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# ALTITUDINAL VARIATIONS IN THE MOUND NESTS OF TERMITES *ODONTOTERMES WALLONENSIS* AND *O. OBESUS*

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**ABSTRACT**

**The nesting form of the mound nest of species *Odontotermes wallonensis* (E. Wasmann) and *Odontotermes obesus* (Rambur) was studied in hilly and tropical deciduous forest area of Kakoijana Reserved Forest of Abhayapuri (Bongaigaon district). It was compared to the plain village forest area of Baksa district (Bajegaon Pather). The morphometric measurement such as height, circumference, depth of the mound nest and the royal chamber from the surface of the ground was recorded along with weight of fungus garden and queen and their sections were photographed. The outcomes revealed that the location of the nest influences the structure and characteristics of the nest. The young and established mound nests of species *O. obesus* and *O. wallonensis* in hilly and plain area had different shape, sizes and colour. The shade of the fungus garden was buff i.e., yellowish brown in young nest whereas it was blackish brown in established nests. The queen termite and the royal chamber unable to be excavated were in hilly area as compared to the plain area. In some of the mound nests, no traces of the queen termites and rest of the castes were observed; and the mound was dead i.e., abandoned after the death of queen termite.**

**Key words:** *Odontotermes wallonensis, Odontotermes obesus*, royal chamber, fungus garden, queen termite, nesting form, excavate, circumference

The termites are social insects which lives in nests (termitoria), they are polymorphic and commonly referred to as "white ants", belonging to the phylum Arthropoda, class Insecta and order Isoptera. According to Emerson (1959) the insect society is a high level, intra-species super organism that are composed of individual multicellular organisms, but exhibiting all of the colonies organismic, but exhibiting all of the colony's organismic properties. The colonies are established and maintained perfectly because of the perfect division of labour in the termite society. Along with social behaviour, termites also tend to produce homeostasis by self-regulation of nutritional, optimal microclimatological and defensive condition such as temperature, humidity and develoment (Emerson, 1956, 1959). The division of labour is met with by different castes such as reproductive, workers and soldiers. The modification of each caste is perfect to perform the specialized functions of the colony, foraging, feeding, defence etc. There are two reproductive casts-primary and secondary reproduction. The primary reproductive includes male and female alates, they swarm their wings, pair and attempt to establish a new colony (Veeranna and Basalingappa, 1984). The king shows changes during the rest of the life and its exclusive task is to mate the queen and fertilize the egg. In contrast, the queen undergoes drastic postmetamorphic changes and demonstrate externally by the increase in size as a result of development of over 1000 ovarioles in each ovary and the ultimate increase in the formation of numerous eggs (Basalingappa and Tharabai, unpublished results). In Macrotermitinae the queens are more or less immobile and usually spend their whole lives in especially build segment of the nest which is known as the royal-chamber (Springer, 2018). This study explore the variations in nests of *O. wallonensis* and *O. obesus*.

## MATERIALS AND METHODS

This survey analyzed the occurrence, location, structures and characteristics of the mound building termites during April to October. The study has been conducted in hilly and dense forest area of Kakoijana Reserved Forest of Bongaigaon district Assam; and plain village, forest area of Baksa district, Assam. Study of the cited locations were performed for examining the emergence, essence, character, structure and number of the mounds of *O. obesus* and *O. wallonensis*. Both the young and established (adult) mound nests chosen the study.

The vertical section of the young mound nest and the established mound nest were taken in the detailed pattern following Smeathman (1781). The morphometrics measurement of the mound nest i.e.,

peak, cirumference, mound intensity and the royal chamber from the floor degree were recorded using the non-stretchable flexible measuring strip (tape) of width-13 mm and length-60"/ 150 cm in both the species. The weight of fungus garden and queen termite were recorded using the digital precision scale after being excavated from the mounds wearing hand gloves. The section of young and established mound nest fungus garden and queen termite and their sections were photographed using the Canon EOS 1200D model for hilly area of Kakoijana (Bongaigaon) and Redmi note 9 pro phone cameras for plain village forest area of Baksa. The age of the mound nests was determined by observing the size of the mound i.e, smaller the size, nest younger.

