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Entomofaunal Assessment of Ecosystem Health and Suitability of Mangroves at Asarama, Andoni Local Government Area, Rives State, Nigeria

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Abstract: Insects which inhabit mangroves at intertidal zones of the aquatic ecosystem contribute immensely to the wellbeing and sustainability of the mangrove ecosystem, and consequently are used to determine the ecosystem health of mangroves. Investigations on the diversity and abundance of insects to assess ecosystem health of mangroves at Asarama, Niger Delta, Nigeria were undertaken. Sweep nets and forceps were used to collect insects from three mangrove-type habitats; *Rhizophora mangle* (Red), *Avicennia germinas* (Black) *Laguncularia racemosa* (White). The insects were placed in sample vials containing 70% alcohol and taken to the Entomology Research Laboratory of the Department of animal and Environmental Biology, University of Port Harcourt, Nigeria, for sorting, and identification. A total of 24 taxa belonging to 7 orders and 15 families were collected during the study; red, black and white mangroves recorded 19, 14 and 7 taxa, respectively. Eight taxa *Camnula pellucid, Jacobiasea formosana, Tettigonia caudate, Vespula vulgaris, Lucilia sericata, Pseudoleon superbus, Chrysocoris stolli*, and *Cordulia shurtleffi* of the 19 that occurred on red were absent from black and white mangroves. Three species; *Pieris rapae, Anopheles gambiae* and *Musca domestica*, occurred across the three mangrove habitats. A total of 104 insects; 54 (red), 35 (black) and 15 (white) mangroves were recorded. In Asarama mangroves *R.mangle* is the most suitable habitat for insects species because it contained more entomofaunal diversity and abundance. The study revealed eight insect species that are indicators of good ecological health of the mangrove ecosystem, and used for the assessment of changes in the ecosystem.

Keywords: Asarama Mangroves, Niger Delta, *Rhizophora mangle*, *Avicennia germinas*, *Lagunculavia racemisa*, Abundance

1. Introduction

1.1. Mangroves and Its Insect Composition

Mangroves are unique plants that occur and survive in the interface between land and ocean in the humid climate of the tropics and subtropics. They are called coastal woodland, or tidal forest or mangrove forest and grow as trees up to 40 metres high or as shrubs below the high-water level. Mangroves occupy the intertidal zone, where they interact with aquatic and terrestrial ecosystems and support marine, freshwater and terrestrial organisms [1]. The mangrove environment is composed of high salt concentrations, regular inundation of their root systems by incoming tides, and freshwater inflow which brings silt with it as substrate for support and nutrients [2].

The mangrove forests of Nigeria are the largest in Africa and third largest in the world after India and Indonesia [1].

The largest extent of mangroves in Nigeria is found in the Niger Delta area between the region of the Benin River in the West and Calabar in the East. The Asarama mangroves in the Niger Delta, is dominated by three species of mangroves; Red (*Rhizophora mangle*), Black mangrove (*Avicenia germinas*), and white mangroves (*Lagunculavia racemosa*). These species are distinguished by the shape of their roots; red mangroves have tangled, reddish aerial and concealed prop roots, black mangroves have a small pencil-like vertical roots called pneumatophores, white mangroves are characterized by peg roots, especially when it occur in oxygen-depleted sediments or flooded for extended periods of time [1], (Figures 1-3).

Figure 1. *Rhizophora mangles (Red mangroves).*

Figure 2. *Avicennia garninans var. africana (Black mangroves).*

Figure 3. *Laguncularia racemosa (White mangroves).*

Mangroves provide a habitat that supports a large number of insects, for instance, Murphy [3] reported that 102 herbivore species were found feeding on 21 species of mangrove plants. In India, 28 species of Dragonflies [4], and in Brazil, 22 species of ants have been reported in mangroves. Other species such as Honey bees, bees, termites, (*Nasutitermes nigriceps*), water strider (*Mesovelia polhemusi*), also occur in mangroves in India, Jamaica, Florida and Costa Rica.

Insects occur in different ecological niches of mangrove forests [1] where many of them are permanent residents or temporary visitors. They inhabit intertidal zones, within mangrove plant tissues, and crab-burrows in the mangrove forests.

Species that inhabit intertidal zones usually retreat to air-filled cavities where they remain until they are again exposed by the falling water [3]. Some other insect species inhabit entirely within the plants where they bore tunnels which are used by other insects for habitation. They include wood-boring moths and beetles, ants, cockroaches, termites and mites [5]. Some insects such as mosquitoes inhabit holes in mangrove trees, particularly *Avicennia* species and crab-burrows where they are used as suitable sites for breeding [6]. Some species of ants and termites also occupy mangrove soil and tree canopies, respectively.

