Applied Entomology
Insecticidal Methods of Pest Control

Household Pests – Termites (The White Ants)

Dr. Anupam K. Varshney
Zoology Department
Hindu College
University of Delhi
Delhi-110007

INTRODUCTION

Termites exhibit the most complex social life of all known insects. Although commonly referred to as '*white ants*', these insects are neither white nor ants. Termites are brown or pale-coloured, soft-bodied insects, which are readily distinguished from ants by the absence of a narrow pedicel (stalk) between thorax and abdomen. They live in highly organized colonies with well-differentiated castes, which exhibit division of labour. Termites are generally considered notorious insects, but they are highly significant from the ecological point of view.

1. SYSTEMATIC POSITION

Phylum : Arthropoda
Subphylum :Mandibulata
Class : Hexapoda
Group : Ectognatha
Subclass : Pterygota
Infraclass : Exopterygota
Order : Isoptera

2. GEOGRAPHICAL DISTRIBUTION

Termites are one of the most abundant terrestrial animals on earth. Their numbers are so huge that it is estimated there might be several metric tons of termites for every human being on earth.

Termites are reported from all zoo-geographical regions of the world. These are mainly tropical and sub-tropical insects, categorized into four distinct types, viz. Dampwood, Drywood, Subterranean, and Arboreal/Mound builders. Overall, termites comprise nearly 2,858 species distributed in about 286 genera (Table 1).

Table 1: TERMITES (ISOPTERA) OF THE WORLD

Family/Subfamily	Number of Genera	Number of Species
Hodotermitidae	3	19
Kalotermitidae	21	448
Mastotermitidae	1	1
Rhinotermitidae	13	359
Serritermitidae	2	3
Termitidae	241	2007
Apicotermitinae	42	206
Macrotermitinae	14	363
Nasutitermitinae	91	675
Termitinae	92	763
Termopsidae	5	21
Total	**286**	**2858**

In India, termites are widely distributed in red, sandy loams, lateritic and red loam soils. Gujarat and Rajasthan provide an interesting field of study on the isopteran fauna over certain types of diverse ecosystems varying from the arid region in the east up to the salty marsh land of Rann of Kutch in the west and over and above, the Aravallis. About 253 species under 54 genera of seven families have been documented from the Indian region (Source: Wildlife Institute of India Newsletter, Vol. 13 No. 1; 2005). And, about 35 species have been reported to damage agricultural crops and timber in buildings (Source: Sociobiology, Vol. 40 No. 1; 2002). Most are soil inhabiting, either as mound builders or as sub-terranean nest builders.

Major mound-building species in India are:

a) *Odontotermes obesus*
b) *O. redemanni*
c) *O. wallonensis*

Major sub-terranean species in India include:

a) *Heterotermes indicola*
b) *Coptotermes ceylonicus*
c) *C. heimi*
d) *Odontotermes homi*
e) *Microtermes obesi*
f) *M. beesoni*
g) *Trinervitermes biformis*

3. TERMITE SOCIETY

Termites are medium-sized (4-15 mm long), wood (cellulose)-eating insects, which vary in colour from white to tan and even black. They live in highly organized and integrated societies, or colonies. A typical colony of termites consists of individuals of different castes that differ in their structure, and duties to be performed for the colony.

A TERMITE COLONY

KING AND QUEEN (LARGE)

WORKER

SOLDIER

The individuals of a termite colony are broadly classified into the following castes:

- the primary reproductives: king and queen
- the supplementary reproductives: prospective kings and queens
- the non-reproductives: the workers, and the soldiers.

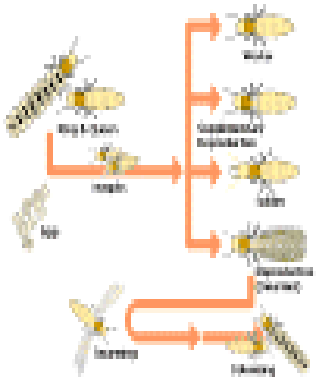
But, how do they differ from each other? The details on the morphological differences among these castes have been discussed in the following section. Nevertheless, all these castes exhibit gradual metamorphosis as described below.

LIFE-CYCLE

The life-cycle of termites exhibits the following three stages:

1. the egg
2. the immature forms or the nymphs, and
3. the mature forms or the adults, which include the sterile workers, soldiers, and the various fertile winged or wingless reproductive forms.

