Environtropica, July 2023, Vol. 18, 009 -020 ISSN 1597-815X

Survey of Termites along Sagbama-Ekeremor Axis of Bayelsa State, Southern Nigeria.

Richard Uzakah[1,*] and Timothy Epidi[2]
University of Africa, Toru-Orua, Sagbama LGA, Bayelsa State,Nigeria[1]. Isaac Jasper Boro College of Education, Sagbama,Bayelsa State, Nigeria[2]
Corresponding Author Email: rikuzakah@gmail.com, richard.uzakah@uat.edu.ng.
Tel: +234 (0) 805 623 5594

Accepted on: March 11, 2023

Abstract

Termites perform beneficial roles in ecosystems as good scavengers and decomposers; helping with recycling of nutrients, soil fertility improvements etc., However, their notoriety around the globe for destruction of wooden products of homes and buildings, household furniture and fabrics, trees and crops amongst others, overshadow and far surpasses all their positive attributes. This survey, is the first of its kind in this Sagbama-Ekeremor axis of Bayelsa State, in the Niger Delta terrain of Nigeria; and it was aimed at identifying the different genera, their distribution and prevalence; a fundamental requirement for their effective control. The results revealed six main termite genera as being the most abundant and widespread in this study area, namely *Globitermes* Holmgren, *Dicuspiditermes* Krishna, *Mirocapritermes* Holgren, *Macrotermes* Holmgren, *Nasutitermes* Dudley and *Hypotermes* Holmgren; their relative abundance and prevalence ranking being 74%, 11.8%, 5.9%, 2.9%, 2.9% and 2.9% respectively. The first four are subterranean termites, while the last two are arboreal. The Simpson's diversity index of the termites in this terrain was 0.44; inferring a somewhat moderate abundance and distribution. The wanton destruction of termite structures and abodes, as a result of land clearing and bush burning for farming activities and increasing infrastructural developments are accountable for this finding. Termite genera seemed to have characteristic mounds and nests, but the actual relationship between them have yet to be fully established. This survey would be a useful baseline information for future works, and shall also serve as a vital guide when planning strategic options for effective termite control/management in Bayelsa State, and for the Niger Delta as a whole.
Keywords: Prevalence subterranean termites, arboreal termites, *Globitermes, Dicuspiditermes, Mirocapritermes, Macrotermes, Nasutitermes, Hypotermes.*

Introduction

Termites are terrestrial, polymorphic, eusocial insects that belong to the Order Blattodea formerly Isoptera, but currently Blattodea due to recent genetic and molecular evidence linking them and cockroaches to a common ancestry (ITIS, 2018). They are widely distributed throughout the temperate, subtropical and tropical regions but with highest diversities in the tropical forests (Eggleton, 2000).

They play both beneficial and destructive roles in the environment. They are for instance, good scavengers and decomposers that feed on diverse food types such as dead or decaying materials, organic soil matter etc., and ultimately help in recycling waste materials (Freymann *et al.*, 2008). They also facilitate soil drainage and aeration (Donovan *et al*., 2001) from their burrowing activities and improve soil fertility amongst others. Termites are a good source of protein, energy, vitamins and minerals (Banjo *et al*., 2006) and hence, eaten by man in several parts of Nigeria (Ntukuyoh *et al*., 2012). They also serve as food sources for chimpanzees, monkeys and baboons (Suzuki 1966, Ntukuyoh *et al*., 2012), and even serve ritual and medicinal purposes (Ntukuyoh *et al*., 2012).

However, termites also constitute a major nuisance to man and society, being harmful to crops, forestry, buildings and wooden structures (UNEP, 2000; Wang *et al*., 2009; Ogbedeh *et al*., 2019; Ugbomeh and Diboyesuku, 2019) and to household furniture, books, fabrics etc. (Borror *et al*., 1989); utility poles (Borror *et al.*, 1989, Egbon, 2022), and may even cause collapse of wooden buildings if their burrowing activities go unchecked (Davies, 1988). The yield losses to crops following termite attacks often range from 50-100% (UNEP, 2000) and global termite control costs $20 billion annually (Su, 2002), though current estimates are put at over $40 billion (Rust and Su, 2012; Ahmad *et al*., 2021).

Of the over 2000 known species, only a fraction has so far been fully identified (Kambhampati and Eggleton, 2000). It has been reported that termites vary from locality to locality (Wekhe *et al*., 2019); also, that knowledge of species composition and distribution of pests are fundamental for their effective control (Kumar, 1984; Wang *et al*., 2009; Ugbomeh *et al*., 2019). This survey therefore aimed at the identifying and determining the composition of the termites in the Niger Delta terrain of Nigeria. There is presently no published work nor documented report on termites in this area. This effort shall therefore serve as a baseline for future works; and most importantly, as a vital guide, when considering environmentally cost effective and sustainable integrated pest management (IPM) options for these pests in the study area.