Insects in the mangrove ecosystem contribute immensely to the wellbeing and sustainability of the ecosystem. Dipterans, for instance contribute to various food chains, human and veterinary medicine [7]. Dipterans fauna in a mangrove forest at the mouth of the Bangpakong River in Thailand recorded the greatest diversity for culicidae (mosquitoes) with 14 species [7]. Mosquitoes play roles as vectors of disease such as malaria and yellow fever. Some species of insects play crucial ecological roles as predators, parasites and pollinators in the mangrove ecosystem. Similarly, termites and ants which occur in the soil and mangrove tree canopy respectively, contribute to soil fertility by breaking down deed plant tissues in the mangrove ecosystem.

Insects that are temporary visitors have ranges between other ecosystems, and provide linkages between the mangroves and other environment [8].

Insects in mangrove ecosystems are faced with a lot of difficulties ranging from pollution, salinity, strong sunlight and high temperatures for intertidal residents. They adapt to some of these difficulties through the various methods of habitation stated above and also by emergence only at night.

Insect diversity has been reported to be less in mangrove ecosystem where there is likely chance of pollution as observed by Grampurohit and Karkhamis [9] in a privately-owned mangrove ecosystem, Mumbail, India, located in the industrial area of Godrej. They further stated that the least insect number recorded was also due to the dumping grounds near the site of study which consequently pollutes the soil and affect growth of insect species. They also reported that mealybugs were abundant and dominate as most of the mangrove trees were infested by it, and that though pollinating species such as bumble, bees and honey bees were many in the mangroves, distribution of insect found were not even.

Apart from pollution, another factor that was reportedly responsible for their observation was the fact that only few insects have been able to invade habitats characterized by high salinities or initial influences [10], both of which are typically of salt marshes. Only few insects can invade such habitats because of their inability to deal with the high osmoregulatory stress and competition with either invertebrates [9].

In the Niger Delta of Nigeria, only few studies have been conducted on insect and wet land, particularly on the use of insect as bio-indicator of water quality. 57 taxa of aquatic insect have been reported [11].

As reported by Gbarakoro and Okene [12], insect abundance at Asarama mangroves was relatively higher on plant parts of *Rhizophora mangle* and lowest on that of *Lacunlaria racemosa*. Additionally, Asarama mangroves contain four insect functional groups; pollinators, predators, burrowers and herbivores with predator as most abundant. Apart from the forestry implication, the medical, agricultural and ecological implications of the diversity and abundance of insect species associated with mangrove in the Niger Delta Region of Nigeria is yet to be investigated.

Following the absence or limiting information on insect and mangrove in the Niger Delta, the present study was designed to address this dearth of information, with the following objectives;

1.2. Objectives

i. To determine the healthiness and suitability of the mangrove habitats for insect assemblage.
ii. To determine the diversity and abundance of insects in the mangroves over the study period.

At the end of the study, data obtained shall provide insect indicators of the well-being of Niger Delta mangrove ecosystems.

2. Materials and Methods

2.1. Description of Study Area/Site

The study was conducted at Asarama mangrove ecosystem of the Andoni River which lies between 4°28[1]N and 4°45[1]E (Figure 1). The study area was divided into three habitat-types; red mangrove (04°.51-07[1]46E), black mangrove (04°52N-07°46E) and white mangrove habitat-types (04°31N-07°27[1]E). Each habitat-type was divided into two stations, giving six stations all together.

