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A rapid survey of the arboreal termites in a university environment in Port Harcourt, Nigeria

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Abstract

Background: Termites inhabiting tree crops are pests which if neglected could result to agricultural loss. In a study to investigate the arboreal termites of planted trees in Rivers State University, 1050 trees were sampled between July and October 2017. The study area was categorised into 10 zones, and all trees were examined for the presence of nests and mud tubes. Samples of termites and tree cuttings were collected from infected trees for identification of termites and trees.

Results: Approximately 37.71% of the sampled trees had some termite infestation as arboreal nests or presence of mud tubes. The trees most affected were *Mangifera indica*, *Elaeis guineensis* (Arecaceae), *Polyalthia longifolia* (Annonaceae), *Pentaclethra macrophylla*, *Eucalyptus* sp., *Terminalia* sp. and *Persea americana* (Lauraceae). The termites identified were *Amitermes* sp., *Nasutitermes havilandi*, *Odontotermes* sp., *Microcerotermes* sp., *Glyptotermes* sp. and *Globitermes* sp. The termites did not show preference for particular trees ($p < 0.05$). There was a significant association between the termite species and the nest type ($p < 0.05$); the observed difference between the species and nest sets arose by chance; in other words, they were not randomly distributed with respect to nest type. Termite-resistant crop trees were *Psidium guajava* and *Cocos nucifera*. With more than one in three infestation rates, there is the need for termite management.

Conclusion: This basic knowledge of the termite species and distribution is vital for effective control measure as it indicates that there is need for control and management. Suggested management would require treatment of infested trees and control measures of all trees in the study area except *P. guajava* and *C. nucifera*.

Keywords: Termitidae, Kalotermitidae, Termites, Rivers State University, Arboreal nests, Mud tubes, Crop trees

Background

Termites have beneficial values such as organic matter recycling, improving soil fertility and serving as food sources for other animals, but they also have harmful effects which include damage of crops, forestry and wooden structures (UNEP, 2000; Wang et al., 2009). Damage may extend to household furniture, paper products, many synthetic materials and food items. In addition to structural wood damage, termites also infest woody plants, such as trees, shrubs, and herbs so that such plants will not be in a state of vigorous growth (Roonwal & Rathore, 1984). Harris (2000) recorded several species of trees that have been injured and even killed by termites of which the damages were more serious in young plants of about one or two years of age. In some cases the termite attack began on the root and then spread to the upper parts of the plant. In older plants the bark and the underlying tissue is eaten up, which gradually exposes the pith and hollows out the stem, resulting in the ultimate death of the plant. Termite damage to living trees fall under two categories mainly; the damage by monophagous (eating only one kind of food type) termites which have restricted distribution, and the colonies are confined to single trees and the damage by polyphagous (feeding on various kinds of food) termites which forage over a wide range or distance in search of food. There are some trees like *Eucalyptus* that are attacked by termites whenever they are planted (Roonwal & Rathore, 1984). Termite foraging activities are

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coordinated in a fashion that allows them to nest, search for food and return to their nest. This activity may cause substantial damage to the affected tree crops (Olugbemi & Malaka, 1994). Termites that infest trees are ubiquitous, numerous with varying predominant species. Vasconcelles (2010) recorded 37 species of termites in an Atlantic forest in Northern Brazil with Nasutiterminae as the dominant group. Wang et al. (2009) recorded 5 species of *Reticulitermes* from homes and forested areas in Indiana while on the grazing lands in the semi-arid Nakasongola in Uganda, it was 16 termite species from 8 genera dominated by *Macrotermes* (Mugerwa et al., 2011). Record of termite infestations include those by Mitchell (2003) that recorded *Ancistrotermes*, *Allodontermes*, *Amitermes*, *Hodotermes*, *Macrotermes*, *Microtermes*, *Odontotermes*, *Pseudacanthotermes* and *Trinervitermes* as important plant pests in South Africa, and Materu, Yarro, and Nyundo (2013) that observed termites in different feeding regimes in croplands, forest and grassland in Tanzania. Reports on Nigerian termites include those by Ogedegbe and Eloka (2015) who recorded five species of termites as pests of various plant species, Echezona, Igwe, and Attama (2012) who observed arboreal termite nests on *Mangifera indica*, *Irvingia gabonensis*, *Cola nitida*, *Pentaclethra macrophylla* and *Newbouldia laevis*, Umeh and Ivbijara (2007) and Olugbemi and Malaka (1994). The present study was undertaken to collect and identify the species of termite and their associated tree crops in the Rivers State University, Port Harcourt with the intention of proffering termite management strategies.

