fjrs.futa.edu.ng

FUTA Journal of Research in Sciences

ISSN: 2315-8239

FUTA Journal of Research in Sciences, 2014 (2): 188-197

# SPECIES RICHNESS, DIVERSITY AND RELATIVE ABUNDANCE OF TERMITES (INSECTA: ISOPTERA) IN THE UNIVERSITY OF LAGOS, LAGOS, NIGERIA

***K.A. Kemabonta.and S.A. Balogun**
Department of Zoology, Faculty of Science, University of Lagos, Akoka, Lagos Nigeria
*Corresponding author email: kkemabonta@unilag.edu.ng; Tel: +234 802 223 5317

**ABSTRACT**
Termites are widely dispersed throughout the tropics as well as some temperate regions and they play vital ecological roles such as nutrient cycling and ecosystem engineering. Random sampling and standardized transect methods were used for sampling termites species during the raining and dry seasons at the University of Lagos Campus, Akoka, Lagos. Two families (Rhinotermitidae and Termitidae), six subfamilies (Rhinotermitinae, Amitermitinae, Macrotermitinae, Nasutitermitinae, Termitinae and Microcerotermitinae) and seven genera were identified from the 229 termite collections made. Subfamily Macrotermitinae constituted 58% of the total number of species sampled. Members of the genus *Macrotermes* were the dominant species and constituted 40% of the total number of species sampled. Eight species were identified and the relative abundance of these eight species were *Amitermes spp.*(29%), *Macrotermes subhyalinus* (24%), *Ancistrotermes spp*. (18%), *Macrotermes natalensis* (16%), *Nasutitermes spp.* (8%), *Coptotermes spp.* (3%), *Microcerotermes spp.*(2%) and *Capritermes spp*. (1%). Based on the distribution map, *Amitermes spp.* was the most widely distributed species (4 zones), followed by *Ancistrotermes spp* (3 zones). *Capritermes spp.* and *Microcertermes spp.* are considered rare species and their distribution was limited to only one zone.
**Keywords:** Termite species, diversity indices, University of Lagos, Rhinotermitidae, Termitidae

## INTRODUCTION

Termites (Isoptera) are social insects characterized by their colonial behaviour. Termites are widely dispersed throughout the tropics as well as some temperate regions and attain highest diversity and abundance in the rain forests of Africa, South America and Southeast Asia (Rahman and Tawatao, 2003). Termites consist of 6 families, 170 genera and about 2600 species, of which 300 species are said to be of economic importance (Engel and Krishna, 2004). They play an important role in ecosystems (Wood and Sands, 1978).

The interaction of termites with man increased as a result of man's interference with termite's environment and natural food supply (Edwards and Mill, 1986; Rahman and Tawatao, 2003) which is mainly wood and woody tissues of plant. Thus, termites engaged in direct competition with man resulting in great loss of properties and damages to agricultural crops such as cash crops and food crops (Harris, 1961), timbers in buildings, posts, fences, clothes, books, underground cables, air fields, earth dams and irrigation canals. They also reduce

water retaining capacity of the soil, by removing the plant cover and thus promote erosion to some extent. The damage done to all these articles are great and amount to millions of Naira in Nigeria (Ibrahim and Adebote, 2012). Beneficial activities of termites on the other hand include the restoration of organic matter from dead wood and woody tissues of plants to the soil (Ohiagu, 1979). They are of high nutritive value and are also utilized as food by various animals including man (Harris, 1961). Termites are also important 'ecosystem engineers' (Wood and Sands, 1978; Lawton and Jones, 1995) and have the potential to act as indicators of decomposition processes in tropical rain forests (Jones and Eggleton, 2000). Termites' mound materials can be used in construction and pottery making (Edwards and Mill, 1986). Species diversity and abundance of termites have been well documented in USA, Canada, Australia, UK, India, Asia, Cameroon and South Africa but not much work done in Nigeria (Malaka, 1996). There is therefore a dearth of information on total number of species in Nigeria. Most studies in Nigeria were on the management of termite infestations (Malaka, 1983; Lewis, 1997; Olugbemi, 2012) and on termite taxonomy (Malaka, 1996). The objective of the present study was to therefore evaluate the species richness and relative abundance of termite in the dry and rainy seasons at the University of Lagos.

