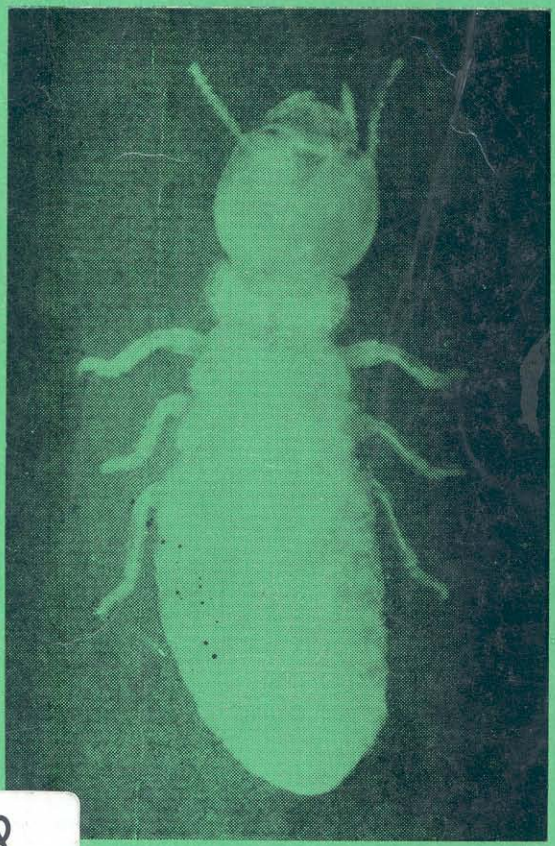
# GUIDELINES FOR CONTROL AND PREVENTION OF TERMITE INFESTATION IN ARCHIVES AND LIBRARIES





NATIONAL ARCHIVES OF INDIA
NEW DELHI
1991

*Conservation of Archives and Library Materials*
*School of Archival Studies*

# GUIDE LINES FOR CONTROL AND PREVENTION OF TERMITE INFESTATION IN ARCHIVES AND LIBRARIES

**Monograph No. I**

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## PREFACE

From among the various species of biological pests that infest books, documents etc., the damage wrought by termites is the most extensive. They not only thrive on cellulosic material of rare and valuable collections but also damage and bore into building material of sorts. Timber used in the construction of buildings, articles of furniture, racks and almirahs, books, papers, fabrics, leather etc. in contact with floor, walls or ceiling, especially in dark and damp places, are attacked by termites. Termites have their colony below the ground and their reproductive rate is very high. As such, killing the live insects seen in the building or infested material does not provide any relief. For effective control, isolation of termite colony itself is the only remedy.

During the past two decades, the department has been approached by various agencies who suffered damage by termites, seeking information on ways and means to control/eliminate the serious threat posed by these insects. The department, therefore, made a study, conducted investigations and also sought information from some state archives, libraries and other institutions regarding the preventive and control measures adopted by them to contain termite infestation. Our investigations and the information received from various institutions (tabulated at Appendix I) reveal that the measures that prove effective to prevent termite infestation are :

A
1. Anti-termite treatment during construction of the building;
2. Reinforced cement concrete construction;
3. Use of steel racks with clearance from the floor, walls and ceiling;
4. Proper drainage to prevent seepage and wet points in the building;
5. Adequate ventilation and air circulation;
6. Maintenance of cleanliness; and

7. Regular inspection.

B In the existing buildings facing termite problem, use of insecticides at the outlet points of termites gives only temporary relief, as the termites find outlet at other weak points in the structure. In such cases, post-construction intensive anti-termite treatment is found to be effective.

To adopt measures that will eliminate or root out the infestation or keep it under control, an understanding of the organisation, habitat and biology of termites will be useful. The present monograph, therefore, provides this background information and also suggests remedial and other control measures.

I hope this Monograph will help the archives, manuscript repositories and libraries in adopting timely control and preventive measures to safeguard their collections from the ravages of this deadly enemy of documentary material.

I am thankful to Shri V. V. Talwar, Senior Fellow, School of Archival Studies for help in compilation of this monograph and also to the members of the Board of Studies for making valuable suggestions.

R. K. PERTI

*Director General of Archives,*
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NEW DELHI :
August 30, 1991

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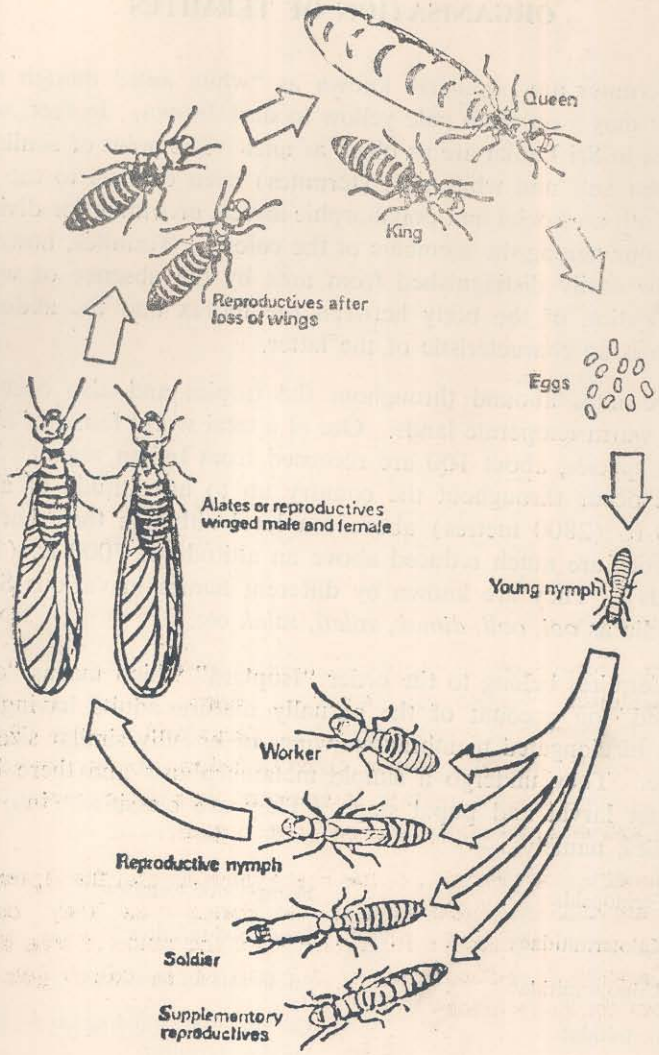
## ORGANISATION OF TERMITES

Termites are popularly known as "white ants" though their colour may vary from pale yellow to dark brown. In fact, some species in Sri Lanka are as black as ants. The point of similarity between ants and white ants (termites) even extends to the fact that both are social and polymorphic insects providing for division of labour among the members of the colony. Termites, however, can be easily distinguished from ants by the absence of waist-like portion of the body between the thorax and the abdomen which is so characteristic of the latter.

Termites abound throughout the tropics and also occur in most warm temperate lands. Out of a total world fauna of about 1600 species, about 100 are recorded from Indian region. Termites occur throughout the country up to an altitude of about 9000 ft. (2800 metres) above sea level although their harmful activities are much reduced above an altitude of 7000 ft. (2200 metres). They are known by different names in various States in India as *ooi, ooli, dimak, valati, saink* etc.

Termites belong to the order "Isoptera" which means "equal winged" on account of the sexually mature adults having two pairs of elongated membranous wings of broadly similar size and shape. They undergo a simple metamorphosis and there is no distinct larval and pupal stage. They are classified into six families, namely :—

| | |
|---|---|
| Termopsidae . . . . | Damp wood termites |
| Kalotermitidae . . . | Dry wood termites |
| Rhinotermitidae . . . | Subterranean termites |
| Termitidae . . . . | Carton nest building and mound building termites |
| Hodo-termitidae . . . | Harvester termites |
| Mastotermitidae . . . | Termites with reproductive features like cockroaches |




Organisation of termites

Fig. 1

From among these, the damage to books, documents and wooden structures in the building is mostly done by subterranean and dry wood termites but the havoc wrought by the former is most extensive.

