Asian Journal of Agriculture and Rural Development

journal homepage: http://aessweb.com/journal-detail.php?id=5005

# Effects of Continuous Cultivation of Soil on Termites (Isoptera) Diversity and Abundance in Savannas of Northern of Côte d'Ivoire

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**Abstract**

To highlight the continuous cultivation of soil on biodiversity in savannas of Korhogo in the north of Côte d'Ivoire, termites were studied with regard to their use as bio-indicators of habitat change in the tropics. Using a standardized method, termites were sampled in five types of plots (PCR 1, PCR 2, PCR 3, PCR 10 and PCR 30) which age of continuous cultivation varies from 1 to 30 years in comparison with the primary savanna. The diversity of termites has differed statistically between the habitat types. The species richness highest in the primary savanna (24 species), decreases progressively with the continuous cultivation of soil to reach lowest in the elderly cultures plots PRC 30 (9 species), either 64 % of reduction. Continuous cultivation of soil causes a drastic reduction in soil-feeders group (75 % of reduction on PCR 2). But there was no significant change in termites' diversity between the savanna and the recent culture PCR 1. The cultivation of soil would have, in the first years, a positive effect on the diversity and abundance of wood feeders. This study shows the impact inflicted by the continuous cultivation of soil on the communities of termites in Korhogo region.

**Keywords**: Soils, continuous cultivation, diversity, abundance, termites

## Introduction

Termites are one of the major biotic components of tropical ecosystems where they are, with earthworms and ants, real ecosystem engineers (Jones *et al.*, 1994 Lavelle *et al.*, 1997; Dangerfield *et al.*, 1998; Konaté, 1998). The ecological importance of termites is observed particularly through their role (1) in food webs where they act as main decomposers and are the prey of many other organisms, (2) in soil structure as well as the storage and the decomposition of plant-derived organic matter (Bignell *et al.*, 1983; Matsumoto and Abe, 1979; Konaté *et al.*, 2003) and, finally, (3) as the leading agency bioturbator in some soils.

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Termites have long been presented as the guarantor of the monitoring of natural ecosystems and processed because of their hypersensitivity against environmental changes (Lavelle *et al.*, 1981; Dibog *et al.*, 1998; Eggleton, 2000; Donovan *et al.*, 2002; Konaté *et al.*, 2005) and can be used as biological indicators to assess the state of degradation of ecosystems.

Thus, several studies have shown that heavy deforestation, urban sprawl and the cultivation of the land are nowadays the factors that affect the balance of ecosystems and hence that of biodiversity. Termite habitat degradation has resulted in the extinction of certain species of invaluable ecological and economic importance (Wilson, 1989).

But, in Côte d'Ivoire studies on the biodiversity of termites in connection with the exploitation of the environment are very seldom, and most of the few studies, conducted concerned only forest zone located in the south of the country (Josens, 1972; Sangaré and Bodot, 1980; Konaté *et al.*, 2005; Tra Bi *et al.*, 2012).

The state of biodiversity of termites in relation to their habitat degradation in the northern region of the country has not been done. Yet, each year large areas are destroyed for the establishment of cash crops. Korhogo region is no exception to this reality with the cotton growing development in recent decades.

Zagbaï (2005) recently found that this region is characterized by high population density and scarcity of undeveloped areas. According to him, this situation began since the 1970s. In fact, during the decade 1970 - 1980, development policy and economic rebalanceing in northern Côte d'Ivoire was taken by the authorities. Thus, as of 1973 the Ivorian Company for Textile Development (CIDT) encouraged farmers to increase cotton cultivation with the plow. To facilitate the use of the plow by farmers CIDT therefore freely did the clearing and grubbing of large areas (blocks) by abusively removing trees (Peltre-Wurtz *et al.,* 1991).

This situation would be the origin of the scarcity of unexploited areas (natural savanna), therefore forcing farmers to operate continuously the same land for decades. The animal care and manure from domestic animals supported by chemical fertilizers ensure the maintenance of the fertility of the fields (fallow is rarely practiced).

These practices have certainly affected the diversity of soil fauna and especially of termites in the area. Faced with this situation, it is urgent to make an inventory to check the status of the diversity of termites in this area.

It is in this context that this study was conducted with the general aim to show the effect of continuous cultivation of soil on the biodiversity of termites in the region of Korhogo.Thus, an estimate of the diversity of termites was realized, using the standard method of rapid assessment of biodiversity in crops including continuous operating range in age from 1 to 30 years in comparison with the savannah areas.

**Study area**

Korhogo region is between 8°30 and 10°30 north latitude and 4° and 7° East. It is mainly watered by numerous tributaries white Bandama river.

