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Subterranean termites of Toru-Orua: a university community in Bayelsa State, Southern Nigeria

Richard Uzakah[1]* & Oscar Maika[1]

[1]Department of Biological Sciences, University of Africa, Toru-Orua, Sagbama, Bayelsa State, Nigeria

**Corresponding author*, E-mail: *rikuzakah@gmail.com*, *richard.uzakah@uat.edu.ng*

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ABSTRACT

Termites play beneficial and crucial roles in ecosystems especially in decomposition of organic matter, recycling of nutrients, and soil fertility improvements. However, they are more of a menace, particularly to man and society globally due to their devastations to food and agriculture; building materials, household furniture etc., and in causing serious depletions of people's sources of livelihood. This study was aimed at unravelling the species composition, distribution, and prevalence of subterranean termites within the university community at Toru-Orua and, the microflora facilitating cellulose digestion within termite guts. The study area was split into ten zones for easy project management and painstaking investigations. Random field samplings undertaken, after 5-10m transect walks across the community, and followed by laboratory analyses/identification of collected termite specimens revealed three main termites, *Globitermes* Holmgren, *Dicuspiditermes* Krishna, and *Amitermes* Silvestri (in order of importance) respectively, as the predominant species. The Simpson's index on the termites' species diversity (0.40) depicted a somewhat moderate species distribution and abundance. Knowledge of pest species composition, distribution, and prevalence rankings are fundamental in planning for environmentally friendly, effective and sustainable pest management strategies. Preliminary microflora investigations on termite guts suggested involvement of cellulolytic bacteria with termites' food digestions; a finding that may also have some potential benefit in planning novel control options for this pest.

Keywords: subterranean termites, species composition, prevalence ranking, Simpson's diversity index, cellulolytic bacteria, synergistic relationship.

RESUME

Termites souterrains de Toru-Orua : une communauté universitaire dans l'État de Bayelsa, au sud du Nigéria

Les termites jouent un rôle bénéfique et crucial dans les écosystèmes, en particulier dans la décomposition de la matière organique, le recyclage des nutriments et l'amélioration de la fertilité des sols. Cependant, ils sont particulièrement plus une menace pour l'homme et la société à l'échelle mondiale en raison de leurs dévastations pour l'alimentation et l'agriculture ; matériaux de construction, meubles de maison, etc., et en causant de graves épuisements des moyens de subsistance des populations. Cette étude visait à démêler la composition, la distribution et la prévalence des espèces de termites souterrains au sein de la communauté universitaire de Toru-Orua et la microflore facilitant la digestion de la cellulose dans les intestins des termites. La zone d'étude a été divisée en dix zones pour une gestion de projet facile et des enquêtes minutieuses. Des échantillonnages aléatoires sur le terrain entrepris, après des marches transversales de 5 à 10 m à travers la communauté, et suivis d'analyses en laboratoire/d'identification des spécimens de termites collectés ont révélé trois termites principaux, *Globitermes* Holmgren, *Dicuspiditermes* Krishna et *Amitermes* Silvestri (par ordre d'importance) respectivement, comme espèce prédominante. L'indice de Simpson sur la diversité des espèces de termites (0,40) dépeint une distribution et une abondance des espèces quelque peu modérées. La connaissance de la composition, de la distribution et des classements de prévalence des espèces de ravageurs est fondamentale dans la planification de stratégies de lutte antiparasitaire respectueuses de l'environnement, efficaces et durables. Des enquêtes préliminaires sur la microflore des intestins des termites ont suggéré l'implication de bactéries cellulolytiques dans la digestion des aliments des termites ; une découverte qui peut également avoir un avantage potentiel dans la planification de nouvelles options de contrôle de ce ravageur.

Mots-clés : Termites souterrains, composition des espèces, classement de prévalence, indice de diversité de Simpson, bactéries cellulolytiques, relation synergique.