## MATERIALS AND METHODS

### Description of the study area

The University of Lagos is situated in the western part of Lagos State at approximately 20˚ 50'N and 30˚ 50'E. It is largely surrounded by the Lagos Lagoon on 802 acres of land in Akoka, North Eastern part of Yaba, Lagos. It is bounded on the North by Ilaje Ese-Odo, South West by Iwaya and South East by the Lagos Lagoon. The total area spans approximately 8194.93$m^2$ consisting of both wet and dry land out of which a conservative 21.5% is estimated to be wetlands (Nwankwo *et al*., 2003). The maximum temperature ever recorded was 37.3$^0$C and the minimum 13.9$^o$ C. University of Lagos experiences two rainy seasons, with the heaviest rains falling from May to July and a weaker rainy season in October and November. There is a brief relatively dry spell between August and September and a longer dry season from December to March. Monthly rainfall between May and July averages over 400 mm while in August and September it is down to 200 mm and in December as low as 25 mm. The relative humidity is high, usually not below 65% in the afternoon. The vegetation consists of semi-deciduous wetland, humid, lowland rainforest (Dibog *et al*., 1998) which is rapidly disappearing due to development structures, classrooms and administrative buildings). There are high degrees of biodiversity in terms of fauna and it provides the endemic Mona monkey and crabs, mud skipppers, squirrels, different species of insects and molluscs. There is also an impressive variety of bird life on the campus (Nwankwo *et al*., 2003).

### Sampling Designs

Sampling was conducted in 2012 and 2013. Two sampling protocols were employed namely the standardized transect and random sampling method.

### Transect Sampling Method

Standardized transect method of Jones and Eggleton (2000) was used for sampling termites. The campus was divided into 26 sites as seen in Table 1, which was further zoned into four. A belt transect of 100m was laid making use of stick and rope. In order to standardize sampling effort, each transect was divided into 20 contiguous sections of 5m x 2m and in each section 20 minutes was spent searching for termites. Within each section the following microhabitats were searched; surface soil , leaf litter and humus on the forest floor (at the base of trees, between buttress roots etc.), inside dead logs, tree stumps, branches, twigs, subterranean nests, mounds, runaway on vegetation and visible arboreal nests up to a height of 2 m above ground. The number of encounters with termites (hits) of a given species within a

transect was taken as the relative abundance of that species within that transect. An encounter is the presence of a species in one transect section (5 x 2 m). Sampling was also conducted in broad survey. The transect method could not be used throughout the campus because of the structures e.g classrooms and administrative buildings. In each site, termite nests were searched for on the ground, in live and dead trees, rotten wood, wooden objects and walls of buildings.

**Table 1: The Groupings of University of Lagos Akoka Campus and Their Geographic Coordinates**

| ZONES | LOCATION | GEOGRAPHIC LOCATION |
|---|---|---|
| **ZONE 1** | EDUCATION GARDEN | $6.51563^0$ N, $3.385584^0$E |
| | KOFO HALL | $6.515529^0$N, $3.38617^0$E |
| | AMINA HALL | $6.515338^0$N, $3.38594^0$E |
| | FACULTY OF EDUCATION | $6.5162^0$N, $3.38524^0$E |
| | EL-KANEMI HALL | $6.51675^0$N, $3.3849^0$E |
| | SECURITY POST AT GATE II | $6.50885^0$N, $3.3864^0$E |
| **ZONE 2** | SHOPPING COMPLEX | $6.51933^0$N, $3.39104^0$E |
| | SOCIAL SCIENCES | $6.51565^0$N, $3.39154^0$E |
| | DISTANCE LEARNING INSTITUTE | $6.51266^0$N, $3.39162^0$E |
| | INTERNATIONAL SCHOOL LAGOS | $6.51195^0$N, $3.3917^0$E |
| | HEALTH CENTRE | $6.51382^0$N, $3.39551^0$E |
| | MOREMI HALL | $6.51782^0$N, $3.39808^0$E |
| **ZONE 3** | JAJA HALL | $6.51624^0$N, $3.39808^0$E |
| | CHEM. ENGINEERING | $6.51501^0$N, $3.39779^0$E |
| | ULWS | $6.51439^0$N, $3.39722^0$E |
| | OZOLUA ROAD | $6.51293^0$N, $3.39726^0$E |
| | UNILAG MEDICAL ROAD | $6.51067^0$N, $3.3967^0$E |
| | HIGH RISE (STAFF QUARTER) | $6.50885^0$N, $3.39716^0$E |
| | FACULTY OF SCIENCE | $6.51674^0$N, $3.40492^0$E |
| **ZONE 4** | FACULTY OF BUS ADMIN | $6.52051^0$N, $3.39923^0$E |
| | FACULTY OF ART | $6.51984^0$N, $3.39827^0$E |
| | GUEST HOUSE | $6.52018^0$N, $3.40013^0$E |
| | LAGOON FRONT | $6.51892^0$N, $3.40074^0$E |
| | ZOO GARDEN | $6.51817^0$N, $3.40097^0$E |
| | VICE CHANCELLOR ROAD | $6.51689^0$N, $3.40298^0$E |
| | FAC. OF ENGINEERING | $6.51828^0$N, $3.40021^0$E |

Note: ULWS= University of Lagos Women Society Nursery and Primary school.

