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Beneficial, Harmful Effects and Physical Control of Termites in The Tropics

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Abstract
Termites are eusocial insects with both beneficial and harmful effects to the land and human beings and largely destructive effects on structural facilities built with wood. In this community, it was observed that termite infestation was rapidly expanding, with termitaria of various sizes dotting the landscape, thus reducing the spaces of land available for agricultural use and other productive ventures. An aggressive move was made to remove the termitaria, through manual labour by means of excavation. The measure proved largely successful, since the removal of the queen, with attendant burning of the colony perimeters led to the termination of termite infestation and re-claiming of the land. The termites identified in the study were *Reticulotermes species*. Another study will be necessary to identify these insects molecularly down to the species level.

Keywords: Beneficial, Effects, Physical Control, Termites, Tropics

Introduction

Termites are successful, social insects, which survive by consuming a wide variety of decaying plant materials and live in colonies. Thus, they have been described as detritophagous and eusocial insects (Korb *et al.,* 2012). They are terrestrial and polymorphic. Members of the family Termitidae are referred to as Higher termites while Lower termites are members of Mastotermitidae, Hodotermitidae, Rhinotermitidae, etc. (Pervez, 2018). Termites are categorized according to their distribution, feeding habit and moisture requirements. Lower termites are further categorized as dry-wood, damp-wood and subterranean, based on their feeding habits and habitat preferences (Pervez, 2018).

Termites are found in all the continents of the world, except in Antarctica (Korb *et al.,* 2012). The diversity of termites is low in Europe and North America, with only 10 species described in Europe and up to 50 species known in North America. In South America, over 400 species of termites have been described (UNEP, 2014). About 2,972 species of termites have been classified currently, out of which 1000 species are found in Africa. About 2,105 species of known termites are regarded as "Higher termites", in the family Termitidae (Korb *et al.,* 2012). In Asia, up to 435 species of termites have been described, with most species distributed in the tropical and subtropical regions south of the Yangtze River (UNEP,2014).

Recent studies show that termites belong to the same phylogenetic group as cockroaches, and both belong to the same order Blattodea. They are traditionally placed in the insect order Isoptera, with *Cryptocercus* their sister taxon (Lo *et al*., 2000; Inward *et al*., 2007b; Djernaes *et al.*, 2015). Similar to ants, bees and wasps (order Hymenoptera), termites live in colonies and organize themselves into a caste system consisting of sterile individuals called "workers" and "soldiers". Each colony, enclosed in a termitarium, begins from two sexually mature individuals, the male, known as the "king" and the female, known as the "queen". Both form a lifelong monogamous pair (Nalepa and Jones, 1991).

Biology and Life Cycle of Termites

Termites are hemimetabolous in their life cycle, undergoing an incomplete metamorphosis, which consists of the egg, larva, few instars of nymph and adult stages. Little is known about moulting in termites due to the absence of synchronization in the timing of their moultings, the cryptic nature of subterranean termites and their long, life cycle. A termite's colony attains its maximum size within 4 to 5 years, with over 60,000 to 200,000 workers (Pervez, 2018).

The life cycle of termites begins with a nuptial flight, during which winged reproductives (alates) are dispersed to colonize new sites. The mating pair shed their wings and establish a new nest. The female (queen) oviposits, the eggs hatch and the emerging nymphs metamorphose into different forms called castes. The castes are determined during post-embryonic development, with each first or second instar larva becoming either a worker, soldier or reproductive (Laine and Wright, 2003). The reproductive caste can have multiple forms and generations (Thorne,1996). The primary reproductives are the first mating pair, which established, and became the king and queen in, the colony. Winged reproductives initiate nuptial flights in April and May (Philip,2004). Following nuptial flights, the queen, accompanied by the king, searches for a site suitable for nesting. Such sites must be moist, with wooden materials. With a successful creation of a royal chamber, the queen begins to lay eggs. The eggs are yellowish-white in colour and require up to 50 and 60 days for incubation. The queen lays about 3000 eggs per day (Su and Scheffrahn, 2000; Thompson,2000). Parthenogenesis (the practice by which the female individuals are able to reproduce without mating with their male counterparts) is also known to occur in termites, but in very low percentages (Pervez, 2018; Matsuura *et al*., 2002).