INTRODUCTION

Termites are the most important invertebrate decomposers of dead organic matter in tropical and subtropical regions (Bignell and Eggleton, 2000). They are key species in ecosystems, as they recycle large units of nutrients. But they likewise constitute a major threat globally to food, agriculture, and infrastructure; which ultimately result in squandering of people's lifetime earnings and even national economies. Ibrahim and Adebote (2012) reported that Nigeria losses millions of Naira annually due to termite damages.

In spite of their serious impacts on man and society, they have received very little attention; and in most cases even been overlooked and considered unworthy for study (Krishna et al.,2013). This study is the first of its kind in Toru-Orua and in Bayelsa State in general. It is aimed at determining the subterranean termites in this university community, and also the synergistic relationship between them and their gut microflora.Subterranean termites are termite species that make their nests below and above soil surfaces and do also construct mounds of soil (Helmiyetti et al., 2020). Their diversity within an area, according to Araujo (1969) is influenced by vegetation cover, soil topography, and the microclimatic conditions of the area. Termites' species are known to vary from locality to locality (Wekhe et al., 2019) particularly in their basic biology and ecology such as their colony size, nesting, feeding, swarming and, reproductive behaviours (Wang et al., 2009). Therefore, proper identification of termite species and the knowledge of their distributions are the first steps in developing environmentally compatible and sustainable IPM strategies (Wang et al., 2009). Of the more than 2,000 known species, only a fraction has been recognized as being of economic importance (Engel and Krishna, 2004); or even been fully identified to date. This study was aimed at unravelling the species composition, distribution, and prevalence of the subterranean termites in this university community; as well as the synergistic relationship between the termites and their gut microbes. Findings of this work would be pivotal in planning for novel, effective, and environmentally sound and sustainable control strategies against these pests.

MATERIALS AND METHODS

Description of study area

This research was done within the campus of University of Africa, Toru-Orua, Bayelsa State, in Southern Nigeria; situated within latitudes $5^0$09'81.9N and longitudes $6^0$06'64.6E (Fig. 1). The area enjoys a long heavy rainy season between March and July each year, with a shorter, yet equally heavy rainfall in September and October. The intervals between these two rainfall periods are dry (August and then November to February respectively) with the monthly average temperatures being between 25 and 28^{O}C.

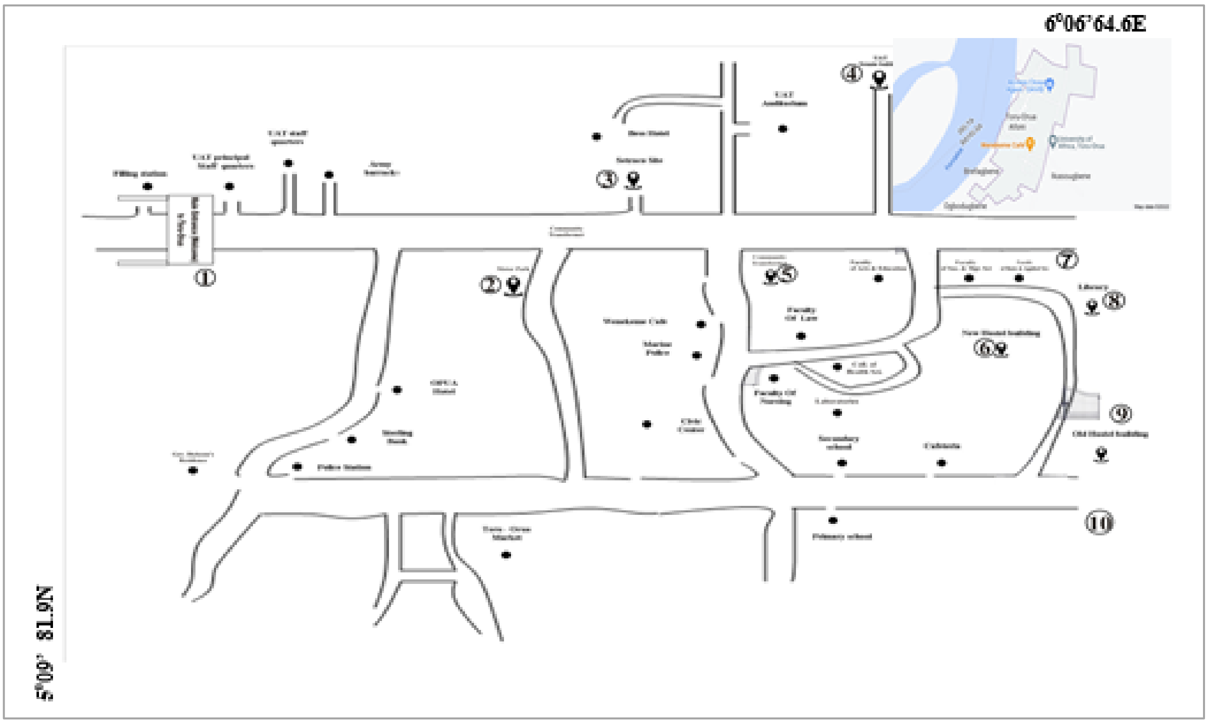
The study area was split into ten zones/locations to allow for easy project management and more thorough investigations. At each study site or location, transect walks of 5-10m were made, beginning from the main entrance to Toru-Orua Community and then followed by random searches for termite mounds/hills to the left, right, and all sides. Observed termite mounds or nests at such locations were then slightly cut open with aid of a machete; and the soil samples containing the termites were collected into universal bottles or perforated Petri dishes, followed by proper labelling with site/location details, collection dates, and mound types then transported to the laboratory for termite species identifications.