The termites are pre-eminently social insects. They live in separate colonies which are independent of each other with a highly developed social system. There is division of labour and the work of the colony is divided among castes or forms which are specialised in structure and behaviour. The principal castes are the reproductive forms and the sterile forms. Each caste has both male and female individuals. In addition to the adult or mature stages of these castes, there are also the nymphal or immature growth stages of the same. The castes of termites are determined in the fertilised egg by intrinsic factors and cannot be changed by external means. Two forms of nymphs differing in the size of brain, eyes and reproductive organs hatch from the eggs, and each gives rise to reproductive or sterile castes (Fig. 1 & 1A)

**The Reproductive Castes**

The reproductive castes comprise Macropterous Form, Brachypterous Form and Apterous Form which represent different stages of development. True Kings and Queens (Royal Pairs) who found new termite colonies belong to Macropterous Form. They have firm dark integument with large eyes and brains and well developed reproductive organs.

The other two Forms i.e. the Brachypterous and the Apterous forms are termed "Substitution Royal Forms" as they could develop into reproductive forms and take the place of true King and Queen if casualties occur or if a part of the colony gets cut off from the main colony.

**The Sterile Castes**

The workers and soldiers of both sexes form the sterile castes as their reproductive organs are not functional. They are small, soft bodied grayish insects with yellowish or brownish legs. They live for about 2–4 years. They are without eyes and wings but have highly sensitive antennae (feelers).

**Workers**

The function of the workers is mainly that of tending the eggs and young nymphs; foraging for food; feeding and cleaning the other castes, especially the royalties; construction, repair and upkeep of the nest and fungus gardens. The workers perform all the communal functions. They keep the tunnels clean and at optimum temperature and humidity.

In almost all species, worker termites never venture into the light, spending their whole lives in the dark. If it is necessary to travel away from the nest in search of food, then a tunnel of soil particles and saliva is constructed. These mud tubes are a conspicuous feature of the tropical environment and allow subterranean termites to bridge gaps from the ground into buildings and thus gain entrance to wood work and books.

**Soldiers**

The soldiers serve in the defence of the colony, protecting the workers when labouring on the nest or when foraging. The soldiers generally have a massive head and formidable long, sickle-like jaws with which they fight their enemies. However, the soldiers of Nasute form, instead of having large jaws, have a snout on the forehead from which they can squirt a jet of gummy, poisonous fluid which disables their enemies at quite a distance. The Mandibulate soldiers eject a similar secretion from a pore situated in front of the head. Some soldiers also work as scavengers. They have truncated heads which function like a shovel or ram (Fig. 2).

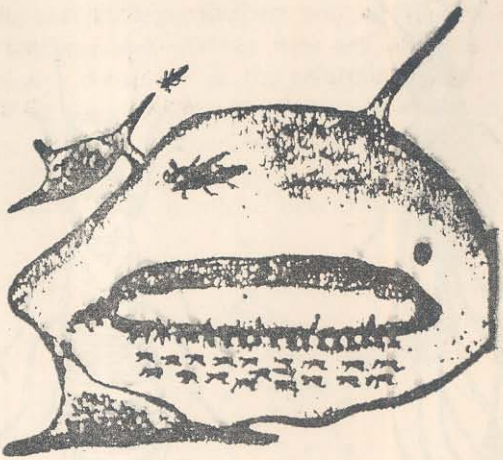
**Formation of Termite Colonies**

New termite colonies are formed—

(i) by isolation or migration of a part of an existing colony and development of Substitution Royal Forms into reproductive forms;

(ii) by pairs of winged reproductive adults during the swarming period.

Under favourable conditions of humidity and temperature the reproductive forms reach maturity. As winged males and females, they remain in the nest until a swarming flight takes place



King &
Physogastric queen.

Eggs

Nymph.

Fig. 1A

## Reproductive Castes

Winged adult.

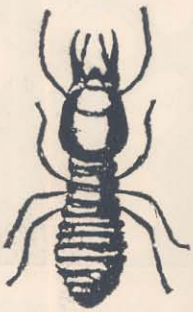
De-alated adult.

## Sterile Castes

Sterile Castes

Worker.

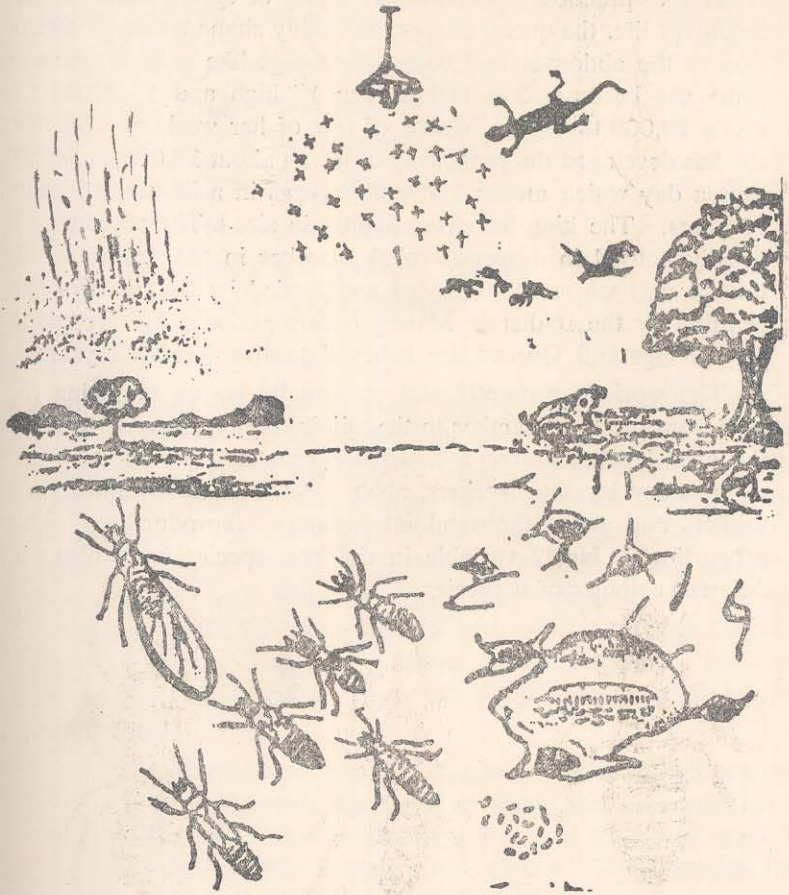
Nasute soldier



Mandibulate soldier.

Fig. 2

usually after the first monsoon showers. The Macropterous royal forms leave the nest in large numbers and spread over great distances while workers and soldiers who are wingless remain in the parent colony. After use in the swarming flight, the wings are broken off at a suture near the base and discarded and dealated termites pair off. While many of the insects are eaten up by frogs, lizards, birds, bats etc., some of the paired Kings and Queens who survive, originate new colonies (Fig. 3).



Subterranean Termites

Fig.3

A small hole is dug in the soil or wood and eggs are laid. The first hatched castes are workers and a few soldiers and are brought up by the parents (royal pair) on a nutritious fluid exuded from their mouths. Soon the workers take on themselves the task of building the various chambers of the nest and looking after the nymphs and the parents i.e. the royal pair. Now the parents move into the royal chamber. The subsequent termite colony is the offspring of the one royal pair.

Due to practically machine-like laying of eggs, good food and sedentary life, the queen changes in bodily shape owing to distension of the abdomen and becomes sausage-like until in about 3 years she becomes 2–4 inches long 1″ high and 1″ broad i.e. about 20,000 times the volume of one of her workers. By then she has developed the propensity of laying about 30,000 to 50,000 eggs a day which means 100 million eggs in a lifetime of about 10 years. The king increases slightly in size. The royal pair is usually housed in a special royal chamber in the middle of the termite nest where they are fed and tended by the workers and guarded by the soldiers. Mating occurs periodically throughout life. Kings and Queens are believed to live for 6–12 years.

The workers promptly and continually go on removing the eggs from the royal camber to the adjoining fungus gardens where the eggs hatch and the nymphs are brought up. Most of the nymphs develop into workers, about a tenth of their number into soldiers and a few thousand into future reproductives. This proportion is highly variable in different species and also in different colonies of a species.