Eggs: Yellowish white and kidney-shaped, almost transparent and differ in their size. Eggs swell up perceptibly before hatching, and increase in size. The incubation period varies considerably. While some eggs hatch in about 10 days, the incubation period is much longer in other, resulting in the presence of young ones of various sizes in the colony. In other words, there is an asynchronous development of the individuals in the termite colony so that it is able to exist perennially.



During the incubation period, the workers tend the eggs.

Nymphs: The nymphs hatch from the eggs after the incubation period of about 10 days. They resemble their parents in the general body shape. The eggs do not hatch into grublike larvae, as in ants, but into young brood, which resemble small workers and, in more primitive kinds of termites, behave like them. In other species the young are fairly helpless and are fed by the workers. All the nymphs appear to be similar upon hatching, but after a few moults, they can be separated into the following two types:

1. the small-headed reproductive forms, and
2. the large-headed sterile forms.

The nymphs are quite active throughout their life of about one year but they become relatively inactive for very short duration when they undergo the process of moulting and exhibit marked morphological changes and growth of their body. Besides these normal changes, marked external and internal changes also take place during their final moult and,

they can be categorized into different castes on the basis of their morphological differences. The nymphs have the potential to develop into any of the three castes stated earlier. Their development into a particular form is regulated by the hormones and inhibitory pheromones secreted by the reproductive individuals.

Some nymphs develop wing buds, become longer, and finally develop into the fully winged adults (*alates*), the future kings and queens. They vary in colour from black to pale brown and the wings are opaque grey to black. As these adults are winged, they fly away in groups of thousands of individuals during their breeding season (usually soon after the first rain). This phenomenon is commonly referred to as ***swarming***. The swarmers are very poor fliers and most of them flutter for only a few yards before falling to the ground. The king and queen stay together after mating. Commonly the queen's ovaries grow enormously so that her abdomen becomes greatly distended, and she is able to lay eggs continuously at a rapid rate. This activity restricts her mobility, and in some species she is confined with the king in a thick-walled "queen cell".

DeAlated Adults

When the short flight is finished, the swarmers drop their wings (de-alated adults) and the males begin a frenzied search for compatible mates. Because the swarmers are exposed to predator birds and insects, very few of them survive to establish a new colony.

4. MORPHOLOGICAL DIFFERENCES BETWEEN DIFFERENT CASTES

The life-cycle and habits of termites are very similar to those of ants. This is the reason termites are also referred to as "white ants". Termites belong to the group of insects called Isoptera. This term is Latin and refers to the fact that termites have 2 pairs of wings that look very much alike (L. *iso*=equal; *ptera*=wings). Termites and ants differ in a number of important aspects, including development. The features which differentiate termites from ants are given below (Table 1, Fig. 1).

Table 1: Morphological Differences Between Ants And Termites

Feature	Ant	Termite
1. Body colour	Blackish brown	Pale coloured
2. Antennae	Geniculate (Elbowed)	Moniliform (beaded)/ Filiform (Threadlike)
3. Wings	Front pair larger than the hind pair	Front pair equal to the hind pair
4. Waist (Narrow stalk/pedicel)	Present	Absent

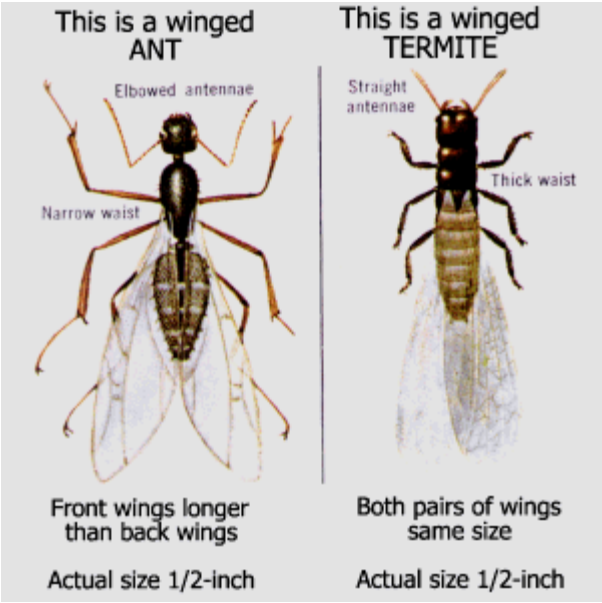


Fig. 1

The morphological features, which distinguish different castes of termites are given in Table 2.

