

Structure of *Odontotermes hainanensis* Light 1924 (Isoptera, Macrotermitinae) Nests in the Red River Dyke System in Vietnam

by

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Abstract

The article refers about the new structure characteristic of *Odontotermes hainanensis* termite nest on the Dikes of the Red river in Vietnam. Structure of *O.hainanensis* termite's nest is inclusive of the following parts: main chamber, auxiliary chamber, tunnel, chimney...these parts change as per researched dyke area. As usual, dimension of main chamber of *O. hainanensis* termite's nest is minimal in the midland area and maximal in the plain dyke. Depth of main chamber and auxiliary chambers is deepest in the midland dyke and shallowest in the plain dyke. Number of auxiliary chambers in the dyke system of the Red River delta is larger than number of auxiliary chamber in the midland dyke and the coastal dyke.

Keywords: Termite damage dyke, *Odontotermes hainanensis*, termite nest

Introduction

Termite species *Odontotermes (O) hainanensis* Light, 1924 was discovered for the first time in Vietnam in 1927 at Hanoi dyke by Bathelier. According to Nguyen Duc Kham, this is the popular species, it allocates all over the North. This termite species is often met and it is the most dangerous species on the dyke of Red river, delta region and coastal delta region. The structure of the termite's nest is the important sign in proposing the solution for exploring and treating the termite's nest. In this article, we present the study results on some changes in the structure of *O. hainanensis* termite's nest in different dyke regions in the Red river dyke system in Vietnam.

Materials and methods

The study was implemented at the termite's nests from 2005 to 2008 on Red river dyke system.

Biological characteristics of the termite's nest was observed and taken notes at the field of the dyke according to the season and according to the operation month of termite. Studying the structure of the termite's nest through digging according to the cutting slices from the outside to the center of the distribution area of the swarming hole of the termite's nest in the swarming season. The cutting slice was from 2-3m long, 0.1-1.8m deep. The cutting slices were 0.2m from each other. On each cutting slice, taking photograph, describing by diagram, the data was taken notes at the field. In order to see clearly the relationship between the structures of the nest, clay mortar was injected into the termite's nest through air ventilation cave, after 3 days, implementing the anatomy of the nest for observation.

The structure of the nest was studied according to 3 regions: midland region was the dyke region located on the hill soil, delta region was the dyke region located on river alluvial soil, coastal region was the dyke region located in the sphere adjacent to 10-km coast. In each region, digging 10 termite's nests.

The receiving data was treated according to biological statistics method and based on calculation tool of Microsoft Excel software.

Results and discussion

General structure of O. hainanensis termite's nest on Red river dyke

According to the study result on external morphology and the structure of 30 nests, we see that structure of *O. hainanensis* nests had basic general characteristics as follows: all termite's nests were sunk completely in the dyke body, they only appeared the swarming hole from the end of February to the middle of May, under the swarming hole, there was extended cavity, the height of this cavity was often from 1 to 2cm, sometimes it was up to 7cm but the width was maybe up to 20cm, it was called exit hole. Most of the exit hole were the concentration place of many tunnels going from the bottom up and did not contain fungus garden. The termite's nest had a main chamber, many auxiliary chambers. Some nests had up to 70 auxiliary chambers, there was complex tunnel, chimney system. The structure of *O. hainanensis* termite's nest on Red river dyke was also suitable with the descriptions of previous authors.



Fig 1. Sign of *O. hainanensis* termite nest

The data on the structure of *O. hainanensis* nest in 3 midland, delta and coastal regions on Red river dyke system was presented in table 1.

In the termite's nest, the depth and size of the empty cavity and the size of the tunnel were important factors for determining the harming degree of the termite's nest to dyke and dam. The deeper the cavity was, the greater the volume was and the bigger the diameter of tunnel was, the higher the harming degree caused by termite would be. Based on the data presented in table 1, we concentrate on analyzing some important criteria such as the depth of main chamber, the diameter of main chamber, the number of auxiliary chamber, the diameter of auxiliary chamber, the depth of auxiliary chamber, characteristics of the tunnel of the termite's nest aiming at studying their distribution characteristics on the regions of Red river system.

