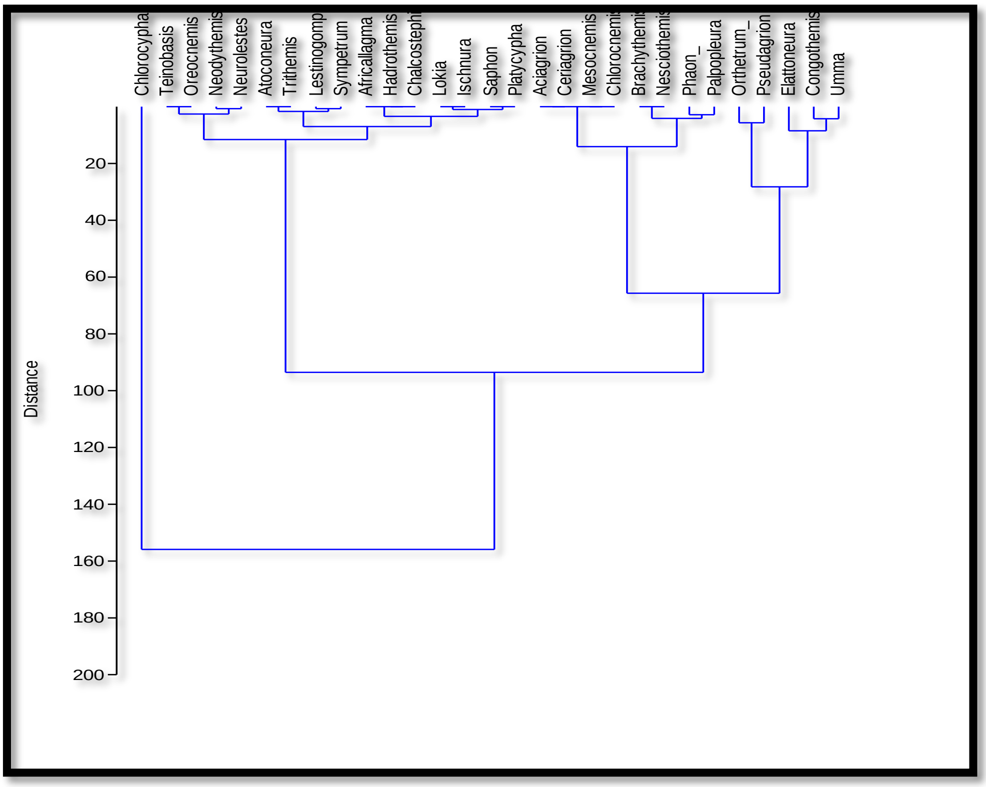

Figure 2: Multivariate (cluster) analysis of Odonata Assemblage at Alatori Stream (May 2008 to April 2010) (*n* = 29, P<0.05)

Discussion

Only one species of Gomphidae (*Lestinogomphus angustus*) was sampled at the stream. The Gomphidae is known to be tolerant to heavy polluted water and they do not occur in large numbers (Acquah – Lamptey *et al.,* 2013). The paucity of members of this genus at Alatori stream is in conformity with Ameilia *et al*., (2006); Dijkstra and Clausnitzer, (2015) and IUCN, (2010) which stated that they are elusive and hunt above streams, usually in the dusk. The active period for Gomphidae did not coincide with the schedule time for sampling in this study, so their paucity could be as a result of sampling time that did not coincide with their active flight period. Libellulidae was well represented at the forest. Members of the family are known to tolerate wide range of habitat. Some forest species of this family that are stenotopics are associated with clean water, while the ubiquitous are generally tolerant of human disturbance (Corbet. 2004).Studies have revealed the abundance of the family in West Africa including South-West Nigeria (Acquah–Lamptey *et al.,* 2013, Adu and Ogbogu, 2013, Adu and Ogunjobi, 2014). *Congothemis dubia* was the most abundant Libellulidae in this study (Table 1). *Congothemis dubia* is widespread from West Africa to Central Africa it is a common forest dragonfly associated with forest streams and swamps in this region (Dijkistra and Clausnitzer, 2015). Five members of the genus *Congothemis* are represented in tropical Africa, four out of the five occurred in Alatori stream and environment. They are *C. dubia*, *C. leakeyi*, *C. sanguinolenis* and *C. erythraea*. *Congothemis* is endemic to tropical Africa with most records from forested areas, especially in the Congo Basin, occurring from North Zambia through to West Africa (Clausnitzer and Dijkistra, 2009).

Palpopleura portia was next to *C. dubia* in terms of abundance among the family (Libellulidae). *Palpopleura portia* tolerates wide range of habitat (Vick, 2003), and can be found on road side ponds, swamps and marches as observed in this study. *Palpopleura lucia* was also found at the study site. *Palpopleura lucia* usually occur together with *P. portia,* the two may appear similar if not closely observed (Samways, 2008; Dijkstra and Clausnitzer, 2015). The similarity in appearance and the fact that they usually co-exist could confuse amateurs who may consider them as a single species. The two (*Palpopleura lucia* and *P. portia*) are among Africa's most photographed dragonflies (Dijkstra, 2007).