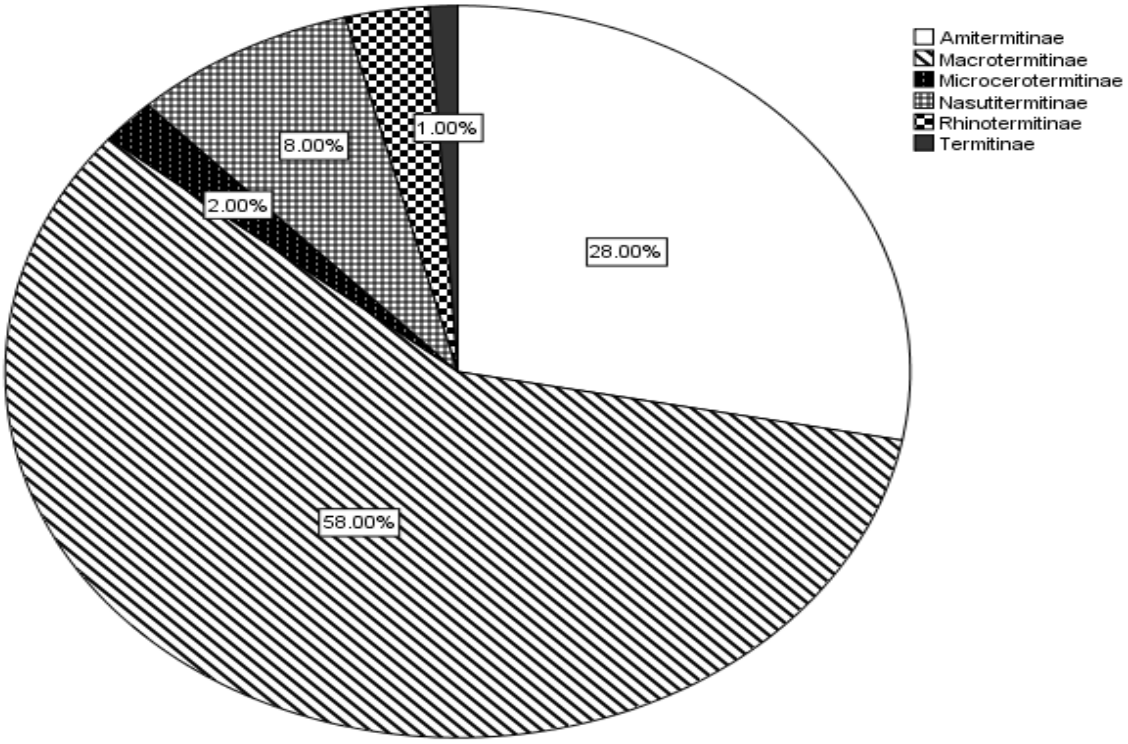


**Figure 1: Subfamilies of collected termites**

**Broad survey/ Random sampling method**

Termite nests were opened using forceps and at least 20 soldiers were collected for identification. Sampled termites were preserved in vials containing 70% alcohol and covered properly to avoid evaporation. Vials were labeled with indelible ink and each had the following information: location, habitat, date and the number of the vial. Termite species were identified using soldier caste characteristics (mandibulate shape) using several identification keys including Krishna and Weesner, (1969), Donovan *et al* (2001), Kambhampati and Eggleton (2000)

**Termite identification**

The Portable Digital Microscopes (Miscope®) was used to observe the termite samples for identification. All samples with soldiers were identified to genus level depending on the shape of the mandibles. Moreover, the names of species were confirmed by insect taxonomists at the insectary of Cocoa Research Institute of Nigeria (CRIN), Ibadan, Nigeria.

**Statistical Analysis**

Descriptive statistics including the mean and standard error of the mean were calculated for termite occurrence data within the sites together with termite species richness per site. The species richness was calculated using the Shannon-Wiener diversity Index (H') while the diversity was calculated using the Simpson index. The Shannon- Wiener Index can be calculated as follows:

$$H=-\Sigma (Pi \ In \ Pi)$$

Where P**i** is the proportion of individuals found in the **i** th species while In is the natural logarithm.

The Simpson Index was calculated as follows:

$$D=\frac{\sum_{i=1}^{s} n_i\left(n_i-1\right)}{N\left(N-1\right)}$$

Where $n_i$ is the number of individual in the ith species while N is the total number of entities in the dataset.

