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ASSESSMENT OF INSECT FUNCTIONAL GROUPS OF MANGROVES PARTS AT ASARAMA, ANDONI, RIVERS STATE, NIGERIA

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ABSTRACT: *Mangroves are intertidal plants which have parts that provide equal opportunities for insects' habitation, yet some infect species prefer certain parts than the others and consequently occur more abundantly and feed voraciously. Investigations on the abundance of insect species associated with three types of mangroves' parts and insect functional groups in the Asarama mangrove ecosystem, Nigeria was undertaken to unravel the level of performance of the ecosystem based on the groups available. Sweep net was used to collect insects from the leaves, and forceps from roots and stems. The samples were placed in a 70% alcohol in a vial and taken to the entomology research laboratory of the Department of Animal and Environmental Biology, University of Port Harcourt for identification using taxonomic keys and grouping into functional groups. Entomofaunal abundance on mangrove parts: leaves (47), stems (36), and root (21). Abundance was highest on parts of Rhizophora mangle and lowest on Lacunlaria racemosa. Some species occur on all plant parts, while others were restricted to a particular part. Pieris rapae occurred on the leaves of 3 mangroves, but absent on stems and roots. Eighteen, fourteen, and two insect species were not found on the roots, stems and leaves, respectively, of the three mangrove habitat-types. The Asarama mangroves contained four insect functional groups: pollinators (19), predators (32), burrowers (20) and herbivores (11). The most abundant functional group was the predator group (39.02%) and the least abundant was herbivorous group (13.4%). The result also showed high abundance of Anopheles mosquitoes and low abundance of Dragonflies. Statistically a high level of significant differences in abundance of species occurred between functional groups recorded on R. mangle and A. germinas habitat-types. There was significant difference between abundance of species collected form plant parts of R. mangle and A. germinas. The implications of these results were discussed.*

KEYWORDS: functional mangroves groups, abundance, pieris rapae, plants part, anopheles, dragonflies

INTRODUCTION

Mangroves and insects have strong relationships in which mangroves provide a suitable habitat for insect habitation, while insects through its feeding activities contribute to the wellbeing and sustainability of the mangrove ecosystem. The suitable habitats provided by mangroves are essentially its plant parts; roots, stems and leaves which are unique ecological environments that host assemblage of entomofauna. In spite of equal opportunity for habitation provided by mangroves, insect species prefer certain plant parts to others and thus occur more in species richness and abundance in one particular part than the other. Some species that occur on the stem bore tunnels within the plant and live (Feller and Mathis, 1997) while mosquitoes inhabit holes in the mangrove trees, particularly *Avicennia species* (Thangam, 1990). Some species of termites live on the canopies (Adams, 1994) they burrow inside the trunks and branches of mangrove trees.

Kathiresan and Bingham (2001) stated that some insects live entirely within the plants to avoid strong sunlight, high temperatures and desiccation. Some beetles and moths excavate tunnels through mangrove stems and these tunnels are used by other species of ants, mites, cockroaches, termites, spiders and scorpions for habitation (Rutzler and Feller, 1996; Feller and Mathis, 1997). Insects particularly herbivores that inhabit canopies had been reported to occur less in canopies that are submerged by tidal waters than canopies that remain exposed, indicating that less herbivore damage to seedlings also occur at submerged canopies (Farnsworth and Ellison, 1991).