Table 1. Structure of *O.hainanensis* in the Red dyke river system

Order	Structure	Midland	Delta	Coastal region
1	Nest	Subterranean nest	Subterranean nest	Subterranean nest
2	Amount of exit hole /nest	20,4 ± 5,2	18,8 ± 2,7	19 ± 3,2
3	Diameter of main chamber (cm)	31,2 ± 2,3	39 ± 4,3	32 ± 1,6
	Depth of main chamber (cm)	190 ± 12,3	78 ± 3,3	114 ± 8,8
4	Amount of auxiliary chamber/nest	12,4 ± 1,7	43,7 ± 9,0	9,7 ± 1,6
	Diameter of auxiliary chamber (cm)	13,8 ± 0,6	13,8 ± 0,6	8,8 ± 0,3
	Depth of auxiliary chamber (cm)	39,2 ± 5,6	36,6 ± 2,7	32 ± 1,1
5	Diameter of tunnel (cm)	2,27 ± 0,44	2,63 ± 0,46	0,76 ± 0,08

Main chamber of termite's nest of *O. hainanensis* species at different dyke regions

Studying the structure of *O. hainanensis* main chamber on different dyke regions was considered on 3 aspects: the diameter of main chamber, the depth of main chamber and some characteristics in main chamber. The data on the depth distribution, the diameter of main chamber between dyke regions was verified by t-Test statistic function with $p = 0.05$ and $p = 0.01$.

Main chamber of the termite's nest was often thought to be the biggest cavity in the nest where starting tunnels to auxiliary chambers, the source of chimney (air ventilation cavities), it was the main living place of the termite. The study result showed that over 80% number of nests having main chamber were within the distribution sphere of swarming of the termite's nest.

On the system of Red river, the main chamber (table 2) in the delta region had the biggest size (39.0 ± 4.3 cm), the difference had statistic significance compared to the midland and coastal regions. As stated above, in the dyke system of Red river, the density of the termite's nests in the delta region was much greater than that in midland region, in the consideration of the diameter of main chamber, in the delta region, it was often greater.

Table 2. Diameter of the main chamber of *O.hainanensis* termite's nest in 3 different areas

Dyke system	Area	Amount of nest	Diameter (cm)	Confidence Level (P)
Red river	Midland	10	$31,2 \pm 2,3$	$P_{(TD-DB)} < 0,01$
	Deltal	10	$39,0 \pm 4,3$	$P_{(DB-VB)} < 0,05$
	Coastal regions	10	$32,3 \pm 1,6$	$P_{(TD-VB)} > 0,05$

Note: TD: midland; DB: delta and VB: coastal regions

On the dyke system of Red river, the main chamber at the dyke in the midland region was located at the greatest depth (190 ± 12.3 cm) and reduced the most strongly at the delta dyke (only 78 ± 3.3 cm deep), reduced the depth over a half compared to the dyke in the midland region. To the dyke in coastal region, they allocated at the depth of 114.5 ± 8.8 cm.

Like this, on the dyke system of Red river, the depth of main chamber of *O. hainanensis* allocated according to a rule: the deepest was on midland dyke and the hollowest was on delta dyke. This happening was not simultaneous with the change in size of main chamber. That thing showed that distribution of main chamber of *O. hainanensis* termite's nest with different depths at different dyke regions may be adaptable characteristics of termite with the environmental condition.

The studies on size and depth of the main chamber of *O. hainanensis* termite's nest at dyke in midland, coastal regions (locating deeper to over twice deeper than delta dyke) on the dyke system and especially the depth distribution rule of the main chamber of *O. hainanensis* termite's nest on dyke regions (the deepest was in midland region, it reduced strongly in delta region, and it increased in coastal region) on the dyke system of Red river, it had important significant in order to serve directly the survey, exploration and termite prevention to attain high efficiency.

