TERMITE PESTS OF VEGETATION IN RAJASTHAN AND THEIR MANAGEMENT

By

D. R. PARIHAR

CENTRAL ARID ZONE RESEARCH INSTITUTE

JODHPUR

DECEMBER 1981

CAZRI Monograph No. 16

Published by the Director, Central Arid Zone Research Institute, Jodhpur and
Printed at the Automobile Press, Jodhpur.

FOREWORD

Termites are found predominantly in the tropical regions of the world. A large number of termite species are found in the desert region and their density is so high that they infest any wooden material, whether live or dead. Termites cause serious damage to grasses, shrubs, trees and crops. These damages are substantial and are an economic drain to the desert people. These socially organized insects are, therefore, severe pests in the desert region. Considering the severity and magnitude of termite depredation, studies on various aspects of termite eco-biogeography, nature and extent of damage, their predators and management have been in progress at the CAZRI under the leadership of Dr. Parihar.

The main results, achieved so far are summarised in this monograph. I am sure that this compilation will be of interest to researchers as well as the extension workers.

H. S. MANN
DIRECTOR

PREFACE

Termites commonly known as white ants are of exceptional interest to man both as polyphagus pest and as a subject of study of their specialised social organisation which was evolved probably several million years ago. long before man appeared on the face of the earth. They adversely affect the economic status of the farmers and foresters, deteriorating the production in the country. Considering the severity and magnitude of termite depradations pertaining to arid zone, studies were taken up at CAZRI on a number of aspects of their biology and control. This monograph deals with termite problem in Rajasthan, wherein 33 different species of termites are found. They occur from the extreme arid lands destroying the trees and grasses to the sub humid zone along the southern Aravallis. They inhabit all the habitats with a bio-climatic zone and damage crops, grasses, trees, timber and household commodities Results of detailed studies on Rajasthan termites are incorporated in this monograph. It also embodies the result of our studies on toxicity of various insecticides for a number of species of termites and the control strategies. Our field trials have pointed out that the pest can be managed effectively through an integrated approach.

This monograph is intended as a practical guide of thermite control for agriculturists. horticulturists, foresters and rangeland specialists.

D. R. PARIHAR

Toxicology & Plant Protection Section

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INTRODUCTION

Extensive work on taxonomic aspects of termites has been carried out in Rajasthan, but very little information is available on the pest dimension and control of this insect. To fill up the gap in knowledge about the pest status of termites and their possible management in Rajasthan, the problem is being investigated in detail at CAZRI, Jodhpur (Parihar, 1977, 1978a, 1978b, 1979, 1980) and the important findings and recommendations of this Institute are reported here.

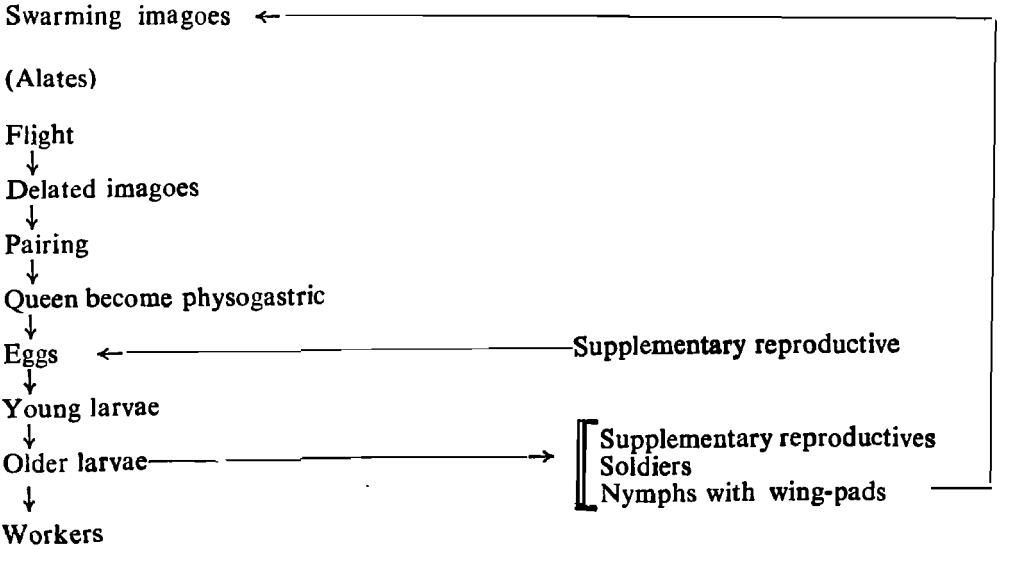
Termites (White ants) locally called **'Udai'** or **'Demak'** are medium sized, soft bodied, dull white to dark brown in colour and belong to the Insecta, order Isoptera. Termites live mostly in underground soil in Rajasthan. Their food consists principally of both dead and living wood as well as roots. Several species are serious pests of agriculture and forestry, necessitating extensive control operations. One of the major problems of Rajasthan from agricultural and afforestation point of view is the severe infestation of the crops and trees by termites. The termite fauna of Rajasthan (area : 3,42,272 sq km) is very rich. 33 species are known to occur there. Among these only 14 species have been observed as major economic pests of agriculture and forestry in Rajasthan (Parihar, 1978). Plants are generally attacked by termites, when they are not in a vigorous state of growth and when their vitality is low either due to internal growth factors or due to environmental causes such as drought or poor soil fertility. Longlived plants such as trees and plantation crops are more susceptible to attack in the seedling stages and annual crops near harvest time. In all cases it is the worker caste which does the maximum damage.