## TERMITE HABITAT

The habitats of termites are of considerable importance in determining the methods that can be adopted to prevent damage by termites. According to their habitat, termites can be roughly divided into two main groups :

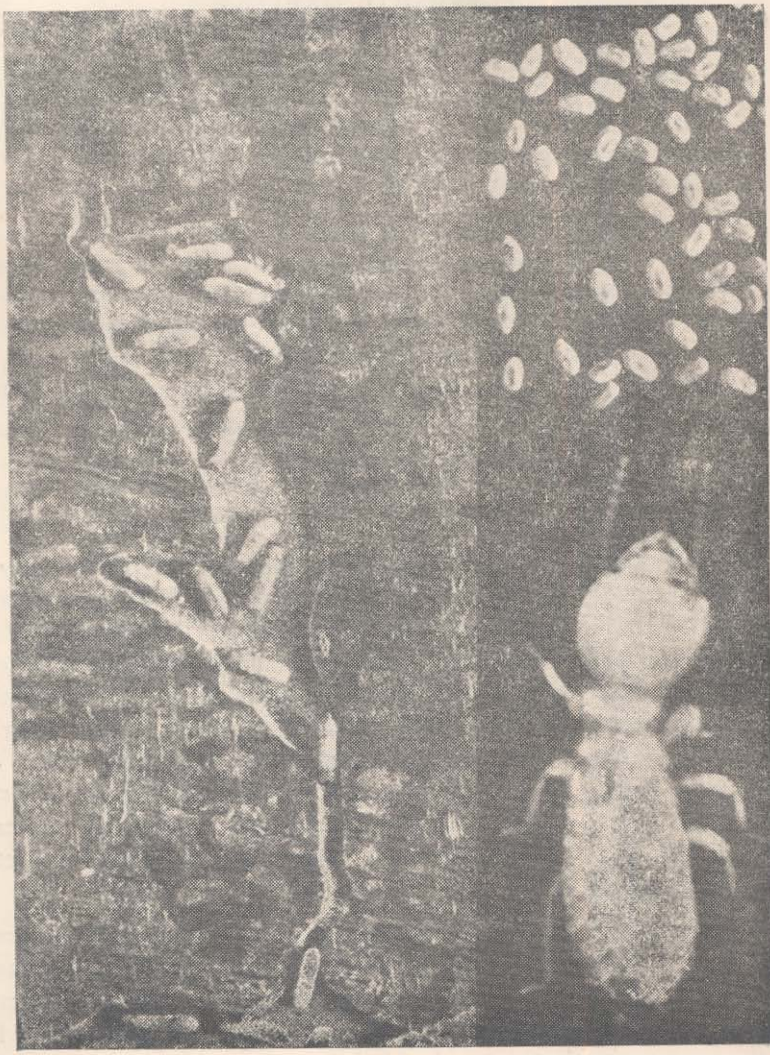
1. *Wood Dwelling Termites*
   (a) Damp wood termites
   (b) Dry wood termites
2. *Ground Dwelling Termites*
   (a) Subterranean termites
   (b) Carton nest building termites
   (c) Mound-building termites

### Wood Dwelling Termites

The colony of wood dwelling termites is confined entirely to wood and is started by a colonising pair which enters the wood above the ground at the time of swarming. Irregular nests are made in logs, fallen trees, stumps, decaying wood or dead wood of living trees. In excavating channels in the wood, the termites follow the grain. The wood is removed to form porous galleries, thus ensuring high humidity within their chambers (Fig. 4). Some species fill the empty cavities with pellets of partly digested excreted wood and this often falling outside reveals the presence of termites while boring dust betrays the presence of beetles (coleoptera).

(a) *"Damp wood termites"* require a constantly high amount of moisture in the wood in which they live, such as is found in dead or decaying logs and stumps of trees in regions with a moist cool climate. Some species live inside the wood of living trees.

(b) *"Dry wood termites"* can maintain their colonies in dry sound wood and are known to occur in humid coastal regions. Narrow tunnels are excavated by the nymphs



*Wood dwelling termites*
Fig. 4

of the colony in which there are no true workers. No fungus combs are constructed. There is no connection with the ground or with the sources of moisture. The soldiers have short truncated heads suitable for blocking the entrances of the tunnels or pushing out the excreta.

**Ground Dwelling Termites**

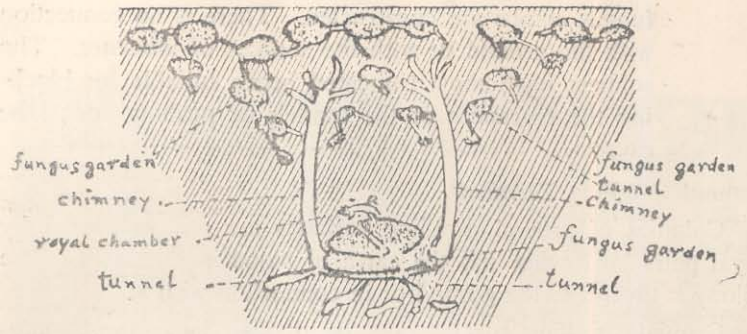
Colonies of ground dwelling varieties are always started by royal pairs burrowing into the earth or wood in the earth. The colony is always in the ground or in connection with it.

Ground dwelling species may be divided into three subgroups :—

(a) *"Subterranean termites"*—They build their nests under the ground and reach their food by burrowing through the earth. Metal, stone, brick, concrete and other substances which termites cannot penetrate, are by-passed and bridged over by wet earthen shelter tubes to avoid bright light and to maintain proper humidity and temperature for their existence. Indian varieties of termites are capable of bridging horizontal gaps of nearly 6–8 cm. and vertical gaps to much greater extent. They have aversion to metals such as zinc or copper. The termite workers may go as far as 50 metres from their underground nest in search of food. It is, therefore, difficult to locate the royal chamber.

A typical subterranean termite nest consists of a royal chamber about 15 cm. × 10 cm. with a flat floor and dome-shaped roof about 5 cm. high in the centre of the nest and 2-3 metres below the ground, connected by a net work of galleries with numerous chambers containing fungus gardens, thus making the colony of the "Diffuse type". Fungus gardens are used as nurseries and communal rooms. Usually there is one particularly large fungus garden adjoining the royal chamber (Fig. 5).

The external openings of the ventilation shaft of the nest are appropriately widened or narrowed by the workers in relation to the prevalent temperature and




Subterranean termite nest – A lay-out

Fig. 5

humidity such that about 35°C temperature and 80–90% relative humidity are maintained near the royal chamber. Termites are thus not very much dependent on external weather conditions because they control fairly well the heat and humidity within their nests. Sometimes they make secondary nests in the wood they eat. The supply of moisture which they usually obtain from the soil can be obtained from wet spots in the building or from other available sources. The secondary nests have only workers and soldiers.

(b) *"Carton nest building termites"*—They construct a cellular nest of carton (a compound of faecal matter, woody fragments and earth). A nest of this type is about the size of a foot-ball with a mass of passages and chambers and may be located in the ground or in hollow trees or attached to the branches or placed in the fork of the trees. The king and the queen live within the carton-comb at the centre and the eggs and the nymphs occupy the outer zones. Connection with the ground is maintained by means of covered runways along the bark of the trunk.

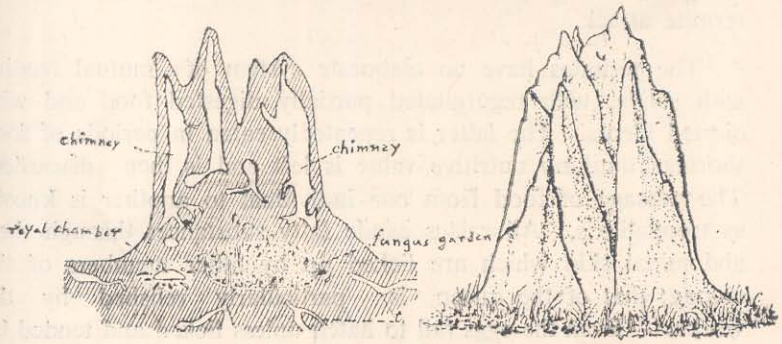
(c) *"Mound-building termites"*—They build a conspicuous heap of earth or white ant hill above the ground. A termite mound may take the most fantastic forms e.g. conical, columnar, turreted, domed, mushroom shaped

etc., furrowed with rain channels. Some of them are 20 feet high with a basal diameter of about 12 feet. The mound is built of earth particles cemented together by means of saliva and is almost as hard as cement.

The mounds structure and composition ensure maintenance of the humidity of the nest at a constant, independent of the conditions outside. Walls of different chambers have differential absorption value to maintain the required humidity for different functions inside the colony. The moisture produced by the metabolism of the termites of the colony is retained and not lost by diffusion or evaporation. Rainfall or soil water is not absorbed in excess in the form of free water within the chambers of the mound.

