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Impact of Human Disturbance on the Abundance, Diversity and Distribution of Odonata in the University of Lagos, Akoka, Lagos, Nigeria

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ABSTRACT

Odonata fauna inhabiting University of Lagos (Unilag), Akoka, Southwestern Nigeria was investigated for a period of 7 months (March to September) 2015. At the time of this study a portion of the University forest was cut down and burnt. The three study sites investigated were: Distance Learning Institute (DLI), High Rise Area and Lagoon Front Area. Data collected from the study sites were subjected to diversity indices, descriptive statistics and diversity t-Test. A total of 787 individuals of Dragonflies and Damselflies from 13 genera, 3 families and 21 species were sampled. The three families include Coenagrionidae (62%), Libellulidae (36%) and Platycnemididae (2%). The most dominant species was Ceriagrion glabrum (42%) followed by Acisoma panoipoides (10%). The DLI study site had the richest odonate fauna (Shannon Wiener index (H' = 1.94), Simpson's Dominance index (C = 0.85); while the least was the High Rise study site (Shannon Wiener index (H' = 1.91), Simpson's Dominance index (C = 0.85). The distribution of the fauna was highest at DLI study site (Evenness = 0.99), followed by Lagoon front (0.98) and High rise (0.97). Degree of concentration at different study sites, was highest at DLI (0.85) and least at High rise (0.85). Most of the odonates sampled in this study are ubiquitous damselflies. When compared with the study on odonates at same study sites a year before, It is obvious that the human disturbance experienced at the study sites is detrimental to the assemblage of localized Odonata species of the forest. Hence, there is a strong need to preserve the Odonata community of the University of Lagos.

Key words:Dragonfly, Damselfly, anthropogenic activities, Distribution, University of Lagos.

INTRODUCTION

Odonata (dragonflies and damselflies) is an insect order containing medium to large sized insects. It is highly diverse comprising two suborders, namely; Anisoptera, and Zygoptera. Dragonflies and damselflies have exceptional agile flight with sound visual responses which enable them to avoid predation. The distribution of various species of Odonata differs. Some genera and species are widespread while others are highly localized in their distribution (Kadoya *et al*., 2004). Some families are restricted to cool streams or rivers, others to ponds or still clear waters, and some to marshy places and wetlands (Bybee *et al*., 2008).The abundance of many species of dragonflies and damselflies has been taken as an indication of good ecosystem quality (Dutra and Marco 2015). The greatest numbers of species are found at sites that offer a wide variety of microhabitats, though dragonflies tend to be much more sensitive to pollution than are damselflies (Millers, 1987).

Odonata nymphs are beneficial to humans because they can be used by fishermen as baits for fishing and to assist in the control of aquatic insect pests (such as mosquitoes in domestic water tanks). Odonates do not sting or bite and the entire species are harmless (Adu, 2012). Dragonflies therefore have a potential health and economic value which is not yet fully exploited.

Comparisons between past and present records show that some species of dragonflies and damselflies have disappeared from numerous water bodies throughout the world. In countries where the dragonfly fauna has been well studied, there is good evidence that several species have gone into extinction locally and nationally (Valientebanuet *et al*., 2015). The main cause of local and national extinction of Odonata species is mainly the destruction of forest on which they depend. The main causes of habitat loss include forest clearance, erosion, agrochemical runoff and deposition of domestic waste and sewage into water bodies (Primack and Morrison, 2013).

In our survey in 2014, 750 Odonates collected at the University of Lagos comprised of 39 species, in 22 genera and 4 families. The families represented include

Libellulidae, Aeshnidae, Coenagrionidae and Calopterygidae. Libellulidae was more dominant (81 %) while Coenagrionidae, Aeshnidae and Calopterygidae were 13%, 3%, and 3% respectively (Kemabonta *et al*., in Press). Thereafter, major forest areas of the University of Lagos (Unilag) was destroyed and burnt due to the need for more infrastructures in the University.

These anthropogenic activities occurred at the forested areas of the Distance Learning Institute (DLI), High Rise, Science faculty and the Lagoon area. Thus the need to carry out another survey of the campus to ascertain the effect of bush clearance and burning on species diversity, abundance and distribution of Odonata species in the University. The objectives of this study were, to evaluate degree of rarity versus ubiquity and to assess the effect of anthropogenic activities on the insect fauna at the study sites.