**RESULTS**

**Species composition**

Termite species representing two families (Rhinotermitidae and Termitidae), six sub-families (Coptotermitinae, Amitermitinae,

Macrotermitinae, Microcerotermitinae Nasutitermitinae and Termitinae) and eight genera were identified from 229 termite collections obtained at the University of Lagos. Random sampling method collected all the insects found while transects sampling method yielded only three species. *Microcerotermes, Macrotermes subhyalinus* and *Capritermes spp.* were collected only through random sampling method (Table 2). Species from the Subfamily Macrotermitinae constituted 58% of the total number of species sampled while Termitinae, Microcerotermitinae and Rhinotermitinae constituted 1, 2 and 3% respectively (Fig. 1). Members of the genus *Macrotermes* were the dominant species and constituted 40% of the total numbers of species sampled while the distribution of *Capritermes spp.* and *Microcertermes spp* was limited to one zone only.

**Feeding group and nesting site**

Following the classification of Donovan *et al.* (2001), the termite assemblage comprised of two feeding groups (Group II and Group IV) (Table 2). Group II (wood and grass feeders) species dominated, comprising of 73% of the total species. The rest of the species (27%) were true soil feeders. *Amitermes spp*. was the only species found in the two groups (Table 2 and Fig. 2). Three (I, 2 and 3) nesting habitats were represented (Table 2), with 70% of the species nesting in wood, 17% in Epigeal mound and 13% of the species nesting in subterranean nests. Wood nesting species include *Amitermes spp. Ancistrotermes spp., Coptotermes spp., Macrotermes subhyalinus, Microcerotermes spp.* and *Nasutitermes spp.* Subterranean nesters were *Amitermes spp.* and *Capritermes spp* while Epigeal mound builders were *Macrotermes natalensis* and *Nasutitermes spp* (Table 2 and Fig. 3).

**Table 2: Details of termite taxa recorded during the survey**

| Termite taxa | Method of collection | Feeding group | Nesting group |
|---|---|---|---|
| Family RHINOTERMITIDAE | | | |
| **Subfamily Rhinotermitinae** | | | |
| *Coptotermes spp.* | R | II (W) | 1 |
| Family TERMITIDAE | | | |
| **Subfamily Amitermitinae** | | | |
| *Amitermes spp*. | T/R | II (W) and IV | 1 and 2 |
| **Subfamily Microcerotermitinae** | | | |
| *Microcerotermes spp.* | R | II (W) | 1 |
| **Subfamily Macrotermitinae** | | | |
| *Ancistrotermes spp.* | | | |
| *Macrotermes natalensis* | R | II (W) | 1 |
| *Macrotermes subhyalinus* | T/R | IV | 3 |
| | R | II (W) | 1 |
| **Subfamily Nasutitermitinae** | | | |
| *Nasutitermes spp.* | T/R | II (W) and II (G) | 1 and 3 |
| **Subfamily Termitinae** | | | |
| *Capritermes spp.* | R | IV | 2 |

(Method of collection: R= random collection, T= transect sampling)
(Feeding groups: II(W) = wood feeders, II(G)= Grass feeders, IV= true soil feeders) (Nesting groups: 1=wood nester, 2= subterranean, 3= Epigeal mound builders)

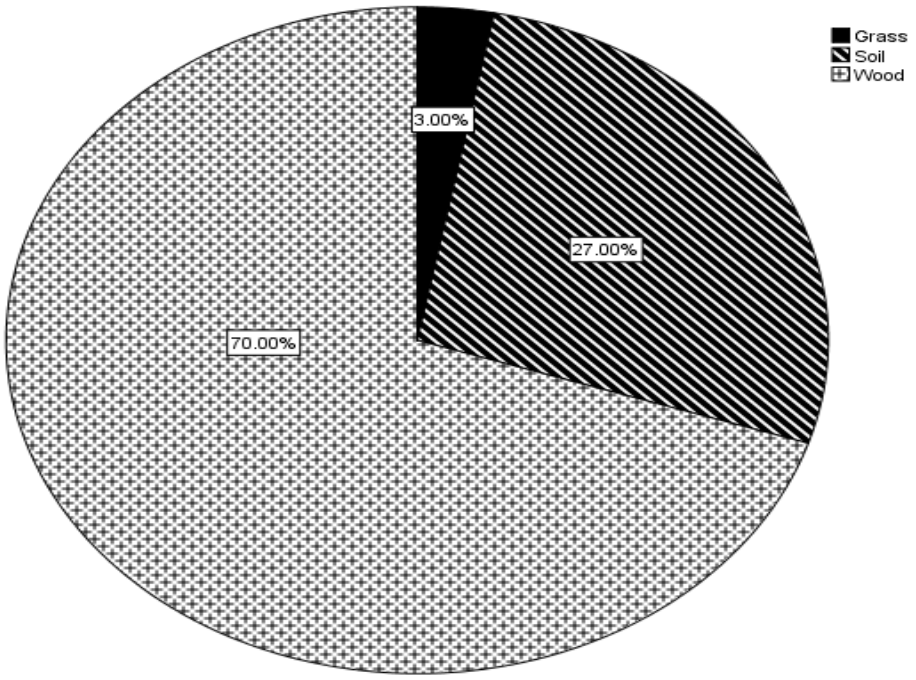


**Figure 2: Feeding group of collected termites**
NB: Feeding groups: Wood = **wo**od feeders, Grass= Grass feeders, Soil= Soil feeders