The royal chamber of compactly cemented earth with oval and low-domed roof and a flat floor is built near the centre of the mound about half a metre below ground level in a zone of small intricate tunnels through which the workers approach with food and to remove eggs to the fungus gardens. The adjacent passages are also used as guard chambers in which soldiers are always on duty. Small tunnels allow access of termites to various parts of the mound above the ground but the regularly inhabited part is at and below ground level (Fig. 6).

The mound building termites do not have supplementary queens able to take the place of founder-mother in case of emergency. Consequently, if the mound is destroyed and the royal pair removed, the colony cannot subsist for long.




Termite mound

Fig. 6

## FOOD OF TERMITES

Termite food consists mainly of cellulose which is an important constituent of plant body. Moist warm soil containing food in the form of wood and other cellulosic materials favours their growth. In nature, termites feed upon wood of fallen or diseased trees and other organic matter. The cellulose is digested by means of juices produced by bacteria or flagellate protozoa living in the intestines of the termites. The lignin of wood has no food value and is excreted unaffected by the digestive juices; it may form two-third of the excrement of a termite feeding on wood with a high lignin content. Those species which are devoid of protozoa obtain their food from humus, fungus and organic soil in addition to wood.

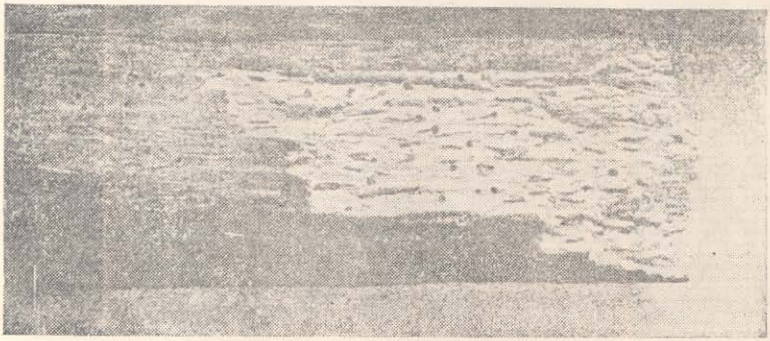
Lichens, algae and grasses are also eaten by foraging termites. Fungi form important items of food in some of the most highly evolved forms. The fungus spores and hyphae are carried about on the bodies and in the intestines of termites and thus reach depths of wood where otherwise they might not arrive. Termites produce and maintain in their burrows a moist atmosphere rich in carbon dioxide which favours the growth of fungi. Termites bring about rot and decay of wood due to their intimate and sustained association with fungi. Measures to control the growth of fungus can, therefore, also be helpful to control termite attack.

The termites have an elaborate system of mutual feeding with saliva, with regurgitated partially digested food and with ejected faeces. The latter is repeatedly eaten in periods of food shortage until no nutritive value is left and is then discarded. The passage of food from one individual to another is known as trophallaxis. All castes exude fatty substances through their abdominal skin which are licked up by other members of the colony; that of the queen is particularly relished by the workers. Even the eggs fail to hatch unless licked and tended by the workers. They also clean each others' body of any dust,

wood particles and moulds. Cast skins and dead bodies as well as sickly individuals are eaten. This characteristic of feeding on faeces, skin exudates, moults and dead bodies, in termites is often utilised in control measures as any poisonous substance carried into the colony by a few individuals rapidly spreads throughout the entire colony and destroys it.

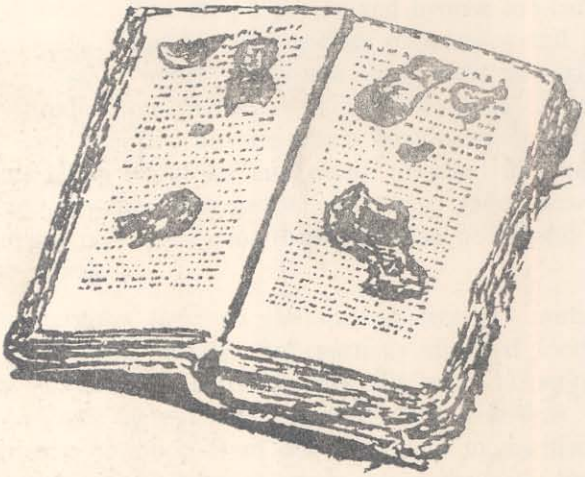
## TERMITE DAMAGE

In nature, termites feed upon wood of fallen or diseased trees and other organic matter. Removal of vagetation and constructing buildings etc. on the cleared ground, diverts the termites to the wooden structures in the building and other cellulosic materials like books, documents, carpets, textiles and fabrics (Figs. 7 & 8). They also damage non-cellulosic materials



*Damage to wooden structure*

Fig. 7



Book damaged by termites

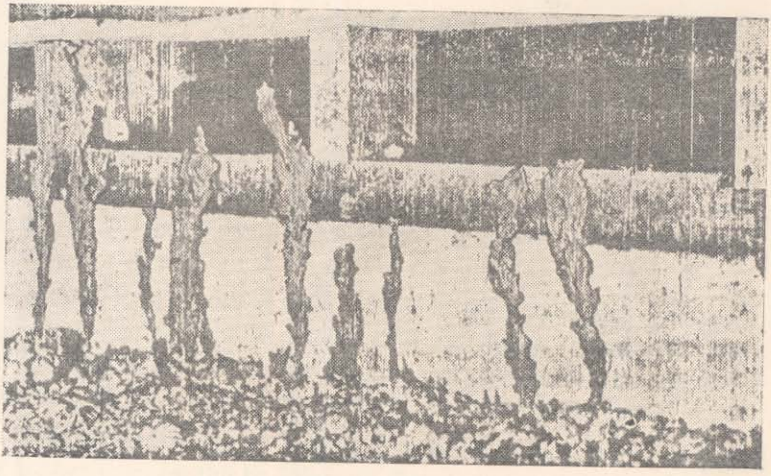
Fig. 8

like plastics and leather. The termites are selective feeders and much of the material damaged may not be actually eaten but bored through to reach their food or corroded with moisture and body secretions or layers of carton-like earth.

Termites enter the superstructure of buildings through untreated wood in contact with the ground, through cracks or hollows in brick work and masonry, through inferior mortar in the walls or through runways built over the surface of foundations, walls, pipes etc. In destroying wood and other edible material like books and documents, the termites work in concealment, eating away from the inside and leaving the exterior untouched. Thus the damage may be extensive before it is detected. In addition, termites cause leakage of electric current by destroying the insulation and earthing of wiring in conduits and joint boxes.

The most important species infesting buildings are wood-dwelling termites and subterranean termites and their infestation may be recognised by the presence of :

(i) earth covered runways in the cracks or joints and over impenetrable surface of floors and walls (Fig. 9);



*Earthen tubes of subterranean termites bridging over concrete foundation and walls leading to wooden frames*
Fig. 9

(ii) earthen tubes projecting from various positions;

(iii) the shed wings of flying termites especially at the onset of rains;

(iv) the powdery pellets of excrement thrown out of cracks by dry wood termites; and

(v) hollowed out wood work.

Detection will be greatly facilitated and chances of damage reduced if at the time of storing books and documents on the racks, sufficient clearance from walls, floor and ceiling is provided to keep track of any cracks and covered runways of termites.

## PREVENTIVE MEASURES

### I. GENERAL PRECAUTIONS AGAINST TERMITE ATTACK

(i) Cleanliness should be maintained in the storage and surrounding areas so that termites and other insects do not find hiding place for damage and propagation. Cracks and crevices in the floor and walls should be immediately treated and properly cemented.

(ii) Waterlogging around the building and damp spots in the building should be removed by improving drainage, preventing leakage and splashing of water.

(iii) Improving ventilation, specially in basements. Ventilation can be augmented by the use of air-circulators and exhaust fans so that no stagnant air or dead air spaces are left.

Ventilators should not be obstructed by racks provided in the storage areas.

(iv) All wood-ground or wood-wall contact should be eliminated as far as possible. Frames of windows, ventilators and doors should be made either of metal or pressure treated seasoned wood.

(v) Ventilators and windows should be provided with a metal grill on the outside and 0.6 mm galvanised iron wire gauze on the inside to prevent entry of rodents and swarming termites.

