

Termite (Isoptera) Assemblages in Rufiji District Tanzania

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Abstract

Different land uses tend to affect termite feeding groups, abundance and species richness. Termites play a major role in the ecosystem particularly decomposition process, carbon and nitrogen cycling. Termite diversity differs between habitats depending on human activities. The main objective of this study was to investigate termite assemblage under different land use. Termites were sampled with a standardized 100m × 2m straight-belt transect at three named habitats. The difference in feeding groups was statistically not significant. Though termite feeding group variations across habitats were caused by human activities but changes were not high enough to cause significant differences. The results from this study provide a database on termite feeding groups which will be useful for future research in the district.

Keywords: Termites, relative abundance, feeding groups

1. Introduction

Termite assemblage were carried out under cropland, grassland and forest areas in Rufiji district Conversion of forest areas to agricultural land in Rufiji causes loss of total habitat area, fragmentation and degradation of remaining adjacent habitat areas. Termites play a major role in the decomposition process (Eggleton & Bignell, 1995). During wet season termites spread widely searching for food and water, for constructing their nests. Loss of forest may have a negative effect on termite species assemblage under different land use.

Termites feeding groups are categorised as dry wood feeding termites, leaf litter feeding termites, soil/wood-feeding termites and epiphyte feeders (Collins, 1984; Roisin & Pasteels, 1996, Anderson, 2000. Sometimes the dead wood is gradually replaced with wood carton, a woody substance with low nutrient concentrations and high levels of lignin and other undigested components. This group includes the Kalotermitids (*Kaloterмес*, *Glyptoterмес*), some Rhinotermitids for example *Schedorhinoterмес*, *Parhinoterмес*, *Heteroterмес* and also *Coptoterмес*) and some members of Termitidae such as *Microceroterмес* and *Termes*.

Hypogean or subterranean nesters:- Termites whose colony centres are below the ground without any indication of their presence. They use their faeces or a mixture of faeces and mineral soil in nest construction. The colony centres are often poorly defined and characterless, especially in the soldier less *Apicotermatinae*. But in some *Macrotermatinae*, *Apicotermes* and *Homaloterмес*, a little internal structure or surface holes are present together with complex underground nests to enable foraging on aboveground vegetation. This group also includes many species that are facultative secondary inhabitants of epigeal mounds such as *Microceroterмес*, *Pericapriterмес*, and soldier less *Apicotermatinae* (Eggleton *et al.*, 1996).

Epigeal mound builders: - Termites whose colony centres are associated with living (free standing or tree buttresses) or dead vegetation above ground (Jones 1990; Eggleton *et al.*, 1996), commonly known as mound builders. The mounds are usually well characterized, often with very complex structures depending on the location and species type (Jones 1990; Culver & Beattie 1983; Holt & Lepage 2000; Chikuvire *et al.*, 2007). Materials used for nest construction are of three main types: - subsoil with relatively low organic content added with salivary secretion (*Macrotermes* and *Corniterмес*), wood carton (a mixture of faeces and macerated wood with a high lignin content) (most wood-feeding termites), or a mixture of faeces and organic-rich topsoil (many soil-feeders). Epigeal mound structure can differ widely within genera and also between regions within widely distributed species. For example *Macrotermatinae* are known to build huge mounds of selected clay-rich subsoil. Soils with high clay content are avoided by termites because they are frequently subjected to cracking and seasonal wetting during the rainy season (Collins, 1980).