Insects in the mangrove ecosystem contribute immensely to the wellbeing and sustainability of the ecosystem while some impact negatively on the ecosystem. Herbivores can alter plant fitness by exerting effects on growth and reproduction (Crawley, 1989; Obeso, 1993). Their sturdy pointed out that changes in plant growth and reproduction caused by herbivore attack have significant implications for the competitive fitness of plants in natural communities. The impact of herbivory includes; changes in leaf chemistry, decrease in nutrient levels and increases in levels of secondary chemicals (Tuomi *et al.*, 1988; Wold and Marguis, 1987). These changes are an indication of the effects of insects in ecosystem nutrient cycling (Choudhurry, 1988). Tong, *et al.*, (2003) reported that 50% defoliation of leaves following herbivore attack significantly affected leaf chemistry of the mangroves as concentrations of soluble tannins and carbohydrates in leaves were significantly lower when compared with the control. Total nitrogen also decreased significantly with increased per cent defoliation (Tong *et al.*, 2003). Some herbivores feeds on leaves, flowers, seeds or mangrove propagules and reduce plant populations. Herbivory often induced important reductions in plant population growth rates (Katz, 2016).

There are insects in the mangrove ecosystem that eat dead wood or decaying leaves. These detritivores contribute to soil or sediment fertility by breaking down dead plant tissues (Macintosh and Ashton, 2003). Some insects in the mangrove ecosystem play crucial roles in the pollination of mangroves. These pollinators, and predators and parasites play key ecological roles in the ecosystem. Dipterans has been described as a great contributor to various food chains and are important in human and veterinary medicine (Prayoonrat, 2004). Mosquitoes (Diptera) play roles as vectors of diseases such as malaria and yellow fever (Macintosh and Ashton, 2002).

In Nigeria the mangroves occupy an area of approximately 10515km^2 (Saenger and Bellan, 1995), out of which 10310.7km^2 are found in the Niger Delta region (UNDP, 2013). This region, particularly Rivers State the abundance of insect species associated with mangrove plant parts had not been studied. The determination of the various groups of insects based on their feeding habits into functional groups associated with Niger Delta mangroves and their medical, agricultural and ecological roles in the ecosystem were yet to be investigated. The present study was designed to ascertain the diversity and abundance of insect species associated with mangrove plant parts and determine the dominant insect functional groups in the Asarama mangrove ecosystem in order to unravel the level of performance of the ecosystem.

MATERIALS AND METHODS

Study Area

The study was undertaken at Asarama mangrove ecosystem of the Andoni River at three mangrove species habitats; red (*Rhizophora mangle)* mangroves located at 04^0.51'N – 07^0.46'E and 04^{0}51'N – 07^0.46'E, black (*Avicennia agerminas*) mangrove 04^0.51'N – 07^0.46'E and 04^0.52'N – 07^0.46'E and