(vi) Doors should also be provided with wire gauze netting. be of self-closing type and flush with the floor. Thresholds and rubber flaps should be provided on the exterior doors to prevent ingress of insects from outside, particularly at night.

(vii) Exterior lights should be installed away from the building rather than on the building, so that the insects are not attracted towards the building, when the lights are switched on at night.

To prevent formation of new termite colonies near the building, insect traps should be installed around the exterior lights during the swarming period of termites as per arrangement indicated in the diagram (Fig. 10). The swarming termites and other flying insects are let into a container containing creosote oil and kerosene oil (1 : 2) which kills them.

(viii) Valuable records and books should not be dumped on the floor. The racks housing the records and books should have adequate clearance from the floor, walls and ceiling for cleaning and inspection. The racks should preferably be of steel, painted olive green to prevent rusting.

(ix) All exposed wood work should be periodically treated with antiseptics or replaced with impregnated seasoned wood.

(x) Wooden blocks or plugs inserted in walls or the floor for the support of shelves, panelling, hooks etc. should be replaced by treated blocks in a well cemented cavity.

(xi) Woody debris or dead leaves should be removed from the surroundings as well as the roof. Creepers and woody climbers should not be allowed to grow up the walls and bridge the termite treatment and barrier (Fig. 11).

(xii) A regular inspection schedule should be established for prompt detection and control of termites and other insect infestation. The results of the treatment should be monitored.

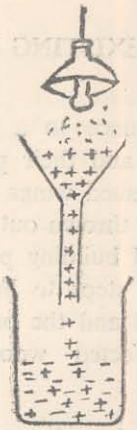
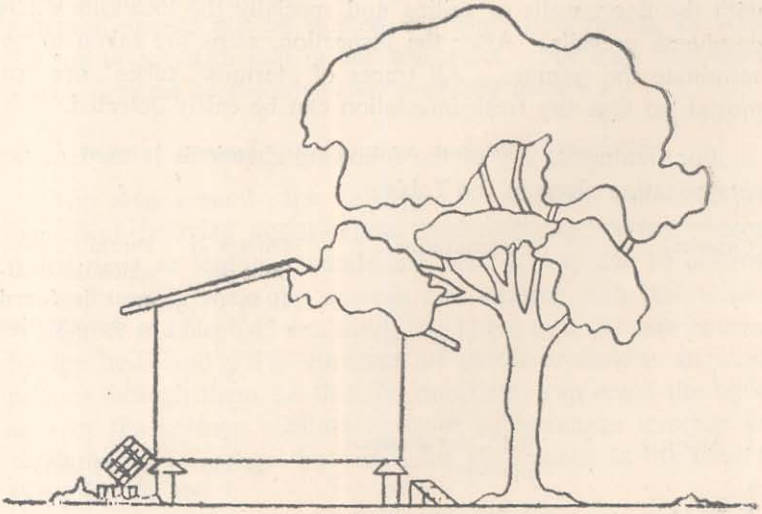



Fig. 10



Contiguous trees or inadvertently placed boxes etc. provide termite entry into otherwise termite-proof buildings.

Fig. 11

## II. TERMITE CONTROL IN EXISTING BUILDINGS

Subterranean termites gain entrance to a building through foundations, walls, floor or ceiling and their presence is manifested by covered earthen runways, shed wings of flying termites or dry powdery pellets of excrement thrown out of cracks by dry wood termites. In such an infested building post-constructional anti-termite treatment consisting of steps to break contact between the termite colony in the soil and the building has to be done. In addition, treatment of affected wood work is also necessary.

Before undertaking the treatment, a thorough inspection is made of the infestation in the building to determine the extent to which it has spread and the route of entry of the termites into the building. Termites are known to travel from floor to floor under cover through lift wells, electrical wiring battens, conduits, switchboards, casings covering telephones cables, utility pipes etc. Other areas which should be examined are wood work in contact with the floor, walls or ceiling and specially the locations where dampness prevails. After the inspection, steps are taken to exterminate the termites. All traces of termite tubes are removed, so that any fresh infestation can be easily detected.

For treatment, any of the following chemicals is used as per concentration given in the Table.

| Chemical | Concentration | Dosage in litres per 10 sq. m. | Period over which the treatment is found to be effective |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1. Aldrin . . | 0.5% as emulsion in water | 40—50 | 13 years |
| 2. Dieldrin . . | 0.5% as emulsion in water | 40—50 | 13 years |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 3. Chlordane | 1.0% solution in fuel oil or emulsion in water | 55—90 | 14 years |
| 4. Benzene Hexachloride | 0.8% gamma isomer (Lindane) or 8.0% BHC in fuel oil or emulsion in water | 60—75 | 7 years |
| 5. D.D.T. | 8.0% solution in fuel oil or emulsion in water | 60—95 | 5 years |
| 6. Creosote Oil | Mixed with an equal volume of used Engine Oil | 50—60 | 7 years |

The chemical solutions or emulsions should be dispersed uniformly in the soil and in the required strength to be an effective barrier against termites. All these insecticides are insoluble in water and are not leached out by sub-soil water. The treatment however, should not be carried out when it is raining or when the soil is wet with rain or sub-soil water. For long term effect aldrin, dieldrin or chlordane are normally used.

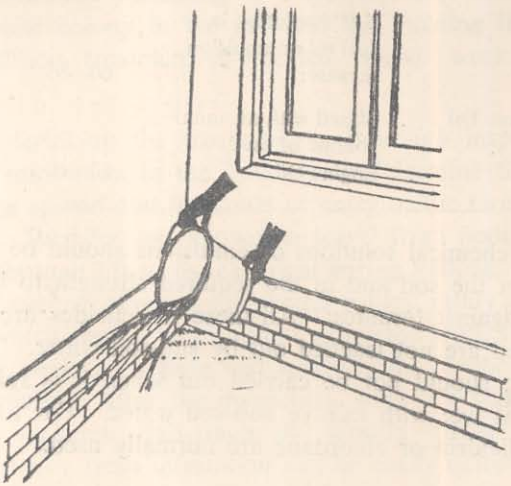
1. *Treatment around the Building and the Foundation*

The area around the building is carefully examined and cleared of decaying wood, debris, dead roots etc. When concentrated nests or termite mounds are located, they can be destroyed by breaking open the mounds and treating with insecticides. A number of holes (45 cm. deep) are bored over the area covered by the nests and 0.5% emulsion of aldrin or dieldrin in water poured through them, so that the insecticide can reach the entire area of the colony. Diffuse nests of subterranean termites are similarly treated when the exit holes are located at the time of swarming flights.

For treatment around the foundation, a trench 25 cm. wide and 50 cm. deep is dug along the exterior walls and around the entire perimeter of the building. For every 3 metres of the

trench 10 litres of one of the chemicals listed earlier in the table at pages 22 & 23 is poured in with the help of a hose or any safe device, 15 cm. of the soil is then replaced and another 10 litres of solution poured in and covered up with earth (Fig. 12). Where the foundations are deep, further treatment through a number of holes can be given.

D.D.T., Gammexane, sodium fluosilicate or white arsenic can also be applied to the trench in powder form duly diluted with fuller's earth (1 : 4).



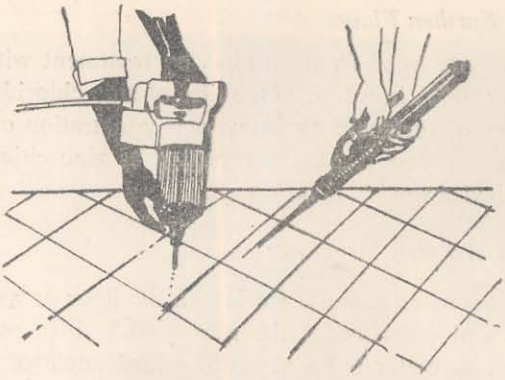
**Treatment around the foundation**

Fig. 12

2. *Treatment of Soil below the existing Floor*

(a) The exit points of termites in the floor are hollowed and treated with soil poisons listed above or in the table at pages 22 & 23. The original structure is then restored using cement concrete.

(b) 12mm diameter holes 30cm apart, are drilled in the floor reaching the soil below. Chemical emulsion at the rate of one litre per hole is poured in and the holes plugged with cement concrete (Fig. 13).