Table 3. Average depth of *O.hainanensis* termite nest in diferrent area

Dyke system	Area	Amount of nest	Depth	Confidence Level P
Red river	Midland	10	$190,0 \pm 12,3$	$P_{(TD-DB)} < 0,01$
	Delta	10	$78,0 \pm 3,3$	$P_{(DB-VB)} < 0,01$
	Coastal region	10	$114,5 \pm 8,8$	$P_{(TD-VB)} < 0,01$

Characteristics of main chamber

The main chamber of the termite's nest is often thought to be the biggest chamber in the nest, this thing is often true for species belonging to termite variety having other fungus garden. But in *O. hainanensis* termite species, each nest often has only 1 main chamber with the biggest size, but sometimes, in some nests outside the main chamber, there are cavities with size similar to the main

chamber. This phenomenon was met at some termite's nests on many dyke sections. The interior structure of the main chamber is completely different from the structure of the cavity having similar size as the main chamber. In the main chamber, there are often many fungus gardens, the fungus gardens area arranged into many layers stacking each other, and the auxiliary chamber has similar size to the main chamber. It often has only 1-layer fungus garden. The important thing is that from auxiliary cavities having similar size as the main chamber, there is no chimney.

The fungus garden in the main chamber has arc type, it is often big, the diameter is often nearly equal to the diameter of the main chamber. The fungus garden in the main chamber often includes 2 - 3 layers. The upper layer is often the biggest, has dark color, the lower layer had brown yellow color. Between the layers of fungus garden often has soil dividing wall to form the bearing frames of the fungus garden and small hollow cavities, this is the place containing egg and young termite. This observation is also suitable with the previous comments of the previous authors (Ngo Tri Coi 1999; Bui Cong Hien et al 2000; Nguyen Van Quang e al., 2000; Trinh Van Hanh, 2008)



Fig. 2. Fungi garden in the main chamber trong khoang chính

As being stated above, some nests have auxiliary chamber with similar cavity to the main chamber and also contains fungus garden but the fungus garden has only 1 layer. Relating to the main chamber, there is a structure called royal cell. Royal cell is the living place of king and queen. For species belonging to *Macrotermes* spp., one of the main factors to determine the main chamber is the presence of king and Queen termites in the main chamber, and for the nest of *O. hainanensis* species, it is not so.

Table 4. Position of royal palace compared to main chamber in *O. hainanensis* nest

Distribution position of royal cell	In main chamber or ≤ 20 cm from main chamber	> 20 cm from main chamber	Find no royal cell	Number of investigation nest
Amount of nest	18	39	23	80
Ratio (%)	22,5	48,8	28,7	100

The investigation data at 80 dig nests to catch Queen termite showed that only 22.5% number of nests had royal cell at the bottom, near the main chamber or not over 20 cm from the main chamber. But the majority of nests (more than twice) had position of royal cell far from the main chamber. In detail, 39 nests (making up 48.8%) having King termite and Queen termite does not locate in main chamber, in royal cell, there is small and independent oyster-shaped slot, >20 cm far from main chamber. Number of remaining termite's nests (28.7%) is not found in the royal cell. They may be collapsed or buried in the course of the termite's nest surgery.

Royal cell connects to main chamber by small tunnel with average cross-section 0.5-1 cm. Location of royal cell may be equal to higher than main chamber. Depending on each depth of main chamber on the dyke in different areas, depth of the royal cell is different. Trinh Van Hanh (2008) thought that over 90% royal cell of *O. hainanensis* termite is at 60-90 cm deep. We saw that said date

is conformable with termite's nests locating in the dyke of the plain region. And in other dyke areas, depth of the royal cell is different from the depth of main chamber as stated in above depth location of main chamber.