The climate is dry Sudan tropical with two distinct seasons: the rainy season (monthly rainfall over 50 mm) stretches from April-May to October and the dry season from November to May.The average annual rainfall varies between 1000 and 1600 mm. Rainfall is the major climatic factor (Sinaly, 1978; CIDT, 1990, 2000; Diomandé, 2002 and Hala, 2006). The hygrometry average is 65-70%. The annual average temperature varies between 24°C and 36°C (Nannou, 2001).Granite and shale are rocks substrate characteristics of the region.

The soils are generally weak in humus and of moderate fertility. The sampled areas are the savannah and plots which ages of continuous culture varies from 1 to 30 years.

**Savanna**

In the region, we have the savannah depending on the presence or absence of forests, called shrub lands and grassy savannas. They are unprotected and strongly influenced savannas by human activities such as bush fires and beef herds. Due to the scarcity of natural habitats in the surrounding areas of the city of Korhogo, sampling in this type of habitat was realized in Guiembé, village at 30 km of Korhogo. Three transects were sampled.

**Cultures**

In Korhogo region, farmers practice traditional agriculture, which uses manual tools and modern tools (plows, tractors). Two types of cultures are performed, food crops and cotton farming. The transformation of a natural environment in crop field varies depending on the type of land use.

**Food crops**

The establishment of a field is done in four major steps:

(1) The clearing is to cut down all the undergrowth vegetation and gather it at the base of some trees.
(2) The burning, method which consists to burn all plant debris grouped around trees that are killed on this occasion.
(3) The plow is turning the soil. It is also to make mounds for yam. In this case, the maximum number of trees is spared to tutor (support) the yam plants. For rice cultivation, plowing is done either at the hoes or with oxen yoked. In this case, some of the trees are cut to prevent damage that would cause their fall on crops.
(4) Finally, the seeding is the planting of seeds and cuttings. In general, in these new plots of 1 year, farmers engage themselves in associating crop such as yam - rice- okra or rice - maze.

The pesticides are not used in this type of culture the first year of soils cultivation; Pesticides were not used in this land use type; the ground was covered by woods and dead leaves and the residues of the cultivated crops.

**Growing cotton**

The cotton is a heliophilous plant that requires a lot of light and heat, depending on the different stages of its cycle (Parry, 1982), its culture requires an indispensable sunshine for a good boll opening (Robert-Romuald, 1961).Therefore the establishment of new plots of cotton requires.

(1) That portion of the trees be uprooted or cut down and burned.
(2) Then, the soil is plowed with machines or yoked oxen before planting.
(3) The massive use of chemical inputs: for a good harvest, is recommended to producers before seeding, spraying his plot with herbicides (Roundup (11/ha) or cotodon (4.5 l/ha)).
(4) Then, 6 insecticides treatments are applied on cotton till the harvest with 2 weeks interval.
(5) The use of chemical fertilizers as NPKB 200 to 300 kg/ha, and then, urea 50 to 75 kg/ha).
(6) The plots are then maintained by weeding and earthing up.

## Materials and methods

### Materials

**Material of Termites sampling**

A decameter and the colorful ribbon served to delimit the transect, a GPS (of Garmin mark 60 CSxes) containing a compass of aim for the orientation of the transect, the trowels to search in the litter, the trays and the entomological clamps served to the sorting of the clods of earths, of the piluliers for the conservation of the termites,

**Material of laboratory**

A binocular gnarls of Zeiss type Stereo Discovery.V12, bound to a screen of computer and the version 4.6 of the software AxioVision FREIGHT of Carl Zeiss to make the photos and the measures for the identification of the termites were used.

### Methods

Sampling of termites has been realized in a natural savanna in food crops and cotton farming plots. The selected plots are cultivations of different durations of agricultural activities. The age and past of the plots are determined on the basis of a survey among the farmers. The owners of the plots refer to events (political, religious or social) local or national.

The sampled plots have all for origin the primary savanna. The number of year of continuous cultivation of soils varies from 1 to 30 years. Five types of plots have been sampled in comparison with the primary savanna. These are:

PCR 1: Plots regularly cultivated during 1 year (n = 3)
PCR 2: Plots regularly cultivated during 2 years (n = 3)
PCR 3: Plots regularly cultivated during 3 years (n = 3)
PCR 10: Plots regularly cultivated during 10 years (n = 3)
PCR 30: Plots regularly cultivated during more of 30 years (n = 3)

**Termites sampling**
Termites were sampled using a standardized method designed for rapid assessment of termite diversity by Jones and Eggleton (2000). One transect (100 m long and 2 m wide) was delimiting in each area. Each transect was subdivided into 20 contiguous quadrats of 10 $m^2$ (5 m x 2 m) each in order to standardize the sampling effort. The search is done in transect by successive sections in two steps.