MATERIALS AND METHODS

Study Sites

The study was conducted within the University of Lagos, Akoka, Lagos State, Nigeria (Figure 1). It is situated in the western part of Lagos State at approximately 20˚ 50'N and 30˚ 50'E. Three study sites were identified in the campus based on the prevailing anthropogenic activities in the campus. The study sites are DLI, Lagoon Front and High Rise Area. The DLI (6.51269°N 3.39094oS) area which is close to the University Second gate. DLI is characterized by the presence of administrative blocks, tall trees, shrubs, sedges and, grasses and the presence of ponds. This area was cut down, burnt and cleared for a building to be constructed there.

The Lagoon area (6.51963oN 3.40059oS) is characterized by the presence of short grasses and tall trees. There is also the presence of brackish water, rotten woods, termitaria and few rocks. The fauna found here include Monitor lizards, Squirrels, Molluscs and Crabs: especially at the Lagoon Front. Other faunas found here include toads, frogs and several exotic insect species. The High Rise area (6.50936oN 3.39703oS) is one of the residential area of the University. It is characterized by tall buildings and fewer vegetation; although gardens are occasionally found within and outside some of the residential homes. Some part of the forest area was also cleared for construction bases.

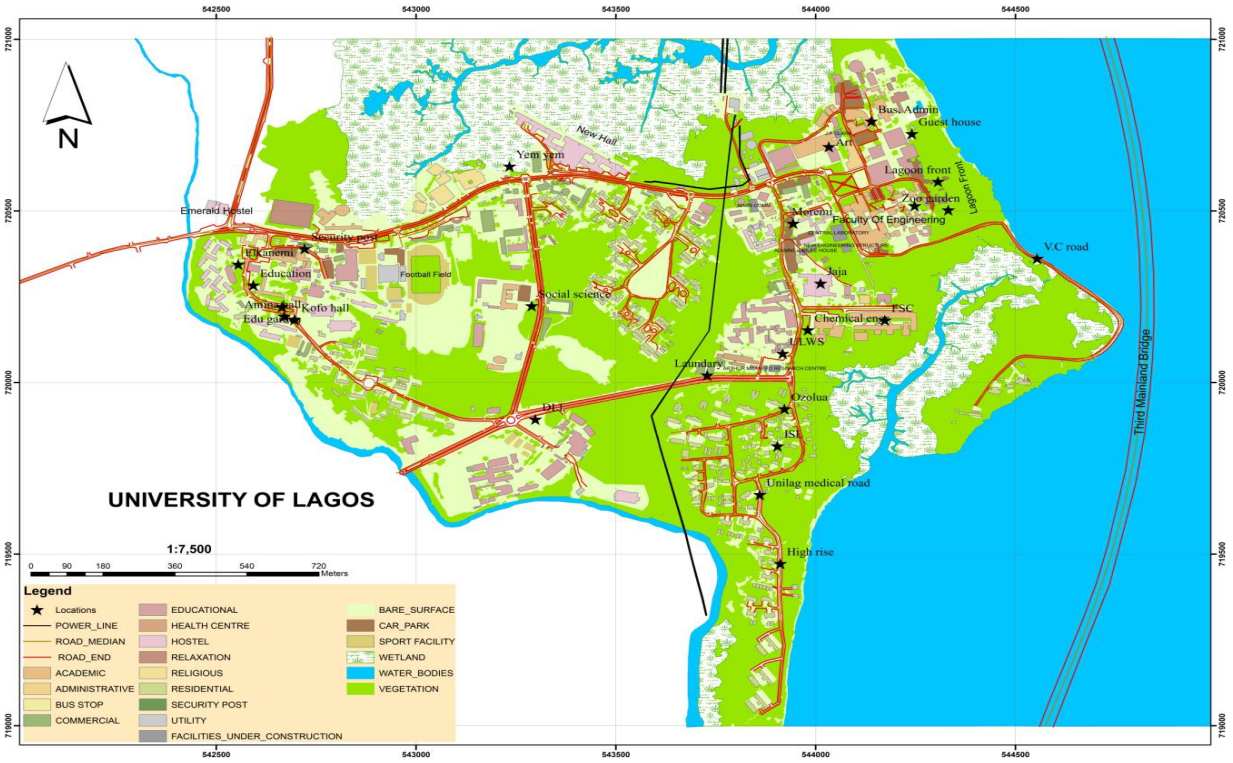

Figure 1: University of Lagos, Akoka, Lagos, Nigeria showing the sampled sites

Sample Collection, Preservation and Identification

Sampling of specimens was carried out twice a week between 7.00am and 3.00pm for a period of seven months (March to September, 2015) using sweep nets. Only adult specimens were collected throughout the period. The sampling was limited to adult because of the difficulties in the identification of the larvae. Captured odonates were carefully placed in triangular envelopes and properly labelled with pencils. Those already captured and labelled were only counted while unidentified ones were captured. The odonates specimens were then soaked in a jar containing acetone for a minimum of 12 hours and then air dried, thereafter kept in insect box and then taken to the laboratory for identification and recording. All specimens collected were identified to the lowest taxonomic level using standard identification manuals (Samways, 2008, Dijkstra and Clausnitzer, 2015). They were also cross-referenced against over 3000 images of Afrotropical species of Odonata on the World Wide Web (www.africa-dragonfly.net/global/results).

