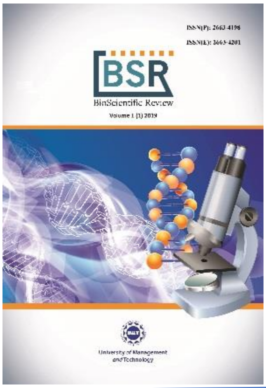

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Rapid Biodiversity Evaluation of the Arboreal Termites in Kano University of Science and Technology, Wudil, Nigeria

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Abstract

A rapid biodiversity evaluation of diversity of arboreal termites was carried out on the campus of Kano University of Science and Technology (KUST), Wudil, Nigeria. Three different trees namely, *Mangifera indica*, *Azadirachta indica* and *Khaya senegalensis* were selected from three different sites (campus new site, premises of administrative offices and the commercial area) in the campus and examined for termite activity such as mud tubes and nests. These were cut open with forceps to expose the termites. A soft brush was used for the collection of termite samples into a labeled sampling bottle containing 10% formalin solution. Sample collection was done during morning hours for one month at 7-day intervals A total of one hundred and twelve (112) individual termites were collected which belonged to five species namely *Coptotermes* sp., *Microtermes* sp., *Odontotermes* sp., *Amitermes* sp. and *Nutitermes* sp. *Coptotermes* sp. The total relative abundance of these species was 81.3% on trees and 80.4% sites, respectively. The diversity indices from the study showed the same species richness of termites on *M. indica* and *K. senegalensis,* while evenness was greater on *K. senegalensis.* Therefore, it had the greatest diversity of the termite fauna as compared to other trees. However, campus new site and commercial area also had the same species richness; although it was low in the premises of administrative offices. Evenness was greater in campus new site which had the greatest diversity. *Coptotermes* sp are insects of agricultural and economic importance and feed on dead wood; therefore, they are insect pests of these trees and other building structures erected on the campus.

Keywords: arthropods, biodiversity, sites, social insects, termites, tree species

Introduction

Termites are social insects which live in nests and form colonies. They belong to the phylum Arthropoda, class Insecta and order Isoptera. In tropical and subtropical regions, they are an important component of the ecosystem [1]. It has been speculated that termites have the greatest influence on the ecology of the world of any animal group, next to humans [2]. A normal colony of termites consists of nymphs, workers, soldiers and reproductive individuals and in some colonies, several egg laying queens are present [3]. They are decomposers and feed on dead plant materials, leaf litter, soil and animal dung [3]. To manage food sources and assess new habitats, termites exhibit a decentralized and self-organized system, swarm intelligence and cooperation among colony members [4]. The population of termites depends on environmental conditions such as food availability, soil texture, soil moisture, and soil temperature [5]. Their movement increases soil micropores through an increase in soil porosity, aeration and soil water permeability [6].

Land use practices which include agricultural practices, industrialization and habitat fragmentation seriously affect the productivity and abundance of termites which results in the loss of biodiversity [5]. Termite species that construct their nest or mound on dead and growing trees are known as arboreal termites, while those which construct their nest or mound in soil are known as subterranean termites [5]. There are also dry wood and wet wood termites, respectively [2].

Termites possess the ability to cause damage to building materials, tarnish the color of structures, and destroy furniture among others; as such they are regarded as demolishers. Of the 2,600 known species of termites about 660 are found in Africa [7]. About 300 of these species have economic importance [8]. *Macrotermes*, *Allodonterms*, *Odontotermes*, *Ancistrotermes*, *Amitermes*, *Pseudacanthotermes*, *Microtermes*, *Trinervitermes*, and *Macrotermes* are some of the most economically important termite genera found in forests and agricultural areas [9]. In certain ecosystems such as the African savanna, termites may be the single most prominent organism involved in biodegrading the nutrients found within dead plant matter. There is extensive contribution of termites in damaging buildings as wood is the best of all foods that termites consume; termites also feed on other materials such as dry grass, fallen leaves, humus-rich soil, and dried animal dung [2]. The diversity and abundance of termite species have been well documented in USA, Canada, Australia, UK, India, Asia, Cameroon and South Africa but not in Nigeria [10]. In the northwestern part of Nigeria in general and in Kano State in particular, there is little or no information available about the biodiversity of termites. Therefore, the current study is aimed at determining the diversity of termite species inhabiting selected trees in KUST, Wudil campus, considering the importance of these trees in the ecosystem.

2. Materials and Method

2.1. Study Area / Layout

The study was conducted in the campus of Kano University of Science and Technology (KUST),Wudil, Nigeria which is located approximately between longitude 8° 45'E and 8° 57'E and latitude 11° 37'N and 11° 56'N.
Three different sites within the campus were selected and investigated for termite diversity, which included campus new site (longitude 8.860460°E: latitude 11.808110°N), premises of administrative offices (longitude 8.851266°E: latitude 11.803913°N) and the commercial area (longitude 8.853255°E: latitude 11.804021°N). These were labeled as site A, B and C, respectively. At each site, three different trees were selected for termite sample collection. They included *M. indica* (Mango), *A. indica* (Neem) and *K. senegalensis* (Mahogany).