Table 2: Morphological differences between different castes of termites

Feature	**King**	**Queen**	**Worker**	**Soldier**
Body colour	Dark brown	Dark brown	Pale whitish	Pale whitish
Body	Smaller than the queen	Largest	Smaller than the king	Smaller than the king
Head	Round	Round	Round	Round or elliptical but greatly enlarged and heavily sclerotized
Eyes	Well-developed	Well-developed	Small or none at all	Small or none at all
Antennae	Long	Long	Long	Long
Mandibles	Normal	Normal	Normal	Enlarged and heavily sclerotized
Wings	Present	Present	Absent	Absent

1. Reproductives:

These are of 3 sub-types:

(i) Macropterous: with large, sclerotized wings; fully formed, dark-bodied individuals (King and Queen)

(ii) *Brachypterous:* with short wing pads, slightly larger and darker than apterous individuals (prospective kings and queens)

(iii)*Apterous:* wingless, small, pale whitish individuals

All the reproductives have round head, long antennae (moniliform or filiform), chewing (mandibulate) mouthparts, and well-developed eyes. They have two pairs of similar, long, narrow, whitish, semi-transparent wings with many indistinct veins; the two pairs of wings are almost alike (Isoptera) in size and appearance.

The primary reproductives, the king and queen, carry out the reproductive function in the colony. They range from 5 to 22 mm (0.2 to 0.8 in) in length and are brown to black in colour, and the head is round. The mouthparts are mandibulate, the antennae are many-segmented, and the eyes are compound. Two small claws are borne at the end of each leg. External genital organs are not present.

Most commonly, there is one pair of king and queen per colony. The king is generally smaller than the queen, but in many species, the abdomen of queen is quite enlarged owing to very large repository of eggs. The Queen can lay up to 1,000 eggs each day, that is one egg each minute of every day for maybe 20 years, i.e. 7,000,000 eggs in a lifetime.

Termite King and Queen

The winged reproductives that develop into king and queen are produced in large numbers seasonally. They leave the colony in a swarming or colonizing flight, shed their wings, seek a nesting site, mate, and establish new colonies. Termites start swarming around the onset of monsoon and continue until the 1st or 2nd week of September. Their actions are entirely based upon the weather.

In the initial stages of colony foundation, the reproductives feed the young and tend to the nest, but these household duties are soon taken over by the young nymphs and workers.

The supplementary reproductives are slightly sclerotized and pigmented brachypterous or apterous individuals with reduced compound eyes. These individuals never reach the fully winged stage but achieve sexual maturity. They take over the function of the king and queen in case of their death or when a part of the colony is separated from the parent colony.

2. Non-reproductive or the sterile castes

The non-reproductive castes include the workers and soldiers of both sexes. These are wingless and sterile individuals, which are mostly blind.

Workers:

The workers are wingless and usually smaller than the reproductives. They are soft-bodied, white or pale-coloured, and sometimes appear translucent. They have

round heads, long antennae (generally filiform), chewing mouthparts, and small eyes or none at all. The legs are well developed and almost of equal size

.***Soldiers:***

The soldiers constitute 5 per cent of the total population of the colony. Their work is to defend the colony against intruders. The body of soldier termites is similar to that of the workers, but their heads are enlarged and heavily sclerotized with massive enlarged mandibles adapted for defense. Their weapons are either powerful jaws, or chemical secretions, or both. Some of the damp-wood termite species have soldiers with very large, heavily armored head capsules and powerful cutting jaws. Soldiers of other species have scissor-like mandibles. The mandibles are long, powerful, hooked, and modified to operate in scissor-like fashion to behead, dismember, or lacerate enemies or predators (usually ants).

The soldiers armed with a physical as well as chemical means of defense, are referred to as “nasutes” in some species. These soldiers have a frontal gland, which opens through a pore on the top of the head. When the insect bites, a droplet of toxic or sticky secretion runs down the pore onto the mandibles or onto the adversary. They squirt out the contents of the frontal gland through the head, which is drawn forward in the shape of a nozzle.The jet of liquid dries in air and forms a sticky thread that entangles the adversary.