Fig 3. Royal cell of *O. hainanensis*

(a)-Royal cell in bottom of the main chamber; (b)- Royal cell not in the main chamber

Auxiliary chamber of O.hainanensis termite's nest on different dyke areas

Other than main chamber, in the termite's nest, there are many auxiliary chamber. As usual, these auxiliary chambers are hemispherical, flat bottom of flat-off bottom. The auxiliary chamber are researched as per criteria: number of auxiliary chambers, diameter of auxiliary chambers and location depth of auxiliary chamber. Compare results of this research on the different dyke areas as tested by t-Test statistic function. The research result shows that number of auxiliary chambers ranges from 12.8 ± 1.9 to 43.7 ± 9.0 chambers in 1 nest.

Table 5. Informations of *O.hainanensis* auxiliary chamber in the Red river dyke

Area	Amount of chamber/nest	Confidence Level P	Diameter (cm)	Confidence Level P	Depth (cm)	Confidence Level P
Midland	$12,4 \pm 1,7$	$P_{(TD-DB)} < 0,01$	$13,8 \pm 0,6$	$P_{(TD-DB)} > 0,05$	$39,2 \pm 5,6$	$P_{(TD-DB)} > 0,05$
Dental	$43,7 \pm 9,0$	$P_{(DB-VB)} < 0,01$	$13,8 \pm 0,6$	$P_{(DB-VB)} < 0,01$	$36,6 \pm 2,7$	$P_{(DB-VB)} < 0,01$
Coastal region	$9,7 \pm 1,6$	$P_{(TD-VB)} < 0,05$	$8,8 \pm 0,3$	$P_{(TD-VB)} < 0,05$	$32,0 \pm 1,1$	$P_{(TD-VB)} < 0,05$

In the dyke of the Red River Delta, number of auxiliary chambers is quite large, there are 43.7 ± 9.0 chambers in 1 nest, especially there are up to 70 chambers in 1 nest as possible.

Character of tunnel of O.hainanensis termite's nest

In the termite's nest, termite soldiers and termite workers can move from this place to other by the underground complicated tunnel system. In terms of structure, we can divide them into some main forms as follows: tunnel connecting auxiliary chambers, tunnel connecting auxiliary chambers and main chamber, tunnel connecting from auxiliary chambers up the ground to search for food, tunnel from main chamber sinking to take water. Besides, there are special caves with big dimensions, starting from main chamber up to the ground called as chimney.

From main chamber, there are two types of cave: Cave to auxiliary chambers and chimney. The chimney has biggest cross-section and is upward, theirs diameter may be up to 15 cm. The majority of upward caves have ventilation function. They is closely upward to the dyke face but is not direct with the outside, about 20-30 cm far from the dyke face. They branch into smaller cross-section caves from 0.5-2.0 cm and closely upward the dyke face, only 1-2 cm far from the dyke face. However, there is also nest with system of large chimney, diameter up to 10 cm and far from the ground only some centimeters. Number of chimney in 1 nest may be up to 25 caves (both big cave

and small cave). When finding the chimney, it will be easy to find main chamber, because it is direct to the main cave. This is an important and quite advantageous character to define main chamber of termite's nest which is treated by manual method (digging) or by chemical, clay mortar pouring equipment to control and cover the termite's nest.

Conclusions

Structure of *O.hainanensis* termite's nest on the dyke of Red River in Vietnam is inclusive of the following parts: main chamber, auxiliary chamber, tunnel, chimney...these parts change as per researched dyke area:

- As usual, dimension of main chamber of *O. hainanensis* termite's nest is minimal in the midland dyke and maximal in the plain dyke.
- As usual, depth of main chamber and auxiliary chambers is deepest in the midland dyke and shallowest in the plain dyke.
- Number of auxiliary chambers in the dyke system of the Red River Delta is larger than number of auxiliary chamber in the midland dyke and the coastal dyke.

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