In termite colonies, division of labour is based on different castes. The caste assemblage differs according to the species of termite. Workers are sterile male and female individuals which are responsible for all labour activities required in the nest (Pervez, 2018). Young (minor) workers are responsible for feeding, grooming and caring for the young individuals in the colony. On the contrary, Older (major) workers are responsible for more hazardous jobs of foraging for food and nest building. But Hinze and Leuthold (1999) inferred that age played an important role in polyethism, which is the division of duties amongst the insect colony members (Pervez, 2018). Workers may be True workers or Pseudergates. The latter are false workers which do the job of workers but still possess the capacity of becoming Reproductives (Roison and Korb, 2011).

Soldiers are responsible for defending the colony. They have distinct head capsules and powerful mandibles for defence against invaders. They cannot feed on their own but depend on workers to be fed. They are sterile and do not reproduce. Soldiers become mature within one year and may live up to 5 years (Myles, 2005).

There are many generations of reproductives. The primary (winged) reproductives (king and queen) are alates and, hence, show evidence of vestigial wings. The queen has the longest life span of up to 25 years (Myles,2005). Neotenic reproductives are the future generation reproductives which often replace the king or queen upon their deaths. Neotenic reproductives may be ergatoid (worker-derived) or nymphoid (reproduced from the nymphal stage) (Thorne,1996).

Termites obtain nutrients from cellulose, which they are unable to digest. In order to digest cellulose, termites depend on microorganisms (bacteria, protozoa, fungi, etc.) which live symbiotically in their gut. Subterranean termites construct long tubes made of mud and faecal matter. Within these exploratory tubes, the termites are protected from predation and desiccation. These tubes are usually conspicuous and tell-tale signs of potential termite infestation (Pervez,2018).

Both biotic and abiotic factors affect the survival, growth, development and reproduction of termites (Omkar and Pervez, 2002). Biotic factors are other forms of life which destroy or prey upon termites, which include ants, birds, reptiles, mammals and human beings. Abiotic factors include temperature, pH and rainfall. There is a positive correlation between increase in temperature and the rate of development, growth and reproduction in termites. For instance, the subterranean termite *Reticulitermes*

Hesperus Banks prefers soil temperatures ranging from 29 to 32 ^{0}C (Smith and Rust, 1994). With their soft, cuticular integument, termites, especially the subterranean species, are easily prone to desiccation. Therefore, moisture or relative humidity is an important abiotic factor which is necessary for their survival. They depend on moisture available directly from their environments or food sources. The nest material moisture requirements of subterranean termites range from 23 % to 50 % by weight (Sponsler and Appel, 1990).

BENEFICIAL EFFECTS OF TERMITES

1) **Organic re-cycling**
   Because of their ability to feed on a wide range of plant and animal materials, including living, dead and decomposing items and even faeces, termites act as excellent scavengers and decomposers. Thus, their activities aid in the re-cycling of organic waste materials, promotion of soil composition and structure, enrichment of soil fertility, aeration and drainage (Donovan *et al*., 2001a).

2) **Traditional medicine**
   It is claimed that termites have useful applications in the traditional treatment of several illnesses, such as asthma, bronchitis and influenza (Alves, 2009). Some communities in Nigeria consider the termite, *Macrotermes nigeriensis*, as having the potency for spiritual protection and in the treatment of wounds (Wikipedia, 2023).

3) **Used as food**
   Some human cultures make use of termites in their diets as spice (Paoletti *et al.,* 2003). In the southern part of Nigeria, many communities catch termites in the form of alates, during their nuptial flights. With the onset of the rainy season in early April, the reproductives swarm and show a positive phototropism, swarming around electric lights at night. Large containers filled with water are deposited near the source of light. The insects that fall into the water are removed, dried, fried and eaten to serve as a very cheap but rich source of protein.

4) **In science and technology**
   The termitaria and biology of termites have inspired researches in fossil fuels with the aim of producing cleaner, renewable energy. Due to the assemblage of microorganisms, the guts of termites have been regarded as an efficient bioreactor, capable of converting hydrogen to cellulose acetate from cellulose. Also, some architectural designs have been copied from the design of the internal chambers of termitaria (Wikipedia,2023).