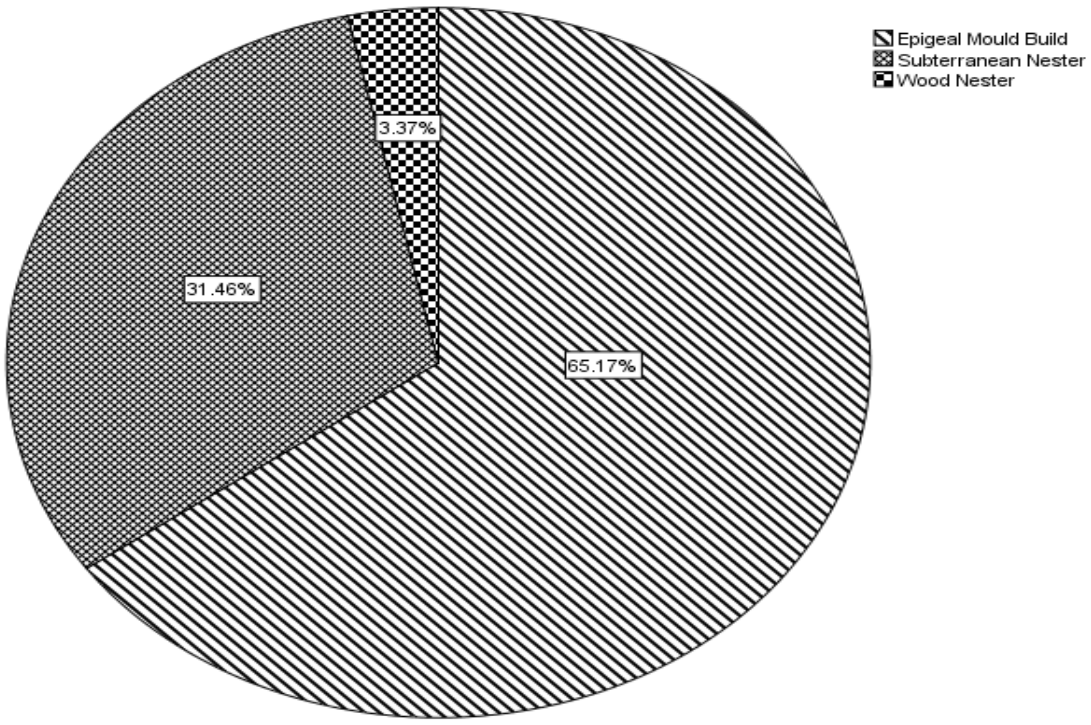


**Figure 3: Nesting group of collected termites**

**Table 3: Total number of Hits of termite species collected within the twenty-six sites during the dry and rainy seasons.**

| Species | Total no. of Hits for dry season (N) | Total no. of Hits for rainy season (N) | Total no. of Hits for the two seasons (N) |
|---|---|---|---|
| *Amitermes spp.* | 19 | 16 | 35 |
| *Ancistrotermes spp.* | 8 | 14 | 22 |
| *Capritermes spp.* | 0 | 1 | 1 |
| *Coptotermes spp.* | 2 | 1 | 3 |
| *Macrotermes natalensis* | 9 | 10 | 19 |
| *Macrotermes subhyalinus* | 27 | 2 | 29 |
| *Microcerotermes spp.* | 1 | 1 | 2 |
| *Nasutitermes spp.* | 2 | 7 | 9 |

**Table 4: Species richness and elative abundance of species in different zones.**

| Species | Zone 1 | | Zone 2 | | Zone 3 | | Zone 4 | |
|---|---|---|---|---|---|---|---|---|
| | DS | RS | DS | RS | DS | RS | DS | RS |
| *Amitermes spp.* | 8 | 3 | 0 | 8 | 9 | 2 | 2 | 3 |
| *Ancistrotermes spp.* | 1 | 2 | 3 | 8 | 4 | 2 | 0 | 2 |
| *Capritermes spp.* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| *Coptotermes spp.* | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| *Macrotermes natalensis* | 1 | 0 | 4 | 1 | 2 | 0 | 2 | 9 |
| *Macrotermes subhyalinus* | 2 | 0 | 11 | 0 | 14 | 1 | 0 | 1 |
| *Microcerotermes spp.* | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| *Nasutitermes spp.* | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 5 |
| Total | 13 | 5 | 20 | 18 | 31 | 9 | 4 | 20 |
| Species richness (M) | 1.56 | 0.62 | 1.34 | 1.04 | 1.46 | 1.92 | 0.72 | 1.34 |
| Species diversity (H') | 1.17 | 0.67 | 1.24 | 1.04 | 1.38 | 1.56 | 0.69 | 1.37 |