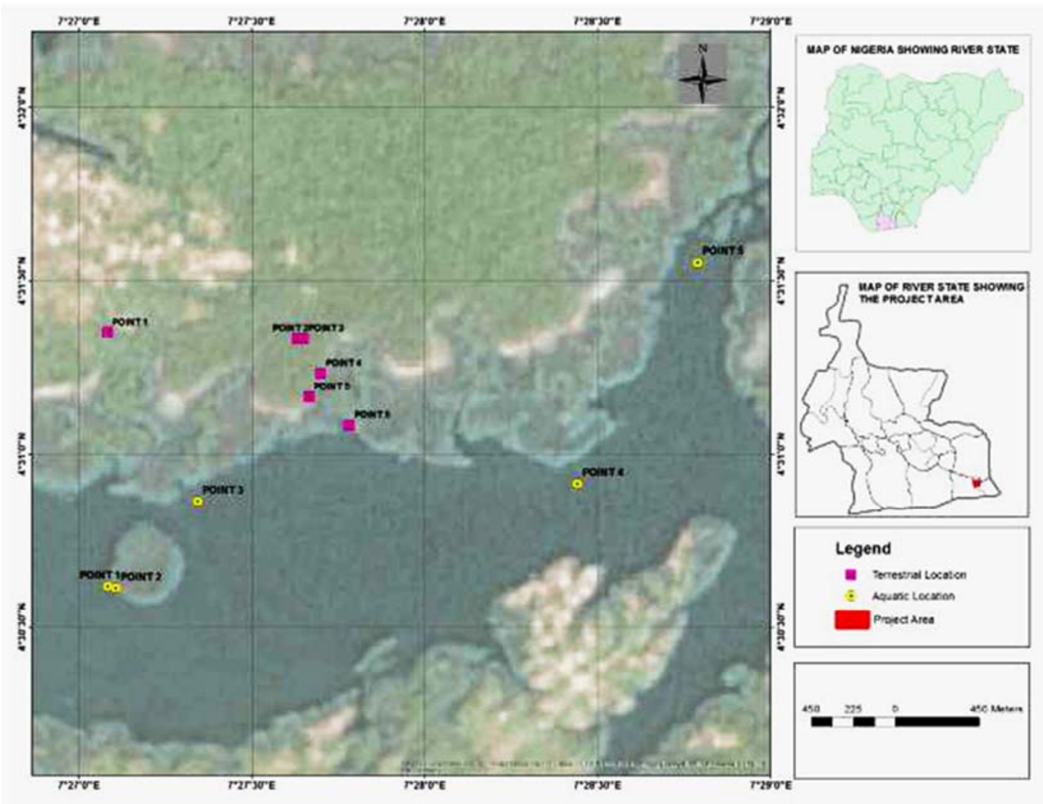

Figure 4. *Study locality in Asarama mangrove ecosystem of the Andoni River, Andoni Local Government Area, Rives State, Nigeria.*

2.2. Sample Collection, Sorting and Identification

Insects that occurred on the three species of mangroves were collected monthly for over three months, using sweep nets and forceps. After collection, the samples were placed in a sample vial containing 70% ethyl alcohol to preserve them before they were taken to the Entomology Research Laboratory of the Department of Animal and Environmental Biology, University of Port Harcourt.

The sample were sorted and identified into Orders, and species level, using binocular microscope. Taxonomic keys [13, 14], Google images, and field guides and websites such as bugguide.net were used for the identification.

2.3. Ecosystem Health and Suitability Studies of Mangrove Type Habitats

i. Species richness and abundance of insect that occurred and identified at the three species of mangroves were counted, and recorded according to the habitat-types.
ii. The recorded species and their abundance were used to determine the mangrove community composition, spatial variation in biodiversity indices, spatial distribution of species.
iii. The data obtained was used as a measure of the healthiness and suitability of a particular habitat-type for insect habitation.

2.4. Statistical Analysis

The data obtained was analyzed by Shannon index (H) used to see how diverse the insect community was, while Simpson's dominance index (D) provides both richness and evenness of species. Evenness index (E) was used to indicate whether the distribution of species was patchy or even, and Hierarchial Cluster analysis was determined using Jaccard similarity index to indicate similarity among habitat species.

3. Results

3.1. Community Composition

At the end of the study, a total of 104 insect individuals were accounted and identified into twenty-four species belonging to seven orders and fifteen families at Asarama, Niger Delta, Nigeria. The major percentage of insect families (Figure 5) was attributed to Orthoptera (26%, 4 families), followed by equal insect abundance (20%) of Lepidoptera and Diptera > Hymenoptera (13%) > equal percentage of insect families: odonata, Hemiptera, and Coleoptera (7%, 1family). The distribution of abundance and species richness among orders was: Hymenoptera (45 individuals, five species), Diptera (24 individuals, five species), Orthoptera (12 individuals, five species), Lepidoptera (10 individuals, four species), Coleoptera (10 individuals, two species), Hemiptera and Odonata (1 individuals, one species)

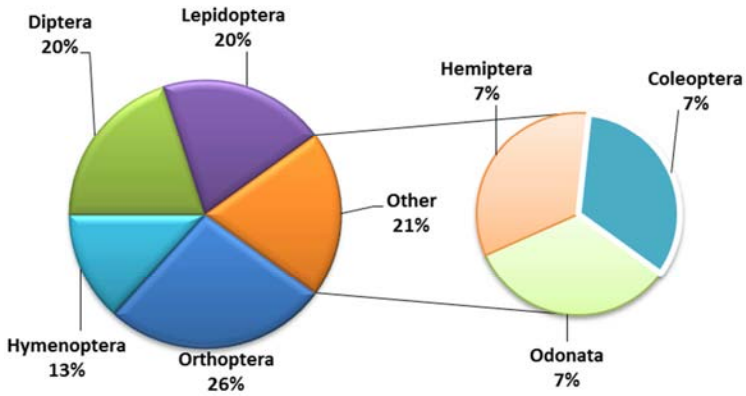

Figure 5. *Percentage composition of sampled insects' families at Asarama, Niger Delta, Nigeria.*

As shown in Figure 6, insect abundance and distribution among three different habitat-types was *R. mangle* (54 individuals, 52%), *A. germinans* (35 individuals, 33%) and *L. racemosa* (15 individuals, 15%). As shown in Figure 7, hymenopterans and Orthopterans are the major abundant individuals in red mangrove habitat followed to that dipteran individuals which no significant variation between there and its abundance in black mangrove habitat. Rare abundance of hemipteran and Odonata individual in mangrove ecosystem, only one individual was recorded in *R. mangle* (red mangrove). Meanwhile, the third mangrove habitat; white mangrove, had less one in number of insect orders; hymenopteran, dipteran, and lepidopteran.