A Nasute

5. HABITS AND HABITAT

Feeding habits

The food of termites is primarily cellulose and it can be obtained from both living and dead wood (vegetation). The termites, however, are not self-sufficient in digesting this cellulose because they are not able to synthesize cellulase, the enzyme that breaks down cellulose into oligo- or mono- saccharides (simpler units of carbohydrates). They are dependent for the digestion of cellulose on the microscopic fauna, which inhabit their intestines. The fauna exhibit a symbiotic association with the termites, and consist of microscopic protozoa: flagellates or protozoans with whip-like appendages, amoebae, spirochaetes, and fungi. Some of these protozoans contain enzymes, which digest the cellulose present in the wood, for termites. Thus, the termites cannot survive without the protozoans.

All termites, however, do not have these beneficial protozoans in their intestines. The higher, more specialized termites, which build mound nests in Africa and the Orient, cultivate

mushrooms for their food in special fungus gardens, and obtain their cellulose indirectly; it is digested for them by these low forms of plant life.

Young termites, as well as soldiers and post-adult queens, are fed regurgitated pre-digested (stomodeal) food from the mouths by workers, a phenomenon referred to as *trophallaxis*. Another source of their food is the semi-liquid proctodeal food which they solicit by stroking the end of the abdomen of the workers with their feelers or antennae. This type of feeding ensures the transfer of the microbial fauna along with the stomodeal and proctodeal food to all the members of the colony.

6. TYPES OF TERMITES:

There are about 2,858 different species of termites now recognized. They have been categorized into the following four distinct groups, viz.:

1. Dampwood
2. Drywood
3. Subterranean, and
4. Arboreal/Mound builders

1. **Dampwood termites** are very restricted in their distribution. They live and feed in very moist wood, especially stumps and fallen trees on the forest floor. These termites do not require soil contact for moisture. They are found in dead, damp, and rotten logs or trees.

2. **Drywood termites** are most common in all the continents. They do not require contact with moisture or soil. They are usually found in posts, stumps, and wooden houses. Their water requirements are fulfilled from the metabolic water generated from the digestion of their food, which is usually wood.
3. **Sub-terranean termites** are abundant in many parts of the world. They live and breed in soil, sometimes many meters deep. Some sub-terranean termites may construct nests in trees or other above ground locations. The sub-terranean termites need to be in contact with the damp soil to survive. This group of termites is the most

destructive to human building works, and costs millions of rupees each year not just in damage repairs but also in the treatment protection of wood.

Wooden structure damaged by sub-terranean termites

Once the subterranean colony is established, termites enter unprotected wooden structures, undetected from underneath the soil. A large extent of damage is carried out, without the notice of the owner of the building, until the building crumbles and falls.

4. The **mound builders** are capable of building earthern towers 8 meters or more in height. Termite mounds are common in Africa, Australia, South-east Asia, and parts of South America, but absent in North America or Europe.

FIG.: A TERMITARIUM OR A TERMITE MOUND

All termites are herbivorous, as they feed on wood and other vegetable matter. Many species feed on decaying wood. The members of Termitidae have symbiotic bacteria, but other families have symbiotic flagellate protozoans that secrete enzymes that help in the digestion of cellulose, which is the main component of wood, which they consume. Many sub-terranean or mound-building species (Harvester termites) cultivate fungi within the nest, called “fungus garden”, which helps in the breakdown of plant material. The term ‘Harvester Termite’ is used for these termites that store up food, as opposed to those that eat by tunneling outwards. The Harvester also farms and reaps, to eat and feed to others, a unique fungus, that grows in termite chambers. This fungus grows on food that has been chewed by the termite and then put into cool storage. This event happened by accident, and obviously came from fungus-spores brought in from the outside. Nevertheless, very hungry termites eat and thrive on this organic material, and thus symbiosis has evolved.

7. ECONOMIC IMPORTANCE OF TERMITES

Termites are very destructive and considered notorious on one hand, but they are also very beneficial, on the other. The positive and negative impacts of termites are given below:

(i) Positive Impacts

Termites contribute significantly to most of the world's ecosystems. They help to recycle the woody and other plant material. Their tunnelling action helps to aerate soils. Termite activity causes patchy changes that improve the soil composition and fertility. Compacted and encrusted soils cannot absorb water and hence can no longer support plant life. Termite tunnelling helps to reclaim greatly damaged soils, which has been successfully demonstrated in the African Sahel zone. Termites also contribute significantly to atmospheric gases.

It has been recently investigated that a fungus cultivated by some harvester termites has cultured an antibiotic producing bacterium. This finding may provide new insight into the identification, production and use of new antibiotics.