In all quadrats, microhabitats (logs, litter, stumps, twigs, nests, runways sheeting, fallen branches, etc.) were hand-searched up to a height of 2 m above ground level. As the method was designed for use in forests, modifications were made in the savanna by searching for termites between grass tufts or by uprooting grass tufts. All termites encountered were collected.

Twelve samples of surface soil (each about 12 cm x 12 cm to 10 cm depth) were dug out in the quadrat at random locations. The soil was hand-sorted in situ, and a representative sample of termites (around 10 individuals of each caste present) was sorted and put into 70% ethyl alcohol.

Termites collected were both of the soldier and worker castes. In order to sample all 20 quadrats in one day, four trained collectors were deployed, with two people at a time sampling 10 quadrats for 30 minutes per quadrat. Samplings were based on the occurrence of individuals (presence-absence) rather than their number, with respect to the social habit of termites.

**Inventory termite's nests**
Using a tape measure, a square of 100 m x 100 m (1 ha) is delimited in different areas. Arboreal termite's nests (hanging to a tree trunk or branch) and epigeous nests termite's nests (as individualized mounds on the soil) (living and dead) were identified and counted in each plot. The number of nest of each trophic group expressed in number of nest per hectare is presented in the results (Tahiri *et al.*, 2007).

**Termite identification**
Termite identification was conducted at the Ecology and Biologic Evolution laboratory at the Free University of Brussels. This identification of termites is based on caste soldiers and the workers for groups of termites lacking the soldier castes. Specimens of the same genus were determined to species using various classification documents or articles of revision of genus: Hamad (1950), Sands (1959), Bouillon and Mathot (1965), Sands (1965, 1972, 1998), Roy-Noel (1966) and Sjöstedt (1926). Termites were observed under a dissecting microscope (Zeiss Stereo Discovery.V12), connected to a computer screen.

The 4.6 version of AxioVision FRET software from Carl Zeiss allowed performing morphometric measures necessary for identification. The identification of some specimens sometimes requires dissection of workers to observe the enteric valve. After the identification, each species was placed into one of the feeding groups (i.e., fungus growers, soil-feeders, wood-feeders, and grass-feeders) defined according to termite diet), mandible morphology and gut content in the worker caste.

**Statistical analysis**
Ecological indices were chosen to describe the communities of termites. We calculated for each area, specific richness (S) (total number of species sampled). Using Estimates software (version 7.0) the Shannon index (H ') which incorporates both richness and equitability (E) was calculated.

Simpson index (SI**)** was also calculated for each area. The β diversity or similarity index of Jaccard (Sj) was calculated using the following formula: Sj = c / (a + b + c); c = species common to both plots, a = number of species found only on Plot A, b = number of observed species only on Plot B. This index varies from 0 (no similarity) to 1 (identical settings) according Dajoz (1982). Analysis of variance (ANOVA) and the comparison test of Test U de Mann-Whitney ($p < 0.05$) were performed with STATISTICA software (version 7.0) (Ihaka et Gentleman, 1996).

They permit to separately identify between certain variable relations (abundance, species richness, diversity index). The relative abundance of termites in transect is the average number of occurrences of a species collected in transect.

It is based on the incidence (presence = 1 and absence = 0) of the species.

## Results

### Termite's nest density

On the studied plots are found both arboreal Termite's nest and Termite's nest built at the soil surface. Savannah has a higher density of nest than in other areas. Then, the density decreases later due to the number of continuous cultivation of soil (Figure 1).

The nest of soil-feeders termites (nest of *Cubitermes*, *Procubitermes* and *Mégagnathotermes*) and wood-feeders (tree nest of *Microcerotermes fuscotibialis* (Sjöstedt) and *Shedorhinotermes lamanianus* (Sjöstedt) appear to be more sensitive to environmental disturbance.

After only one year of cultivation, arboreal nest of these wood-feeders have completely disappeared and soil-feeders nest after 2 years of cultivation. Contrary to these ones, the first years of areas exploitation seems to be beneficial for some wood-feeders as *Amitermes* which nests were observed only in the recent crop of 1 and 2 years.

Only nest of grass-feeders seem less affected by the cultivation of the soil. On the plantations aged of more than 30 years, it has been observed living nest *Trivervitermes* (2.33 living nests / ha). For fungus-growers termites most of the nest observed (78.10%) in cultures are dead.