Materials and methods

Study area

The study area was the Rivers State University (Fig. 1) in the Mile 3 area of Port Harcourt, made of residential areas, classroom and office blocks, administrative offices, farms and streets that are lined with different trees primarily *Elaeis guineensis*, *Polyalthia longifolia*, *Gmelina arborea* (Verbanaceae) and two pines *Pinus caribaea* (Pinaceae), *Casuarina equisetifolia* and others.

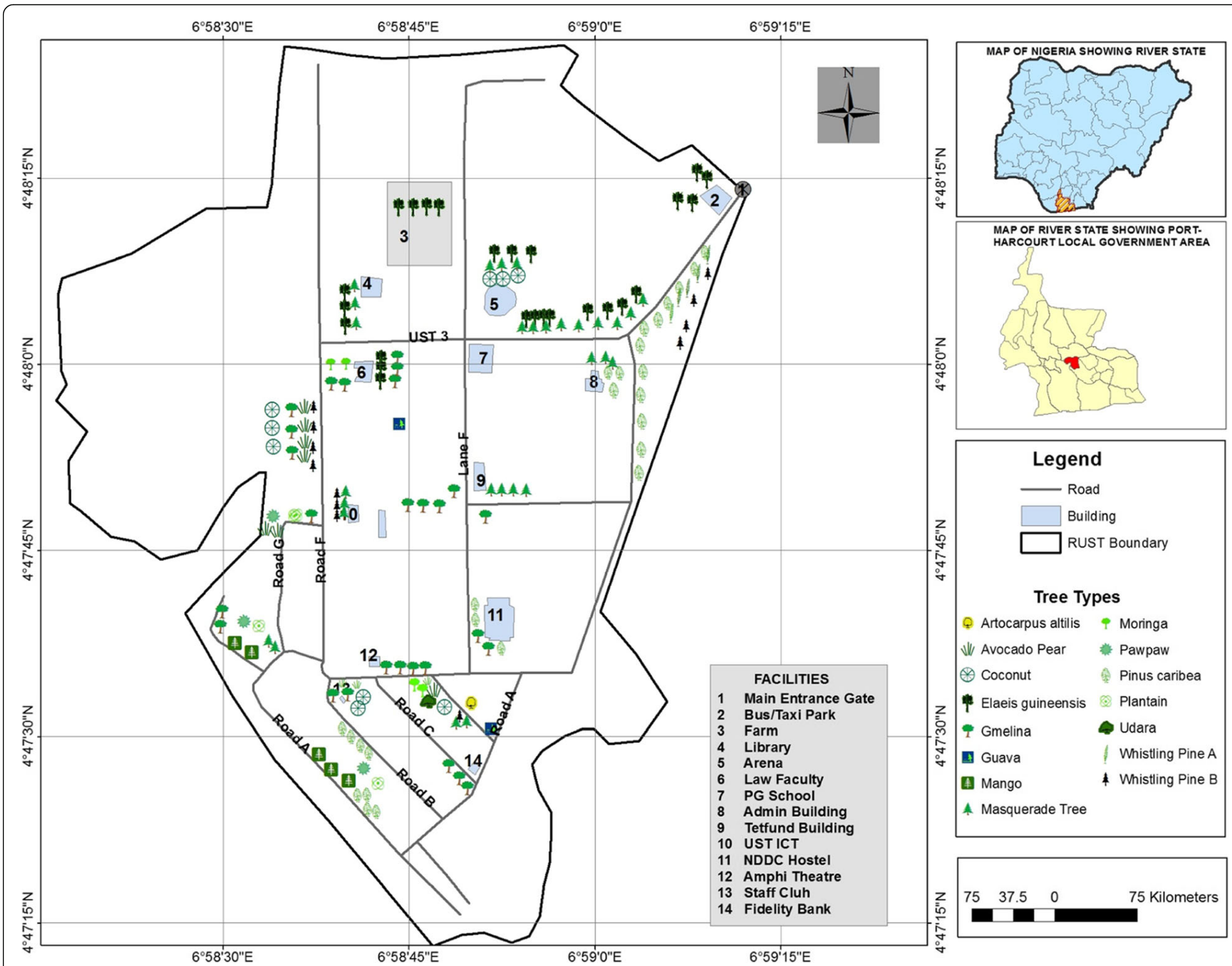

Fig 1 Map of Rivers State University showing location of major trees

Collection and identification of sample

Samples were collected between July and October 2017. The trees in the study area were examined for termite activity either as arboreal nests or as mud tubes. The presence of mud tubes or arboreal nests was equal to an infestation. The study area was divided in to 10 zones as shown in Fig. 1. Samples of termites were collected by cutting open and collecting termites from mud tubes and nests on live and dying trees. All samples collected were sorted and preserved in 10% formalin. One thousand and fifty (1050) individual trees were examined for termite infection. Samples of leaf and stem cuttings of the trees were taken to a plant taxonomist for identification (common names, scientific names and family) using standard manuals.

Termite specimens collected from different infested trees were examined under a dissecting microscope and identified using a manual by Muzaffer (1965) to a genus level based on the shape of the head, shape and serrations of the mandible, pronotum, postmentum and antennal elements. The absence of an inventory of termites found in Nigeria and the difficulty in identification using only morphological characters limited the identification of species. Statistical analysis include % prevalence per tree type and for all trees and chi-square test for a two-way variable using JMP software for termite tree preference, nest type and preference area.

Results