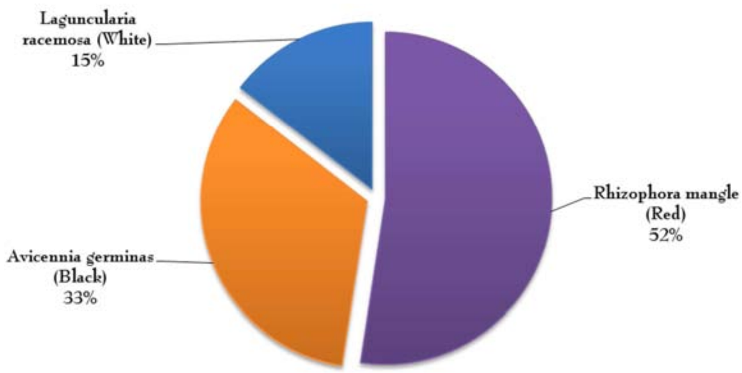

Figure 6. *Percentage abundance of sampled insects between three different mangrove habitats: red mangrove habitat-type (R. mangle), black mangrove habitat-type (A. germinas, and white mangrove habitat-type (L. racemosa) at Asarama, Niger Delta, Nigeria.*

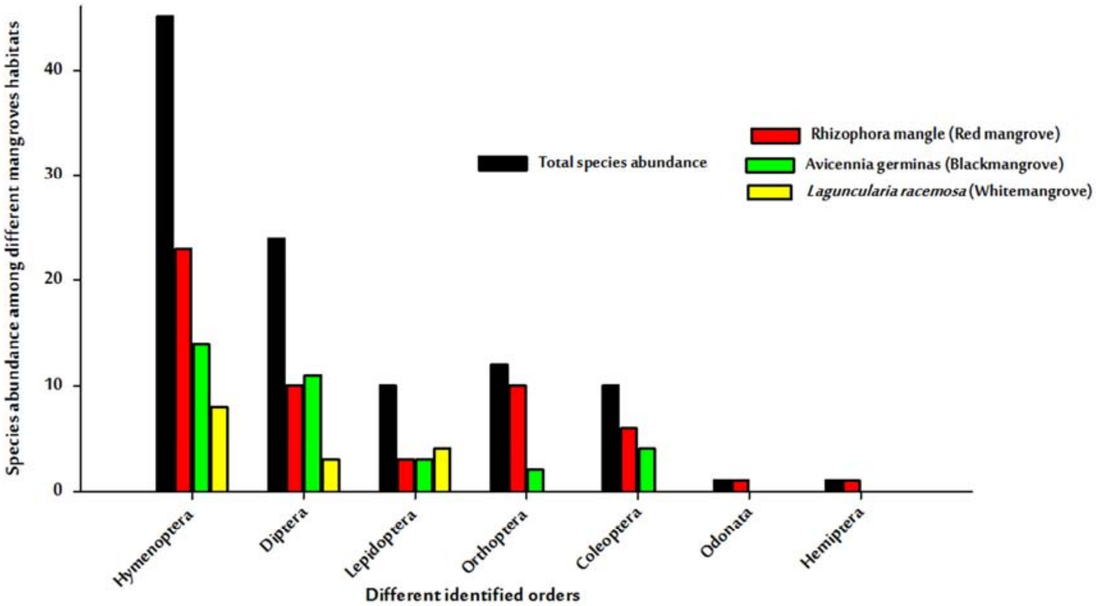

Figure 7. *Insect abundance among different identified orders and distribution between three different mangrove habitats: red mangrove habitat-type (R. mangle), black mangrove habitat-type (A. germinas, and white mangrove habitat-type (L. racemosa) at Asarama, Niger Delta, Nigeria.*

3.2. Spatial Variation in Biodiversity Indices

Overall species richness in studied habitats of mangroves were identified at Asarama, Niger Delta, Nigeria. The red mangrove habitat-type (*R. mangle)* recorded alone nineteen species, black mangrove habitat-type (*A. germinas,* fourteen species and white mangrove habitat-type (*L. racemosa*) seven species. Increasing insect abundance was recorded in the red (54 individuals) > black (35 individuals)> white mangrove habitat-type (15 individuals) overall current study, as shown in Figure 8A. That in turn, decreasing dominance index of species was attributed to mangrove habitat type; red (0.093)< black (0.122)< white mangrove habitat-type (0.227) which was oppositely with the increase of species throughout the current study. The competition of species within different mangrove habitats types around food source was revealed by species evenness (Figure 8B) which value increasing of species richness, abundance and decreasing in dominance index was corresponding with less value of species evenness and species competition with in community as following clarified; red (0.722)< black (0.767)< white mangrove habitat-type (0.793).