(ii) Negative Impacts

Of about 2,858 described species of termites, fewer than 185 are considered pests. Known primarily for their destruction of wooden structures, termites can also be agricultural pests. Termites are known to damage major field crops such as wheat, maize, sugarcane, cotton, groundnut, pulses, and forest plantation trees such as eucalyptus, silver oak, and all kinds of timber in buildings. Termites attack the roots of crops at all stages of plant development, seed sets, newly planted seedlings, tree trunks and also wooden logs. In natural ecosystems, termites feed an organic matter too. They are responsible for reducing soil fertility by removing both plant and animal debris and locking them in their underground nests, thus making them unavailable for plant growth. They are also litter consumers in forest ecosystems and contribute to the breakdown of dead wood and decomposition of organic matter on the forest floor. Losses due to termites run to several millions of rupees in agricultural crops alone. About 10-25 per cent loss is estimated in most field and forest crops. Severe losses due to termites have been recorded on wheat and sugarcane in northern India, maize, groundnuts, sunflower and sugarcane in southern India, tea in north-eastern India and cotton in western India.

In general, damage by termites is greater in rain-fed than irrigated crops, during dry periods (droughts) than periods of regular rainfall, in lowland rather than highland areas, and in plants under stress (lack of moisture, disease or physical damage), than in healthy and vigorous plants. In particular, exotic crops are more susceptible to termite attacks than indigenous crops. The extent of termite damage to agricultural crops, the nature of loss they cause, and the plant species they infest, are very much related to the geographic region.

8. MANAGEMENT OPTIONS

For the management of sub-terranean termites, care should be taken to avoid contact of woodwork of the buildings with the ground. A thin sheet of metal should be placed in between the foundation and timbers of the house. Foundation brick or stonework should be laid with good grade cement mortar, well capped, and all cracks and crevices should be eliminated. All wood that has contact with the soil should be termite proofed by pressure impregnation with coal tar, creosote, mercuric chloride, sodium fluosilicate, pentachlorophenol and its sodium and copper salts, DDT or other tested preservatives after the wood is cut. Moreover, no bit of waste wood should be left buried in the soil near the wooden structures.

Drilling holes in infested timbers, forcing a small amount of poison dust into the holes, and then plugging up the holes may also eliminate the drywood termites. Termites constantly

groom one another, and once a few individuals get this dust on themselves, the other individuals of the colony will eventually obtain it and be killed.

For the treatment of infestations of drywood termites, ¼ to ½ inch holes are drilled into the galleries in timbers and adjacent wood at 1- to 2-foot intervals. A dust gun with a delivery tube fitting snugly into the holes is then used to inject free-flowing dusts of sodium fluosilicate, sodium fluoride, calcium arsenate or paris green at about 1 ounce to 15 to 20 holes. The openings are then sealed with putty, plastic wood, or cork. Other options for the management of termites include:the use of plant extracts and biological enemies of termites, which are discussed below.

Use of plant extracts

Various parts of plants and plant extracts have been investigated in the laboratory and proven effective against termites. Extracts of neem, wild tobacco and dried chili, have been found helpful in the management of termites in the field and storage warehouses.

Wood ash heaped around the base of the trunk of coffee bushes has been recorded as preventing termite infestations. Wood ash has also been reported to repel termites from date palms.

Biological control

Termites have a wide range of predators, both opportunist and specialist, but ants are the greatest enemies of termites in all regions of the world. Although ants limit termite numbers under natural conditions, their effective use as biological control agents for target termite management has yet to be ascertained. The traditional farmers of Uganda use dead animals, meat bones and sugarcane husks as baits for predatory ants to supplement their chemical control methods used for poisoning *Macrotermes* mounds for termite control.

Among the pathogens (bacteria, viruses, protozoa and fungi), the entomopathogenic fungi are considered good termite control agents. Fungi infect their host through the cuticle and do not need to be ingested. The entomopathogenic fungus, *Metarhizium anisopliae*, has recently been developed into a product for control of termites in buildings in the USA, Brazil and Australia. The effectiveness of *M. anisopliae* to control termites in maize cropping system was demonstrated for the first time in Kenya and Uganda.

Above all, if the microbial fauna inhabiting the intestines of the termites is attacked, the entire termite colony can be effectively managed as the termites will then not be able to digest the wood (cellulose), and eventually starve to death.