Data Analysis

Data collected from the study sites were subjected to descriptive statistics and diversity t-Test. The Palaeontological Statistics Software (PAST) for scientific data analysis was used to calculate the biodiversity indices. The biodiversity indices used include Shannon-Wiener diversity index (H'), Evenness (E) and Simpson's Dominance index (Wahizatul-Afzan *et al*., 2006). The diversity indices were used to determine the richness of various odonate species and to compare their occurrence at three study sites. The higher the value of H', the greater the diversity and the cleaner the environment. All encountered species of dragonfly and damselfly were recorded, ranked and classified into three categories based on their abundance: Uncommon 1 – 10, Common 11 – 45, and Dominant 46 >. To determine the degree of rarity versus ubiquity each of the classes were assigned with the starting value of their class, for instance Rare species was allotted 1, Common has 11 and the Ubiquitous species was allotted 46 (Adu *et al*., 2015).

RESULTS

Monthly distribution of Odonates at the University of Lagos

A total of 787 specimens of Odonata were sampled at the three study sites, representing 21 species, 13 genera and 3 families. The three families found inhabiting the forest include Coenagrionidae (62%) Libellulidae (36%), and the Plathycnemida (2%). The abundance of odonates fauna at the University of Lagos from March to September, 2015 is shown in Figure 1. Largest number of specimens (122) was recorded for the month of August while April had the least (94) specimens. Table 1 also presents the total monthly collection at the three study sites for the period of this study. DLI area had the largest number (492) of individuals. The largest number of odonates sampled in DLI was in July (89) followed by August (64) while the total number of specimens sampled in High rise area was 203 and Lagoon front area had the least (92).

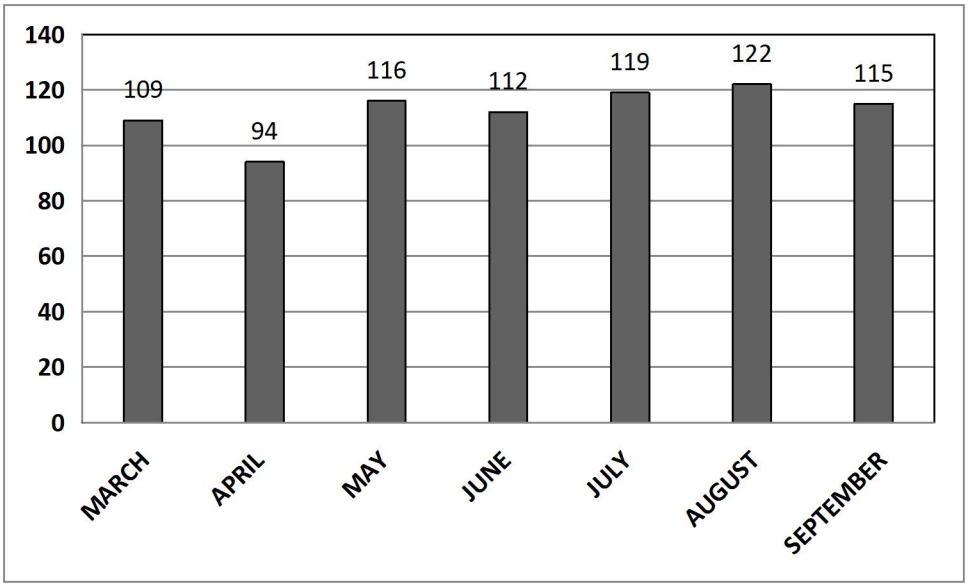

Figure 2: Number of odonates sampled per month in the University of Lagos

Table 1: The monthly abundance of odonates fauna at the three study sites in University of Lagos from March to September, 2015