DS= dry season
RS= raining season

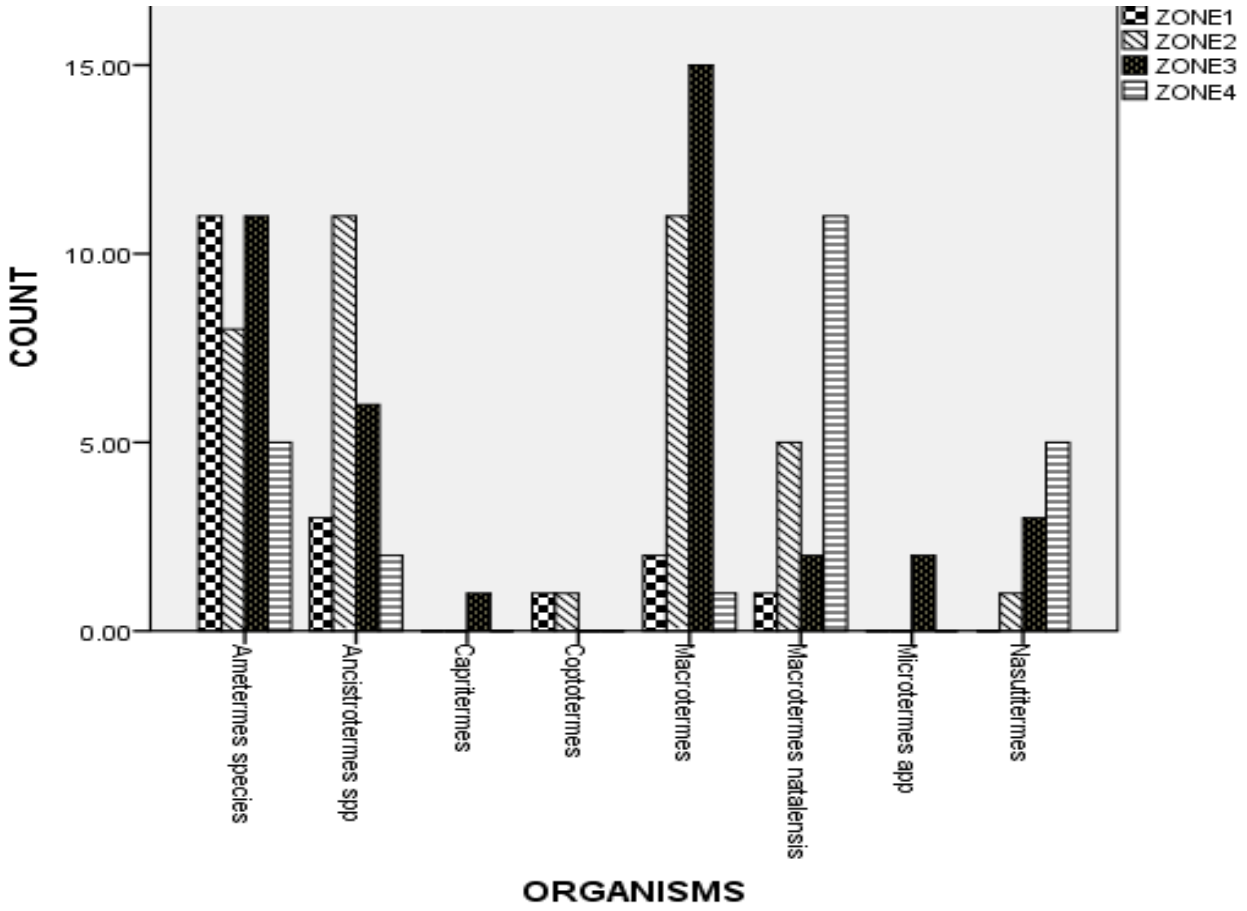


**Figure 4: Distribution and abundance of termites found in the four zones**

**Species Richness, Diversity and Relative Abundance of Species**

There were 68 hits in the dry season compared to 52 in the rainy season. Species diversity index gave a value of H'=1.51 for the dry season which was lower than the rainy season (H'=1.66). Species richness was lower in the dry season with 1.42 and higher in the rainy season (M=1.77). (Table 3). The *Amitermes spp* was the most widely distributed and the most abundant termite species followed by *Ancistrotermes spp* while the least distributed and abundant species was *Capritermes spp.* Zone 3 had the highest species richness both in the dry and rainy seasons while Zones 4 and 1 had the least species richness in the dry and rainy seasons respectively (Table 4 and Fig. 4)