Materials and methods

Description of study/survey area

This survey was carried out in the communities along the Sagbama and Ekeremor Local Government Areas (LGAs) of Bayelsa State, Southern Nigeria, situated between latitudes 5^{o}05’63” and 5^{o}15’93” N and longitudes 5^{o}78’13” and 5^{o}19’71” E; involving nine different communities namely- Sagbama, Bolou-Orua, Tungbo, Angiama, Ebedebiri, Toru-Orua, Angalabiri, Ofoni and Ayanmasa (as shown in Fig. 1). Bayelsa is amongst nine States that make up the Niger Delta basin of Nigeria, the others being Rivers, Delta, Cross River, Edo, Akwa Ibom, Ondo, Abia and Imo (Agumagu and Todd, 2015). The State is bounded by Delta State on the north, Rivers State in the East and the Atlantic Ocean on the western and southern parts (Fig. 1). The vegetation here is mainly swamp forest and tropical rainforest (Olorode, 2002), and experiences two rainfall seasons annually, March-July, and then September-October; neatly interspersed with the dry seasons in August, and November-February respectively. The average monthly temperatures range between 25^{o}C and 29^{o}C, while annual precipitation is 2000-4000 mm, and with a relative humidity of above 70% (Ohwo, 2018).

Soils are generally sandy, loamy and clayey: and the arable lands hosts various food crops (yams, cassava, maize, plantains, bananas etc.,) and cash crops (oil palm, raffia palm etc.,). Common trees include Rubber, *Irvingia* (“ogbono” aka bush mango tree), *Gmelina, Morinnga* and diverse timber species, most of which are used in building houses and canoes etc., or sold for income generation. Flooding and coastal erosions are occasional and/or seasonal environmental challenges often faced by most communities in Bayelsa, and in several other Niger Delta States; usually occasioned by climatic changes and rising sea levels (Ohwo, 2018).