MONTH	DLI	LAGOON FRONT	HIGH RISE
MARCH	69	32	8
APRIL	60	23	11
MAY	76	25	15
JUNE	66	31	15
JULY	89	20	10
AUGUST	64	39	19
SEPTEMBER	68	33	14
TOTAL	492	203	92

Table 2: Checklist of Odonate species sampled at University of Lagos between March and September 2015 (after bush burning)

Family	Species	Individuals
Libellulidae	*Aethriamanta rezia* (Kirby, 1889)	7
	Thermochoria equivocate (Kirby, 1889)	8
	Thermochoria jeanneli (Martin, 1915)	6
	Orthethrum chrysostigma (Burmeister, 1839)	7
	Acisoma trifidum (Kirby, 1889)	33
	Acisoma panorpoides (Rambur, 1842)	76
	Orthethrum julia (Kirby, 1900)	25
	Diplacodes lotebviri (Dijkstra, 2006)	8
	Hemistigma albipunctum (Rambur, 1842)	13
	Palpopleuraportia (Drury, 1773)	44
	Palpopleura lucia (Drury, 1773)	16
	Orthethrum stammale (Burmeister, 1839)	10
	Chalcostephia flavirons (Kirby, 1889)	27
	Pantala flavescens (Fabricus, 1789)	9
Ceonagrionidae	*Agriocnemis falcifera* (Pinhey, 1959)	18
	Agriocnemis sania (Le roi, 1915)	15
	Agriocnemis maclachlani (Selys,1877)	26
	Ceriagrion glabrum (Burmeister, 1839)	324
	Ceriagrion suave (Ris, 1921)	66
	Teinobasis alluaudi (Martin, 1896)	32
Platycnemididae	*Platycnemis rufipe* (Forster, 1916)	17

Spatial distribution and abundance of odonata at the three study sites

From the ranking, seven species were found to be uncommon, the species include *Thermochoria equivocate*, *Thermochoria jeaneli, Orthetrum stammale, Ortherum chrysostigma,* and *Diplacode lotebviri*. *Others are Aerheriamanta rezia and Pantala flavescens. Thermochoria jeanneli* was the most uncommon species in this this study. All the uncommon species are member of family Libellulidae. Eleven species were found common, six (6) of them were Libellulidae, three were Coenagrionidae and one species belong to family Platycnemididae. Only three species were found dominant. The species include *Ceriagrion glabrum,* Acisoma *panorpoides* and *Ceriagrion suave*. *Ceriagrion glabrum* was the most abundant odonate species in all the three study sites. Species abundance status of individual species sampled the University of Lagos are presented in Figure 2. Checklist of Odonata in University is Lagos after bush burning is presented in Table 2.

The most abundant family observed I was the Coenagrionidae with 481 specimens. All the specimens belong to six species, with *Ceriagron glabrum* having 324 individuals. Libellulidae was next to Coenagrionidae with 289 specimens. This was the family with the largest number of species (14). The family with least number of specimens and species was Platycnemididae. The most abundant species found in the three sites were *Ceriagron glabrum* having 324 individuals while the least abundant was *Thermochoria jeanneli* having only 6 individuals in DLI and Lagoon Front sites. The highest number of dragonfly species captured from the study site was the *Acisoma panoipoides* (76) and is found in all three study sites while the least number recorded for the damselfly species was 15 individuals for *Agrocnemis sania*. DLI area had the highest number of odonates sampled (437) followed by the Lagoon front and High rise study sites with 232 and 118 individuals respectively. DLI area also had the highest number of species for both Dragonflies and damselflies with the *Acisoma panoipoides* and *Ceriagrion glabrum* having 40 and 196 odonate species.

