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TERMITES (ISOPTERA) IN KIBALE FOREST NATIONAL PARK, WESTERN UGANDA

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ABSTRACT

A survey in medium altitude primary forest yielded eleven species of termites in three families. At least three species are mainly West African. Low levels of termite consumption were observed in woody litter on the forest floor, but relatively high levels of attack on standing wood in the canopy were inferred. The chimpanzees are not known to eat termites at Kibale, but this is probably because no suitable species are present. Land that had been cleared of forest had a very different termite fauna.

INTRODUCTION

All termites feed on vegetable matter, but different species utilise forms that can vary from living tissues, through dead plants in all stages of decay, to humus incorporated in the soil. Those termites that feed on the tissues of living plants can be significant pests in forestry, agriculture and pasture. Some species that do not attack living tissues may exploit the heartwood of living trees, reducing the value of their timber. They may enter the tree through dead snags, knot-holes or damaged bark, or underground from the roots (Harris, 1961). Termites contribute to the breakdown and humification of dead plant tissues, and the recycling of nutrients. Soil-dwelling termites can be important in maintaining an open soil structure, and in reversing the downward leaching of soil nutrients by rain, but soil-feeding termites may also reduce the humus content of soils (Lee & Wood, 1971).

Termites are most important in relatively dry ecosystems such as savannahs, where other decomposers are scarce. In moist tropical forests the decomposition of wood and leaf litter depends mostly on fungal and bacterial decay, with termites playing a lesser role. Little is known about the intensity or modes of attack by termites on standing trees in indigenous forests. Even the composition of the termite fauna in East African forests is poorly known.

The present study was very limited in scope, but represents a first attempt to tackle an important aspect of forest ecosystems and biodiversity.

STUDY SITE AND METHODS

Kibale Forest National Park is an area of 560 km² at altitudes of 1,000 to 1,500 m to the south of Fort Portal (0°45'N-30°15'E) in the Toro District of Western Uganda. The vegetation was originally Medium Altitude Tropical Montane Forest, with varied topography. Part of the area was cleared for agriculture in the 1970s, but is now abandoned. Most of the rest was selectively logged in the 1950s and 1960s and has not regenerated well, but some small protected areas of primary forest remain (Hamilton, 1984; G. Basuta, pers. comm.). The work reported here was mostly carried out in one such area, adjacent to the Kibale Forest Field Station.

Many hours were spent collecting, on various dates over a period of one month. Termites were collected by systematic search over small areas of the forest floor. Traces of termite activity were noted, and shallow scrapes were dug in the soil. Dead wood (in the form of wood litter, logs, standing stumps and dead snags on living trees) was cut up with a sharp cutlass. Specimens were collected by hand into vials of 70 % alcohol. This was either done in the field, or else bulk samples were taken back to the laboratory, where the light was better.

RESULTS

Ten species of termites were collected, and one further species was recognised by its characteristic traces (Appendix 1). An annotated systematic list is given below.

Kalotermitidae

Termites of the family Kalotermitidae live inside solid wood where they eat out galleries, even in very hard woods. The galleries are not lined, but the walls are roughened by shallow sculpturing from the termites jaws. Some galleries are filled with dumps of small, dry, seed-like faecal pellets. These traces remain clearly recognisable when termites are no longer present.

Neotermes sp.

This is the largest kalotermitid species found. It was collected only once, as a nest fragment inside a fallen branch. Another large branch of very hard wood, over 4 m long and 25 cm in diameter, that had fallen from a dead tree and become suspended in the undergrowth, was riddled with large galleries that could have been made by the same termite species. This suggests that *Neotermes* infests tree branches (dead or alive) while they are still in the forest canopy.

Bifiditermes sylvaticus (Wilkinson)

This is a medium-sized species found in wood litter, and also inside the standing stumps of fallen trees. Thus it is obviously active at ground level, but perhaps also in the canopy.

B. sylvaticus was described (Wilkinson, 1959) from Kichwamba in the Ankole District of Western Uganda at an altitude of 1,540 m. It has also been found near Meru, on the slopes of Mount Kenya. All the known localities are in moist upland forest.

Glyptotermes sp.

This is a small species found living both in wood litter and in standing stumps. Small numbers of alates (winged reproductives) belonging to this species were caught repeatedly in a Malaise trap set up in primary forest. These were the only termite alates caught in this way.