Regarding to species diversity indices (Figure 8C), Shannon and Simpson diversity indices reflect the spatial variation of species which recorded the highest diversity indices in the red mangrove habitat-type (Shannon, 2.62 & Simpson diversity index, 0.91) and the minial mangrove habitat was in white one (Shannon, 1.71 & Simpson diversity index, 0.77) overall current study.

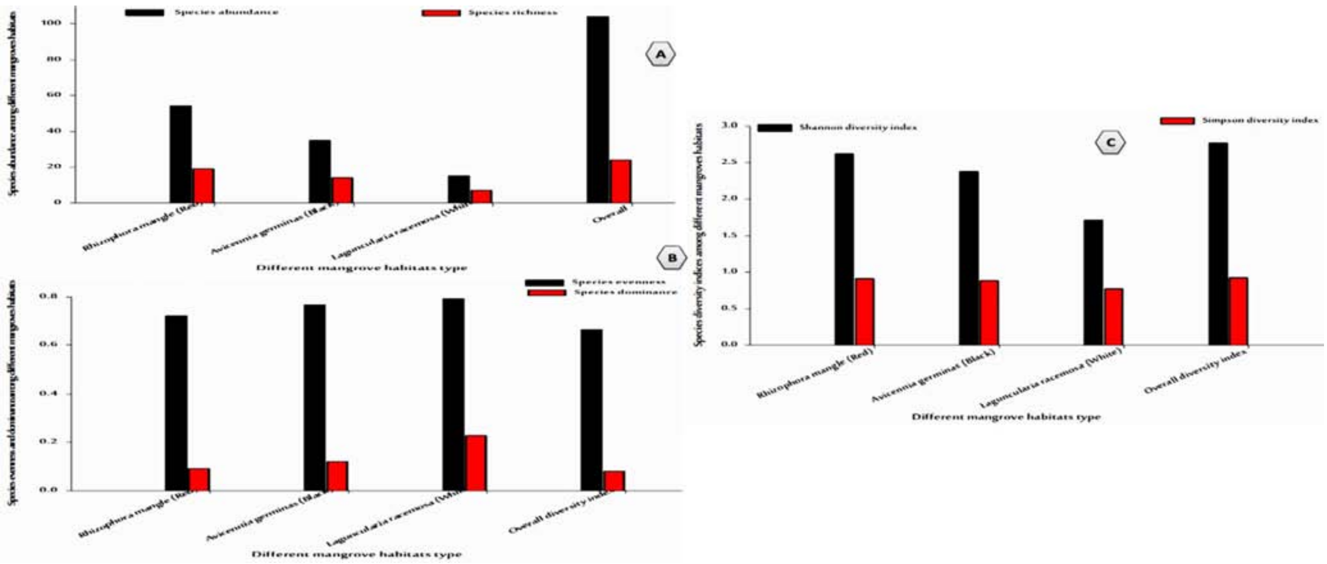

Figure 8. *Spatial variation of overall pattern of diversity indices among different mangrove habitats: red mangrove habitat-type (R. mangle), black mangrove habitat-type (A. germinas, and white mangrove habitat-type (L. racemosa) at Asarama, Niger Delta, Nigeria.*