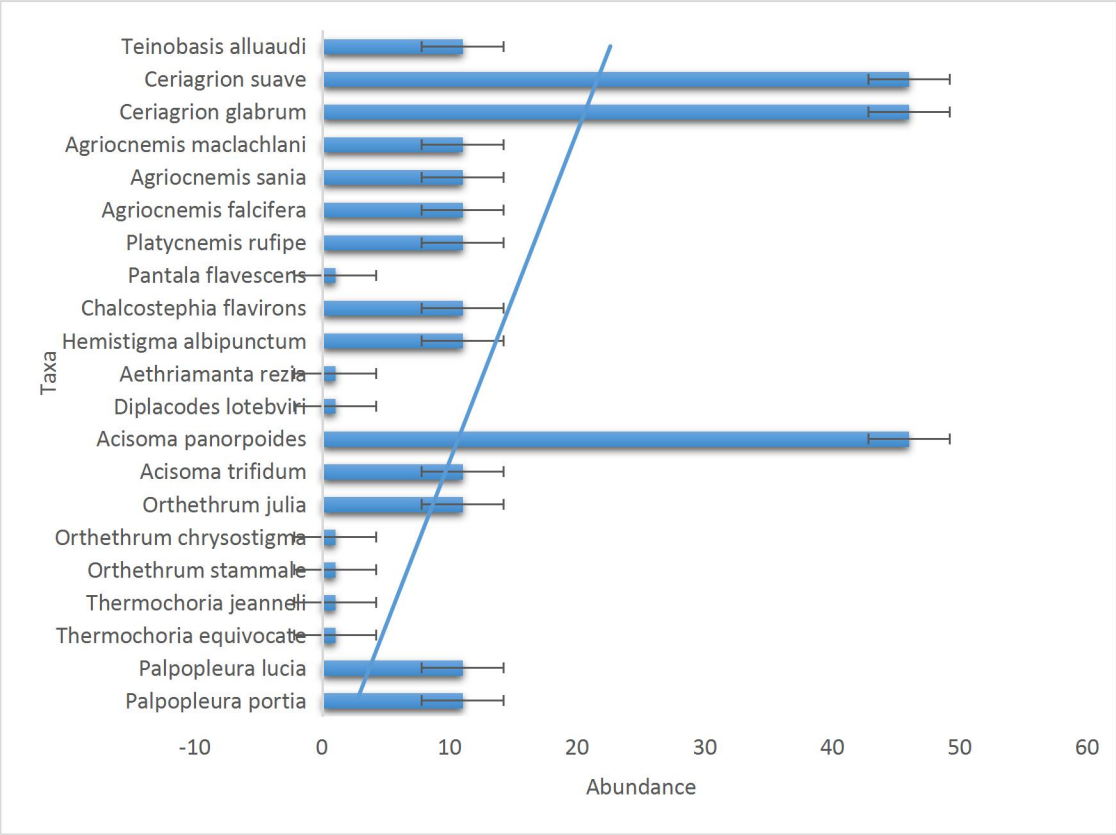

Figure 2: Species abundance ranking (rarity versus ubiquity) of dragonflies and damselflies of University of Lagos

Table 3: Diversity of odonate species at the study sites of the University of Lagos

Diversity	DLI	LAGOON FRONT	HIGH RISE
Number of Individuals	492	203	92
Number of species	21	20	18
Number of families	3	3	3
Shannon_H'	1.94	1.92	1.91
Simpson_1-D	0.85	0.85	0.85
Evenness_e^H/S	0.99	0.98	0.97
Margalef, d	0.97	1.13	1.33
Mean of total collection for 7 months	70.29±9.6	29±6.61	4±3.72

Odonata Diversity and Distribution in the University of Lagos

Table 3 presents diversity of odonate species at the three study sites. The diversity indices result for DLI was the highest among all the sites (Shannon Wiener index (H') = 1.94 and Simpson's Dominance index (C) = 0.85). Species distribution was also best when compared with other two study sites (Evenness value of E = 0.99). It is also noteworthy to state that DLI area had the highest number of species (21), while the Lagoon Front and High Rise Area had 20 and 18 species respectively. Based on the evenness value, the species in all the study sites were well distributed although the best distribution occurred at DLI (Table 3). All the study sites had a representative species in each of the families Libellulidae, Coenagrionidae and the Platycnemididae: the first two belonging to suborder Anisoptera and the last one in suborder Zygoptera. The High Rise study site had the least number of samples caught (92) and also the least in term of species diversity (Shannon Wiener index (H') = 1.91 and Simpson's Dominance index (C) = 0.85). A total of 203 samples were caught at the Lagoon front which is next to DLI in terms of species abundance and richness (Shannon Wiener index (H') = 1.92 and Simpson's Dominance index (C) = 0.85 (Table 3).