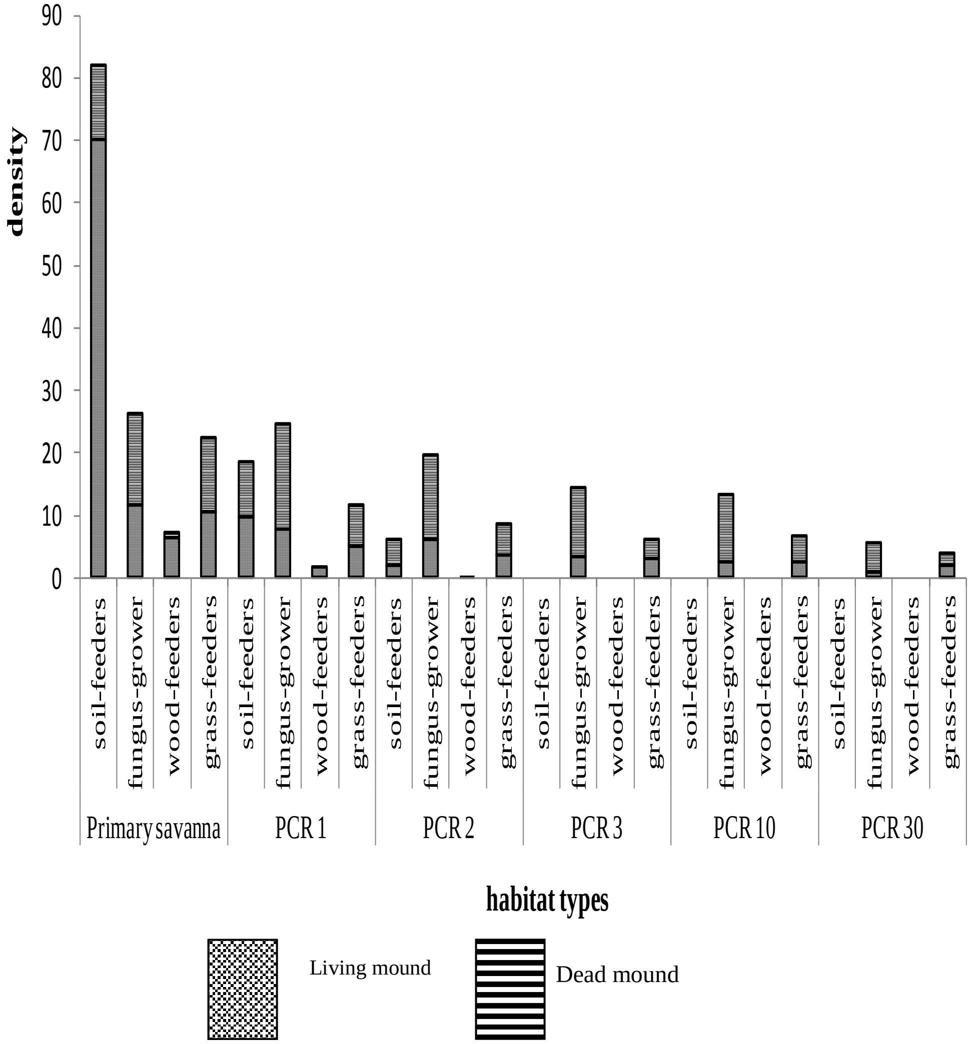


**Figure 1: Density of the termites mounds observed in the different habitats (number of nest per hectare)**

**Species richness of termites**

On all plots, 27 species of termites were collected. They belong to 2 families (Rhinotermitidae Froggatt and Termitidae Latreille) divided into 7 subfamilies and 17 genera in the classification of Krishna *et al.*, 2013: the subfamily of Rhinotermitinae Froggat, Coptotermitinae Holmgren, Nasutitermitinae Hare, Macrotermitinae Kemner, Apicotermitinea Grasse and Noiro, Cubitermitinea Weidner and Termitinae Kemner. The list of termites identified is presented in Table 1. Most of the species were encountered inside the savanna (24 species).