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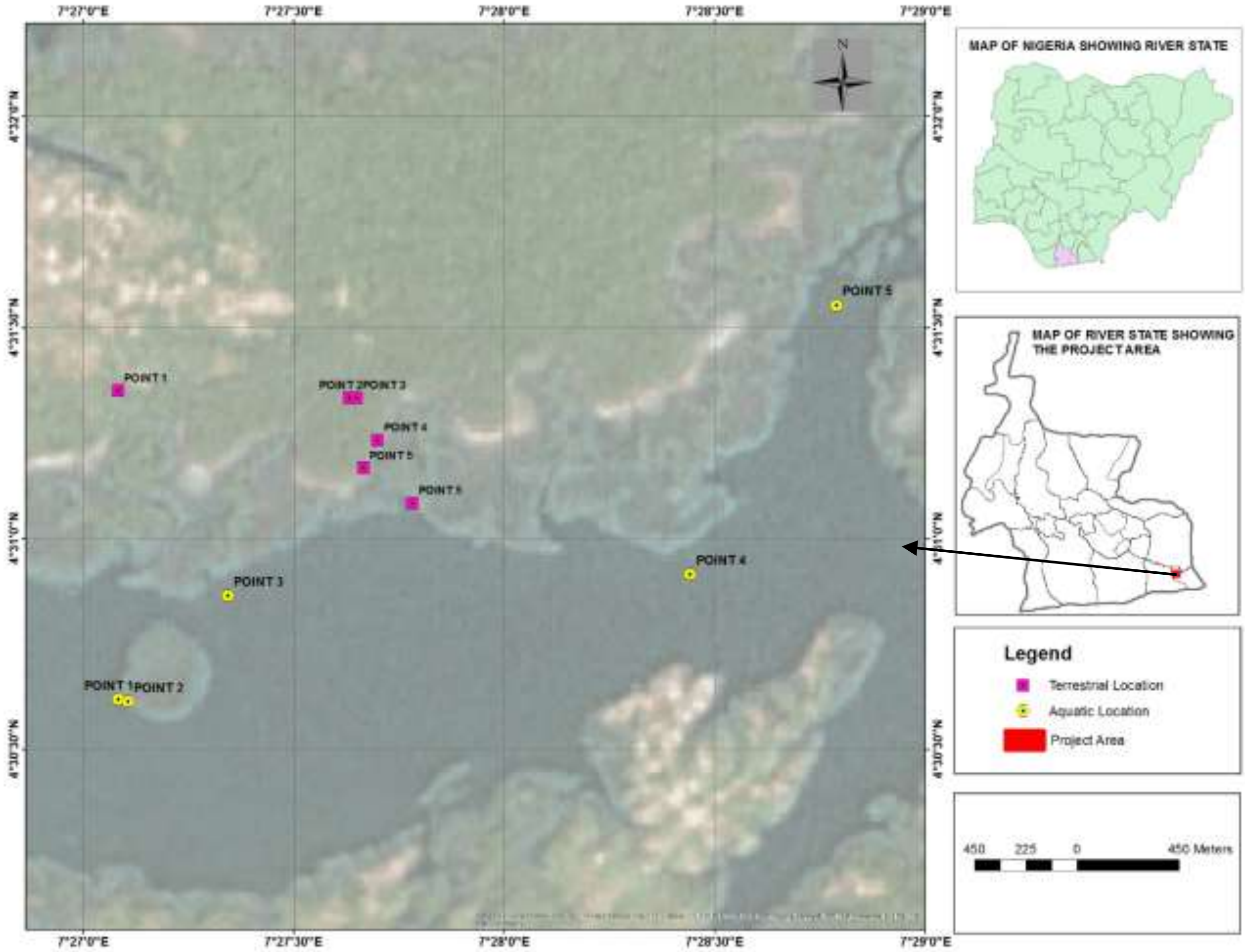
white (*Laguncularia racemosa*) mangrove 04^0.31’N – 07^0.27’E and 04^0.31’N – 07^0.27’E.The study sites based on the dominance of the species of mangroves available were divided into three habitat types;*Rhizophora-,Avicennia-,and Leguncularia*-habitat-types.



Sample Collection

Insects associated with a particular mangrove species part were collected with sweep net and forceps for three months (September, October and November, 2016). Sweep net was used to collect insects from the leaves, and forceps used to collect from roots and stems. The samples were placed in a 70% ethyl alcohol contained in a vial and taken to the Entomology Research Laboratory of the Department of Animal and Environmental Biology, University of Port Harcourt for identification. Taxonomic keys (Krantz, 1978; Robert, 1978), google images, websites such as www.buggide.net, were used for identification of insects with the aid of binocular microscope. Insects identified were grouped into based upon two criteria into functional groups; pollinators, burrowers, herbivores and predator groups. The criteria (i) Grouping in accordance with Hoper and Vitousek (1997), that functional groups are grouping of species based on physiology, morphology, life history, or other traits relevant to control on an ecosystem.(ii)Groupings based on species that respond in a similar way through association to certain unknown attractants inherent in a mangrove species as in the present study or a syndrome of environmental factors (Gitay and Noble, 1997). With respect to the consideration of these criteria, insect species in each functional group was counted and recorded, based on mangrove species and habitat-type. Mangrove species containing the greatest or lowest percentages of a particular functional group was used as a measure of the magnitude of ecological services provided at the habitat-types to ascertain its impact on ecosystem productivity, agriculture and medical health. This was done because a functional group is the basis for a context-specific simplification of the real world to deal with predictions of the dynamics of the system or any of their components (Gitay and Noble,1997).Predators in this study are those insects which are biological agents that naturally feed on other insects.Hebivores refer to insects that feed on mangrove leaves. Burrowers refer to insects that drag mangrove seeds into the soil or burrows. Pollinators refer to insects that pollinate the mangrove flowers.