Analyses of collected termite samples

In the laboratory, the collected samples were analyzed by closely examining termite mandibles, pronotum, and postmentum areas under the stereomicroscope (model MICS-ST 30LL) and then compared with the identification keys provided by Ahmad, M. (1965) and Scheffrahn & Su (1994) for correct species identifications. Similar procedures were adopted by previous researchers (Anantharaju et al., 2014, Ugbomeh et al., 2019, Wekhe et al., 2019). All field samplings and termites' species analyses lasted 8weeks (February and March 2022).

Microbiological studies

To ascertain the relationship between host termites and their gut microflora, termite guts were extracted after careful dissections, and cultured in four carboxyl methyl cellulose (CMC) agar plates. The plates were inoculated by pour plating and inversely incubated at $37^{O}C$ for 24 – 48 hours in the lab for microbial growth. Plates with the most prominent microbial growths were flooded with 1% Congo red dye and then monitored for zone of clearance around colonies of the microorganisms. A zone of clearance was usually indicative of presence of cellulolytic bacteria in termite guts for aid with cellulose digestions.



KEYS:
Key Landmarks in Toru-Orua

1 = Main Entrance (Welcome to T 'Orua)
2 = Community Mot or Park
3 = Setraco Construction Site
4 = UAT Senate Rd
5 = Community Power Transformer
6 = Uncompleted New Hostel
7 = Area before UAT Library
8 = UAT Library
9 = Student Old Hostel (Back Gate)
10 = Area opposite Student Old Hostel

Figure 1. Map of the study area, showing infrastructural layout and termites' sites/zones in the University community.

RESULTS

Termites' species composition

Three termite species were identified as the predominant subterranean termites within this university community of Toru-Orua; namely, *Globitermes* Holmgren, *Dicuspiditermes* Krishna and *Amitermes* Silvestri (in that order of importance) (Table 1). The identified species are briefly described below (courtesy of keys and illustrations provided by Ahmad, 1965)

Head not parallel sided beyond eyes; cutting edge between two marginal teeth of left imago-worker mandible nearly straight; antennae with 15 articles; wings hairy and dark…*Globitermes*

Clypeus not bilobed. Head as broad as long or slightly broader; mandibles long, slender, very strongly curved apically . . . *Globitermes* (Soldier). Mandibles large, strongly curved, each mandible with a laterally directed tooth situated below middle . . . *Globitermes sulphureus* (Haviland) (suspected; but subject to confirmation through biochemical tests for clear-cut identification)