## RESULTS AND DISCUSSION

Nesting form of young mound nest of O. obesus in the hilly and plain area (Table 1). The shape of the mound nest of this species have been conical in form with one or more than one hole cone shaped turrets upright in position starting from the ground surface in hilly are (Fig. 1-A) as well as in the plain area (Fig. 1-B). The thickness of the wall of this species i.e., turrets in the young mound was around 0.8-1.8 cm in hilly area and 0.5-1.8 cm in plain area. In both areas, the turrets walls were mostly seen to be possessed with aeration pits and simple cavity containing aggregated fungus garden, these cavities when enlarged, was observed extended towards the chimneys. The fungus-garden appears to be concave at the base in plain area and the colour of the fungus garden were found to be yellowish brown (Fig. 1-C) and concave in shape. The royal or regal chamber were bow shaped and usually ranged from 3.3-5.5 cm in hilly area and 3.2-5.5 and 2.55 cm in plain area respectively. The royal chamber and queen were easy to locate and excavate in the plain area as compared to the hilly area. Lastly, by the colour of the fungus garden after being excavated from the mound nest (yellowish brown and blackish brown) (Fig. 1-C and F and Fig. 2- C and F) (Table 1).

Later the emergence of copularium (i.e., first chamber build by a newly mated paired sexual termites) the technique of egg laying, hatching of young ones also achieving the maturity takes place between hundred to hundred thirty days. The laborers are discovered feeding and forgaging the royal couples. The first batch of workers are visible excavating a chamber over the regal cell and constructing a small fungus-garden in which the fungus gets larger. The workers start building the mound over the land as soon as the populace increases in the territory. Usually, workers boost only one turret in the beginning. The innermost surface of turrets and mound wall are plastered using their mouth parts. The lively formation of the mound was determined all through the wet and spring seasons in place the summer months. The employees of this species enlarged their nests by joining fresh construction to the current ones.

The mound structures of the established nest of both the hilly (Fig. 1-D) and plain area (Fig. 1-E) were found to be complicated and larger in size with added galleries, runways and vaults. The nest was found growing in a vertical direction and turrets were fused to one another. The inner wall was found to be similar with the young ones but with numerous aeration pits. The form of fungus lawn (garden) seemed just like the younger mound nest besides their colour and size. The coloration of the fungus garden in established nest is blackish brown (Fig. 1-F) and huge masses of eggs were observed. The area of the royal chamber differed from the young nest they are centric and excentric in some cases. The royal chamber is usually completely big, thick, having exits and entrance holes. Its longitude and wideness extend from 6.0 to 12 cm and 2.5 to 3.2 cm in hilly area and 7 to 12 cm and 2.5 to 3.5 cm in plain area. The fungus garden was found situated nearby royal chamber. In the village forest area, the nest was less complicated and it was easy to excavate the royal chamber (Fig. 1-G) and queen termite (Fig. 1-H) whereas the nest was dead (abandoned) in hilly area with totally complex structure and unable to locate the royal chamber, also no traces of queen termite and other castes were seen (Table 1).

The mound nest studied in both the hilly and plain area was dome shaped erected on the ground with 1 or 2 turrets (Fig. 2-A, B). The turret wall was slender around 0.8-2.5 cm having aeration pits. The interior structure was very simple cavity with aggregated fungus garden and it was plate like (dome) in appearance, with so many entries and exit holes which were more or less horizontally oval (Table 2). The fungus garden was yellowish brown in colour (Fig. 2-C). The figure of the royal chamber was quite alike to the species *O. obesus* and situated below the fungus garden at the base of the mound (Kumar et al., 2006). The queen termite was easy to excavate and situation of royal chamber was easy to locate as the mound nest were simpler in structure in plain village forest area of Baksa district whereas in the hilly area of Kakoijana Reserved Forest in Bongaigaon district it was difficult to excavate out the royal chamber and the queen termite from the mound as the tree

Table 1. Young and established mound nests of *O. obesus* in hilly and plain area- measurements