Of the 1050 trees that were examined, 396 had termite infestation (37.71%). The proportion of termite-infested tree species varied from 0 to 100% (Table 1). Two trees, guava—*Psidium guajava* (Myrtaceae) and coconut—*Cocos nucifera*, had neither termite nests nor mud tubes. All other trees had some form of termite presence. All *Mangifera indica* (mango) examined had mud tubes on them with termites *Amitermes* spp. or *Nasutitermes havilandi*. There was only one tree sample of "Udara"—*Chrysophyllum albidum* (Sapotaceae) and the native

Table 1 Prevalence of termite infestation on examined trees and their presentations

Common name of trees	Scientific name	No examined	% infected	Presentation	Termites found
Mango tree	*Mangifera indica*	38	100	Mud tubes	*Nasutitermes havilandi* *Amitermes*
Caribbean pine and Australian pine	*Pinus caribaea* (Pinaceae) and *Casuarina equisetifolia*	263	23.57	Mud tubes	*Amitermes* *N. havilandi* *Microcerotermes*
Avocado pear	*Persea americana* (Lauraceae)	18	72.22	Nest and mud tubes	*Amitermes* *Microcerotermes*
African oil palm tree	*Elaeis guineensis* (Arecaceae)	290	77	Nest and mud tubes	*Amitermes*
Moringa tree	*Moringa oleifera* (Moringaceae)	55	11	Mud tubes	*Amitermes*
Gmelina tree	*Gmelina arborea* (Verbanaceae)	154	60	Nests and mud tubes	*Amitermes* *Microcerotermes* *Globitermes* *N. havilandi*
Guava tree	*Psidium guajava* (Myrtaceae)	19	0	Nil	Nil
Grape tree	*Citrus paradisi*	9	11	Mud tubes	*Amitermes*
Coconut tree	*Cocos nucifera*	137	0	Nil	Nil
Mast "Masquerade" tree	*Polyalthia longifolia* (Annonaceae)	54	30	Mud tubes	*Amitermes*
"Udara" tree	*Chrysophyllum albidum* (Sapotaceae)	1	100	Nest and mud tubes	*Glyptotermes*
Native "Ube" pear	*Dacryodes edulis*	1	100	Nest and mud tubes	*Microcerotermes*
Oil bean plant	*Pentaclethra macrophylla*	2	100	Nests and mud tubes	*Amitermes*
	Eucalyptus sp.	4	100	Nest and mud tubes	*Amitermes*
	Terminalia mantaly	2	100	Mud tubes	*Microcerotermes* *Amitermes*
	T. superba	3	100	Mud tubes	*Amitermes*
Total		1050	37.71		