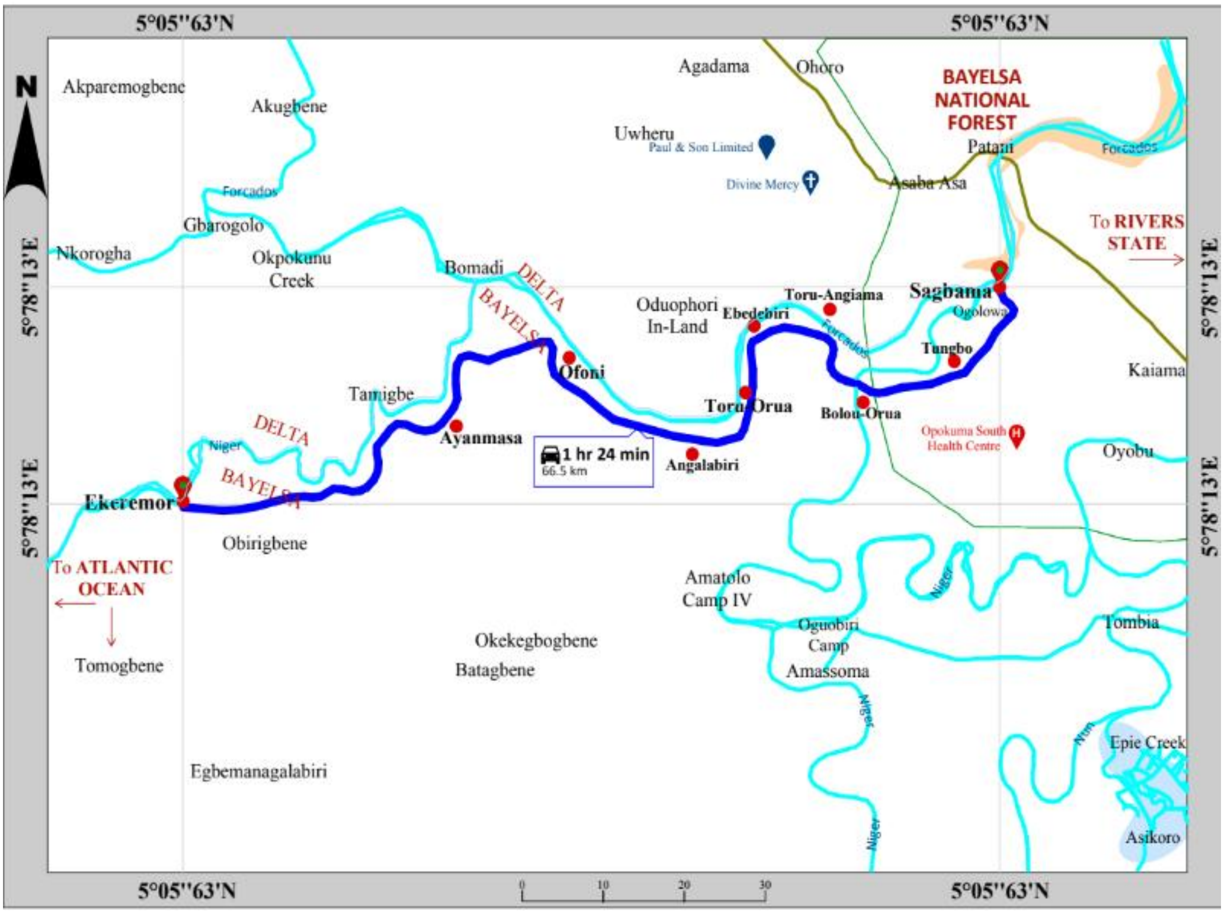


Fig. 1: Map showing the key locations on the Sagbama-Ekeremor axis of Bayelsa State, Southern Nigeria, namely – Sagbama, Tungbo, Bolou-Orua, Angiama, Ebedebiri, Toru-Orua, Angalabiri, Ofoni, Ayanmasa and Ekeremor.

Termites survey strategy

This survey involved monitoring of termites in a 100 m by 20 m transect (Prastyaningsih *et al*., 2020) every 5-10 minutes' drive along the Sagbama-Ekeremor road. The total distance of this road is approx. 66.5km; and it takes approximately 1hr 30 mins to cover it when driving through the Local Government roads. Termite mounds/hills or nests on both sides of the road were always noted and recorded during surveys; including the mound heights. About 3-5 termite mounds or hills were randomly selected for investigation at each location, resulting in sampling a total of 30-50 mounds during this entire survey. At each location, the randomly selected mounds were slightly cut open with a machete for collection of soil and termite samples. Such samples were collected by means of camel's brush or a pair of forceps and carefully placed in perforated petri-dishes or glass vials and properly labelled with site/location and mound details, as well as collection dates. These were then later transported to the laboratory for species identification. Data collection time at each site/location usually lasted between 20-30 minutes. The field samplings in this survey project lasted 8 weeks (April and May, 2022)

Termite identification

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 (1965) and Scheffrahn and Su (1994) for correct identifications. Previous researchers (Anantharaju *et al*., 2014, Ugbomeh *et al*., 2019 and Wekhe *et al.*, 2019) adopted similar procedures. Photographic images of all identified termite specimens were always captured also for reference purposes, and for inclusion in the report write-up. All identifications were made to genera levels only, based on external morphological characters. The absence of a local termite inventory for comparing observed species with type specimens; and also, the lack of essential molecular diagnostic tools/techniques to complement morphological identifications; and for specimen confirmations, prevented termite identifications beyond generic level.

Results and Discussion

Termites survey findings

The survey results for all the different sites and locations visited are summarized in Table 1 and Plates 1 a & b. Six main termite genera were found in this survey, namely *Globitermes* Holmgren, *Dicuspiditermes* Krishna, *Mirocapritermes* Holmgren, *Macrotermes* Holmgren, *Nasutitermes* Dudley and *Hypotermes* Holmgren; and their relative abundance and prevalence ranking were 74%, 11.8%, 5.9%, 2.9%, 2.9% and 2.9% respectively.

Globitermes was most abundant and found in virtually all the locations sampled except Ebedebiri (i.e. present in 8 out of 9 locations). It was the main subterranean termite in this Sagbama-Ekeremor Axis of Bayelsa State. Ahmad (1965) had earlier also reported it as one of the commonest mound building termites in Thailand. Wekhe *et al*., (2019) and Ugbomeh *et al*., (2019) both found this termite in Port Harcourt, a neighbouring town in Rivers State. Wekhe *et al.* (2019) found it in cultivated areas and even termed it as a soil feeder; while Ugbomeh *et al* (2019) found it as a rare genera on trees as it was found only on *Gmelina* trees. Uzakah and Maika (2022) reported it as the most predominant subterranean termite in Toru-Orua, Bayelsa State; as it was present in all the locations visited.

Globitermes was closely followed by *Dicuspiditermes* which was present in two locations namely, Angiama and Toru-Orua, out of the nine locations investigated. It was also the second most abundant subterranean termite genera in Toru-Orua community, as seen from the work of Uzakah and Maika (2022). Work on this termite genus is very scanty in literature. Ahmad (1965) as well as the National Science Foundation (2017) which listed this genus as a common termite genus of South-East Asia and as a “mounding nest builder” are two notable reports of this genus globally. The third genus in respect of prevalence in this study was *Mirocapritermes*, found at a single location, Ebedebiri at two different locations. No other work has mentioned the occurrence of this genus so far, except Ahmad’s (1965) work where *M. connectens* (Holmgren) were found at the bases of bamboo stumps and tree logs in Thailand.

Table1: Termite genera and their distribution along Sagbama-Ekeremor axis, Bayelsa State, Nigeria.