Statistical Analysis

Analysis of variance (ANOVA) was used to analyse the differences in the total abundance of species between plant parts and between functional groups. Student's T-test was used to test the level of significance. The software used was SPSS version 20.

RESULTS

A total abundance of 104 insect species were collected from the three plant parts across the mangrove species habitat-types. Out of these, *R. mangle* plant parts recorded 54, *A. germinas* (35) and *L. racemosa* (15). Abudnace of entomofuana on the mangrove plant parts was; leaves (47), stems (36) and roots (21) (Tables 1, 2 and 3). Abundance was highest on leaves, stems and roots of *R. mangle;* 29, 15 and 10, respectively. *A. germinas,* and *L. racemosa* recorded lowest abundance on the leaves and stems.Abundance refer to the total number of individual species or taxa that occurred on a particular mangrove plant part.

Some species occurred on all plant parts, while others were found on one or two of plant parts, in each mangrove habitat-type. *P. rapae* occurred on the leaves of the three mangroves, but absent on the stems and roots; *C. discrepans* was revealed on the leaves of *R. mangle* and *A. gerinas* but absent on the stems and roots of the three mangroves. Two species *C. herculeanus* and *Crematogaster* sp., were absent fromt eh leaves of the three mangroves, but the former was present on the stems and roots of *R. mangle* and *A. germinans* while the latter was present on the stems of *A. gerninans* and *L. racemosa* and roots of *A. germinas.*

Eighteen species were not found on the roots, fourteen species not found on the stems, two species not found on the leaves of the three habitat-types.

The result of the data analysed showed that the difference in abundance of species collected from plant parts of *R. mangle* and *A. germinas,* and *R. mangle* and *L. racemosa* was highly significant.

However, the difference between *A. germinas* and *L. racemosa* was only slightly significant.

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Table 1: Total Relative Abundance of Insect Species found on the Mangrove Leaves

S/N	Insect Species	Mangrove Habitat-Types (Red)	Mangrove Habitat-Types (Black)	Mangrove Habitat-Types (White)	Total
1	*Cammula pellucid*	1	-	-	1
2	*Chorthippus albormarginatus*	2	1	-	3
3	*Chrysocoris stolli*	1	-	-	1
4	*Anopheles gambiae*	4	-	-	4
5	*Camponotus herculeanus*	-	-	-	-
6	*Pieris rapae*	2	2	2	6
7	*Jaciobiasca formosana*	5	-	-	5
8	*Lucilia sericata*	1	-	-	1
9	*Colia eurythene*	-	1	1	2
10	*Turneria bidentata*	1	-	-	1
11	*Calopteran discrepans*	3	2	-	5
12	*Tettigonia caudate*	1	-	-	1
13	*Cordulia shurleffi*	1	-	-	1
14	*Lasius niger*	-	-	-	-
15	*Microcentum rhombifolium*	-	1	-	1
16	*Crematogaster sp*	-	-	-	-
17	*Colias croceus*	-	-	1	1
18	*Pseudoleon superbus*	1	-	-	1
19	*Calopteran terminale*	3	2	-	5
20	*Caliphora vicina*	1	1	-	2
21	*Vespula vulgaris*	1	-	-	1
22	*Unidentified species*	-	1	-	1
23	*Musca domestica*	1	2	1	4
24	*Culex quinquefasciatus*	-	-	-	-
	Total	**29**	**13**	**5**	**47**