pear *Dacryodes edulis* which were infested with *Glyptotermes* sp. (Froggart) and *Microcerotermes* sp. (Silvestri) respectively. *Gmelina arborea* was infested by four different termites (Table 1). The termite presentation on the trees differed from tree to tree.

Glyptotermes sp. and *Globitermes* sp. appeared to be selective as they were found on *C. albidum* and *G. arborea* respectively (Table 2). *Amitermes* sp. was found in more tree types (12); *Microcerotermes* sp. and *Nasutitermes havilandi* were found in 7 and 5 tree types respectively.

Table 3 shows the chi-square probability ratio for termite spp. and tree type, termite spp. and nest type and termite abundance and sample area. No association implies random distribution for the termite spp. and tree type and termite abundance and sample area. There was a significant association between termite spp. and net types which was not random but was species specific.

Discussion

The total infestation of 37.71% of the trees in the study area represents an unexpected impact on the trees found in Rivers State University. This is considering the fact that the area is enclosed, with modern buildings and ongoing construction work that is rapidly destroying the trees and homes of the termites. With the number of infested trees and most bearing mud tubes, the whole appearance of the university trees appears to show termite infestation or presence in one out of three trees. Some *E. guineensis* were seen to be totally damaged with large termite nests on the tree. However, the short time in which this research was done precludes the possibility of discovering how much of the damage in the tree was actually due to the termites and how much would have been the termites simply taking advantage of prior damage (e.g. natural branch breaking due to winds and student's breakage of tree branches by sitting on them). It was also assumed until recently that termite will only inflict damage on unhealthy tree (Harris, 1998), but this is no longer accepted as a lot of presumed healthy fruiting trees were found with nest and mud tubes.

There are many factors that affect a tree's vulnerability to termites, any number of which may be at work for a given species. In this study, it was observed that *P. guajava* and *C. nucifera* were not infested by termites whereas grape fruit (*Citrus paradisi*) which is potentially toxic to dogs (https://www.gardenfactoryny/toxicplants.pdf) was among the trees infested. The *C. paradisi* were fruiting and so assumed to be mature as immature trees tend to be more susceptible to termite damage (Cowie, Logan, & Wood, 1999) and mature trees can be difficult for termites to attack (Cooke & Royner, 1984). The distribution of termites in the study area did not have a significant association with the tree type and the sampled stations of the study area indicating random infestation. However, the presentation of the termites was dependent on the termite present. This means that it is possible to know the termites by their presentations on a particular tree: either as nests or mud tubes. Arboreal nests observed in *Persea americana*, *E. guineensis*, *C. albidum*,

