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ON THE ECOLOGY OF A TERMITE HILL AT SANTINIKETAN, WEST BENGAL

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The ecology of termite hill at Santiniketan, Birbhum in association with *Odontoternes redemanni* was studied. Along with *Xylaria* sp., species of *Aspergillus, Chaetomium, Paecilamyces, Penicillium and Verticillaster* were isolated from the hill. The association of these fungi indicate their possible role in cellulose decomposition.

INTRODUCTION

Termite hills are produced in nature due to the activity of termites and these hills attain variable shapes depending on the local environmental conditions. Within the hills the termite nests consist of under ground tunnels for the safe mevements of termites and several chambers including a central chamber with minute ventilation and fungal gardens. Actually these fuugal gardens are honey-comb shaped and harbour various kinds of fungi, usually microscopic, such as *Xylaria* (Petch, 1913) and spherules of *Termitomyces* species (Bose, 1923 ; Bakshi, 1951). Heim (1948, 1951, 1958) also reported the occurrence of fungi in fungal gardens. These combs are, in fact, nurseries occupied by newly hatched termite young workers. According to Grasse and Noirot (1958), these fnngi of the combs affect favourably the growth and survival of termites. Grasse (1945) also considerered that the fungal gardens act as sources of vitamins for the growing population of termites.

Emerson (1933), Synder (1949), Roonwal and Sen Sharma (1960) and Ebling (1968) studied the systematics of termites. Diverse aspect of biology and the control of these insects have been studied by Ebling (1968), Howse (1970), Krishna and Weesner (1970) and Lee and (1971).

In Santiniketan, termite hills are very common and their development is favoured by the climatic condition of the area which is generally considered as a hot and dry place. In rainy seasons and after several heavy showers, crops of *Termitomyces microcarpus* Heim suddenly appear on these hills, but they disappear within two days (Roy & Bhattacharya, 1986). As a part of our study on the ecological relationship between fungi and termites, a preliminary investigation was made to find out the fungal flora and their relationship with the associate termite fauna within a termite hill at Santiniketan. Results obtained are presented in this paper.

MATERIAL AND METHODS

A cone shaped termite hill of about 200 cm in diameter and 85 cm in height above the soil, made up by *Odontotermes redemanni* (Wasmann) in the vicinity of our Department was selected for our study. For convenience of detailed study the cone was arbitrarily divided into 3 zones viz. upper zone, i.e. the zone near the environment ; inner zone. i.e at the deeper part of the cone and an in-between middle zone.

Soil samples from each of the 3 zones were collected in sterilised polythene packets and stored for future study. Combs which were found in the chambers of inner zones were also collected for study. The hill was opened by sterilized equipment and special care was taken to see that the study materials were not contaminated. As July-August is the monsoon season, one-collection of materials was made on the 10th August, 1986, when it rained for several consecutive days and weather was rather humid and another collections was made on the 10th September, 1986, when it rained occasionally and the climate was comparatively dry. From each sample, population of fungal colonies in the termite hill and also the *p*H, moisture, carbon and nitrogen contents were determined.

Fungal population was studied from soil samples by the standard dilution plate method (Fred and Wakman 1928). The dilutions were plated on 2.5% malt extract agar. A dilution of 10^{-3} was found to yield satisfactory result. Colony counts were made after 3 days incubation at room temperature (28°—35°c). For colony count from each sample, avaeage of colony counts from 3 replicates of each medium was taken as an unit.

Moisture content was studied by air drying the samples to 85°C. The *p*H values were determined by using a glass-electrode pH meter. Nitrogen content was studied by followlng Kjeldahl micromethod in which the organic matter was digested by concentrated H_2SO_4 and nitrogen converted quatitatively to ammonia. For determining carbon. the sample was treated with H_2S in $K_2Cr_2O_7$ and carbon was converted quantitatively to carbon dioxide.

To detect the fungi present within the combs forming the gardens. samples taken aseptically from combs were studied following the same procedure as the soil samples. Three combs also were kept in humid chambers in the laboratory to find out if any macroscopic fungi grew out of them.

For behavioural study of the termites and their relationship with the fungi in the fungal gardens two fungal gardens of eliptical shape (10 cm × 7cm × 5 cm, 12 × 10cm × 6 cm) were reared in the laboratory condition. A glass jar of rectangular size 26 × 27 × 30 cm was used for the study. Moist sandy soil was poured in the glass jar upto a height of 9 cm. Both the fungal gardens were kept separately in polythene bag and was placed on the sand surface of the experiment jar. For studying

the termite population of the fungal gardens, two freshly collected combs more or less similar in size as the above, from the experimented hill were kept under light extraction chamber for 24 hours.