Apical tooth of imago-worker mandibles as long as or slightly shorter or slightly longer than first marginal tooth. Posterior cutting edge of first marginal tooth of left imago-worker mandible sinuate; second marginal tooth of same mandible distinct and somewhat pointed. Right mandible with second marginal tooth distinct; angle between apical tooth and first marginal tooth in both mandibles comparatively narrow; head covered with bristles and a mat of short hairs… *Dicuspiditermes* (Soldier). Mandibles asymmetrical, left mandibles bent in middle … *Dicuspiditermes makhamensis,* new species (suspected; but subject to confirmation via other tests) Mandibles not serrated; with a tooth… *Clypeus* bilobed; head narrowed anteriorly, longer than wide; mandible with pointed, laterally or posteriorly directed tooth . . . *Amitermes* (Soldier). Mandibles short, thick at bases, strongly hooked, each mandible with a prominent laterally directed tooth . . . *Amitermes dentatus* (Haviland) (suspected; but subject to confirmation via other tests).

Table 1. Species composition and distribution of subterranean termites in Toru-Orua community

Species Composition	Sites / Locations											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**Total**	**% Distribution**
Globitermes	0	5	1	2	0	1	0	2	1	0	12	75
Dicuspiditermes	1	0	0	0	1	0	1	0	0	0	3	19
Armitermes	0	0	0	0	0	0	0	0	1	0	1	6.3
Total (N)	**1**	**5**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**0**	**16**	

Keys:
A = Main Entrance (Welcome to Toru-Orua) F = Uncompleted Students Hostel
B = Community Motor Park G = Area before UAT Library
C = Setraco Construction Site H = UAT Library
D = UAT Senate I = Students Hostel @ Back Gate
E = Community/PHEDC Power Transformer J = Area opposite Students Old Hostel

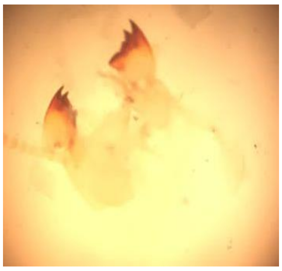
Species Composition	Locations/Sites [and frequencies found]	Mound Type	Photo of Termite Specimen
***Globitermes* spp**	B = Community Motor Park Area [5] C = Setraco Construction Site [1] D = University Senate Road [2] F = Uncompleted New Hostels [1] H = University Library [2] I = Opposite Students Old Hostel (Bk Gate) [1]		
***Dicuspiditermes* spp**	A = Main Entrance/Welcome to Toru Orua [1] E = Community Power Transformer [1] G = Area before the University Library [1]		
***Amitermes* spp**	I = Opposite Students Old Hostel [1]		

Plate 1. Photo images of subterranean termites of Toru-Orua, their characteristic mounds and spread within the community

Relative abundance and diversity index of subterranean termites in Toru-Orua

The predominant subterranean termites in Toru-Orua, and their relative abundance are as presented in Table 2. The Simpson's index of diversity (0.40) revealed a moderate species diversity.

Table 2. Relative abundance and diversity index of subterranean termites in Toru-Orua

Spp composition	N	n/N	∑(n/N}^{2}	Simpson's Index [1 - ∑(n/N}^{2}]
Globitermes	12	0.75	0.563	
Dicuspiditermes	3	0.188	0.035	
Amitermes	1	0.063	0.004	
Total (N)	**16**		**0.602**	**1 - 0.602 = 0.40**

NB**:** Simpson's index ranges between 0 and 1. Values close to 0 imply low diversity, while values close to 1 indicate high diversity (Jones et al., 2014 - Cambridge International AS and A'Level Biology Coursebook)