Table 2: Total Relative Abundance of Insect Species found on the Mangrove Stem

S/N	Insect Species	Mangrove Habitat-Types (Red)	Mangrove Habitat-Types (Black)	Mangrove Habitat-Types (White)	Total
1	*Cammula pellucid*	1	-	-	1
2	*Chorthippus albormarginatus*	-	-	-	-
3	*Chrysocoris stolli*	-	-	-	-
4	*Anopheles gambiae*	2	4	2	8
5	*Camponotus herculeanus*	3	2	-	5
6	*Pieris rapae*	-	-	-	-
7	*Jaciobiasca formosana*	-	-	-	-
8	*Lucilia sericata*	-	-	-	-
9	*Colia eurythene*	-	-	-	-
10	*Turneria bidentata*	4	-	6	10
11	*Calopteran discrepans*	-	-	-	-
12	*Tettigonia caudate*	-	-	-	-
13	*Cordulia shurleffi*	-	-	-	-
14	*Lasius niger*	4	2	-	6
15	*Microcentum rhombifolium*	-	-	-	-
16	*Crematogaster sp*	-	1	2	3
17	*Colias croceus*				
18	*Pseudoleon superbus*	-	-	-	-
19	*Calopteran terminale*	-	-	-	-
20	*Caliphora vicina*	-	-	-	-
21	*Vespula vulgaris*	-	-	-	-
22	*Unidentified species*	-	-	-	-
23	*Musca domestica*	-	-	-	-
24	*Culex quinquefasciatus*	-	-	-	-
	Total	**15**	**11**	**10**	**36**

Table 3: Total Relative Abundance of Insect Species found on the Mangrove Root

S/N	Insect Species	Mangrove Habitat-Types (Red)	Mangrove Habitat-Types (Black)	Mangrove Habitat-Types (White)	Total
1	*Cammula pellucid*	-	-	-	-
2	*Chorthippus albormarginatus*	-	-	-	-
3	*Chrysocoris stolli*	-	-	-	-
4	*Anopheles gambiae*	-	1	-	1
5	*Camponotus herculeanus*	2	7	-	9
6	*Pieris rapae*	-	-	-	-
7	*Jaciobiasca formosana*	-	-	-	-
8	*Lucilia sericata*	-	-	-	-
9	*Colia eurythene*	-	-	-	-
10	*Turneria bidentata*	3	-	-	3
11	*Calopteran discrepans*	-	-	-	-
12	*Tettigonia caudate*	-	-	-	-
13	*Cordulia shurleffi*	-	-	-	-
14	*Lasius niger*	5	-	-	5
15	*Microcentum rhombifolium*	-	-	-	-
16	*Crematogaster sp*	-	2	-	2
17	*Colias croceus*	-	-	-	-
18	*Pseudoleon superbus*	-	-	-	-
19	*Calopteran terminale*	-	-	-	-
20	*Caliphora vicina*	-	-	-	-
21	*Vespula vulgaris*	-	-	-	-
22	*Unidentified species*	-	-	-	-
23	*Musca domestica*	-	-	-	-
24	*Culex quinquefasciatus*	-	-	-	-
	Total	**10**	**11**	**-**	**20**

Insect Functional groups in the Three Habitat-Types

In the three habitat-types, insects functional groups were recorded. The groups whose insect abundance varied from one habitat-type to another included; pollinators, communition or herbivorous spp., burrowers and predators.Total relative abundance of insects in functional groups was 82: pollinators 19(23.2%), predators 32(39.02%), burrowers 20(23.4%), herbivores 11(13.4%) (Table 4). Abundance across the habitat-types was *R. mangle* 45(54.88%), *A. germinas* 24(29.27%), *L. racemosa* 13(15.85%) (Table 4).

Species in the various groups were: pollinators (*C. croceus, P. rapae, C. eurythene, C. discrepans* and *C. terminale*), predators (*V. vulgaris, T. bidentata, Crematogaster*), burrowers (*C. herculeanus, C. vicina, L. sericata,* and *L. niger*), herbivores (*C. pellucida, C. albormarginatus, J. formosana, T. caudate* and *M. rhombifolium*). A generalist pollinator, *P. rapae* occurred on the three mangrove plants. Burrowing ants (*C. herculeanus* and *L. niger*) and dipteran (*C. vicinia*) speices occurred on *R. mangle* and *A. germinas* but absent on *L. racemosa* (Table 2).