DISCUSSION

The anthropogenic activities at the University forest have resulted to degradation of the forest vegetation structure. A total of 21 species, 13 genera and 3 families were found at the University of Lagos. This result is very low when compared 39 species, 22 genera and 4 families that were sampled in 2014 at same time (Kemabonta *et al*.,in Press) before some parts of the forest in the university were burnt. A right vegetation structure is known to promote rich Odonate community structure (Nwankwo *et al*., 2003). With the prevailing human disturbance at the study sites at the time of this study it is believed that some of the localized odonate species have either been killed or relocated to a more conducive habitat. The sampled specimens were those that tolerate the disturbance and were not seriously affected by the disruption processes. Others are the returnees who were formerly inhabitant of the forest and are habitual colonizers of recovering disturbed areas. Usually population of libellulids are expected to be more than the coenagrionids in open landscapes like the study sites. Also, libellulids who have escaped at the time clearance and burning of bushes and are now returning to their enclaves now that the bush burning has ceased and fresh vegetation has emerged. It is expected that within a year or two the population of libellulidae like *Orthetrum, Palpopleura* and *Trithemis* would have increased as observed in *Acisoma*. Generally, libelulids and Coenagrionids are known to be good colonizers of disturbed environments.

The water bodies found around the DLI and Lagoon front study sites also provide the needed buffer zone for the survival of many species of odonata. The riparian vegetation that were not devastated by the fire at those study sites provided the right roosting spots for the adult while the undergrowth and shrub provided perching spots for the low flying adults. Also, there are fragmented openings at the adjacent forest which serve as mating rendezvous for mature adults. According to Corbet (1999), odonates display two behavioral characteristics which are functions of habitat selection of the species (eurytopic and stenotopic).

The two dominant families (Coenagrionidae and Libellulidae,) were found to be same with the previous study by Adu (2013) carried out in Owena forest. The loss of the main vegetation that characterizes the University of Lagos is largely due to regular human disturbance. Although some forest species (*Pantala flavescens*, *Aethriamanta rezia*, *Thermochoria jeanneli* and the

Thermochoria equivocate) where captured in this study; heterogeneity exhibited by odonates in habitat selection, especially when the best desired habitat is not available cannot be over looked (Corbet, 1999). Based on the absence and dominance of some species in the study sites at the University of Lagos in terms of occurrence and disturbance, it can be speculated that the habitat of the University of Lagos is disturbed. Disturbance in this context range from cutting of vegetation to burning them and this is a usual/regular occurrence throughout sampling period and this led to the large migration of the odonates, as they are known to be pollution sensitive (Clausnitzer, 2003).

The larger number of damselflies than dragonflies captured (511) while sampling, also gives a good clue of disturbance: as the damselflies are more disturbance/pollution tolerant than the dragonflies (Fulan *et al*., 2008). The absence of forest Odonate species at the High rise study site and the reduction in population of these species at the DLI and Lagoon front study sites calls for urgent action to be taken in preserving them as one of these species (*Thermochoria jeanneli*) is on the IUCN red list and coded as threatened (IUCN, 2001). Moreover, a higher population of Damselflies than dragonflies recorded at the study sites shows that the habitat in the University of Lagos is not protected and is really being degraded: this is buttressed by researches that have shown that damselflies are more tolerant to pollution and vegetation degradation than the dragonflies (Adu, 2013; Chovanec, 2000; Primack *et al*., 2005 and Sahle´n and Ekestubbe, 2001).

It can be concluded that most of the vegetation that could support stenotopic species have been affected by the clearance and bush burning, the few sampled forest species are from vegetation outside the study sites at the University of Lagos, while the ubiquitous species are found roaming about in open areas within the study sites. Moreover, the survival of the remaining forest species is doubtful in a few years to come if no action is taken to preserve this unique assemblage of vegetation. Hence, there is need to preserve the Odonata community of the University of Lagos, which will cumulate to the preservation of other fauna occupying the University of Lagos and will help maintain the structural integrity of the surrounding landscapes of the study sites.

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