Arboreal nesters: - Nests are attached outwardly on trees at different heights. These nests are normally made of wood carton. In most cases the nests are connected to the ground by covered runways. This may assist in distinguishing some arboreal termite nests from those of ants. Nonetheless, some arboreal nesting *Nasutitermitinae*, (e.g. *Hospitaliterмес*), form open foraging columns without any connecting runways between the nest and foraging sites. Termite families so far known to occur in tropical forest and grassland savanna areas worldwide include *Mastotermitidae*, *Kalotermitidae*, *Hodotermitidae*, *Termopsidae*, *Rhinotermitidae*, *Seritermitidae* and *Termitidae* (Krishna & Weesner 1970). Furthermore, the most economically important termites in agricultural and forest areas are *Macrotermes*, *Allodoterмес*, *Amiterмес*, *Pseudacanthoterмес*, *Odontoterмес*, *Ancistrotermes*, *Trinerviterмес*, *Hodoterмес* and *Microtermes* (Mitchell, 2002). Economic

damage due to termites is important because termites are present throughout the cropping season and form part of the environment.

Members of the family *Termopsidae* are known as damp wood feeders as they nest, forage and feed within damp wood partially or fully buried in the soil. Common sub-families include *Termopsinae*, *Porotermitinae* and *Stolotermitinae*. The *Hodotermitidae* construct underground nest and mostly feed on dead grass from the soil surface. Common sub-families in this family include *Hodotermitinae* and *Acanthotermitinae*.

Rhinotermitidae is one of the common families which build their nests in dead wood decaying at different stages or old trees and also they are easily found in epigeal mounds. Common sub-families in this family are *Coptotermitinae* and *Heterotermitinae*. *Coptotermes* which are widely distributed in the forest area and in old farms and they have ability to infest old trees both in forest and crop land areas (Cowie & Wood 1989). Their nest is characterized as epigeal or subterranean and most of these species feed on living plant material or dead wood. Common genera in this family include *Microtermes*, *Ancistrotermes*, *Odontotermes* and *Macrotermes*. These genera differ in their biology, nesting habit and mode of infestation.

The sub family *Nasutitermitinae* is widely distributed infesting grasses, dead parts of old coconut, citrus, cashew, and mango trees. The soldiers are characterized by heads extended into a tube like material for defensive purposes. Furthermore, their nest in cropland, grassland or forest areas are either subterranean, epigeal mounds or attached on tree branches located at different plant heights (Sands, 1961; 1965; Araujo, 1970). This study presents termite functional groups from different habitats in Rufiji district

2. Materials and Methods

2.1 Termite sampling

Three habitat types namely cropland, forest and grassland lies between 7° 27'S - 8° 27'S and 37° 52'E - 39°28'E, were used to estimate termites feeding groups. The study area was 300 msl and is characterized by hills, plains and varying vegetation types. Temperatures ranged between 25 to 35°C The district gets an average rainfall of about 1,100 mm per annum. Two transect lines 100m x 2m with 5m x 2m quadrates were used to sample termite feeding groups. The transect lines were 20m far apart. In each sub plot termite sampling was carried out by two people for 60 minutes to get quick estimates of local termite fauna in terms of taxonomic and feeding groups (Jones & Eggleton, 2006). During data collection, termites were hand sorted randomly to a depth of 10 cm below the soil surface during wet and dry season (Silva & Martius, 2000).

2.2 Termites identification

Identification of termite species collected from cropland, forest and grass land in Rufiji district was made based on feeding preferences (Hill, 1942; Watson *et al.*, 1978; Wood & Sands, 1978; Collins, 1979; Collins, 1984; Brenznak, 1994; Eggleton *et al.*, 1996; Jones & Eggleton, 2000, Donovan *et al.*, 2001). For example, wood feeding termites were those collected from dead wood, dead brunches at different stages of decay. Termite food preference correlates very well with the relative amount of plant tissue fragments in the gut (Donovan *et al.*, 2001).

All samples with soldiers were identified to genus level and then allocated with morphospecies number. A working reference collection was maintained so that materials from all transects could be cross-referenced and the morph species designations applied consistently.

3. Data analysis

Probability results at 0.05 were carried out using non parametric test from 2003 Graphpad programme. The termite abundances from different habitat types were compared using Kruskal-Wallis ANOVA similarly comparison between two feeding groups Mann-whitney was used.