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The vectors, *Culex quinquesfasciatus*, *Anopheles gambiae* occurred at all habitat-types except *C. quinquefaciatus* that was absent at *L. racemosa* habitat-type.

R. mangle	8	19	8	10	**45**
A. germinas	7	5	11	1	**24**
L. racemosa	4	8	1	0	**13**
Total	**19**	**32**	**20**	**11**	**82**
Percentage	**23.2**	**39.02**	**24.4**	**13.3**	

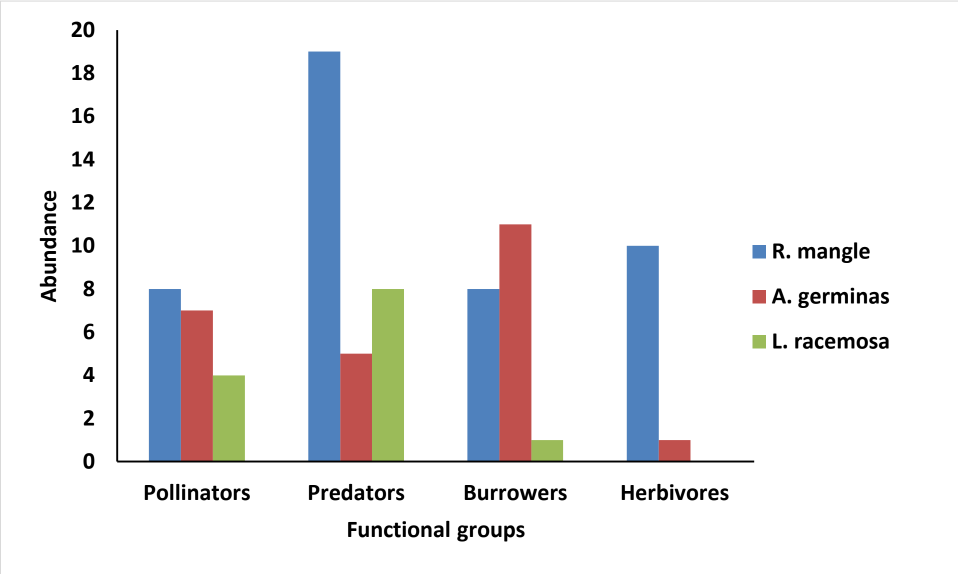

Figure 1: Abundance of functional groups in the habitat-types

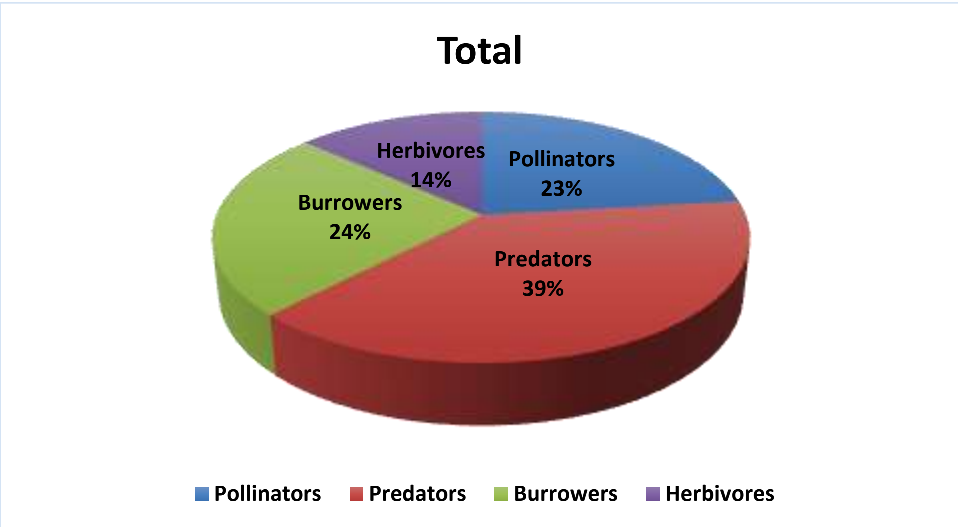

Figure 2: Percentage abundance of functional groups in the habitat-types

DISCUSSION

Entomofaunal diversity and abundance was more in the *R. mangle* mangroves, as their leaves, roots and stems recorded the highest abundance of individual insect species than same plant parts of the *A. germinas* and *L. racemosa.*The leaves of *R. mangle* recorded more individual insect species than its other plant parts and those of other mangroves. This indicates that entomofaunal assemblage is more on the leaves of mangroves at the mangrove ecosystem, as they prefer the leaves.

The higher entomofaunal diversity recorded at the *R. mangle* indicated that the productive potentials of this mangrove were more; this was probably its abundance in the Niger-Delta region, particularly Asarama community. *R. mangle* habitat had the highest percentage abundance of all the four functional groups; indicating increased ecosystem services. This is collaborated with the result of the statistical analyses which indicated that the occurrence of functional groups were significantly different on *R. mangle* as compared to other mangroves. The most abundant functional group was the predator group (39.02%) and the least was herbivorous groups (13.4%). Ants (Hymenoptera) dominated this predator group and may be involved in mangrove seed cleaning, which agrees with the work of Passos and Olivera (2003) that such seeds do not succumb to decay. Abundance of ants predators showed that ecological services of providing clean seedlings for germination occur in the mangroves particularly in *R. mangle* habitats.

The pollinator and burrow or functional groups which recorded relative high abundance of 23.2% and 23.4% respectively in this present study indicates that;

i. There is thorough mixing of soil and organic materials in the mangrove ecosystem, particularly at the *R. mangle.*