**Table 1: List of termite species collected in the different habitats**

| Familly | Sub-Familly | Species | PCR 1 | PCR 2 | PCR 3 | PCR 10 | PCR 30 | PS | F Gr |
|---|---|---|---|---|---|---|---|---|---|
| Rhinotermitidae Froggatt | Coptotermitinae Holmgren | *Coptotermes intermedius Silvestri* | * | * | * | | | | X |
| | Rhinotermitinae Froggat | *Shedorhinotermes lamanianus (Sjöstedt)* | | | | | | * | X |
| Termitidae Latreille | Macrotermitinae Kemner | *Ancistrotermes cavithorax (Sjöstedt)* | * | * | * | * | * | * | C |
| | | *Ancistrotermes crucifer Silvestri* | * | * | * | * | * | * | C |
| | | *Ancistrotermes guineensis Silvestri* | * | | | | | * | C |
| | | *Macrotermes bellicosus (Smeathman)* | * | * | | | | * | C |
| | | *Macrotermes subhyalinus (Rambur)* | * | * | * | | | * | C |
| | | *Microtermes sp1* | * | * | * | | | * | C |
| | | *Microtermes sp2* | | * | * | * | * | | C |
| | | *Odontotermes pauperans (Silvestri)* | * | * | * | * | * | * | C |
| | | *Pseudacanthotermes militaris* | * | * | * | * | * | * | C |
| | | *Astalotermes sp.* | * | * | * | * | * | * | H |
| | | *Fulleritermes tenebricus Silvestri* | * | * | * | | | * | F |
| | | *Trinervitermes oeconomus (Trägardh)* | | | | | | * | F |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *Trinervitermes trinervius (Rambur)* | * | * | * | * | | * | F |
| | *Trinervitermes geminatus (Wasmann)* | * | * | * | * | * | * | F |
| | *Cubitermes subcrenulatus Silvestri* | * | * | | | | * | H |
| | *Cubitermes fungifaber* | * | | | | | * | H |
| | *Megagnathotermes Silvestri* | * | | | | | * | H |
| | *Procubitermes jöstedti (vonRosen)* | | | | | | * | H |
| | *Basidentitermes potens* | * | | | | | * | H |
| | *Amitermes guineencis* | * | * | | | | | X |
| | *Amitermes evuncifer Silvestri* | * | * | * | * | * | * | X |
| | *Microcerotermes fuscotibialis (Sjöstedt)* | * | * | | | | * | X |
| | *Microcerotermes sp* | * | * | * | * | * | * | X |
| | *Pericapritermes urgens Silvestri* | * | | | | | * | H |
| | *Promirotermes holengrni* | | | | | | * | H |
| Total | 7 | *27* | 22 | 18 | 14 | 10 | 9 | 24 |

The subfamily of Macrotermitinae is the most diverse with 9 species. It followed that of Termitinae and that of Cubitermitinea (formerly part of Termitinae group) with respectively 5 and 6 species. Four (04) species were collected in the family of Nasutitermitinae.

The subfamilies of Rhinotermitinae, Apicotermitinae and Coptotermitinae are the least represented with one species each.

**NB:** C**:** fungus-growers; H: Soil-feeders; X: Wood-feeders, F: grass-feeders; PCRn: Plantation and n: number of year of continuous cultivation, FGr: feeder group.Six (06) species are present as well in the primary savanna as in cultures.Three (03) species were sampled only in cultures plots and 4 species were collected only in the primary savanna.

The species richness of termites has differed statistically between the habitat types. Of 24 species in the primary savanna, the species richness decreases and passes to 9 species in PCR 30 (either 64% reduction). This reduction is 44 % and 56 % respectively in PCR 3 and PCR 10.

**Species diversity and relative abundance of feeding groups**

The Shannon index shows that diversity is significantly influenced by the habitats types (F = 188.6 and p = 000). This index, higher in Savannah (H= 2.88) varies little between PCR 1, PCR2 and PCR3 with a mean index of 2.73. But it reached its lowest values in PCR 10 (H' = 2.01) and PCR 30 (H = 1.72) (Table 2).

**Table 2: Variability of the diversity index in the habitats types**

| | Primary savanna | PCR1 | PCR2 | PCR3 | PCR 10 | PCR 30 |
|---|---|---|---|---|---|---|
| **Relative Abundance (N)** | 272 | 286 | 329 | 237 | 125 | 73 |
| **Species richness (S)** | 24 | 22 | 18 | 14 | 10 | 9 |
| **Shannon (H')** | 2.88 | 2.91 | 2.77 | 2.52 | 2.01 | 1.72 |
| **Simpson (1-D)** | 0.94 | 0.94 | 0.93 | 0.91 | 0.84 | 0.78 |
| **Equitability ( E)** | 0.94 | 0.94 | 0.96 | 0.95 | 0.87 | 0.78 |

Simpson index (SI) following variations of species richness with values between 0, 78 and 0, 94. The highest values were observed in the savanna and PCR 1 (0.94). PCR 10 and PCR 30 recorded the lowest values with 0.84 and 0.78 respectively.

The Equitability (E') is highest in the savanna and recent cultures PCR1, PCR2 and PCR 3, but the highest value was recorded in PCR 2 (E = 0.96). PCR 30 registered the lowest Equitability (0.75).

The hierarchical clustering dendrogram based on Shannon index distinguishes 4 groups (I, II, III and IV) (Figure 2).

Group I is composed of savanna and PCR 1 and PCR2 with highest Shannon index, the second group is composed of PCR 3. The Group III includes PCR 10 and the group VI, PCR 30 with lowest Shannon index.