4. Results

4.1 Termite abundance and feeding groups between habitat types

Abundance of soil feeding termites from grassland habitat was less represented compared to cropland and the highest number of soil feeding was from the forest habitat. These species were found feeding on soil with high organic matter content and wood which has already lost its structure. Five species were recorded from the forest and only two species were recorded from the grassland habitat type. Species encountered during the study period were *Cubitermes*, *Fastigitermes*, *Profastigitermes*, *Ophiotermes* and *Termes*.

Furthermore, dry wood feeding termites were found feeding on dry wood and nest in wood material. *Cryptotermes*, *Glyptotermes*, *Coptotermes* and *Schedorhinotermes* were recorded.

Wood and leaf litter termite species were under the family Termitidae. This group was found feeding on range of food types including wood and leaf litter. The common species encountered were *Macrotermes*, *Microtermes*, *Pseudacanthotermes*, *Odontotermes* and *Trinervitermes*. Wood and leaf litter feeding were equally represented in the forest.

The termite abundances were compared using Kruskal-Wallis test which showed that there were no significant differences ($P = 0.427$) (Table 1). Furthermore, U-test revealed that comparison between termite feeding groups was not significantly different from each other (Table 1). Termites species richness and their functional groups is summarised in Figure 1. Check list of common species present in the study sites is summarized in Table 2.

5. Discussion

The overall termite abundance and their functional groups did not show significant differences from different habitat types in Rufiji. Table 1. Grassland was the least habitat with least of individuals probably due to human activities. Similarly variation of food quality from different trees was related to different feeding habit in contrast with Traniello & Leuthold (2000). Studies carried out in Sumatra revealed that termite abundance was frequent in disturbed habitat (Tho, 1992).

Termites sampled were grouped as follows:- dry wood feeding termites were those feeds on dry wood and they do not contact with soil. Dry wood termites were found in old coconut farms infesting on old citrus trees but in the grassland and forest habitats they were confined to and feeding on dead trees and standing trunks. Many species in this family are considered as serious pests of forest products and one common species *Glyptotermes* was found in all the three habitats. Its soldiers head are characterised for a particular value in blocking and defending nest members in their galleries from their natural enemies similar observation made by Collins (1988). The *Cryptotermes* sp. is another species in this family and they were found to be more numerous soldiers than workers. No individual of *Glyptotermes* and *Cryptotermes* were recorded from lying logs where they could be easily attacked by predators like ants. Frass or faecal materials could easily be seen in dead wood infested by the *Cryptotermes* sp. Since Kalotermitid termites feed on dry wood and nest there, they do not forage or lay foraging pathways. This behaviour distinguishes them from other termites like *Coptotermes* sp. and *Schedorhinotermes* sp. (Rhinotermitidae) which also feed on dry wood materials were found to lay foraging path ways in contrast with Jones *et al.*, (1995). Termite species in the families Kalotermitidae and Rhinotermitidae are considered as primitive or lower termite species and were about 5% of the total termites recorded Table 2.

Wood and leaf litter feeding termites were represented by 73% of the total individuals under the family Termitidae (Figure1). Common sub families recorded were Macrotermitinae, Termitinae and Nasutitermitinae similar observation was reported by Wood and Johnson (1986) and Collins (1988). Furthermore, studies carried out near Darwin; northern Australia has shown that the termite fauna of the monsoonal forest were under the same sub families Macrotermitinae, Termitinae and Nasutitermitinae (Tracy, 2003). They include the most advanced and diverse groups of termites, and exhibit a wide variety of social specializations. Termite species in this group have a more elaborate external and internal anatomy compared to the lower termite species in contrast with (Breznak & Brune, 1994).