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Young mound nest | | | | | | | |
| S. No. | | 1 | 2 | 3 | 1 | 2 | 3 |
| Mound circumference (cm) | | 87 | 155 | 150 | 48 | 75 | 120 |
| Mound height (cm) | | 19 | 25 | 20 | 18 | 20 | 25 |
| Mound depth (cm) | | 32 | 25 | 22 | 26 | 22 | 35 |
| Depth of the royal chamber (cm) | | Unable to locate | Unable to locate | Unable to locate | 21 | 17 | 30 |
| Situation of the royal chamber | | Unable to locate | Unable to locate | Unable to locate | Centric | Centric | Centric |
| Fungus garden weight (kg) | Hilly area | 2.80 | 1.22 | 1.52 | 0.55 | 0.58 | 2.55 |
| Queen termite weight (gm) | | Unable to excavate | Unable to excavate | Unable to excavate | 1.3 | 1.9 | 3.2 |
| Established mound nest | | | | | | | |
| Mound circumference (cm) | | 372 | 188 | 447 | 155 | 158 | 348 |
| Mound height(cm) | | 67.2 | 61.5 | 112.5 | 65 | 66 | 125 |
| Mound depth(cm) | | 70 | 91 | 65 | 40 | 60 | 122 |
| Depth of the royal chamber (cm) | | Unable to locate | Unable to locate | Unable to locate | 21 | 17 | 102 |
| Situation of the royal chamber | | Unable to locate | Unable to locate | Dead mound | Excentric | Excentric | Excentric |
| Fungus garden weight (kg) | | 2.80 | 1.22 | Nil | 4.80 | 8.20 | 2.25 |
| Queen termite weight (gm) | | Unable to excavate | Unable to excavate | Nil | 5.8 | 7.8 | 10 |

Table 2. Young and established mound nests of *O.wallonensis* in hilly and plain area- measurements

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Young mound nest | | | | | | | |
| Sl.No. | | 1 | 2 | 3 | 1 | 2 | 3 |
| Mound circumference (cm) | | 107.5 | 75 | 85 | 150 | 170 | 210 |
| Mound height (cm) | | 43 | 28 | 20 | 20 | 18 | 11 |
| Mound depth (cm) | | 44 | 39 | 45 | 26 | 22 | 35 |
| Depth of the royal chamber (cm) | | Unable to locate | Unable to locate | Unable to locate | 39 | 40 | 45 |
| Situation of the royal chamber | | Unable to locate | Unable to locate | Unable to locate | Centric | Centric | Excentric |
| Fungus garden weight (kg) | Hilly area | 1.57 | 1.23 | 0.86 | 1.48 | 1.01 | 2.30 |
| Queen termite weight (gm) | | Unable to excavate | Unable to excavate | Unable to excavate | 2.00 | 2.15 | 4.09 |
| Established mound nest | | | | | | | |
| Mound circumference (cm) | | 278 | 206 | 431.5 | 330 | 350 | 451 |
| Mound height (cm) | | 87.4 | 60.5 | 140.5 | 18 | 27 | 101 |
| Mound depth (cm) | | 56 | 35 | 60 | 30 | 32 | 58 |
| Depth of the royal chamber (cm) | | Unable to locate | Unable to locate | Unable to locate | 35 | 40 | 102 |
| Situation of the royal chamber | | Unable to locate | Unable to locate | Unable to locate | Excentric | Excentric | Excentric |
| Fungus garden weight (kg) | | 3 | 3.90 | 6.24 | 2.20 | 1.60 | 2.25 |
| Queen termite weight (gm) | | Unable to excavate | Unable to excavate | Unable to excavate | 8.35 | 6.50 | Nil |


Fig. 1. Structure of young and established mound nest of *O. obesus* along with their fungus garden, royal chamber and queen termite being excavated. (A) Young mound nest in hilly area. (B) Young mound nest in plain area. (C) Fungus garden of young mound (similar in plain and hilly area). (D) Dead (abandoned) established mound nest in hilly area. (E) Established mound nest in plain area. (F) Established mound nest (similar in plain and hilly area). (G) The queen termite of established mound found in royal chamber of plain area. (H) The queen termite excavated from the mound nest of plain area.

provides additional support. They are more complex and extensive, also provided with some additional structural support for the tunnels and chambers.