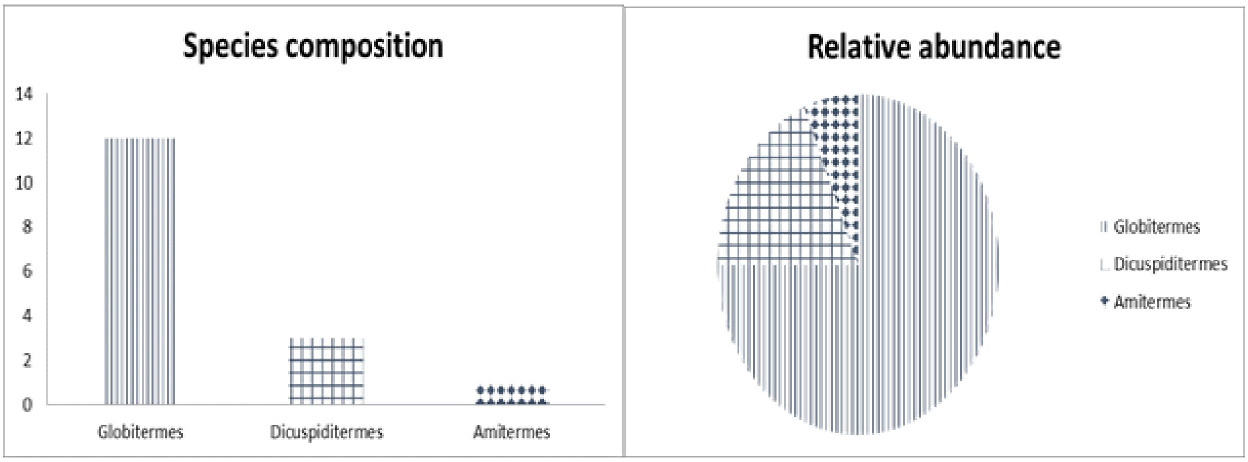


Figure 2. The species composition and relative abundance of subterranean termites of Toru-Orua community

Microbiological studies

Zones of clearance were observed around the colonies of microorganisms that emerged from the inoculated CMC Agar plates. This observation suggested the presence of cellulolytic bacteria in the termite guts and a likely involvement with cellulose digestion for the termites (i.e.a synergistic support): the termites provided accommodation to the microbes, while they in turn aided with the termites' food/cellulose digestions. The identities of these bacteria shall be determined shortly in a follow-up/diagnostic study. Several strains of identified cellulolytic bacteria have been isolated from termites in the past (Ali et al., 2019).

DISCUSSION

Termites exist in almost all biomes and are major threats to buildings, woods, crops, and forests (Wekhe et al., 2019). In spite of their serious impacts on man and society, they have received very little attention, and in most cases, even been overlooked or considered unworthy for study (Krishna et al., 2013). This study is the first of its kind in this university community of Toru-Orua, and even in Bayelsa State, southern Nigeria. It has revealed that the main subterranean termites in this locality as *Globitermes* Holmgren, *Dicuspiditermes* Krishna and *Amitemes* Silvestri, respectively. Works by Wekhe et al., (2019) in the neighbouring Rivers State University (RSU), Port Harcourt, Nigeria revealed five termite species: *Amitermes spp, Amitermes spp Globitermes spp, Macrotermes gilvus* (Hagen), and *Macrotermes spp* (with Armitermes being the most abundant, while Globitermes was least abundant). But, Kemabonta and Balogun's (2014) work in Lagos (also southern Nigeria) revealed eight species: *Amitermes spp* (29%), *Macrotermes subhyalinus* (Rambur) (24%), *Ancistrotermes spp* (18%), *Macrotermes natalensis* (Haviland) (16%), *Nasutermes* spp (8%), *Captotermes spp* (3%), *Microcerotermes spp* (2%), and *Caprritermes spp* (1%). Again, *Amitermes* was found to be the most prominent and widely distributed. In this very present study, however, only three termite species were detected: Globitermes, Discupiditermes, and Amitermes: Globitermes being the most predominant or widespread here while Amitermes was the least abundant. This corroborates Wekhe's observation that *Globitermes* spp are typically soil-feeders (i.e., subterranean), while Amitermes are mainly wood-eaters hence associated mostly with residential areas. This work did not cover arboreal termites (i.e., termites attacking trees and buildings) but only soil-infesting termites. Reasons for the low (or rather, the modest termite diversity as corroborated by the Simpson's index of 0.40) cannot be explained, but may not be unconnected with the highly intensive developmental projects on-going within this university community. Many termite abodes (hills, mounds, and nests) have been demolished for modern infrastructural developments in this community, in recent times; also increased farming and bush burning activities by the local natives may all have contributed to this observation.