2.2. Sample Collection and Identification

Termite samples were collected following the procedure described by Ugbomeh *et al.* [11] with slight modification. Sampling was done in the morning for one month at 7-day intervals, from 19th January, 2020 to 29th February, 2020. A total of eighty-four trees (twenty-eight each of *M. indica*, *A. indica* and *K. senegalensis*) from sites A, B, and C were randomly examined for termite activity represented by either mud tubes or nests which indicate infestation by termites. These were opened with forceps to expose the insects. Using a soft brush, termite samples were collected into labeled sampling bottles containing 10% formalin solution and trees were marked with paint for the ease of recognition. The insects collected were taken to laboratory for identification.

Termites were examined with hand lens and dissecting microscope. Identification was conducted to genus level with the aid of the guides by Donovan *et al*. [12] and Kambhampati and Eggleton [13]. Identification was based on morphological features such as body color, shape of head and mandibles, number of segments on abdomen and antenna. The identified species were counted and their relative abundance was calculated.

2.3. Data Analysis

The data collected were subjected to diversity analysis and abundance models separately for trees and sites. Diversity indices and species richness analysis was conducted with BioDiversity Professional Ecological Statistical software (Version 2).

3. Results

Table 1 shows the relative abundance of termite species present on selected trees in KUST, Wudil campus, *Nigeria* The *Coptotermes* (81.3%) was the most abundant species of termite on both trees with a higher number of individuals recorded. This was followed by *Odontotermes* (8.4%) and *Macrotermes* (5.4%), respectively. The species of termites least found on trees were *Nasutitermes* (1.79%) and *Amitermes* (3.57%), respectively.

Table 2 shows the diversity indices and models of fit for the termite species inhabiting sampled trees in KUST, Wudil campus. The results showed that species richness was the same on two (*M. indica* and *K. senegalensis*) of the three trees. The Fisher alpha and Margalef indices were similar for these trees, while the Chao-1 index was greater for *K. senegalensis* as compared to *M. indica*. Also *K. senegalensis* had a greater Simpson index than *M. indica*. The Shannon index of these trees was equal and the Berger-Paker index of the trees was similar. Evenness was greater in *K. senegalensis* than *M. indica*. *A. indica* had a higher species richness and Fisher alpha indices than the other two trees, while its Margalef index was low. The Chao-1 index of *A. indica* was below that of *K. senegalensis*. Shannon and Berger-Paker indices were greater than that of other trees, while the Simpson index was similar to *K. senegalensis*. The log series and broken stick models poorly fitted into the data.

Table 1. Relative Abundance of Termite Species Inhabiting Different Trees at KUST, Wudil Campus

	Sampled Trees			
Termite Species	***M. indica***	***A. indica***	***K. senegalensis***	**Total**
Coptotermes	82.9	80.0	81.1	81.3
Macrotermes	8.6	2.5	5.4	5.4
Odontotermes	2.9	10.0	10.8	8.0
Amitermes	5.7	2.5	2.7	3.6
Nasutitermes	0.0	5.0	0.0	1.8
Total	100.0	100.0	100.0	100.0

Table 2. Diversity of Termite Species on Three Different Trees in Table 1 and The Fit of Termite Species Abundance and Distribution, Log Series and Broken Stick

	Sampled Trees		
	M. indica	***A. indica***	***K. senegalensis***
Diversity			
Species Richness	4	5	4
(S) Individuals	35	40	37
Dominance_D	0.698	0.645	0.629
Simpson 1/D	1.451	1.551	1.590
Shannon_H_{max}	0.602	0.699	0.602
Shannon J	0.456	0.462	0.478
Margalef	2.591	2.497	2.551
Berger-Parker	1.207	1.250	1.233
Fisher's alpha	1.165	1.509	1.140
Chao-1	5.000	6.350	7.670
Fit of Model			
Log Series	No	No	No
Broken Stick	No	No	No

The value of *p* in Chi square goodness of fit test is 0.05.

Table 3 shows the relative abundance of termite species from three different sites irrespective of the trees in KUST, Wudil campus. *Coptotermes* (80.4%) was the most abundant species at both sites. It was followed by *Odontotermes* (8.9%) and *Amitermes* (5.4%), respectively. The least found were *Nasutitermes* (1.8%) and *Macrotermes* (3.6%). *Coptotermes* had the highest relative abundance (92.9%) at site B, while *Odontotermes* (17.6%), *Macrotermes* (5.9%) and *Nasutitermes* (2.9%) were most abundant at site A. *Amitermes* (11.1%) had the highest relative abundance at site C.