Established mound nest in hilly area of *O. wallonensis* was observed to be cone shaped with a greater number of turrets (Fig. 2-E). The turrets were spread on the ground and in some of the cases turrets were of open type in plain area (Fig. 2-D) with many vaults, they were arranged in a horizontal manner. The vaults were present mostly vertical and adjacent to one another and seemed like saucer. Vaults were connected to each other by galleries and in the vaults the fungus garden were housed. The fungus garden shape was similar in shape and it was blackish brown in colour (Fig. 2-F). The royal chamber is usually a bit fragile consisted with numbers of entry, exit holes and somewhat horizontally oval in shape. The royal chamber is usually located in excentric. The length of the regal chamber differed from 7 to 14 cm and 2.5 to 3.6 cm respectively in hilly area. The royal chamber was unable to locate and excavate in hilly area of the Kakoijana Reserved Forest (district Bongaigaon). Some of the huge established nest was also found abandoned and after excavating the mound nest no traces of termites and fungus garden were found. Whereas in the plain forest area of the village (Baksa district) the longitude and wideness of the royal chamber respectively varied from 7.0-9.5 and 2.6-3.6 cm. The royal chamber was easy to locate and excavate in the plain area (Table 2).

There are several key aspects of the nesting sequence of the termites, these are structure of nest, nest location, division of labour, reproduction, nest defence mechanisms. Termites plays an important role as decomposers, by breaking down dead plant materials and returning the nutrients back to the soil. This process helps in enriching the soil and the growth of plants. Termites also have a positive impact on the physical structure of the soil as they tunnel through the soil by creating channels which somehow allows water and air to circulate through it which improves the fertility of the


Fig. 2. Structure of young and established mound nest of *O. wallonensis* along with their fungus garden. (A)Young mound nest in area. (B) Young mound nest in hilly area. (C) Fungus garden of young mound nest (similar in plain and hilly area). (D) Established mound nest in plain area. (E) Established mound nest in hilly area. (F)Fungus garden of established mound nest (similar in both plain and hilly area).

soil and structure. The nest building engineering of the termites is quite fascinating, behind all of the present investigated data there is one significant foundation i.e., the environment take part as a crucial role in the structure and look of nest. In hilly areas of tropical deciduous forest (Kakoijana Reserved Forest), termites build their nest in a variety of locations, including underground and nearby trees, so the mound nest build in hilly areas was found to be more complex and it was difficult to excavate the queen termite along with its royal chamber. Whereas in the plain village area of Baksa (Bajegaon Pather) the mound nest was simple and easy to locate the royal chamber as well as to excavate the queen termite.

Therefore, the following research describes that the environmental factors and conditions such as soil quality, presence of rocks, roots of trees brought the difficulties in excavating the queen termite and locating the royal chamber in hilly areas thus, also making it difficult to identity the species as well but rest of the properties, nest building pattern, characteristics and appearance of the mound nest has helped out in identifying the mound nest of the species *O. obesus* and *O. wallonensis*. Nesting structures also provides defences against predators and buffering of environmental changes, with the elaborate structures of termite mounds conferring stable microclimates in temperature, humidity and ventilation are well managed (Luscher 1961, Singh et al. 2019). Termites are a prototypical example of the extended phenotype given their ability to shape their environments by constructing complex nesting structures and cultivating fungus gardens. Such engineered structures provide termites with stable, protected, habitats and nutritious food sources, respectively (Hongie Li, Chris Greening, 2022). As the species termites are soil designers they perform as an essential position in working of numerous

tropical and subtropical ecosystem. "They may work as decomposers in dry and semi-dry environmental conditions, and exerts supplementary influences throughout their formation of biological structures (mounds, vaults, galleries and sheetings, etc.) with specific chemical of soil and bodily residences. Also, effects the division of natural assets for example like water and nutrients within the panorama and various soil microorganisms, animals and also the vegetation" (Jouquet P. 2011). Termites mounds of certain species also typically contain chambers to store food and, for fungus farming termites, cultivate fungi for food (Holt and Lepage 2000, Schmidt et al. 2014).

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**AUTHOR CONTRIBUTION STATEMENT**

A K Haloi and Nirmali Brahma conceived and designed this research problem, Nirmali Brahma collected data and conducted experiments, A K Haloi and Nirmali Brahma analysed the data. Nirmali Brahma wrote the manuscript.

**CONFLICT OF INTEREST**

The authors declare that they have no conflict of interest.

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