Genera	Locations (including no. of encounters)										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**Total No**	**% Distribution**
Globitermes	3	2	1	6	0	4	2	3	4	**25**	**74**
Dicuspiditermes	0	0	0	2	0	2	0	0	0	**4**	**11.8**
Mirocapritermes	0	0	0	0	2	0	0	0	0	**2**	**5.9**
Macrotermes	0	0	0	0	1	0	0	0	0	**1**	**2.9**
Nasutitermes	0	1	0	0	0	0	0	0	0	**1**	**2.9**
Hypotermes	0	0	1	0	0	0	0	0	0	**1**	**2.9**
Totals	**3**	**3**	**2**	**8**	**3**	**6**	**2**	**3**	**4**	**34**	

Key: A= Sagbama B = Bolou-Orua C= Tungbo D= Angiama E = Ebedebiri
F = Toru-Orua G = Angalabiri H= Ofoni I = Ayanmasa

Next in prevalence was *Macrotermes*, also found only at Ebedebiri, in a small, black mound (approx. 0.3m high) – a mound that looked abandoned due to a seeming bush burning incident. Wekhe *et al*. (2019) found this termite genus in cultivated areas and termed it a soil feeder. Ahmad (1965) had earlier reported *M. gilvus* (Hagen) as one of the most widespread fungus-growing termites in Thailand; present in virtually every tree log examined. It was also found to be most prevalent in Edo State, Nigeria (Ogedegbe and Eloka, 2015), though it ranked fourth in this Sagbama-Ekeremor survey (Bayelsa State); but 2nd in earlier studies by Kemabonta and Balogun (2013) and Wekhe *et al*. (2019) at Lagos and Port Harcourt respectively. *Macrotermes* species are known herbivores and decomposers that feed on diverse living, dead or decaying plant materials (Khan *et al*., 2018; Ejomah *et al*., 2020). They are economically important crop pests and wood-eaters. Ogbedah *et al*., 2016 reported that they constantly attacked planted cassava cuttings in South East Nigeria, while Egbon (2022) found them responsible for consuming two-thirds of public utility poles and causing about 53% of poles in Ekosodin, Edo State Nigeria to tilt.

The last two genera in terms of prevalence namely *Nasutitermes* and *Hypotermes* were arboreal termites. *Nasutitermes* was found at Bolou-Orua, and *Hypotermes* at Tungbo. Ugbomeh *et al*. (2019) found *Nasutitermes* on several different trees such as *Gmelina arborea*, *Mangifera indica*, *Pinus caribea*, *Casuarina equisetofolia* in Port Harcourt. Uzakah and Festus (2022) similarly confirmed it as an arboreal termite whose attacks started from the fields to the home-front (i.e., from arboreal to indoor termite) via transference by humans. This occurs when timber infested with *Nasutitermes* is used in building houses or domestic structures like sheds or stalls. Ahmad (1965) found it present in virtually all tree logs examined in Thailand. *Hypotermes*, the least prevalent genus in this survey) is reported as being native to Thailand, Vietnam and Cambodia (South-East Asia) and serve as degraders of leaf litter and decomposers of dead wood (Lavelle and Spain, 2001; Yamada *et al*., 2003).

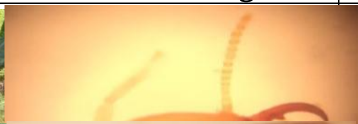
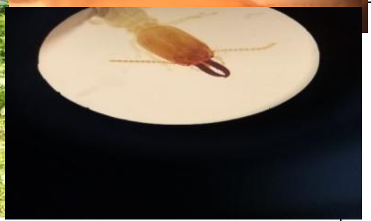
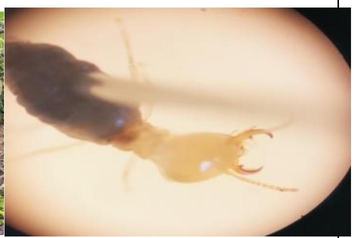
Surv. Location	Termite Mound	Termite Image	Genera
1			*Globitermes*
2a			*Globitermes*
2b			*Nasutitermes*
3a			*Globitermes*
3b			*Hypotermes* (Arboreal termite)
4a			*Globitermes*
4b			*Dicuspiditermes*

Plate 1a: Plate showing images of identified Termite genera and their characteristic mounds at different locations along the Sagbama-Ekeremor axis, Bayelsa State, Southern Nigeria [1=Sagbama 2=Bolou-Orua 3=Tungbo 4=Angiama]

The percentage composition of the termite species along the Sagbama-Ekeremor road, as well as their relative abundance and prevalence ranking are presented in Figs 2 and 3 respectively; while Table 2 highlights their diversity index.