Macrotermes sp. are mound nesting termites feeding on various types of food including decomposing wood, living, and fallen wilting leaves, in both the grassland and in the forest habitat. Farmers from the selected villages consider *Macrotermes* sp. nests as part of their farming system, possibly because of improved soil fertility around the mounds serving as a possible risk reducing factor for subsistence farmers. In Rufiji, farmers plant annual crops including maize, rice and vegetables around the termite mounds as mound soils are more fertile than the surrounding soils.

Mounds of *Macrotermes* sp. are frequently subjected to annual erosion during long and short rain seasons modifying surrounding soil structure (Josens, 1983). In grasslands where seasonal fires frequently breakout and water logging commonly occurs during rain seasons, the mounds save termite from fire and flooding and are also used for storage of food.

Microcerotermes sp. are widely distributed throughout the study sites feeding on dead wood materials, characterised by lower numbers of soldiers than workers and numerous nymphs in both seasons. Their alates, soldiers and workers were located at different heights inside dead wood decaying at different stages but no queens were observed. *Microcerotermes* sp. were found feeding on dead parts of poorly managed tree crops include citrus, dead coconuts leaves, mangoes and cashews daed parts.

Pseudacanthotermes sp. was one of the subterranean termite genera and are also fungus growing termites found in coconut farms feeding on dead coconut leaves, coconut husks, cassava cuttings originally used as planting materials, planted or uprooted cassava and tree logs lying on the ground. *Pseudacanthotermes* sp. was widely distributed during the rainy season (February to June). Their soldiers and workers are black. Workers construct runways covered with soil from their nests to the food sources for example the dead parts of various trees. Their nests were located at different depths in the soil and sometimes they invade the walls of nests of *Macrotermes* sp. *Pseudacanthotermes* sp. was not recorded in the grassland habitat probably due to frequent disturbance *i.e.* overgrazing, seasonal flooding and frequent fires during wet and dry season.

Nasutitermes sp. from different habitats include both wood and grass feeding species and they dominate the grassland and the forest areas consuming large quantities of dead standing wood, stumps, decaying wood and

grasses. They construct nests in various locations such as in soil, within dead wood and on trees. *Nasutitermes* sp. constructs connecting galleries from their nests to dead trees by cartons of red soils in the cropland and forest areas. This finding was in contrast with other studies carried out in northern eastern Brazil (Vasconcellon *et al.*, 2008).

Studies carried out in other places showed that *Nasutitermes* sp. mostly occurs in tropical and sub tropical areas and are characterised by nasute soldiers (wood boring termites) in contrast with Darlington *et al.*, (1997). In cropland and grassland habitats *Nasutitermes* was considered as economical agricultural pests because they feed on old parts of coconut, cashew, mango, citrus trees through trailing up the trees without causing major injuries and grass. *Nasutitermes* sp. was observed to occupy nests of other termite species such as *Cubitermes* sp. *Macrotermes* and *Termes* sp. in contrast with Wood *et al.*, (1982).

Termes sp represented 8% of the total individuals and was found to feed on soil and were characterised by long snapping mandibles. Soil feeding termites were found to be forest dominant, feeding partly on rotten wood (damp wood material) that has lost structure or fallen or standing tree logs. Their soldiers are less aggressive and in terms of their numbers they were found to be fewer than workers but widely distributed.

On the other hand, soil or damp wood feeding termites, for example, *Cubitermes* sp. Represented 78% of the total individuals and was widely distributed in both in the forest and grassland. Their nests ranged from 0.2m to 0.5m high with no openings except during the swarming period and were sealed after swarming. Some nests of *Cubitermes* sp. was also located at tree bases and plastered with soil. Generally the trees provided shade to nests especially in the grassland areas where vegetation is sparse. *Cubitermes* sp. was found in the forest feeding on wood which has lost its structure or damp wood materials and also in cropland where there was minimum disturbance. In the grassland *Cubitermes* sp. was widely spread but their densities were highest in the cropland probably due to frequent farm operations. *Cubitermes* sp. was found in all habitats and was the only soil feeding termite species which build small mounds with different shapes i.e. simple dome or several caps in contrast with Williams (1966).