Atoconeura luxata is another forest insect found abundant in the forest. Most members of the genus are high landers except *A.luxata* which can occur in places with low altitude (Dijkstra and Clausnitzer, 2015).

Previous studies on assessment of Afro tropical Odonata, revealed that Coenagrionidae is next to Libellulidae in terms of abundance (Vick, 2003, Samways 2008Adu and Ogbogu, 2011). Also most species of Coenagrionidae tolerate wide range of habitat like Libellulidae (Samways, 1989). In this study species of Chlorocyphadae (16) were found to outnumber Coenagrionidae (12). Most chlocyphids have narrow niche and are sensitive to environmental perturbation. Their occurrence in large number at the vicinity of the stream revealed the serenity of the stream. Three families (Chlorocyphidae, Calopterygidae and Protoneuridae) of suborder Zygoptera were well represented at the forest an occurrence that could designate Alatori stream is a biodiversity hotspot for the families. These three families have narrow niche and are very sensitive to human disturbances, besides they are dwellers of shaded enclaves in the forests. This confirms the work by Subramanian (2005) and Arulprakash and Gunathilagaraj (2010) who proposed that shaded places favour damselflies more than dragonflies. It is also obvious that stenotopic damselfly families which are weak fliers dominate the odonate diversity of the stream. Only a species of Megapodagrionidae (*Neurolestes trinervis*) was found inhabiting the stream vicinity during this study. Megapodagrionidae is poorly represented in West Africa although there are 25 species in the family, only one species is represented in West Africa, from Guinea to Nigeria (Dijkistra and Claunistzer, 2015) and that is the same species that occurred in Alatori stream. The most abundant Coenagrionidae in this study is *Pseudagrion kersteni* (18). Generally members of this genus are widely spread and are colonizers of open water bodies. *P. kersteni*, occurs at almost any open stream in tropical Africa (Vick 2003, Samways, 2008; Dijkistra and Claunistzer, 2015).

Alatori stream is a clear water body with low turbidity. Turbidity and electrical conductivity serve as visual cues for an adult fly to oviposit. Naturally turbid water is repulsive to female adult Odonata who wants to oviposit. Conductivity level of Alatori stream is not at the extremes and could not have harmful effect on the osmoregulatory processes of the insect larvae (D'Amico et al., 2004). Odonata larvae can tolerate wide range of pH from strongly acidic (pH 4.0) to strongly alkaline (pH>8.1) (Corbet, 2004). The average pH of the stream water is 7.43 ± 0.13 which is still within the tolerable range, therefore the pH has no effect on odonate's community in the stream. Canning and Canning (1994) corroborated this assertion by stating that Odonata species seemed to respond more to habitat form and structure than to its acidity. Brooks (1994 and 1996) also agreed with the statement made by Canning and Canning (1994) by stating that Odonata larvae are relatively insensitive to pH. The mean and the standard deviation of conductivity (184.25 ± 6.37) were indicative of an unpolluted freshwater system with stable habitat structure. Ambient temperature influences emergence processes in Odonata (Corbet, 2004). It determines the metabolic processes leading to withdrawal of odonate larvae from the water, it also determine the duration of emergence and maiden flight. Low ambient temperature delays emergence especially among the bigger species which need a higher temperature while higher temperature reduces the period of eclosion (Trottier, 1973; Corbet, 2004). There was a positive significant relationship between some of the physical parameters (electrical conductivity, ambient temperature, water current velocity and water depth) and the odonate fauna inhabiting the stream.

Most of the emerged teneral adults have already been sampled as adults except *Umma declivium* and *Platycypha eliseva* that were only sampled as larvae. The two were among the stenotopic species inhabiting the stream. The presence of these species and many other stenotopic organisms with narrow niches revealed that the stream vicinity is still rich in some localized Odonata species that has narrow niches. It also shows that the anthropogenic activity at the stream environs is not hazardous for the odonate fauna to tolerate. In conclusion the odonate community assemblage at the stream revealed that Alatori stream is healthy. The rich diversity of species of Odonata at the stream suggests that the anthropogenic activity at the stream is minimal. The occurrence of eleven (11) genera that are sensitive to polluted and disturbed environment further proved that Alatori stream and forest environment is healthy. It is therefore inferred that Alatori stream possesses right structures that can sustain other fauna and flora in the ecosystem.

In conclusion, Alatori stream have odonates that are stenotopics, the occurrence of these fauna revealed that some portion of the stream is not experiencing severe human disturbance. For instance the presence of species of Chlorocyphidae and Calopterigidae which are stenotopics in large number at the stream suggest that water is not experiencing severe human disturbance. Members of these families (Chlorocyphidae and Calopterigidae) are sensitive to polluted water and disturbed environment. Nevertheless some are known to tolerate fairly polluted water. In this study only a species of Gomphidae (*Lestinogomphus angustus)* was sampled at the stream. Generally Gomphidae are associated with heavily polluted water, but with just a species represented at the stream, it cannot be established that the stream is heavily polluted. The occurrence of rare species of Megapodagrionidae (*Neurolestes trinervis*) which is stenotopic suggests the need to protect the forest so that such uncommon species will not go into local extinction.

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