HARMFUL EFFECTS OF TERMITES

1) **As Pests**
   The most harmful effects of termites are noticed in their activities as pests of wooden structures in buildings, furniture and even books. Termites also cause considerable loss to agriculture by attacking trees and crop plants such as maize, rice, okra, etc. In tropical Africa, 24 species of termites are considered pests. Worldwide, the genus Coptotermes has the highest number of pests, with 28 species known to cause most damage (Su and Scheffrahn, 2000). Termites generally attack trees with soft wood fibre. It is not known, why they do not so much attack fast growing plants.

METHODS OF TERMITE CONTROL

Like in other insects, the control of termite populations in an area can be undertaken through chemical, biological and mechanical methods.

1) **Chemical method**
   Chemical method involves the use of repellent and nonrepellent soil termiticides. The six main types of insecticides include organophosphate, carbamate, pyrethroid, neonicotinoid, phenylpyrazole and avermectin (Chen *et al.,* 2015). Liquid termiticides are either neurotoxins or inhibitors of mitochondrial respiration. The usual technique is to inject the chemical into the soil to establish a toxic concentration. The use of proper application technique is important to reduce the impact of the chemical to the environment and its flora and fauna. When termites forage on termiticide-treated territories, they acquire the chemical and inadvertently share it with unexposed

inmates within the colony. This method is referred to as Horizontal transfer (Khan and Ahmad, 2018).

2) **Biological method**
This involves the use of natural products such as oils, seeds, bark, leaf, fruit, root, wood, resin, etc. Other natural predators of termites include bacteria, fungi, nematodes, spiders and ants (Verma *et al*., 2009). Entomophagy is the practice of consuming termites as part of the human diet (Srivastava *et al.,* 2009). This practice can also assist, though minimally, in reducing the population of termites.

3) **Mechanical method**
This is the use of physical methods to remove or utterly destroy termites and their termitaria. Early detection of termite infestation is very profitable. Visual detection is the normal procedure for dry-wood termite detection, even though it is not 100% effective (Evans, 2002). Manual excavation of termitarium, removal of the queen and subsequent burning of the site is an inexpensive method of control of termite infestation at a particular site. This method was employed in the present study.

MATERIALS AND METHODS

The study site was a farm land located within residential quarters in Calabar metropolis of Cross River State, Nigeria. The land was infested with termitaria which were sparsely located all over the landscape. Using manual labour, the termitaria were excavated deep down to the royal chamber of the queen. Materials needed for the job were spade, matchet, and pickaxe.

Plate 1: A Termitarium before excavation at the study site.

RESULTS

After digging down to the royal chamber, the queen was removed. The queen, a beautiful creature, milky white in colour, The distended abdomen measured 5 cm in length and 2 cm at the broadest width. The thorax and head region measured up to 1.5 cm. The head a pair of short antennae, with an eye on either side of the head. The abdomen consisted of 5 to 6 segments. Like all insects, there were three pairs of jointed legs. The queen was identified as that of subterranean termite *Reticulotermes species.*

A ventral view of queen termite *Reticulotermes species* (excavated from a termitarium at the study site).

A dorsal view of queen termite *Reticulotermes species* excavated from a termitarium at the study site (preserved in 10 % formalin showing the head region).

DISCUSSION AND CONCLUSION

Infestation by termites has ruined some areas of land in Calabar, thus reducing the immediate availability of the land spaces for agricultural purposes and other uses. Early detection of termitaria can lead to their destruction and elimination from the land through manual labour. Once the termitaria are excavated, and the queen identified and removed, the colony becomes vulnerable and easily dysfunctional.

Physical excavation of termitaria, supported by burning, is a cheap method of control, when compared with chemical method and other sophisticated techniques. Elimination of termitaria by excavation is very suitable to the African situation with lean resources.

It is, hereby, concluded that although termites also have their benefits as food for man and animals and also useful in land and ecological re-engineering, their harmful effects, to crops and other wooden structures used in building constructions, renders them as dangerous pests in most communities. Physical methods of control, e.g. through manual excavation is a cheap, adaptable method for their control in areas with lean infrastructural resources.

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