**DISCUSSION**

The survey yielded eight termite species from seven genera, two families (Termitidae and Rhinotermidae) and six subfamilies (Rhinotermitinae, Amitermitinae, Macrotermitinae, Nasutermitinae, Termitinae and Microcerotermitinae). Members of the genus *Macrotermes* were the dominant species and constituted 40% of the total number of species sampled. Unlike other species, *Capritermes spp.* and *Microcertermes spp.* were considered rare species as their distribution was limited to only one zone. Due to the absence of a well developed inventory on termite species and the lack of facilities for termite taxonomy in the University of Lagos, only one genus (*Macrotermes spp.*) out of the nine species was identified beyond genus level. In a study carried out in Teluk Bahang Forest Park, Penang Island, Harris *et al.* (1961) in their study found two families and six subfamilies. Moreover**,** Rao *et al.* (2012) also reported two families (Termitidae and Rhinoternitidae) in Bhadrachalam Forest Region, Khammam District, Andhra Pradesh. Termitidae was the

most dominant family. A similar result was obtained by Godoy *et al*., (2012) in Argentina both in species richness (83.3%) and abundance (90%) with Macrotermitinae and *Macrotermes* being the most dominant subfamily and genus respectively. Mugerwa *et al. (*2011) in their study found that 69% of the total number of species sampled in Semi-arid Nakasongola belonged to be the genus *Macrotermes*. Wood (1991) also noted that the dominant species in natural ecosystems was of the subfamily *Macrotermitinae.* Group II (wood and grass feeders) was the dominant feeding group at the University of Lagos. The microhabitats most frequently occupied by termites were pieces of dead wood (fallen branches and trunks) with high water content. Godoy *et al*. (2012) also reported that termites were found on drywood, trees and wooden electric pole at the gallery forest relic in the Chaco province of Argentina. The relatively high abundance can be due to their large body-size as reported by Dahisjo *et al*. (2014) who recorded the high abundance of wood feeding termite in Malaysia. This biomass and abundance anomaly may have an effect on the processes of soil and wood decomposition and in turn the turnover and availability of nutrients in the respective sites. Mugerwa *et al.* (2011) also found Group II as the dominant feeding group on grazing lands in semi-arid Nakasongola, Uganda. Mitchell (2002) noted that generalist feeders such as members of the genera *Macrotermes* and *Odontotermes* are predominantly litter feeders. Once the species are deprived of sufficient amounts of litter or when the density of termite mounds is high, they resort to standing biomass and can consume more than 60% of the standing crop. There was no significant variation in termite species richness and diversity during the dry and rainy season**.** Species diversity index was 1.51 for the dry season and was lower than the rainy season (H'=1.66). Species richness was lower in the dry season (1.42) compared to the rainy season (M=1.77). This might be attributed to high rainfall during the rainy season which leads to formation of new colonies. *Macrotermes subhyalinus* was the most dominant species both in the dry and rainy seasons while C*apritermes spp.* was not recorded during the dry season. Of the total number of termite recorded for both seasons, species richness was highest in *Amitermes spp*. This might be as a result of their being amongst the wood feeders which are arboreal (attached to trees), subterranean or epigeal nesters (Eggleton *et al*., 1996). Comparing abundance of termite recorded in the four zones during the dry season, *Macrotermes subhyalinus* was the most widely distributed species as it was found in the four zones. Of the eight species recorded during the dry season, *Capritermes spp*. was absent throughout the four zones. Species richness was highest in Zone 1 while the diversity was highest in Zone 3. Zone 4 tend to have the least species richness and diversity. Of the eight species recorded during rainy season, *Coptotermes spp*. was only present in Zone 2 while *Capritermes spp* and *Microcerotemes spp* were only found in Zone 3. Species richness was highest in Zone 3 and least in Zone 1 while the diversity was highest in Zone 3.

## CONCLUSION

In conclusion, University of Lagos campus has a termite fauna of eight species which are randomly distributed across the campus. Wood-nesting subfamily Macrotermitinae was the most abundant while subfamily termitinae was the least abundant termite fauna

## REFERENCES

**Dahisjo, C. A., Parr, C. L., Malhi, Y., Rahman, H., Jones, T. and Eggleton, P.** (2014). First comparison of quantitative estimates of termite biomass and abundance. Journal of Tropical Ecology 30**:** 143-152.

**Dibog, L., Eggleton, P. and Forzi, F.** (1998). The scasonality of a soil termite assemblage in a humid tropical forest. Mbalmayo, Southern Cameroon. Journal of Tropical Ecology 14: 841-850.