RESULTS AND DISCUSSION

After 4 days of incubation white strands of mycelia appeared on the comb which were kept in humid chambers of laboratory. Of the strands, some were thicker from which narrower branches anastomosed freely in all directions. Within 10 days the strands became transformed into block tough stromatic tissue. However, after 20 days, transverse section through some of these stromatic tissues showed peripherally embedded young perithecia proving thereby that these stromatic bodies were actually produced by some species of *Xylaria*.

The data of chemical analysis of the soil somples as well as of the combs and the average number of fungal colony per gram of the sample are given in Table 1. It will be evident therefrom that the fuugal population was higher in August, i.e,, during rainy season than in September where there was occasional rain. But the fungal population within the comb remained almost stable. Obviously environmental conditions such as atmospheric humidity and water content within the samples influenced the fungal population.

Table 1. *Average number of propagules and chemical analysis of samples collected from four zones of the termite hill*

Region of the termite hill where samples were collected	Time of year	Average number of Fungi per gram of sample	Moisture content (% net weight)	Carbon content (% dry weight)	Nitrogen content (% dry weight)	pH
Upper Zone	August	47,000	5.2	0.37	0.040	5.4
	September	40,000	4.5	0.36	0.040	5.1
Middle Zone	August	40,000	5.0	0.36	0.037	4.6
	September	30,000	4.0	0.35	0.035	4.7
Inter Zone	August	35,000	3.2	0.35	0.043	4.2
	September	20 000	3.0	0.33	0.039	4.3
Comb	August	70,000	7.6	37.02	0.030	4.4
	September	68,000	7.4	36.35	0.028	4.3

The chemical analysis shows that the moisture within the upper and middle zones was lower in September than in August. It was also observed that the moisture content within the inner zone was lower than within the upper two zones. Possibly rain water flowing over the termite hills caused this difference in moisture content of the different zones of termit hill, as deeper zones obviously

have less chance to be affected by this flowing water than the upper zones. Moisture content within the comb, however, was relatively much higher.

As regards the carbon content, it was fairly high in comb than in soil samples and also it was almost constant in all the soil samples tested. Nitrogen was least within the comb. Environment also affects the *p*H values as it was found that the *p*H values in the inner zone and in the comb were lesser than those in the upper two zones.

Fungi isolated from soil samples and from the comb are also given in Table 2. Fungi representing 6-genera were isolated from comb. This is expected as the comb with high moisture content is definitely favourable for cultivation of fungi. An interesting finding is the isolation of a fungal species ef Basidiomycetes group that produced hyphae with clamp-connections. Although 3-isolates were recovered, their growth characteristics and hyphal anatomy indicate that they represent a single species. Unfortunately the species could not be identified.

Table 2. *Fungi isolated from Termite hill of* Odontotermes redemanni

Name of fungi	Upper zone	Middle zone	Inner zone	Comb
Aspergillus sp.	+	+	+	+
Basidiomycetes sp.	-	+	+	+
Chaetomyces sp.	-	-	-	+
Paecilomium sp.	-	+	-	+
Penicillium sp.	+	+	+	+
Trichoderma sp.	-	-	-	+
Verticillaster sp.	+	-	-	+

+ = present, — = absent

The termites are benefitted in several ways by such cultivated fungal gardens within the nests. It is believed that the stromata are masticated by the termites and utilised for building new combs and dead remains of *Termitomy ces* are used as food and as a source of vitamins. The great abundance of anastomosing mycelium within the comb helps to maintain the humidity there and the mycelium is also used as food of the termites. The isolation of *Aspergillus*, *Penicillium*, *Trichoderma Chaetomium*, *Paecilomyces* and *Verticillaster* from termite nests also suggest their possible role in decomposition of cellulose in this environment, as it is a known fact that the termites do not produce cellulase and therefore cannot decompose cellulose, though cellulose decomposition is essential for the existence of termites themselves.

Within 30 minutes after replacing the fungal garden in the experimental jar, the termites cut the polythene bag and entered into the soil of the jar. After a few days several tunnels were noticed within the sand from outside through glass. The termites were found to move inside these tunnels from outside upto 18th September

1986, i.e. for 38 days. After that no movement of the termite was noticed from outside. The sand was examined and the whole colony was found dead. They made a cone shaped mini-termite hill inside one of the polythene bags. The mound was more or less like a small hillock, 6 cm. high, and having oval shape of 12 cm. × 8 cm. Inner chamber of this mound was connected with the outside through eight small rounded openings, each of 22 mm. in diameter. Thickness of the well of the chamber varied from 1 cm. to 0.5 cm. Ratios of the different castes of the extracted termit individuals was 33.3% nymph, 60.6% worker and 6.1% soldier when 1000 individuals were taken into consideration. Presence of a huge number of worker indicates that perhaps they play an important functional role in making the fungal garden.

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