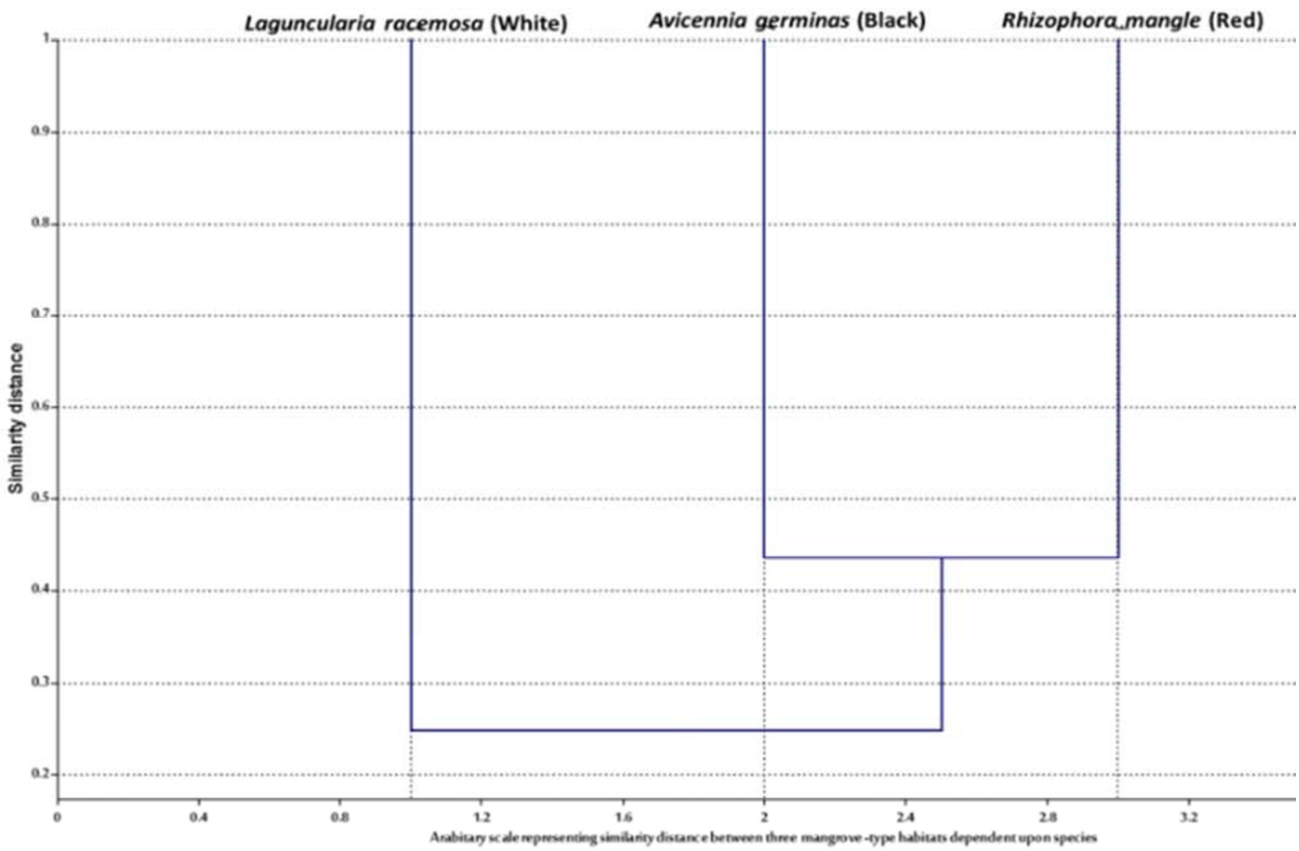

Figure 9. Hierarchical Cluster Analysis dependent upon spatial distribution of species and similarity distance between three different mangrove habitats using to Jaccard similarity index. The similarity distance was expressed in the figure by the length of each node between cluster pairs.