Treatment of soil below the existing floor

Fig. 13

(c) *Rodding*—Another method of application of insecticidal water emulsion under the slab or other type of solid floor is known as Rodding. This entails drilling of holes and forcing of a long length or jointed lengths of perforated steel pipe through the soil or through the foundation wall. The chemical emulsion is applied through this pipe.

3. *Treatment of Voids or Cracks in Masonry or Walls*

(a) Holes are drilled in the walls at a downward angle of 45° and at 30 cm. intervals and one litre of chemical emulsion is poured in each hole which is replugged with cement concrete. 5% solution of Boric acid and Borax (1 : 1) in water can also be used.

(b) Cracks and holes in the walls are opened up by tracing back the runways and tunnels of termites. If the cavity appears to be of limited extent it is soaked with coal tar creosote and kerosene (1 : 2). If the cavity is connected with further inaccessible tunnels, it is treated with fine dry poison dust either dropped in with a spoon or blown in with a dust gun. Paris Green, white arsenic or sodium fluosilicate can be used. The dust treatment is effective as it is carried by the worker termites to the colony.

4. *Treatment of Earthen Floors*

Earthen floors are freed from termites by treatment with zinc chloride solution (20%) in water. One litre of zinc chloride solution per sq. metre of surface with an average penetration of 1" is sufficient, but this process has to be repeated as zinc chloride is likely to be leached away.

5. *Treatment of Wooden Structures*

(i) Points of contact of wood work with the floor or walls are treated by chemical emulsion at the rate of 0.5 litre per hole by drilling 6 mm diameter holes at a downward angle of 45° at 15 cm. intervals and sealing the same.

(ii) The eaten away portion of wooden structure is filled in with liquid paraffin wax and the structure treated with any of the chemical solutions listed below :—

(a) 20% zinc chloride solution in water.

(b) One part of coal tar creosote in 2 parts of kerosene oil.

(c) 1% solution of chlordane in kerosene oil.

(d) Orthochlorophenol 2.5 parts.
β naphthol 2.5 parts.
Petroleum 100 parts.

(e) Aldrin emulsion in water 0.2%.

Badly damaged wood work should be replaced by fresh material properly treated with preservatives.

(iii) In an infested building, it is also desirable to avoid the use of wooden almirahs built in the wall.

If wooden almirahs or racks are in use, they should be kept at least 15 cm. away from the walls and should have at least 15–20 cm. clearance from the ground/ceiling. If possible, the almirahs or the racks be segregated from the infested ground by placing its legs in bowls containing coal tar creosote in kerosene oil (1:2) or in a strong solution of phenyle (Fig. 14). If the

*Chemical segregation of wooden almirah*

Fig. 14

wood is not protected by paint or varnish, one of the chemical solutions listed at point (ii) above could be applied to the surface of almirahs including the legs, and squeezed into cracks and joints as far as possible. At least two coats are to be applied, the second after the first one has dried.

In cases where the racks are supported with the walls, these should be separated by providing iron brackets between the wall and the racks.

*Control of Dry Wood Termites*

Dry wood termites are able to exist without any association or communication with moisture other than what is present in wood. Dry wood termite infested furniture/structure can be treated with any of the chemical solutions listed below by injection into the holes or by brush coat :

(a) 5% solution of borax and boric acid (1:1) in water.

(b) Solution of coal tar creosote and kerosene oil (1:2)

(c) 20% zinc chloride solution in water.

(d) 1% solution of chlordane in kerosene oil.

(e) Shelltox wood preservative.

(ii) Moveable items of furniture/racks etc. are freed of infestation by exposing them to hot sun for 3-4 hours or by fumigation in a vault as explained in para 6 below :

(iii) *Use of Desiccant Dusts*—Termites have a thin waxy outer layer (lipoid layer) through which they control and prevent water loss of the body. Some mineral dusts damage this layer and the insects are unable to control the water loss and die through desiccation and poisoning by fluoride. The chemicals used are fluorinated silica or boric acid which are blown into the holes.

6. *Treatment of Infested Books and Manuscripts*

Termite injury to books, manuscripts and records is really secondary to their injury to wood work which is their primary

target. Books on wooden shelves, in wooden book cases, on floors particularly in damp basements will be damaged if termites gain access to them. The termites bring along damp earth to make shelter tubes to bridge gaps and to reach their food, thus increasing humidity in their surrounding environment. The termites also carry fungus spores on their bodies. It is, therefore, advisable to clean and fumigate the infested books and documents with fumigants like paradichlorobenzene or killoptera (ethylene dichloride and carbon tetrachloride 3:1) in an air-tight almirah or vault. Vacuum fumigation with carboxide (a mixture of carbon dioxide and ethylene oxide 9 : 1 parts by weight) is however, more effective.

After treatment books are cleaned again and repaired as per individual requirement.

7. *Treatment of Electrical Fixtures*

If infestation in electrical fixtures (like switch boxes in the wall) is noticed, covers of the switch boxes are removed and inside of such boxes treated liberally with 5% chlordane powder. The covers of the switch boxes are refixed after dusting.

8. *Inspection*

After the preventive treatment, vigilance and periodic inspection are necessary especially during subsequent humid and hot season, as the termites may find another inlet/passage in the building which will also require treatment.

## III. PRECAUTIONS WHILE PLANNING A NEW BUILDING FOR A LIBRARY OR AN ARCHIVES

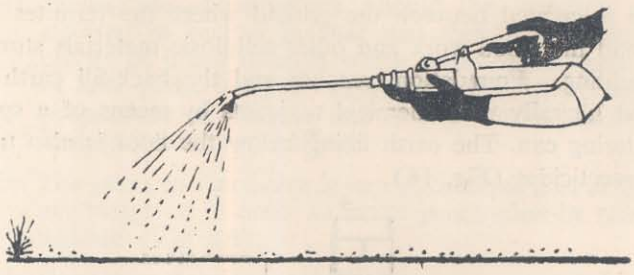
The eradication of termites from a building in which they have established themselves is difficult and costly. It is, therefore, advisable to keep this in view while planning a new building for a library or an archives and provide necessary safeguards against damage by termites. Selection, preparation and treatment of site to eliminate and prevent any chance of breeding and development of termite colonies in the vicinity of the building and making the building termite-proof at the time of construction are of vital importance.

(i) *Selection and Preparation of Site*

First and foremost requirement is the selection of site. Hard and rocky area is preferable. Sites used for dumping refuse or having loose/moist soil are not suitable for a library or an archives building as such a soil is sure to be infested with termites.

Site clearance is a necessary first step to building. It is advisable to do this even before some temporary structures are erected. All dead wood, stumps, roots, scrap etc. should be dug up and disposed off carefully, preferably by burning. Throwing them away in an adjacent plot or burying them in the ground should be strictly avoided as this could lead to the development of a termite colony there and continue to be a hazard to the building. On no account should stakes, wooden slabs or waste wood be buried within the foundation of the building. When construction is completed, special care should be taken to remove wooden shuttering completely.

*Treatment of Site*—If termite activity is noticed in the area, the soil is loosened and treated with any of insecticides listed in the Table at pages 22 & 23 (Fig. 15).



***Sterilisation of Soil-***

Fig. 15

*Drainage*—Since moisture in the ground encourages termite activity proper drainage of the site and lowering of water-table immediately below the proposed building is an important element in termite control.

Apart from the natural drainage of the site, provision is to be made for carrying away storm water from the roof via down-spouts or down pipes to a gutter or storm water disposal system that does not leave water around the site when the building is completed. A cemented apron should be provided all around the building.

(ii) *Termite-proof Construction*

Termite proof construction involves :

(a) incorporation of chemical and structural barriers against termite entry;

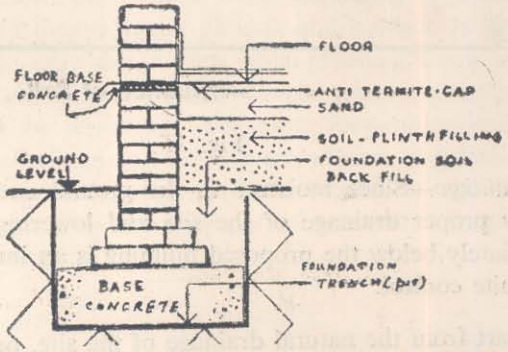
(b) ensuring that the construction is free from cracks, crevices, holes and similar other faults; and

(c) use of seasoned and treated wood.