The species could not be identified, but it was not one of the five species previously recorded from Uganda (Wanyonyi *et al.*, 1984)

Rhinotermitidae

Coptotermes sp.

No living termites were found. The upright timbers of an old wattle-and-daub building in Lower Camp had been extensively attacked by this termite, as shown by the characteristic lining and lacey infill of yellowish-grey carton inside its galleries. It is possible that this termite was brought to the site in building materials, as it has not so far been seen in the forest.

Termitidae

Apicotermitinae

Only one species (not identified) was collected but there are likely to be several more. These are soil-dwelling, humus-feeding termites that may be important as soil-conditioning organisms but are not known ever to be pests. Most species have no soldier caste.

Termitinae

Microcerotermes sp.

This is probably the most abundant termite in Kibale Forest. Like most Termitinae it has centralised nests containing large numbers of individuals, which may be inside wood or in the soil. It forages extensively in the litter layer, and infests stumps of standing dead trees. It is a small termite and makes small galleries, lined with a thin layer of brown, woody faecal carton. It also builds characteristic small covered galleries of carton on the outside of logs and tree boles, to protect foragers when they are away from the nest. It often builds carton galleries inside the larger galleries left by other termites. It seems able to attack dead wood in almost any condition, from hard, sound wood to soft, pulpy, rotten wood.

All the samples collected appeared to be of one species, but this could not be identified. Two species are recorded from Uganda and seven from East Africa (Wanyonyi *et al.*, 1984) but the taxonomy in this genus needs revising.

Basidentitermes ? *aurivillii* (Sjostedt)

This appears to be mainly a soil-feeding termite, but it also infests well-rotted, moist wood litter. It builds nest-like galleries with thick walls of dark grey soil (which is faecal in origin), sometimes in contact with a food source, but usually in close proximity to the nest of some other termite. Although juveniles were sometimes present, no reproductives were found, and the nest-like structures generally occupied a small volume, probably representing only a small part of a larger polycalic nest. Occupied galleries were found under a nest of *Termes*, and surrounding a large nest of *Microcerotermes* in a tree stump, in both cases in primary forest. This termite was also encountered in the wall of a large earth mound built by *Pseudacanthotermes spiniger* (Sjostedt) at Bigodi, on cultivated land that was formerly part of the forest (see below).

B. aurivillii is mainly West African, recorded from Ghana, Nigeria and Congo/Zaire, but also from Uganda and the Sudan (Snyder, 1949). The samples collected at Kibale Forest appeared to contain two distinct soldier morphs, a feature not previously recorded in this genus.

Termes hospes (Sjostedt)

A large nest was found on the outside of a large fallen tree trunk lying on the forest floor, the nest structure penetrating well into the partly-rotted wood. The part of the nest outside the log was built of thin blackish carton, forming a structure that was light but strong, and rather brittle. Inside the log the nest consisted of closely-spaced galleries lined with similar carton.

This is a West African species previously known from Guinea, Ghana, Cameroon, Congo and Zaire (Snyder, 1949). There are no published records of this genus from East Africa (Wanyonyi *et al.*, 1984), but *T. hospes* has recently been collected in Western Kenya (R.K.N. Bagine, pers. comm.).

Macrotermitinae

This very successful subfamily contains all the fungus-growing termites, which are found only in Africa and Asia. The termites build distinctive structures called fungus combs using their own faecal pellets in which the vegetable matter is largely undigested, and inoculate the combs with spores of a symbiotic fungus. The fungus breaks down the undigested vegetable matter into substances that the termites can assimilate. The fungus combs are housed in purpose-built chambers in the soil, which can be widely dispersed, or aggregated into elaborate centralised nest structures. The termites may bring in forage from a considerable distance to build their combs.

Three species of the genus *Odontotermes* were found in Kibale Forest. Each was collected only at a single site, but traces of their foraging activity were recognised at a number of other sites. At Kibale, foraging by *Odontotermes* is easy to recognise even in the absence of the termites. They eat out large galleries inside wood, then plaster them with quantities of red clay. (*Macrotermes* behaves in the same way, but no *Macrotermes* were found in the forest.) In other areas *Odontotermes* (and *Macrotermes*) also build clay foraging covers and galleries on the outside of trees and woody litter, but this was not observed at Kibale Forest.