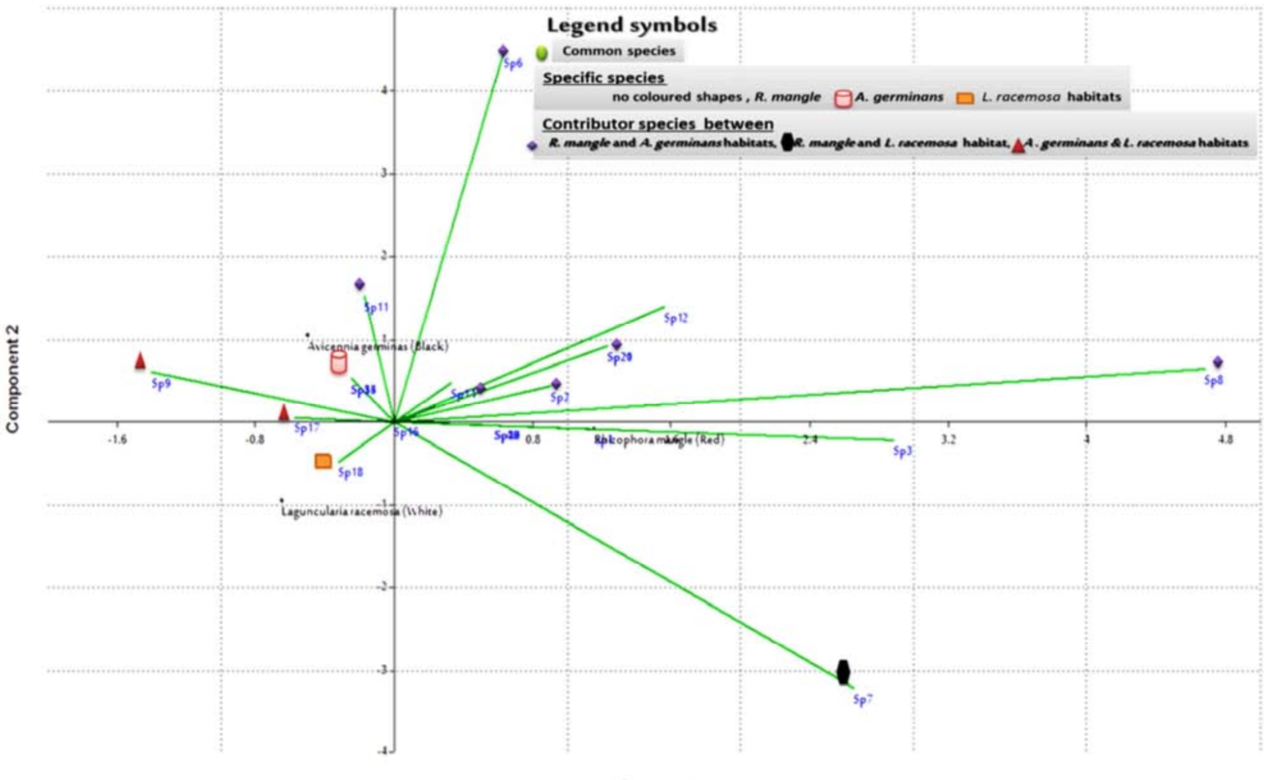

Figure 10. Principle component Analysis (PCA) dependent upon spatial distribution of species among different mangrove habitats: red mangrove habitat-type (R. mangle), black mangrove habitat-type (A. germinas, and white mangrove habitat-type (L. racemosa) at Asarama, Niger Delta, Nigeria.

3.3. Spatial Distribution of Species

As clarified in Figure 9, Hierarchical Cluster Analysis between three mangrove species habitats using Jaccard similarity index indicated that the more similar in habitat species were between red and black mangrove habitats, while the first separator clade was related to third mangrove habitat; white mangrove habitat. The corresponding correlation by this similarity index was equal 0.87 between these different mangrove habitats.

Principle Component Analysis (PCA) (Figure 10) clarified the spatial distribution of recorded species and attributed that three mangrove habitats around axis 1 and 2 (Eigen value=49.99& 38.43 and variance percentage=56.49& 43.5%, respectively). Along axis one and two, twenty-four different species that sampled from three mangrove habitats; *R. mangle,* red (19 species), *A. germinans,* black (14 species), and *L. racemosa,* white mangrove habitat (7 species). Three species; dipteran species *Anopheles gambiae* and *Musca domestica* (sp.12 & 15, respectively) and *Pieris rapae,* sp.16 (Lepidoptera; Pieridae), occurred commonly at all habitat-types. Meanwhile, PCA analysis detected that there are different species specific habitat as in *R. mangle* habitat-type which had eight restricted species: *Cammula pellucida,* sp.1, (Orthoptera; Acrildae), *Jacobiasea formosana*, sp.3, (Orthoptera; Cicadelledae), *Pseudoleon superlus*, sp.19, (Lepidoptera; Libellucidae), *Chrysocoris stolli*, sp.22, (Hemiptera; Scuttelleridae) and *Cordudia shurtteffi*, sp.23, (Odonata: Cordullidae). Meanwhile, two species; *Microcentum rhombifolium*, sp.5, (Orthoptera; Tettigonidae), and one unidentified species, sp.24, occurred exclusively at *A. germinas* habitat and *Colias croceus*, sp.18, (Lepidoptera; pieridae) was restricted to *L. racemosa* habitat.

PCA analysis indicated that contributor species between *A. germinas* and *L. racemosa* habitats along negative partition of axis 2 were two species; *Cremotogaster* sp., Sp9, (Hymenoptera; Formicidae) and *Colia eurythene,* Sp17, (Lepidoptera; papillionidae) rather third mangrove habitat at *R. mangle.* Meanwhile along positive portion of PCA, seven insect contributors: *Chorthippus albormarginatus,* Sp2, (Othoptera; Acriidae), *Camponotus herculeanus,* Sp6*, and Lasius niger,* Sp8, (Hymenoptera; Formicidae), *Culex pipiens, sp11,* (Diptera; Culicidae), *Caliphora vicina,* Sp14, (Diptera; Calliphoridae) and C*alepteran terminale and Calopteran discrepans,* Sp20 & 21 respectively (Coleoptera; Lycidae) were recorded at *R. mangle* and *A. germinans* habitats.

4. Discussion

The total abundance of 104 taxa recorded in our study agrees with the report of Murphy [3] that mangroves support a large number of insects. Though, Murphy did not report on the suitability of particular mangrove species, our study revealed that a single species, R. *mangle* was the most suitable habitat for colonization among the mangroves as it harboured the highest number of taxa, while the *L. racemosa* that contained 7 insect taxa was the least suitable habitat. Furthermore, eight taxa that were present at the *R. mangle* but absent on the other two mangroves also give credence to the fact that *R. mangle* was more suitable than the others for habitation. Mangrove-insect specificity also attest to the suitability of the *R. mangle*, for instance, while only two species were specific on the *A. germinas,* eight species were specific on *R. mangle,* and only one species on *L. racemosa* thus preferring *R. mangle* to other mangroves. The next suitable habitat after *R. mangle* was *A. germinas* because it contained 7 species that occurred commonly on both *R. mangle* and *A. germinas.*

Similarly, with the abundance of 54 individual species representing 52%, 35 individual species representing 33% and 15 individual species representing 14% recorded *R. mangle*, *A. germinas* and *L. racemosa*, respectively, indicates that *R. mangle* is the most suitable habitat for insect habitation among mangroves at the Asarama mangrove community. Entomofaunal diversity and abundance was more in the *R. mangle* mangroves, as indicated by the Shannon and Simpson diversity indices.