ii. Provision of adequate soil porosity for the movement of nutrients in pollinator abundance and pollination efficiency effect plant population dynamics and persistence in communities (Dauber, *et al.*, 2010).
iii. Provision of good aeration of the soil which enhanced the capacity of the soil to hold water adequately in the mangrove ecosystem.
iv. The abundance of the pollinator functional group was relatively higher at *R. mangle*, compared with those of *A. germinas,* and *L. racemosa,* indicating that pollinating activities has been going on at higher levels in the *R. mangle,* resulting in healthy growth and higher population of the plant.

The higher abundance of *Anopheles* mosquitoes recorded in the mangroves and low abundance of Dragonfly is an indication that there will be increase in malaria diseases in the area, particularly as there is low abundance of its predator that biologically regulates the population of these mosquitoes.The result of the statistical analyses indicated a high significant difference in abundance of species between functional groups recorded on *R. mangle* habitat and *A. germinas* habitat, and slight significant difference between *R. mangle* and *L. racemosa.*

CONCLUSION

There is an eco-balance in the Asarama mangrove ecosystem which is higher at the *R. mangle* habitat-type, caused by the high levels of predators and low-level of herbivores. This implies that the activities of the herbivores dominated by Orthoptera (Grasshoppers) as a pest on the mangrove leave is very reduced as their abundance is minimal. Productivity of the mangrove ecosystem is adequate, particularly that of *R. mangle* because the pollinator abundance is higher thus pollinating activities is highly appreciable.

RECOMMENDATIONS

1. There should be enhancement of the production of dragonflies and its subsequent release into Asarama mangrove ecosystem so as to biologically control the high abundance of mosquitoes that could cause severe incidence of malaria in the community.
2. There should be regular monitoring of the Asarama mangrove ecosystem in order to maintain and improve the existing eco-balance in the ecosystem.
3. There should also be enhancement of the production of pollinator species in the ecosystem in order to increase the growth of more mangrove species.

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