Odontotermes rectanguloides Sjostedt

This is the largest of the three species, and the only one for which a nest was located. The nest was probably about five metres in diameter but extremely inconspicuous, with no apparent mound and only a few open holes, 5–12 cm across but disused and blocked by litter. By shifting logs and shallow digging, the nest was broken open in several places. Fungus combs were sampled from 40–50 cm below ground level, in tall, narrow chambers, with high roofs that reached to within a few cm of the soil surface where they were sealed by domes lined with red clay. The combs and chambers were aggressively defended by termite soldiers; but in the few cases where we left holes open, the chamber roofs were not repaired, the chambers apparently being sealed off underground and abandoned. Two fallen tree trunks that were originally rooted on the nest, and several others nearby, were riddled with foraging galleries and plastered with red clay. Foraging did not appear to extend far from the nest, the furthest tree attacked being about 30 m away. A large dead tree still standing had been infested from ground level apparently right up into the canopy. Another tree that had been cut down and left lying about two

years before (G. Basuta, pers. comm.) appeared to have been attacked in the heartwood while still alive, the termites probably having entered through damaged bark near its base. Many examples of clay-lined galleries in fragments of branches lying on the ground, with no signs of the termites having entered them from the soil, indicate that the termites forage in the canopy rather than the litter layer. It was not possible to tell whether the branches had been alive or dead when attacked.

The species is known from Zaire, Uganda (Snyder, 1949) Kenya and Tanzania (Wanyonyi *et al.*, 1984).

Odontotermes kibarensis (Fuller)

Small samples were collected from inside pieces of a fallen branch that appeared to have been attacked in the canopy. Neither the nest nor the tree could be located.

The species is known from Uganda, Kenya and Tanzania (Wanyonyi *et al.*, 1984).

Odontotermes ? *nolaensis* Sjostedt

This was the smallest of the three species. It was collected from the same general area as *O. kibarensis*, also from fallen wood, and again neither nest nor tree could be found.

The species is widely distributed in West Africa, and also in Uganda (Snyder, 1949) and Kenya (Wanyonyi *et al.*, 1984).

Nasutitermitinae

This is another very successful subfamily, with worldwide distribution in the tropics, including all the termites that have nasute soldiers. There are many forest species known to nest in trees, but no arboreal nests were found at Kibale Forest.

Afrosubulitermes congoensis Emerson

This minute termite was found only once, living in tiny galleries within the thickness of the coarse soil walls built by *Basidentitermes* in contact with the *Termes* nest (above). The populous nest included primary reproductives.

The genus and species were described (Emerson, 1960) from six colonies, all of which were found in the nests or mounds of other species of termites. The type colony was collected at Kisangani (Zaire), a mere 600 km from Kibale Forest. Other samples were from Kinshasa (Zaire) and Brazzaville (Congo), all in second-growth woodland. This is the first time it has been recorded in East Africa.

Termite fauna of cleared forest

Only one cleared site was visited, and that only briefly. The site was 3 km west of Bigodi (25 km by road from the Kibale Forest Field Station). The land had been cleared and settled, apparently many years ago, and was partly cultivated and partly under pasture. The grass had recently burned, revealing many termite mounds. Most were small (up to half a metre high), steep-sided mounds of fine grey soil containing nests of a humus feeder, *Cubitermes ugandensis* Fuller (Termitinae), a species that occurs in open sites at altitudes of 1,100–2,400 m in East Africa (Williams, 1966). A minority were large dome-shaped bare mounds of coarse soil. One of these was found to contain a healthy nest of *Pseudacanthotermes spiniger* (Macrotermitinae) and a small secondary nest of *Basidentitermes*.

DISCUSSION

Modes of exploitation by termites

Relatively little termite foraging seemed to occur in the litter layer, by termites foraging on the surface, or entering fallen woody litter from the soil below. On the other hand, levels of attack on wood (dead or alive) while it was still in the canopy seemed to be high. (This is in comparison with lowland tropical rainforest observed elsewhere.) There is no comparable survey data for other tropical forests at such relatively high altitude.

Termite fishing by chimpanzees

The chimpanzees in Kibale Forest have never been observed to fish for termites, and it has been suggested that this represents a cultural difference between them and the chimpanzees at Gombe (Tanzania) and elsewhere. However, the survey reported here indicates that the species of termites recorded elsewhere as having been harvested by fishing (Goodall, 1986) do not occur in Kibale Forest.