Table 2 Termite species found on infected trees in study area

Termites Family	Termite Species	Trees Infected
1. Family: Termitidae Sub-Family: Amitermitinae	*Amitermes* sp. (Silvestri)	*Elaeis quineensis* *Moringa oleifera* *Mangifera indica* *Polylalthia longifolia* *Pinus caribea* *Gmelina arborea* *Persea americana* *Casuarina equisetofolia* *Pentaclathra macrophylla* *Eucalyptus sp.* *Terminalia mentally* *T. superba*
	Microcerotermes sp. (Silvestri)	*Pinus caribea* *Gmelina arborea* *Dacryodes edulis* *Persea americana* *Casuarina equisetofolia* *T. mentally*
	Globitermes sp. (Holmgren)	*Gmelina arborea*
Sub fam: Nasutitermitinae	*Nasutitermes havilandi*	*Gmelina arborea* *Mangifera indica* *Pinus caribea* *Casuarina equisetofolia*
2. Family: Kalotermitidae	*Glyptotermes* sp. (Froggart)	*Chrysophyllum albidum*

Table 3 Chi-square probability ratio of termite species, tree type, nest type and distribution

Variable	Test	Chi-square	Probability	Significance
Termite spp. and tree type	Likelihood ratio	80.785	0.454	No association
	Pearson's	137.462	< 0.0001*	Distribution was random
Termite and nest type	Likelihood ratio	16.964	0.0493*	Significant association
	Pearson's	16.467	0.0578	Distribution was not random
Termite abundance and sample area	Likelihood ratio	123.935	0.999	No association
	Pearson's	239.575	0.0086*	Distribution was random

*Significant at $p < 0.05$

G. arborea, *P. macrophylla*, *D. edulis* and *Eucalyptus* sp. in this study agree with the work by Echezona, Igwe, and Attama (2012) to an extent. They observed nests in *P. macrophylla* and *M. indica*, but nests were not found on *M. indica* in this study. The presentation of termites on trees may therefore depend on the termite infesting at a particular time. The ability of the termites to affect more than one tree type shows lack of specificity presenting a generalist and polyphagous behaviour. Only *Glyptotermes* sp. appeared specific infesting only *Chrysophyllum albidum*.

The termite species recorded in this study belonged to two families—Termitidae and Kalotermidae, and five genera—*Amitermes*, *Microcerotermes*, *Globitermes*, *Nasutitermes havilandi* and *Glyptotermes* while Ogedegbe and Eloka (2015) recorded five species as important pests of plants in Edo State, Nigeria (*N. havilandi*, *Odontotermes* sp., *Nasutitermes arboreum*, *A. evencifer* and *Microtermes* sp.). *Coptotermes* which has been found as the insect pest of palm plantain in Malaysia (Bong, King, Ong, & Mahadi, 2012) was not among the species obtained in this study.

The basic knowledge of termite species and their distribution in any given area is vital for effective control measures as it also helps determine if there is need for control (Logan, Cowie, & Wood, 1990). The infestation in the study area requires control as it leads to damage of the trees. Wood ash heaped at the base of tree crops to prevent infestation has been found to be effective (Ogedegbe & Eloka, 2015), whereas in some studies it has not been effective (Logan, Cowie, & Wood, 1990). This difference may depend on the wood used for the ash. There could be some benefit if the wood ash comes from plants that are resistant to termite infestation; however, this requires further studies to verify their use and benefit.

Conclusion

In conclusion, study area had 37.71% infestation by 5 genera of termites on 15 different tree types. Two trees *P. guajava* and *C. nucifera*, showed no termite presence. There was no association between termite species and tree type or location in the study area classifying the termites as generalists and polyphagous. The presence of nests or mud tubes was dependent on the termite species infesting the tree. This basic knowledge of the termite species and distribution is vital for effective control measures as it indicates that there is need for control and management. Suggested management would require treatment of all trees in study area except *P. guajava* and *C. nucifera*.

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Availability of data and materials
All data generated and analysed during the current study are deposited in the Department of Animal and Environmental Biology, Rivers State University, Port Harcourt and are available on reasonable request.

Authors' contributions
APU designed the study, wrote the protocol, and wrote the first draft of the manuscript. AE and OM managed the analyses of the study and performed the statistical analysis. APU and DDSB managed the termite identification. All authors read and approved the final manuscript.

Ethics approval and consent to participate
To the best of author's knowledge, there are no ethics committees set up at an institutional or national level on the collection and use of termites for study.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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