Table 3. Relative Abundance of Termite Species from Three Different Sampling Sites at KUST, Wudil Campus

	Sampled Sites			
Termite Species	**Site A**	**Site B**	**Site C**	**Total**
Coptotermes	70.6	92.9	75.0	80.4
Macrotermes	5.9	0.0	5.6	3.6
Odontotermes	17.6	4.8	5.6	8.9
Amitermes	2.9	2.4	11.1	5.4
Nasutitermes	2.9	0.0	2.8	1.8
Total	99.9	100.0	100.0	100.0

Table 4. Diversity of Termite Species on Trees from Three Different Sites in Table 3 and the Fit of Termite Species Abundance and Distribution, Log Series and Broken Stick

	Sites		
	A	**B**	**C**
Diversity			
Species Richness (S)	5	3	5
Individuals	34	42	36
Dominance_D	0.520	0.862	0.603
Simpson 1/D	1.921	1.160	1.657
Shannon_H_{max}	0.699	0.477	0.602
Shannon J	0.575	0.276	0.559
Margalef	2.612	2.464	2.591
Berger-Parker	1.417	1.077	1.296
Fisher's alpha	1.617	0.740	1.165
Chao-1	3.700	4.780	6.130
Fit of Model			
Log Series	No	No	No
Broken Stick	No	No	No

The value of p in Chi square goodness of fit test is 0.05.

Table 4 shows the diversity indices and models best fit for termite species from different sites at KUST, Wudil campus. The results showed that the species richness of termites was the same at two (site A and site C) of the three sites. The Fisher alpha and Margalef indices were greater for site A, while Chao-1 index was greater for site C as compared to site A. Simpson, Shannon, and Berger-Parker indices were greater for site A. Evenness was also greater for site A but dominance was less as compared to site C. At site B, species richness was the lowest and Chao-1 index of site B was greater as compared to site A. Although dominance was greater than the other two sites, evenness and all other indices were the lowest. The log series and broken stick models poorly fitted into the data from the respective sites.

4. Discussion

A total of one hundred and twelve (112) individual termites were collected for the current study. This is similar to the findings of study by Nwosu and Akor [14], who collected 185 individual termites in Naka, Benue, Nigeria. Five species of termites were documented from the study sites which were among the species that attack trees and woods. This discovery corresponds to the findings of Ogedegbe and Eloka [3], who reported that five of the seven species of termites recorded on farmlands in Edo state, Nigeria attack trees and build their nests on them. *Coptotermes* sp. were found to be the most abundant termite species, both from the sites and on the trees studied. On the contrary, Wekhe *et al*. [5] stated that *Amitermes* sp. was the most abundant subterranean termite species at River

State University campus. However, the abundance of Coptotermes could be due to the fact that they were the insect pest of the studied trees as reported by Bong *et al*. [15], who found *Coptotermes* as the insect pest of oil palm plantation in Malaysia. According to Cranshaw and Redak [2], subterranean termites never expose themselves aboveground during forage because they are very sensitive to drying, they may build shelter tubes from soil and bits of debris cemented together with feces and secretions to reach the wood beyond a barrier. All the five species of termites were recorded as nested on the trees studied. In the same vein, Kemabonta and Balogun [16] reported Coptotermes, Amitermes, and Nasutitermes among wood nesting species of termites at University of Lagos.

Fisher alpha and Margalef indices provided *M. indica* and *K. senegalensis* with a similar diversity of termites, though these trees had an equal species richness. However, Chao-1 index extrapolated a greater termite diversity on *K. senegalensis* as compared to *M. indica*. Also *K. senegalensis* had low abundance and rare species as compared to *M. indica* as shown by the Simpson index and Berger-Parker index. The greater evenness and lower dominance recorded by *K. senegalensis* indicated that its termite fauna was more diverse than *M. indica*. *A. indica*, despite having a greater species richness, also had a greater species diversity than *M. indica* due to greater evenness and lower dominance, although it was less diverse as compared to *K. senegalensis*.

Site A with lower extrapolated species richness according to Chao-1 index and lower dominance had all other indices greater than that of other sites; hence the termite species were more diverse there. This was followed by site C and the least diverse was site B, despite the fact that the site had more individuals and estimated species richness than other sites.

For both trees and sites, the unsatisfactory fit of the model for log series predicted too many rare species of termites, while broken stick predicted fewer rare species of termites than were recorded.

5. Conclusion

The abundantly found arboreal termites on KUST, Wudil campus are mud tube *Coptotermes* sp. They are found on all the trees selected for the study. Therefore, they are considered as insect pest of these trees. Termite species prefer inhabiting *K. senegalensis* mainly because these species remain undisturbed on this tree as compared to other trees. Moreover, campus new site (site A) has greater termite diversity on trees as the area has some ongoing constructions.

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