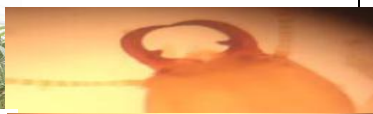
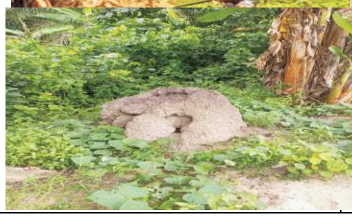
Surv. Location	Termite Mound	Termite Image	Genera
5a			*Macrotermes*
5b			*Mirocapritermes*
6a			*Globitermes*
6b			*Dicuspiditermes*
7			*Globitermes*
8			*Globitermes*
9			*Globitermes*

Plate 1b: Plate showing images of the Termites and their characteristic mounds at different locations along the Sagbama-Ekeremor axis, Bayelsa State, Southern Nigeria
[5= Ebedebiri 6= Toru-Orua 7= Angalabiri 8 = Ofoni 9=Ayanmasa]

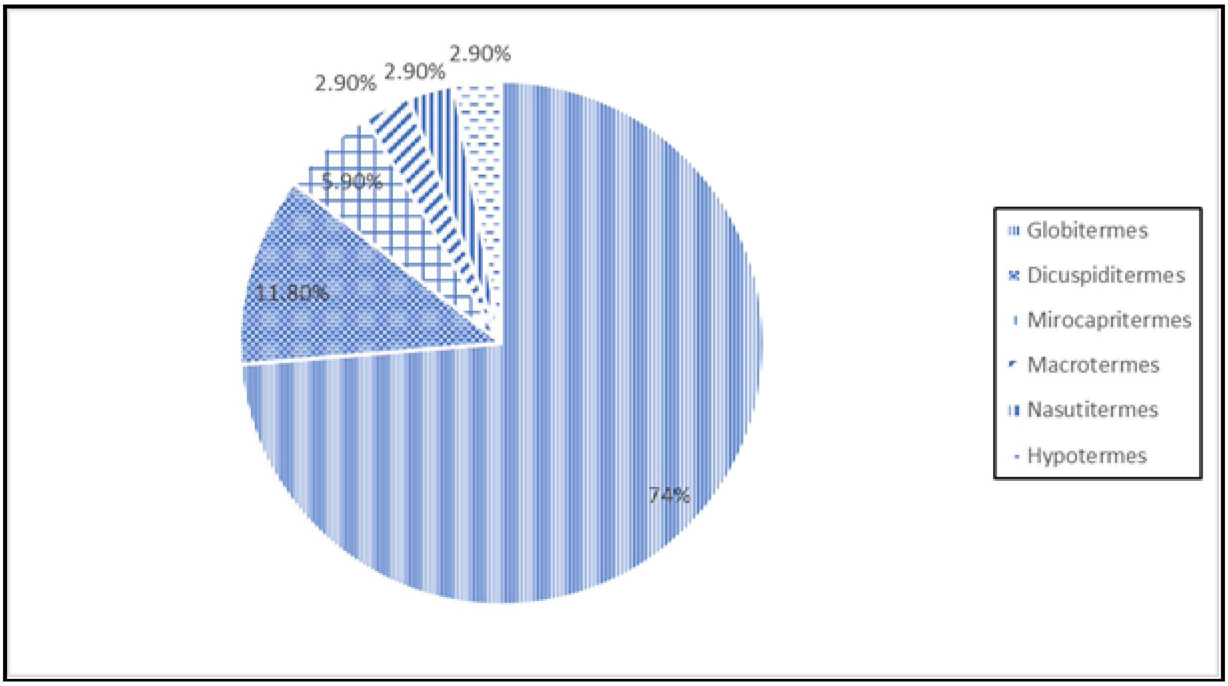


Fig. 2: Percentage composition of the termite genera along Sagbama-Ekeremor axis

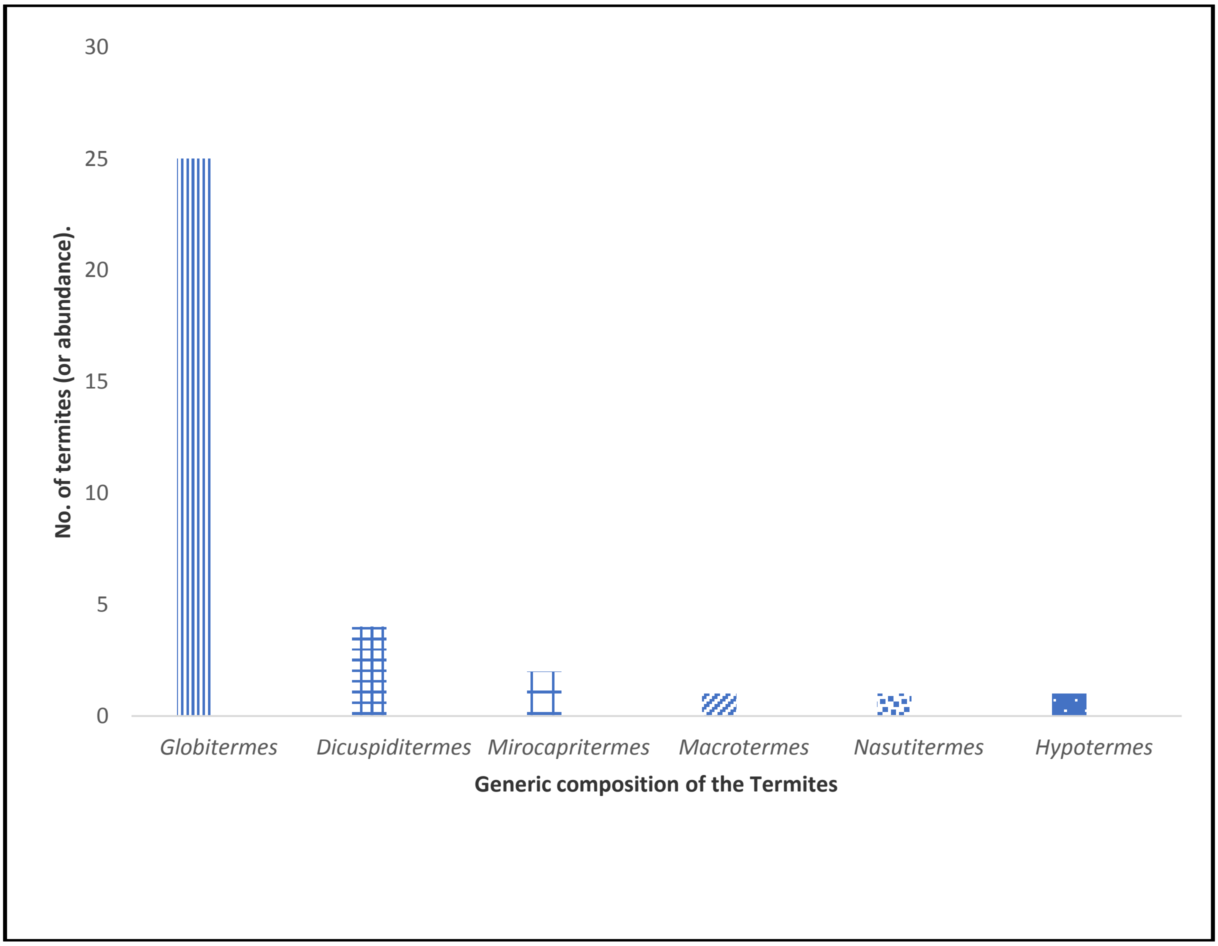


Fig. 3: Relative abundance and prevalence of the Termite genera along Sagbama-Ekeremor axis.

Table 2: The relative abundance and diversity index of the Sagbama-Ekeremor termites

Genera	**N**	**n/N**	**∑(n/N}^{2}**	**Simpson's Index 1 - ∑(n/N}^{2}**
Globitermes	25	0.735	0.540	
Dicuspiditermes	4	0.118	0.014	
Mirocapritermes	2	0.059	0.003	
Macrotermes	1	0.029	0.0008	
Nasutitermes	1	0.029	0.0008	
Hypotermes	1	0.029	0.0008	
Total No (N)			**0.5594**	**1-0.5594 = 0.44**

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)*

Different termites seemed to have characteristic mounds/nests, but this relationship between mounds and their infesting termites could not be established, because of the generally low encounters with these termites. The most abundant termite in this study (*Globitermes*), seemed to have a typical small, black dome-shaped mound with a height of between 0.1 – 0.5m, as witnessed in Sagbama, Bolou-Orua, Tungbo, Angiama, Toru-Orua