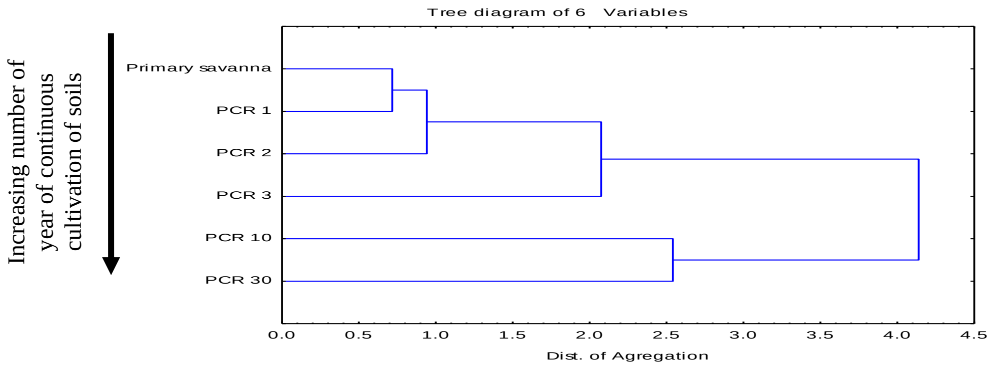


**Figure 2: Classification of habitat types based on the termite species composition using Shannon index as the distance between groups**

The comparative analysis (Kruskal- Wallis test) of habits by pairs shows that there was no significant difference (p = 0.071) between PCR 10 and PCR 30, although the dendrogram do not place them in the same group. Similarity assessment between the different areas confirms these observations (Table 3).

**Table 3: Similarity of termite's community in different habitats**

| Habitat 1 | Habitat 2 | Nb of total species | Nb of shared species | Similarity (β-diversity) |
|---|---|---|---|---|
| Primary savanna | PCR 1 | 26 | 20 | 0.77 |
| Primary savanna | PCR 2 | 27 | 15 | 0.56 |
| Primary savanna | PCR 3 | 26 | 13 | 0.50 |
| Primary savanna | PCR 10 | 25 | 9 | 0.36 |
| Primary savanna | PCR 30 | 25 | 8 | 0.32 |
| PCR 1 | PCR 2 | 23 | 17 | 0.74 |
| PCR 1 | PCR 3 | 23 | 13 | 0.57 |
| PCR 1 | PCR 10 | 23 | 9 | 0.39 |
| PCR 1 | PCR 30 | 23 | 8 | 0.35 |
| PCR 2 | PCR 3 | 19 | 14 | 0.74 |
| PCR 2 | PCR 10 | 18 | 10 | 0.56 |
| PCR 2 | PCR 30 | 18 | 9 | 0.50 |
| PCR 3 | PCR 10 | 14 | 10 | 0.71 |
| PCR 3 | PCR 30 | 14 | 9 | 0.64 |
| PCR 10 | PCR 30 | 10 | 9 | 0.90 |

PCR 1 and PCR2 have a positive effect on the diversity and relative abundance of wood-feeders termites.

The number of species of this group passes from 4 (in the primary savanna) to 5 species in PCR1 to PCR 2.

Only *Shedorhinotermes lamanianus* (Sjöstedt) and *Microcerotermes fuscotibialis* (Sjöstedt) species disappeared respectively in PCR 1 and PCR3. Two (2) other species, *Coptotermes intermedius* Silvestri and *Amitermes guineencis* were collected in exploited plots. The number of species of wood-feeders is low in PCR 30 (2 species).

The relative abundance of this group increases from 13% in the savanna to 28% in PCR 1 (Figure 3), but relative abundance is lowers in PCR 10 and PCR 30. The fungus-growers group of termites was the least affected by the cultivation of the soil.

Only 3 species (out of 8) of fungus-growers group disappeared in elderly field PCR 30.

This group dominates the abundance of termites in the cultivated plots, with maximum abundance of 88% in PCR 30 (Figure 3).

The cultivation of the soil also has an effect on the group of grass-feeders termites. The number of species of this group decreases from 4 species in the savanna to 1 species in PCR 30. However, many individuals belonging to this group are collected in the cultivated plots.