This study has provided some useful information on the biodiversity of termites in this university community of Toru-Orua in the Niger Delta area of southern Nigeria. These findings would serve vital roles in future projects and in planning for environmentally friendly and sustainable efforts for control against termites.

CONCLUSION

This pioneering research work in Toru-Orua, has helped to shed some light on the biodiversity of termites in the Niger Delta area of southern Nigeria. It has provided vital baseline information to guide future projects and would certainly be helpful when considering environmentally safe and sustainable control programs against termites in this terrain. Follow-up work on termite's guts would shortly reveal the exact identity and/or diversity of their gut microflora; a finding that may also have a potential for novel control of termites.

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Conflict of interest

The authors declare they have no conflict of interest.

REFERENCES

Ahmad, M. (1965). Termites (Isoptera) of Thailand. Bulletin of the American Meseum of natural history, 131 (1):1-114

Ali, H., Hemada, N. F., & Abdelaliem, Y. F. (2019). Symbiotic cellulotic bacteria from the gut of the subterranean termite Psammotremes hypostoma Desneux and their role in cellulose digestion, AMB Express 9:111. https://doi.org/10.1186/s13568-019-0830-5

Anantharaju T., Kaur, G., Gajalakshmi, S., & Abbasi, SA. (2014). Sampling and identification of termites in Northeastern Puducherry. Journal of Entomology and Zoology Studies 2(3): 225-230

Araujo, R. L. (1969). Biology of Termites, In: FMW Kumar Krishna (Eds). Biology of Termites First Edition, Academic Press New York and London. https://doi.org/10.1017/CBO97811074 15324.004

Bignell, D. E., & Eggleton, P. (2000). Termites in ecosystems. In: T. Abe, DE. Bignell, & H. Higashi (Eds). Termite; Evolution, sociality, symbiosis, ecology (pp 363-387). Dordrecht: Kluwer Academic Publishers

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

Helmiyetti, Darmi, & Wesa, R. O. (2020). The Species and Abundance of Subterranean Termites (Insecta: Isoptera) in the area of University of Bengkulu. Advances in Biological Sciences Research 14:158-164. Proceedings of the 3rd KOBI Congress, International and National Conferences (KOBICINC 2020). Atlantis Press, Indonesia

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

Jones, M., Fosbery, R., Gregory, J., & Taylor, D. (2014). Cambridge International AS and A'Level Biology Coursework Fourth Edition, Cambridge University Press, United Kingdom. 535 p

Kemabonta, K. A., & Balogun, S. A. (2014). Species richness, diversity and relative abundance of Termites (Insecta: Isoptera) in the University of Lagos, Lagos, Nigeria. FUTA Journal of Research in Science (2):188-197

Krishna, K., Grimaldi, D. A., Krishna, V., & Engel, M. S. (2013). Traise on the Isoptera of the World: Vol. 1. *Bullentin of American Museun of Natural History*, 377, 1-200.

Scheffrahn R. H., & Su, N. (1994). Keys to Soldier and Winged Termites (Isoptera) of Florida. The Florida Entomologist 77(4); 460-474. Florida Entomological Society. https://www.jstor.org/stable/3495700

Ugbomeh, A. P., Membere, O., Efuka, A. & Bawo, D. D. S. (2019). A rapid survey of the aboreal termites in a university environment in Port

Harcourt, Nigeria. Journal of Basic and Applied Zoology 80(29). https://:doi.org/10.1186/s41936-019-0095-1

Wang, C., Zhou, X, Shujuan, L. L., Schwinghammer, M, SCHARF, me, Buczkowski, G, & Bennett, G. (2009). Survey and identification of Termites (Isoptera: Rhinotermitidae) in Indiana. Annals of Entomological Society of America 102(6):1029-1036

Wekhe, C., Ugbomeh, A. P., Ebere, N., & Bawo, DDS. (2019). Subterranean termites of a University enviroment in Port-Hacourt, Nigeria. Asian Journal of Biology, 8 (2):1-10.