Of the termites so far collected, the only one that is large enough and aggressive enough to be a likely prey for termite fishing is *Odontotermes rectanguloides*. It is questionable whether the chimpanzees could locate the termite nests, which are very inconspicuous. Having located one, they would still have difficulty in reaching the termites, as there are no open access holes into the nest.

The termites might become vulnerable when they build flight holes to allow the annual brood of alates to leave the nest. These holes are vigorously defended when in use, which is usually during or immediately after heavy rain. The flight holes are usually built on small conical structures that act as launching platforms for the alates. The cones may be only about 30 cm in diameter and 15 cm in height, or less, and might be difficult to see. But if, like the chamber walls and gallery linings, they are built with red clay that contrasts with the grey topsoil, they may in fact be quite conspicuous, especially when viewed from above by a chimpanzee or monkey up a tree. The likeliest time to find flight holes is at the beginning of the most dependable rainy season in the year. The cones would be constructed and then maintained until flighting had taken place, but the flight holes would be sealed with a thin clay plug when not in use.

Effects of forest clearance on termites

Clearance of the forest drastically affects the nature and quantity of food available to termites, the climate at the soil surface, and the predators and competitors that they encounter. It is thus not surprising to find that the termite fauna of cleared land is very different from that of intact forest.

At Bigodi, the fauna was dominated by termites of two genera that were not found in the forest. Three species were found at Bigodi compared to eleven in the forest, but the termite density seemed to be greater than in the forest.

Such comparisons have been made in low altitude forest and savannahs in West Africa. Riparian forest in Nigeria contained 33 termite species while only 8 species were found on adjacent cultivated land (Wood *et al.*, 1982). Savannah woodland contained 23 species, while adjacent maize fields cultivated for 24 years contained only four species. In southern Cameroon there were 46 termite species in near-primary forest while recently-cleared forest contained 16 species (Eggleton *et al.*, 1995).

Forests at higher altitude have not been studied in so much detail. Okwakol (1994) compared the composition of the soil fauna at sites in eight categories ranging from primary

forest to land that had been cultivated for 20 years. She compared the numbers of individuals of different insect orders, but did not identify them any further.

Implications for future research

This small project points up some important gaps in our present knowledge of the termites of East Africa in general, and Western Uganda in particular.

Biodiversity. The termite fauna of the surviving forests in Uganda remains largely unknown. Preliminary surveys have recently been made in some Kenyan forest reserves by the Centre for Biodiversity at the National Museums of Kenya.

Anthropogenic changes. When land use changes, the termite fauna also changes. Primary forest usually has the greatest number of species, but their biomass has not been estimated in any East African forest. After forest clearance the termite fauna is typically dense but species-poor, and often includes some species that are agricultural pests.

The surviving fragments of protected indigenous forests in East Africa, and the adjacent cultivated lands and pasture derived from forest clearance, provide excellent material for research on this subject. The standard survey methods devised by Eggleton and his colleagues would be suitable here. Such studies should be undertaken as soon as possible, in view of the accelerating damage and destruction of indigenous forest in this area.

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APPENDIX I. CLASSIFIED LIST OF TERMITES COLLECTED IN THE KIBALE FOREST, WESTERN UGANDA.

	Catalogue number *
KALOTERMITIDAE	
Neotermes sp.	1486
Bifiditermes sylvaticus	1500, 1501, 1506, 1507
Glyptotermes sp.	1505, 1464 (alates)
RHINOTERMITIDAE	
Coptotermes sp.	no specimens
TERMITIDAE	
Apicotermitinae	one species, not identified; specimens lost
Termitinae	
Microcerotermes sp.	1458, 1476, 1488, 1502
Basidentitermes ? aurivillii	1452, 1489, 1491
Termes hospes	1451
MACROTERMITINAE	
Odontotermes rectanguloides	1508, 1518
O. kibarensis	1499
O. ? nolaensis	collection of M. Leponce
NASUTITERMITINAE	
Afrosubulitermes congoensis	1453 (reproductives in collection of M. Leponce)

* The catalogue numbers refer to samples in the collection of JPEC Darlington, which will eventually be deposited in the Entomology collection at the National Museums of Kenya.