Acknowledgement

The authors would like to thank the Ministry of Agriculture and Food Security for financial support. Furthermore, many thanks are dedicated to Mr Pius Ngwangwa and Erick for their support during termite sample collection also Rufiji district administration for their acceptance to allow this work to be carried out in their district

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Table 1: Termites relative abundance and their feeding groups from the three habitat sites recorded from Rufiji district

Feeding groups	Cropland (n)	Forest (n)	Grassland (n)	SEM
Soil feeder	2282	720	1755	1585±459
Drywood feeders	4309	311	44	1554±1379
Soil/damp wood	280	165	0	148±81
Wood/leaf litter	11360	2827	2113	5433±2970

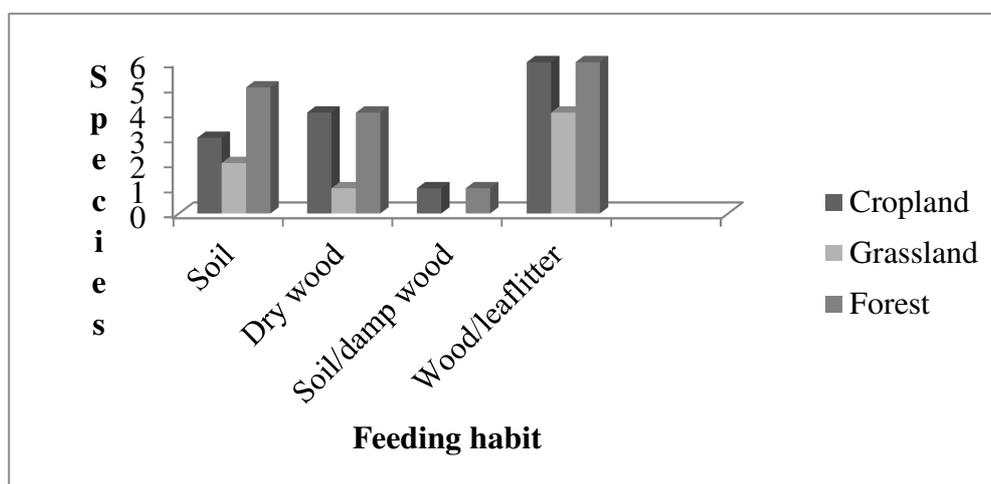


Figure 1. Termite feeding habit from different habitat types

Table 2: Termite species richness checklist recorded from three habitats showing their distribution and their feeding types

Species	Functional habit	Cropland	Grass	Forest
Kalotermitidae				
<i>Cryptotermes</i> sp.	W	-	-	+
<i>Glyptotermes</i> sp.	W	+	+	+
Rhinotermitidae				
<i>Schedorhinotermes</i> sp.	W	+	-	+
<i>Coptotermes</i> sp.	W	+	-	+
Termitidae-Termitinae				
<i>Microcerotermes</i> sp.	W	+	+	+
<i>Fastigitermes</i> sp.	S	+	-	+
<i>Profastigitermes</i> sp.	S	+	+	+
<i>Cubitermes</i> sp.	S	+	+	+
<i>Termes</i> sp.	S	+	-	+
<i>Ophiotermes</i> sp.	S	-	-	+
Macrotermitinae				
<i>Macrotermes</i> sp.	W/L	+	+	+
<i>Microtermes</i> sp.	W/L	+	+	+
<i>Pseudacanthotermes</i> sp.	W/L	+	-	+
<i>Odontotermes</i> sp1	W/L	+	-	+
<i>Odontotermes</i> sp. 2	W/L	-	-	+
Nasutitermitinae				
<i>Nasutitermes</i> sp.	W	+	+	+
Total		13	7	16

Note: W= Wood feeding termites, W/L= Wood and leaf litter, S= soil feeding termites

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