This indicates that the mangrove habitats were more suitable for Hymenopterans, moderately suitable for Coleopterans, Dipterans and less suitable for *Lepidopteran* and *Orthopterans*. The *R.mangle* habitat-type was more suitable for habitation of insects, particularly *Hymenopterans* and *Orthopterans* because they are the major abundant individuals. This agrees with the report that the occurrence of functional types at the *R.mangle* habitat-type was responsible for the higher entomofaunal diversity [12] as it provided adequate suitability.

The decreasing dominance index of species attributed to mangrove habitat-type indicated that no particular insect species or taxa actually dominated the Asarama mangroves. This showed that the ecosystem is eco-balance, ecologically healthy and without any noticeable pollution or disturbance which if it occurred would have cause changes in the biological component. This is certain because pollution has been pointed out to cause a low insect diversity in mangroves [9]. The high abundance and diversity recorded in our study showed pollution stressed-free mangroves, which allowed the growth of insects' species.

The presence of eight taxa or species which occurred at *R.mangle* but absent in other two mangroves can be used to assess the ecological health of mangroves because they give good indication of the fact that *R.mangle* is healthier. This agrees with Okiwelu *et al* [15] that those taxa that occurred in a particular ecosystem but absent in another are ecological indicators, and used in the assessment of ecosystem changes.

5. Conclusion

At Asarama mangroves, no insect species actually dominated the ecosystem, though the *R.mangle* habitat-type contained more insect species. The presence of eight species at this habitat is an indication that it is more suitable than the other habitat- types and attracted more insect species. Their presence or absence is used for assessment of changes in the mangrove ecosystem. The high diversity and abundance of insects in mangrove ecosystem in our study is an indication of pollution stressed-free habitat, used to determine pollution impact.

References

[1] Macintosh, D. J. and Ashton, E. C. (eds). (2003). Report on the African Regional Workshop on the sustainable management of mangrove forest ecosystems. ISME/Centre/CAW…?

[2] Kathiresan K., and Bingham, B. L. (2001). Biology of mangroves and Mangrove Ecosystem. Advances in marine Biology Vol. 40: 81-251.

[3] Murphy, D. H. (1990). The recognition of some insects associated with mangroves in Thailand. Mangrove Ecosystem occasional paper 7: 15-23. UNDP/UNESCO, New Delhi.

[4] Mitra, T. R. (1992). Odonata of the mangrove tidal forest of West Bengal, India. *Odonatologia* 3 (9), 141-143.

[5] Feller, I. C., and Mathis, W. N. (1997). Primary herbivory by wood-boring insects along an architectural gradients of *Rhizophora mangle*. *Biotropica* 29, 440-451.

[6] Thangam, T. S. (1990). Studies on marine plants for mosquito control. Ph. D Thesis, Annamala University, India. 68pp.

[7] Prayoonrat, P. (2004). Dipteran Fauna in Thai Mangrove Forest: A survey of insects in the Mangrove Forest at the Mouth of the BangPackong River in Thailand. Asian *Journal of Biology Education*. Vol. 2.

[8] Ananda Rao, T., Molur, S., and Walker, S., (1998). Report of the workshop on conservation Assessment and Management plan for mangroves of India. Zoo outreach organization, Coimbatore, India. 106 pp.

[9] Grampurohit, B., and Karkhamis, H. (2013). Insect Biodiversity at Mangrove Ecosystem. A paper presented at National Conference on Biodiversity; Status and challenges in conservation, Mumbai, India.

[10] Merit, R. W. and Cummins, K. W (1996). An Introduction to the Aquatic insects of North America. Third Edition. Kendall/Hunt Publishing Company, Iowa. Pp. 862.

[11] Arimoro, F. O., and Ikomi, R. B. (2009). Ecological integrity of upper Warri River, Niger Delta using aquatic insects as bioindicators. *Ecol. Indic*. 9: 455-461.

[12] Gbarakoro, T. N. and Okene, P. F. (2020). Assessment of Insect Functional Groups of Mangroves parts at Asarama, Andoni, Rivers State, Nigeria. European Journal of Agriculture and Forestry Research. Vol. 8 No 2: 18-27.

[13] Krantz, G. W. (1978). A manual of Acarology, Oregon 173 State University Book Stores Inc.

[14] Robert W. P (1978). Fresh water Invertebrates of the United States (2nd Edition). Pp. 708.

[15] Okiwelu, S. N., Gbarakoro, T. N., Badejo, M. A. (2011). Soil microartthropods in a Secondary Rainforest, Rivers state-11-Ecosystem Health Indicators of Oil Pollution. *Journal of Ecology and the Natural Environment*. 3: 29-32.