Measures to prevent and control termite attack require considerable experience and may perhaps be attended to by experts in the line. It is, however, advisable to have an understanding of the treatment involved.

*"Chemical Barrier/Soil Treatment"*—The use of chemicals to produce a layer of soil lethal or repellent to termites is a very

useful method of protecting structures. In this way, a chemical barrier is created between the ground where the termites come from and the wood work and other cellulosic materials stored in the building. Foundation trenches and the back-fill earth are sprayed liberally with chemical toxicants by means of a sprayer or watering can. The earth filling below the floor is also treated with insecticides (Fig. 16).




Sterilisation of foundation pit, back-fill earth and soil-plinth filling.

Provision of anti-termite metal shield.

Staggering of joints

Fig. 16

Any of the following chemicals in water emulsion is used for soil treatment to prevent termite attack :

| | |
|---|---|
| 1. Aldrin emulsifiable concentrate | 0.5 per cent |
| 2. Heptachlor emulsifiable concentrate | 0.5 per cent |
| 3. Chlordane emulsifiable concentrate | 1.00 per cent |

Special care is taken to ensure an intimate bond of poisoned soil at the junction of the wall and the floor and after treatment every effort should be made not to rupture the protective membrane of the soil treated with chemicals.

*"Structural Barrier"*—Protection against termites is also offered by materials and methods of construction which prevent their gaining access to the building. The measures adopted are to be carefully executed as any loopholes left will tend to reduce their usefulness.

(i) *Foundatian*—Foundations should be carefully constructed in such a manner that they do not develop cracks or faults through which termites can pass. Use of low grade sand or aggregate, use of inadequate proportions of cement and faulty workmanship can lead to cracks and hollows.

(ii) The joints in successive layers of concrete tiles or bricks are staggered in order to make penetration by termites difficult (Fig. 16).

(iii) Door-sills, flooring, steps etc. are separated from rougher concrete foundation by at least 1″-2″ thick layer of dense concrete without cracks or joints (Fig. 17).

(iv) *Anti-termite shields*—Metal shields provide a method for preventing hidden entry of termites. Shields can be used for capping masonry, foundations, piers and walls. Termite shields are made of about 0.5 mm thick non-corroding metal like galvanised iron or copper sheets. A

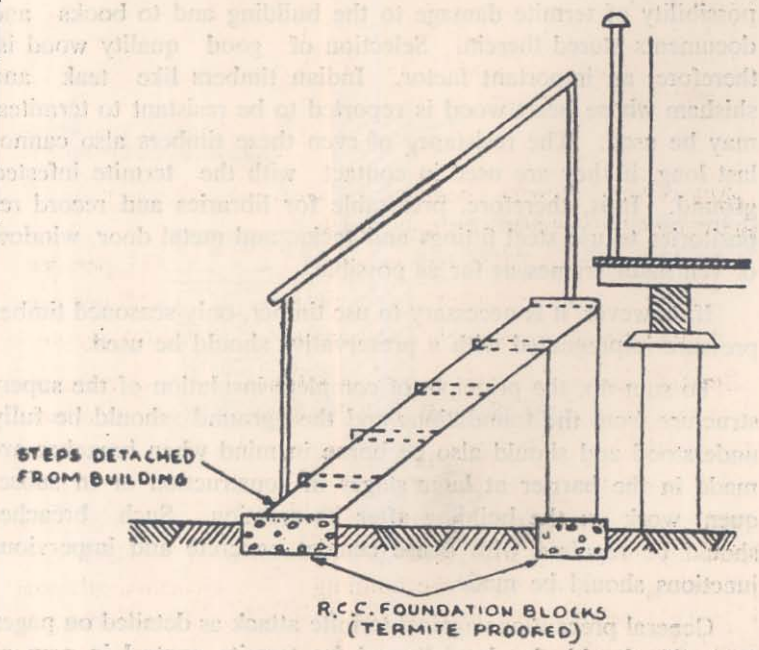



Fig. 17

damp proof coating is provided underneath the shield to prevent corrosion from water acting from below. Methods of fixing anti-termite shields in some locations are illustrated in Fig. 18.

The metal shield by its narrow edge and slope provides a practically complete obstacle to termites that construct surface shelter tubes. They may be able to build tubes downwards over metal shields but not upwards. Careful and regular inspection and maintenance are very important in the case of metal shields which are liable to be dented or damaged.

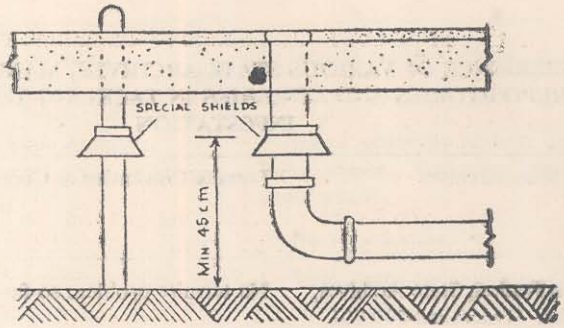
(v) A moisture-proof impenetrable barrier of 3″-4″ thick continuous layer of concrete all along the internal and external walls at about one foot above the floor level also acts as a satisfactory barrier (Fig. 19).

"*Use of Seasoned and Treated Timber*"—Use of wood of poor quality for construction work, almirahs, racks etc. increases the possibility of termite damage to the building and to books and documents stored therein. Selection of good quality wood is, therefore, an important factor. Indian timbers like teak and shisham whose heart wood is reported to be resistant to termites, may be used. The resistance of even these timbers also cannot last long, if they are used in contact with the termite infested ground. It is, therefore, preferable for libraries and record repositories to use steel fittings and racks, and metal door, window or ventilator frames as far as possible.

If, however, it is necessary to use timber, only seasoned timber pressure impregnated with a preservative should be used.

To sum up, the principle of complete insulation of the superstructure from the foundations and the ground should be fully understood and should also be borne in mind when breaches are made in the barrier at later stages in construction or in subsequent work on the building after its erection. Such breaches should be repaired with dense cement concrete and impervious junctions should be made.

General precautions against termite attack as detailed on pages 19 & 20 should also be followed for termite control in new as well as existing buildings.




Anti-termite shield fitted to pillar and pipes

Fig. 18

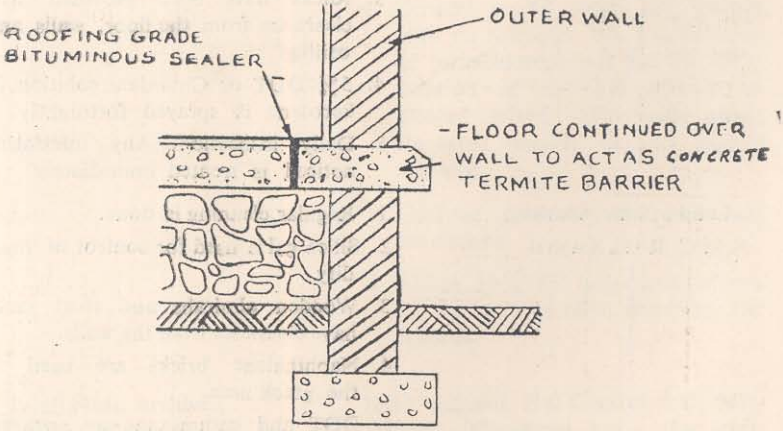



Fig. 19

## EXPERIENCE OF VARIOUS STATE ARCHIVES, MANUSCRIPT REPOSITORIES AND LIBRARIES IN TACKLING TERMITE INFESTATION

| State Archives | Termite Preventive & Control Measures |
|---|---|
| 1 | 2 |
| Andhra Pradesh State Archives, Tarnaka, Hyderabad-500 001 | No termite problem so far. |
| Madhya Pradesh State Archives, Bhopal. | No termite problem so far on account of—<br>1. regular cleaning.<br>2. regular spraying of pip insecticide and use of naphthalene bricks.<br>3. Use of steel racks in the stack area. |
| Maharashtra State Archives, Elphinstone College Building, Fort, Bombay-400 032. | 1. Cleanliness is maintained and naphthalene bricks are used in the stack area.<br>2. Cracks in floors and walls are cemented. Seepage is prevented.<br>3. Racks have been provided with clearance from the floor, walls and ceiling.<br>4. 5% DDT or Chlordane solution in kerosene is sprayed fortnightly.<br>5. Daily inspection. Any infestation noticed is treated immediately. |
| Manipur State Archives, R.M.C. Road, Imphal. | 1. Regular cleaning is done.<br>2. Silica gel is used for control of humidity.<br>3. Wooden almirahs and steel racks have clearance from the walls.<br>4. Naphthalene bricks are used in the stack area.<br>5. DDT and gammexane are sprayed twice a month, phenyle and Finit with kerosene oil once a week. |