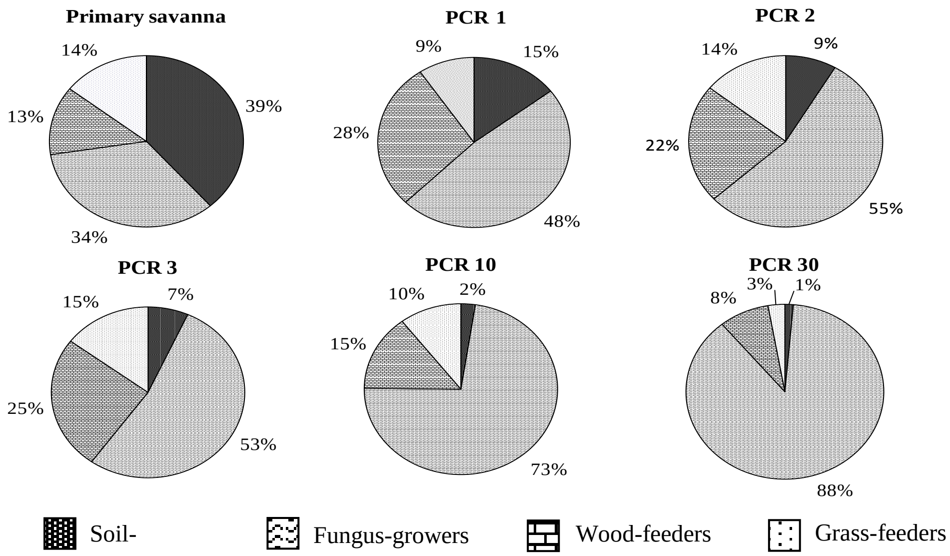


**Figure 3: Relative abundance of feeding groups of termites in the habitats types**

The species *Trinervitermes geminatus* seems to resist the continuous cultivation of soil. This species has been harvested in PCR 30.

The effect of soil cultivation is relatively lower in this group compared to the soil-feeders group. Continuous cultivation soil causes a drastic reduction in soil-feeders species. Indeed, from the second year of cultivation (PCR2), we observe a reduction of the soil-feeders diversity from 8 (in savanna) to 2 species. The relative abundance changes as well from 39% in the savanna to 15% in PCR 1 (Figure 3).

The species *Astalotermes sp* seems to resist to the continuous cultivation of soil but it has been collected only once in PCR 30.

## Discussion

In total, 27 species of termites were collected in different habitat types.
These results are very different from those obtained by Tano (1993) in the natural savanna of Booro - Borotou. This author has identified 42 species in the watershed of Booro-Borotou.

This difference is linked to the particular nature of the savanna of Booro-Borotou. These studies have shown that this savanna has a great species diversity and major ecological groups, despite its small size (136 ha).

Compared to other African savannas, species diversity encountered would place this among the richest savanna sampled in Africa.

The low density of the termites' nestin cultured plots and the high proportions of dead mounds are linked to their systematic destruction at the time of plot cultivation by farmers (Tahiri *et al.*, 2007).

Termites' abundance is relatively high in all sampled plots. This is explained by the fact that sampling was conducted in October-November period marked by the end of the rainy season. Sarr (1999), working in fallows in Senegal showed that the densities of termites were higher at the end of the rainy season.

This high density of termites could be explained by the fact that during the end of rains seasons, termite foraging activities are more because the termites consume imports dry plant matter ant preferentially residuals of culture in the upper soil horizons.

The evident foraging activities enabled an easy collection of a great number of species. The species richness of termites is high in Savanna (24 species) and decreases with the continuous cultivation of soil to reach its lowest values (9 species) in PCR 30. The effect of cultivation depends on the trophic group.

The fungus growers' groups are dominant in all areas and they are less affected by the continuous cultivation of soil.

Their ability to live in disturbed habitats is due to their remarkable adaptation favored by the symbiotic relationship they have with Termitomyces fungus.

This fungus degrades wood fragments that become digestive for termites (Matoub, 1993 Guedégbé *et al.*, 2008).

The relative abundance of wood-feeders varies depending on the habitat types.

The abundance of this group almost doubles the first years of cultivation of the soil. Although most soil disturbance resulting from the loss of the canopy have negative effects on soil fauna in general, it should be noted that the dead plant material lying on the ground after the destruction of the canopy may have opposite effects.

The cut wood constitutes nutrient reserves, shelters or nesting sites for this group of termites as meant Rameau *et al*. 2000.

Their effects on termites are much more quantitative and qualitative as some species of wood-feeders as *Shedorhinotermes Silvestri* were not collected in cultured plots.

When the soil is continuously cultivated for so many years, this significant amount of food decreases considerably and affecting thus the populations of wood-feeders termites. The positive effect of soil cultivation on the abundance of termites could also be explained by increasing plant diversity.

Deconchat and Balent (2001) showed that in short term, and especially locally, the destruction of the shrub will cause an increase in plant diversity which could be related to the effect of setting light to the ground.

Soil exploitation also affects grass-feeders termites. The species which seems most resistant is *T. geminatus* as was observed other authors (Sands, 1965; Lepage, 1974). These authors observed that *T. geminatus* was more resistant to precarious conditions compared to certain species such as *T. trinervius*.