and Ayanmasa. However, at Angalabiri and Ofoni some exceptions were remarkably noticed. Big and tall, black mounds (ranging between 1.8 – 2m high, n = 4) were for the first time witnessed at Angalabiri; while some other big, tall, but brown-coloured ones were seen at Ofoni (range 1.4 –2m high; n = 9). These big mounds were surprisingly also occupied by the big soldier caste of *Globitermes.* No *Globitermes* mound was found at Ebedebiri

Ugbomeh *et al*. (2019) reported a significant relationship between arboreal termite species and their nest types ($P < 0.05$); but this could not be established in this study, because of the low encounters here (only a single *Nasutitermes* nest was found during this survey (at Bolou-Orua); and only a single encounter with *Hypotermes* nest (found only at Tungbo). This was also the case with the subterranean mounds of *Macrotermes* and *Mirocapritermes* at Ebedebiri (i.e., only a single occurrence for each of these termites genera respectively). These trends could perhaps have been different if logistics and financial supports had been adequate to cater for sustained and repeated samplings over a longer time frame, rather than the one-off sampling done in this 8-week survey.

Wekhe *et al*. (2019) work is corroborated in the findings of this study that *Globitermes* and *Macrotermes* are subterranean termites. These authors had also tagged these two termite genera as soil-feeders. Kemabonta and Balogun (2014) reported *Macrotermes subhyalinus* as being the most widely distributed in Lagos where they found it in all the four zones surveyed.