| 1 | 2 |
|---|---|
| Orissa State Archives, Bhubaneswar. | No termite problem so far. |
| Rajasthan State Archives, Bikaner. | Termites generally appear during the rainy season. Following measures are undertaken:<br>*Preventive Measures*<br>1. Steel racks and shelves with clearance from the floor and walls are used.<br>2. Exhaust fans and air circulators have been provided for circulation of air.<br>3. Cracks and crevices in the stack area quickly attended to.<br>*Control Measures*<br>Depending upon the degree of severity of termite infestation, the following measures are adopted:<br>1. Termite outlet points are treated with (i) Kerosene oil, (ii) Solution of pentachlorophenol and (iii) 40% solution of mercuric chloride in alcohol mixed with white paint. Repeated thrice at one month intervals.<br>2. Coal tar creosote oil applied on the shelves.<br>3. Aldrin 30% EC is sprayed/painted on the shelves after removing the records. |
| Tamil Nadu Archives, Egmore, Madras-8. | Have engaged Pest Control firm, M/s. Jardine Hendersen Ltd., for anti-termite treatment which is given every month. |

| 1 | 2 |
|---|---|
| Uttar Pradesh State Archives, Mahanagar Extension, Lucknow. | The main building of the Archives at Lucknow was given anti-termite treatment during its construction and being of reinforced cement concrete there has been no termite problem since its occupation in 1973. In addition, steel racks have been installed in the stack areas. In the absence of air conditioning, provision has been made for proper ventilation and air circulation.<br><br>For prevention of termites in the regional repositories at Allahabad, Varanasi, Nainital, Agra and Dehradun insecticidal sprays are used at intervals which have proved quite effective. However, for control of termites during the rainy season in the regional repository at Allahabad, the crevices in the floor and walls are treated with paradichlorobenzene and are then cemented. |

| Institution | Termite Preventive & Control Measures |
|---|---|
| 1 | 2 |
| The Asiatic Society of Bombay, Town Hall, Bombay-400 023. | Have engaged M/s Pest Control (India) Pvt. Ltd. for anti-termite treatment. |
| National Library, Belvedere, Calcutta-27. | Termite problem exists in the old building. Pip insecticide is sprayed. Have engaged M/s. Jardine Hendersen Ltd. for anti-termite treatment. |
| Central Reference Library, University of Delhi, Delhi. | Termite attack is rare but whenever it is noticed, the Zoological Deptt. of the University carries out the treatment of affected area using 2%solution of aldrin in water. The treatment is found to be very effective. |
| Delhi Public Library, S.P. Mukherjee Marg, Delhi. | Have engaged a Pest Control firm for regular monthly anti-termite treatment of their main library as well as zonal libraries. |
| Indian Council of World Affairs Library, Sapru House, Barakhamba Road, New Delhi. | 1. Insecticidal sprays are used which provide short term relief.<br>2. Planning to approach a Pest Control firm for long-term effective treatment. |
| Dr. Zakir Hussain Library, Jamia Millia Islamia, New Delhi. | Baygon and creosote oil are sprayed in the area effected by termites. Found to be quite effective. |
| The Adyar Library & Research Centre, The Theosophical Society, Adyar, Madras. | 1. Books are brushed with a solution of Bronidiol in kerosene oil.<br>2. Fumigation is done using paradichlorobenzene.<br>3. Previously the whole library used to be disinfected by a Pest Control firm periodically. |
| Govt. Oriental Manuscripts Library, University Library Building, Madras. | 1. Adequate ventilation and circulation of air is maintained in the storage area.<br>2. Cleaning is done with the help of a vacuum cleaner. |

| 1 | 2 |
|---|---|
| | 3. Racks and shelves are treated with disinfectants.<br>4. Naphthalene bricks are used on the shelves.<br>5. Records are fumigated with paradichlorobenzene. |
| Khuda Baksh Oriental Public Library, Patna. | No termite problem since 1986, when their building was given anti-termite treatment by M/s. Pest Control (India) Ltd. |
| Bhandarkar Oriental Research Institute, Pune. | 1. Overall cleaning is done at short intervals.<br>2. Common insecticidal sprays are regularly used. |
| Vaidika Samsodhana Mandal, Pune. | 1. Manuscripts and library books are housed on the first floor, so that there is no direct contact with the ground.<br>2. Gammexane Powder is periodically used. |

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Carruthers, R.H. . . Publishing Library, 1937.

## LIST AND ADDRESSES OF FIRMS ENGAGED IN PEST CONTROL

1. Pest Control (India) Pvt. Ltd.,
   7, Jantar Mantar Road,
   New Delhi-110 001.
2. Pest Control Advisors & Services,
   102, Madhuban,
   55, Nehru Place,
   New Delhi-110 019.
3. Pest Control Operations,
   C-40, New Delhi South Extension Part II,
   New Delhi-110 049.
4. United Pest Control Services,
   Hans Bhawan,
   New Delhi-110 002.
5. Pest Control and Aides,
   C-491, Defence Colony,
   New Delhi-110 024.
6. Beekay Pesticides Pvt. Ltd.,
   63, Old Rajinder Nagar Market,
   New Delhi-110 060.
7. Inland Pest Control & Allied Services Pvt. Ltd.,
   D-288-289, Street No. 10,
   Laxmi Nagar,
   New Delhi-110 092.
8. Pest Control National Association of India,
   1620, Bahadur Garh Road,
   Delhi-110 006.
9. Pest & Insect Exterminator (India),
   F-10/3, Vasant Vihar,
   New Delhi-110057.
10. Pest Kill,
    19/23, Basti Rohilla,
    New Delhi-110 035.
11. Pest & Insect Eradicators (India),
    G-203, Narain Vihar,
    New Delhi-110 028.

12. Pest Control Pioneer,
D-268, Sarvodya Enclave,
New Delhi-110 017.

13. Pest Control Surindra,
A-4, Vijay Enclave,
Palam Road,
New Delhi-110 015.

14. Marco Pest Control Operations,
237, Jhandewalan Extension Phase I,
New Delhi-110 005.

15. Ankur Pest Control Services,
4558, Main Bazar Paharganj,
New Delhi-110 055.

16. Pest Control and Fumigation Enterprise,
C-62, Inderpuri,
New Delhi-110 012.

17. Pest Control Services of India,
B-179, Fateh Nagar,
New Delhi-110 018.

18. Super Pest Control (P) Ltd.,
SPC Building,
258, Bharat Nagar,
New Delhi-110 049.

19. Friends Pest Control Services,
51, Main Bazar, Old Sabzi Mandi,
Opposite Indra Market,
Delhi-110 007.

20. Pest Control Consultants & Services,
G-50, Gulmohar Enclave,
New Delhi-110 049.

21. Hardy's Pest Control Services,
CB-96, Ring Road,
Naraina, New Delhi-110 028.

22. Aggarwal's Pest Management Services,
D-13, Maharani Bagh,
New Delhi-110 065.

23. Pest Control Incorporated,
260, Sant Nagar,
East of Kailash, New Delhi-110 065.

24. Indian Farm Services,
R-237, Greater Kailash I
New Delhi-110 048.

25. Pest Control Company,
103, Vishal Bhawan,
95, Nehru Place, New Delhi-110 019.

26. Pest Control A.S. Goel,
8/12 Rajpur Road,
Delhi-54.

27. Pest Control (Dr. Sarup's) Pvt. Ltd.,
AB-8, Community Centre,
Safdarjang Enclave,
New Delhi-110 016.

28. Pest Control B.L. Kapur,
Ahata Kidara, Bara Hindu Rao,
Delhi-6.

29. Pest Control Bluedot,
1668/1, Govindpuri Extension,
Kalkaji, New Delhi-110 019.

30. Jardine Henderson Ltd.,
Pest Control Divn.,
Indra Palace, Connaught Place,
New Delhi-110 001.



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