This could be explained by the fact that *T. geminatus* constitutes significant reserves of stubble or grass, while most of the other species of the same genus could not build only less or no reserves (Lepage, 1974).

Unlike the first two groups, soil-feeders are strongly affected by the continuous cultivation of soil. Several reasons justify this significant decline of the diversity and abundance of soil-feeders termites especially in the exploited areas.

Firstly, the massive use of chemical inputs. Indeed, for some crops such as cotton, herbicides and insecticides is recommended to use for a good harvest. To this must be added the use of chemical fertilizers and a significant maintenance plots with weeding and hilling work (Ochou *et al.,* 2007).

All these practices are meant for reducing the biodiversity of soil macrofauna and particulary of the termites (Kouassi, 1999).

These results are similar to observations made in other areas (Basu *et al*, 1996; Dibog *et al.*, 1999; Jones *et al.*, 2003; Eggleton *et al.*, 2002; Donovan *et al.,* 2007; Black and Okwakol, 1997).

These authors showed that the use of land and a high anthropogenic activity related to the massive and often abusive use of inputs affects the trophic structure and species richness of termites.

Lavelle (1987) observed that soil cultivation can quickly lead to the disappearance or reduction of certain communities responsible for soil fertility.

Epigeous nests of soil-feeders termites are destroyed in the crops, and this contributes to the disappearance of these species (Kooyman and Onck, 1987 and Wood *et al*., 1977). Only termites that have nests and systems of deep underground galleries are less affected by disturbances (Wood et Johnson, 1978).

This observation could explain the rapid disappearance of soil-feeders Cubiter-mitinae while soil-feeders Apicotermitinae are still observed in the plots cultivated continuously for 30 years (PCR 30). Wood *et al.* (1977) reported the presence of termites Apicotermitinae in plots cultivated continuously for 40 years, in Nigeria.

During the first 2 years of cultivation, it was found that the number of soil-feeders species decreases meaning a reduction of 75%. Black and Okwakol (1997) estimated that the disappearance of soil-feeders species is linked to a significant reduction of the rate of organic matter due to cultivation.

More recent studies have shown that some insects such as ground beetles (*Carabus auratus*), are influenced by agronomic practices as these insects are more abundant on soils where the work is reduced and in agricultural systems where the use of chemicals is reduced (Nash *et al.,* 2008).

This idea is supported by several authors who have shown that the removal of trees and a higher frequency of increased weed control which support some tropical agricultural systems can increase the limit nesting site for many species (Armbrecht and Perfecto, 2003; Philpott and Armbrecht, 2006).

However, this result is in disagreement with studies that have found no effect of the operating system (Melnychuk *et al.*, 2003; Purtauf *et al.,* 2005a) Or agronomic practices (Lalonde *et al.,* 2008; Ekroos *et al.,* 2010) on the diversity and abundance of insects.

Recently, in the United States, Werling and Gratton (2008) have shown that increasing the diversity of beetles in the fields of potatoes, but this increase was related to the presence of non-cultivated areas around these fields.

Yeo *et al.* (in press) also in Lamto, did not found significantly difference between the diversity and abundance of the ants observed in the natural area and those observed in the cultivated plots. They explained this by the fact that during the first year of land use, farmers usually planted the feet of banana plantain together with other crops.

After harvesting the annual crops, bananas continue to grow and create shady undergrowth with a relatively large amount of litter (leaves of annual crops).

These microclimate conditions are favorable for the establishment of ants. This author has not assessed the impact of the continuous cultivation of the soil on the ants' diversity.

The land affected by his studies were used for 1 or 2 years and then abandoned by the farmers to become fallow, unlike our study zone, farmers are forced to cultivate the same plots continuously for decades.

## Conclusion

This study allows highlighting the impact of the continuous cultivation of soils on termite's diversity and abundance in the region of Korhogo.

The results show that the high diversity recorded in the primary savanna lowers progressively according to the number of year of continuous use of soil. The trophic composition of termites is also affected, especially the group of soil-feeders that disappears when soil is exploited in continually.

However, this transformation of the habitat seems to have at first, a positive effect on the abundance of some wood-feeders as *Amitermes* and *Coptotermes* which abundance increased in the first years of soil cultivation. These results encourage the practices of sustainable land use, to allow natural recovery after a period of agricultural disturbance.

This approach will contribute to the conservation of termites' biodiversity.

**Acknowledgments**

This work was carried out with the support of Belgian National Focal Point to the Global Taxonomy Initiative *(cbd-gti@naturalsciences.be)*. We sincerely thank Dr. Marie Lucie SUSINI Manager of this program at the Royal Institute of Natural Sciences of Belgium to finance my training in Belgium. We also thank Prof. Jean Deligne and Prof. Guy Josens for their help in the determination of species.

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