The Simpson's diversity index of 0.44 implied a moderate termite species abundance and distribution in this Sagbama-Ekeremor axis. This is very true because of the generally low termite's encounters made. Locations with highest counts or high termite frequencies were Angalabiri (6) and Toru-Orua (4) respectively. This moderate termite abundance and distribution here may not be unconnected with the currently increasing infrastructural development projects, and intense farming activities (including bush burnings) and also more recently, intense floods over these localities. This development would most certainly impact negatively on termite biodiversity; due to the wanton destructions on their abode and dwelling places.

Conclusion

This survey is the first to report the presence of *Dicuspiditermes, Mirocapritermes* and *Hypotermes* in the Niger Delta terrain. It has therefore added to existing information on the much-desired termite survey data in the study area, and indeed the entire Niger Delta terrain of Nigeria. This work would undoubtedly constitute a baseline for future works particularly when contemplating environmentally safe, cheap and sustainable integrated pest management (IPM) options.

Acknowledgements

The authors wish to express profound appreciation to the Tertiary Education Trust Fund (TETFUND) for providing funds for this research. Special thanks are also due to Mrs Esther B. Enaregha and Mr Goodluck Ikah of the Isaac Jasper Boro College of Education, Sagbama as well as Messrs Oscar Maika and Ejike Ugwuoke. of the University of Africa, Toru-Orua respectively for their help with data collection during this project.

References

Agumagu O. and Todd, M. (2015). Modelling the climatic variability in the Niger Delta: influence of climatic change in hydrology. *Journal of Earth Science & Climatic Change* 6:1-7 [Goggle Scholar]

Ahmad, F., Fouad, H., Liang, S., Hu, Y. and Mo, J. (2021). Termites and Chinese agricultural system: applications and advances in integrated termite management and chemical control. *Insect Science 28*:2-20. Doi:10, 1111/1744-7914-12726

Ahmad, M. (1965). Termites (Isoptera) of Thailand. *Bulletin of the American Museum of Natural History, 131*(1):1-114

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

Banjo, A.D., Lawai, O.A., and Songounga, E.A. (2006). The nutritive value of fourteen species of edible insects in Southern Nigeria. *Agric. J. Biotechnol.* 5:291-301

Borror, D.J., Triplehorn, C.A., and Johnson N.F. (1989). *An introduction to the Insects.* 6th Edition, Saunders College Publishing, Philadelphia, USA. 875pp

Davies R.D. (1988). *Outlines of Entomology*, 7th Edition. Chapman and Hill, London. 408pp.

Donovan, S. E., Eggleton, P., Dubbin, W. E., Batchelder, M., and Dibog, L. (2001). The effect of a soil-feeding termite, Cubitermes fungifaber (Isoptera: Termitidae) on soil properties: Termites may be an important source of soil microhabitat heterogeneity in tropical forests. *Pedobiologia*, *45*, 1–11.

Egbon, I.N. (2022). Preliminary survey of Macrotermes bellicosus infestations on public utility poles in Ekosodin community, Nigeria. *African Journal of Health, Safety and Environment 3(*1):242-252. https://doi.org/10.52417. ISSN 2695-1819

Eggleton, P. (2000). Global patterns of termite diversity, pp 25-51 In: T. Abe, D.E. Bignell and M. Higashi (Eds.) *Termites: evolution, sociality, symbiosis, ecology.* Dordrecht. Kluwer Academic Publishers. Boston MA 466pp

Ejomah, A.J., Osariyekemwan, O.U. and Ekaye, S-O (2020). Exposure of the African mound building termite, Macrotermes bellicosus workers to commercially formulated 2,4-D and atrazine caused high mortality and impaired locomotor response. *PLoS ONE 15*(3)e0230664; https//doi.org/10.1371/journal.pone0230664

Freymann, B. P., Buitenwerf, R., and Desouza, O. (2008). The importance of termites (Isoptera) for the recycling of herbivore dung in tropical ecosystems: A review. *European Journal of Entomology*,*105*, 165–173.

Integrated Taxonomic Information Systems (ITIS) Standard Report (2018). *"Blattodea" Taxonomy and Nomenclature*. www.itis.gov. Retrieved 10th May 2018.