**Donovan, S. E., Eggleton, P. and Bignell, D. E.** (2001). Gut content analysis and a new feeding group classification of termites. Ecological Entomology 26: 356-366.

**Edwards, R. and Mill, A. E.** (1986). Termites in Buildings. Their Biology and control. Rentokil Ltd., West Sussex, U.K. 54-67.

**Eggleton, P., Bignell, D. E., Sands, W. A., Mawdsley, N. A., Lawton J. H., Wood, T. G. and Bignell, N. C.** (1996). The diversity, abundance and biomass of termites under differing levels of distribution in the Mbalmayo Forest Reserve, southern Cameroon. Phil. Trans. R. Soc. London. B. 351: 51-68.

**Engel, M. S. and Krishna, K.** (2004). Family-group names for Termites (Isoptera). American Museum Novitates 3432: 1-9.

**Godoy, M. C., Laffont, E. R., Coronel, J. M. and Etcheverry, C.** (2012). Termite (Insecta, Isoptera) assemblage of a gallery forest relic from the Chaco province (Argentina): taxonomic and functional groups. Arxius de Miscel·lània Zoològica 10: 55–67.

**Harris, W. V.** (1961). Termites: Their Recognition and Control. Tropical Agric. Series. 30-34pp

**Ibrahim, B. U. and Adebote, D. A.** (2012). Appraisal of the economic activities of termites. Bayero Journal of Pure and Applied Sciences 5(1): 84-89.

**Jones, D. T. and Eggleton, P.** (2000). Sampling termite assemblages in tropical forests: testing a rapid biodiversity assessment protocol. Journal of Applied Ecology 37: 191-203.

**Jones, D. T., Susilo, F. X., Bignell, D. E., Suryo, H., Gillison, A. N. and Eggleton P.** (2003). Termite assemblage collapse along a land-use intensification gradient in lowland central Sumatra, Indonesia. Journal of Applied Ecology 40: 380-391.

**Kambhampati, S. and Eggleton, P. (2000).** Taxonomy and phylogeny of termites. Kluwer Academic Publishers. pp 1–23.

**Krishna, K and Weesner, F.** M. (1969) Biology of Termites 1: 598 pp

**Lawton, J. H and Jones, D. G.** (1995). Linking species and ecosystems: organisms as ecosystem engineers. In: Linking species and ecosystems.eds. C. G. Jones and J. H. Lawton, New York: Chapman and Hall. 141 – 150

**Lewis V. R.** (1997). Alternative control strategies for termites. Journal of Agricultural and Urban Entomology 14 (3) 291- 307

**Malaka, S. L. O** (1983). Economic importance of termites: six case studies in Nigeria and Ghana. Nigerian Field 47 (4): 222-230

**Malaka, S. L. O** (1996). Termites in West Africa, University of Lagos Press, Lagos, USA,ISBN:978-017-144-4 165pp

**Mitchell, J. D** (2002). Termites as pests of crops, forestry, rangeland and structures in southern Africa and their control. Sociobiology 40: 47–69.

**Mugerwa, S., Nyangito, M., Mpairwe, D., Bakuneeta, D. and Nderitu, Z.** (2011). Termite assemblage structure in Grazing lands in Semi-arid , Nakasongola. Agric. Biol. J. N. Am. 2(5): 848-859.

**Nwankwo, D. I., C., Adesalu, T. A., Olabode, R. J., Osiegbu, G. O and Owoseni, T. I.** (2003). Additions to a Preliminary check-list of Planktonic Algae in Lagos Lagoon, Nigeria. Journal of Science, Technology and Environment 3(1-2): 8-12.

**Ohiagu, C. E.** (1979). Nest and Soil population of *Trinervitermes* spp. with particular References to *Trinetvitermes germinatus* (Wasmann) Isoptera in Southern Guinea Savanna, near Mokwa, Nigeria. Ecologia 40 : 167-178.

**Olugbemi, B. (**2012) Termiticidal activity of *Parkia biglobosa* (Jacq) benth seed extracts on termites Coptotermes intermedius Silvesti (Isoptera: Rhinotermitidae) Psyche 2012

**Rahman, H. and Tawatao, N.** (2003). Isoptera. Introductory course to entomology. Pp. 121-133

**Rao, N., Samatha, C. and Sammaiah, C.** (2012). Biodiversity of termites in Bhadrachalam Forest Region. Journal of Biodiversity 3 (1): 55-59.

**Wood, G. T.** (1991)**.** Termites in Ethiopia: The Environmental Impact of Their Damage and Resultant Control Measures. Ambio 20: No. 3-4.

**Wood, T. G. and Sands, W. A.** (1978). The role of termites in ecosystems. In: Brian MV, editor. Production Ecology of Ants and Termites. Cambridge University Press. 245–292.