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

Kambhampati, S. and Eggleton, P. (2000). Taxonomy and phylogeny of termites, pp 1-23. In. T. Abe, D.E. Bignell and M. Higashi (Eds.) *Termites: evolution, sociality, symbiosis, ecology*. Dordrecht. Kluwer Academic Publishers. Boston MA

Kemabonta, K.A., and 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

Khan, M.A., Ahmad, W, and Paul, B. (2018). Ecological impacts of termites, In: Khan, Ahmad E (Editors) *Termites and sustainable management, sustainability in plant and crop protection*, New York. Springer Publishing pp 201-216

Kumar, R. (1984). *Insect Pest Control with special reference to African agriculture*. Edward Arnold (Publishers) Limited, London. 298pp. ISBN 0-7131-8083-8

Lavelle, P and Spain, A.V. (2001). *Soil ecology*. Kluiver Academic Publishers, New York. https//doi.org/10.1007/978-94-017-5279-4

National Science Foundation (2017). "*An annotated checklist on termites (Isoptera)from Sri Lanka".* https://researchgate.net/publication/309665163

Ntukuyoh A.I., Udiong, D.S., Ikpe, E. and Akpakpan, A.E (2012). Evaluation of nutritional value of termites (*Macrotermes bellicosus*): soldiers, workers and queen in the Niger Delta region of Nigeria. *International J. of Food Nutrition and Safety* 1(2):60-65. USA. ISSN: 2165-896 X

Ogbedeh, K.O, Epidi, TT., Ihejirika, G.O., Obilo, O.F., Ezeibekwe, I.O., Ogwudire, V.E. and Dialoke, S.A. (2016). Effect of tillage and organic manure sources on termites infestation on cassava (*Manihot esculenta* Crantz) stems in a cassava field in Owerri, Southeastern Nigeria. *Futo Journal Series (FUTOJNLS) 2(1): 17-31*

Ogbedeh, K.O, Epidi,T.T., Dialoke, S.A., Bosah, B. O. and Ugwoke, F.O. (2019). Field survey of cassava susceptibility to termite infestation as influenced by time, scale and management strategy in selected Owerri agricultural zones, Southeast Nigeria. *Asian Journal of Advances in Agricultural Research 10*(2):1-10.

Ogedegbe, A.B.O. and Eloka, E.V. (2015). Biodiversity of termites on farmlands in Ugoniyekorhionwvon, Orrhiowvon LGA, Edo State, Nigeria. *International Journal of Pure and Applied Sciences and Technology 27*(2):65-76

Ohwo, O. (2018). Climate change impacts, adaptation and vulnerability in the Niger Delta Region of Nigeria. *Environ. Earth Sci 8*: 171-179 [Google Scholar]

Olorode, O. (2002). *"Vegetation and Fauna" in African Atlases. Atlas of Nigeria,* Les Editions, J.A. Paris, France. Pp 57-59

Prastyaningsih, S.R, Hardiwinoto S., Musyafa, M and Agus C (2020) Diversity of Termites (Isoptera) on industrial forest plantation of *Eucalyptus pellita* stands of tropical ecosystem Riau, Indonesia. *Biodiversitas Journal of Biological Diversity 21*(11): 5498-5505

Rust, M.K and Su, N.Y. (2012). Managing social insects of urban importance. *Annual Review of Entomology 57:*355-375.

Scheffrahn R.H., and 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

Su, N.Y. (2002). Novel technologies for subterranean termite control. *Sociobiology*, 40:95-101

Suzuki, A. (1966). On the insect-eating habits among wild chimpanzees living in the savanna woodland of Western Tanzania. *Primates*, 7(4), 481–487.

Ugbomeh, A.P. and Diboyesuku, A.T. (2019). Studies on termite infestation of buildings in Ase, a rural community in the Niger Delta of Nigeria. *The Journal of Basic and Applied Zoology*. 80 (27): 1-7

Ugbomeh, A.P, Membere, O., Efuka, A. and Bawo, D.D.S (2019). A rapid survey of the arboreal 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

United Nations Environment Programme UNEP (2000). *Finding alternatives to persistent organic pollutants (POPs) for termite management.* Prepared by members of the UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management - established in 2000 to support international activities on Persistent Organic Pollutants (POPs) covered by the Stockholm Convention. 50pp

Uzakah, R.P. and Festus, A. (2022). Survey on indoor termites of Toru-Orua: A University Community in Bayelsa State, Southern Nigeria. *Environtropica*, 17*:*46-54

Uzakah, R.P. and Maika, O. (2022). Subterranean termites of Toru-Orua: A University Community in Bayelsa State, Southern Nigeria. *African Journal of Tropical Entomology Research.* 1 (3): 176-182.

Wang, C., Zhou, X, Shujuan, L.L., Schwinghammer, M, Scharf, M.E, Buczkowski, G, and 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., and Bawo, D.D.S. (2019). Subterranean termites of a University environment in Port Harcourt, Nigeria. *Asian Journal of Biology,* 8 (2): 1-10

Yamada, A., Takematsu, T.K.., Hyodo, F., Fujita, A., Kumai, T., Tayasu, I., Abe, T., Klangkaew, C., Kirtbutr N and Kudo, T. (2003). Abundance and biomass of termites (Insecta: Isoptera) in dead wood in a dry evergreen forest in Thailand. *Sociobiology*, 42 (3): 560-585.