Termites are social insects and live in small to large colonies, a colony in some species containing about a million or more individuals. They also exhibit polymorphism, a species consisting principally of three forms or castes, viz. workers, soldiers and reproductives. The castes are morphologically distinguishable and have different functions. Thus, the soldiers, which have a strongly chitinised head usually with large mandibles generally take an active part in the defence of the colony. The majority of individuals in a colony are workers, there are a few soldiers (10 per cent) and usually only a pair of reproductives. The last named are initially winged and swarm out of a colony, usually once or twice a year to form new colonies. As a rule a colony has only a pair of primary reproductives (a male and a female often called king and queen respectively)

which are generally kept by workers in a "royal cell" and their sole function there is to reproduce. Fecundity is high and the physogastric queen in some species are known to lay almost one egg per second throughout their life of several years. The eggs hatch in a few days into whitish larvae which, after a series of moults, become fully developed workers, soldiers or winged reproductives as the case may be.

LIFE CYCLE

A termite colony generally consists of numerous workers (or pseudo workers), fewer soldiers and a pair of reproductives (a king and a queen). Periodically, the colony produces numerous winged imagoes (alates) which swarm out in considerable numbers usually once or twice a year most often in the rainy season. After a short flight lasting a few minutes to an hour or so, the alates descend to the ground, cast off their wings, and segregate in pairs, a male chasing a female, tandem fashion. The pair settles down in some hole or crevice and start breeding. The queen gradully becomes much larger in size due to the enlargement of the abdomen (Physogastry), but the king remains unchanged. The queen lays several thousand eggs per day. The eggs are small, white and longish oval with rounded ends (Fig. 1); they hatch in a few days and the young larvae undergo a number of moults. They produce mostly workers and soldiers. Periodically, they produce fully winged or primary reproductives which swarm out and repeat the cycle. If the primary reproductives die or are removed, some of the larvae may develop into secondary reproductives which are not fully winged but are still capable of reproduction.



Generalised life-cycle of termites.

ECO - BIOGEOGRAPHY OF IMPORTANT TERMITES OF RAJASTHAN

A summary of the known information on the more important economic species of Rajasthan is given below as it will be useful to termite control operators.

1. *Anacanthotermes macrocephalus* (Desneux) (Family - Hodotermitidae) : It is the only species of this family found in Rajasthan. It is the best known and the most destructive species. It occurs from eastern Afghanistan to western India. In Rajasthan, it occurs in the districts of Bikaner, Barmer, Jaisalmer and Jodhpur. Its distribution is characterised by severe summer (mean above 34°C) and cold winter (mean below 18°C), low rainfall (100 mm-300 mm). More important than the temperature seems to be the aridity which governs its biogeography. Imagoes are 12-77 mm long with wings; soldiers with mandibles 10.5-16.7 mm; workers 6.0-10.5 mm. Swarming occurs in August. It prefers sandy or gravelly soil, open shrub or little vegetation desert. It is a true harvester termite and attacks grasses, which it cuts and carries to its underground chambers.

2. *Psammotermes rajasthanicus* (Roonwal and Bose) (Psammotermitinae): It occurs in western Rajasthan and Pakistan. In India it is confined to the extreme arid portion (districts of Barmer, Jaisalmer, Bikaner) which is characterised by high summer and low winter temperatures and scanty rainfall (below 300 mm). It prefers open scrub and loose sandy soil. Occasionally it attacks living trees of *Tecomella undulata*. It is medium sized brownish yellow termite whose soldiers are trimorphic, the length (with mandibles) ranging from 4-8 mm; workers are about 3-4 mm long. Nothing is known about its swarming and alates.

3. *Amitermes belli* (Desneux) : It is a soil-dwelling species which attacks the roots and bark of living plants. It prefers soil which is loam and clay in texture in Rajasthan. It tolerates moderate to high temperatures (Summer, mean 36°C, winter 14°C). It flourishes in open as well a dense deciduous forest, open scrub and cultivated fields but avoid barren sandy areas. It has preference for moist situations, such as irrigated plantations and gardens. It has been observed as a pest of *Bursera delpechiana* plantations at CAZRI, Jodhpur.

4. *Eremotermes paradoxalis* (Holmgren): A wide spread species in Pakistan (Sind, Punjab, North-west frontier province), and India (almost whole of India).

In Rajasthan it has been recorded from Nagaur and Jodhpur. It is a soil-dwelling species with small, whitish, sluggish soldiers and workers, swarming in Rajasthan occurs in August. In Rajasthan it is found in open scrub cultivated fields and dense forests. It just enters the arid area at Jodhpur but seem to avoid extreme aridity. It tolerates hot summers (mean, 34°C). It has wide tolerance for soils being found in all types from light sandy to heavy black. Workers are dimorphic. Imagoes are 7 9-9.1 mm with wings; soldiers with mandibles are 3.5-4.2 mm; workers 2.3-4.0 mm.

5. *Microtermes mycophagus* (Desneux) : A widely distributed species in Pakistan (Baluchistan, Sind and Punjab) and western India. In Rajasthan it has been reported from Jaipur (Sambhar Lake); Nagaur (Didwana), Jodhpur, Sikar (Palsana). It is found throughout the Thar desert and may be regarded mainly as arid zone species. It is a soil-dwelling species. Swarming occurs from late June to early September. Imagoes with wings are 17.4-21.9 mm; soldiers with mandibles are 3.2-4.8 mm.

6. *Microtermes obesi* (Holmgren) : A wide spread species in south and south east Asia : Pakistan, all India, Ceylon, Burma and Thailand. In Rajasthan it is distributed in Jodhpur, Nagaur, Jaipur and Udaipur districts. It is a soil-dwelling species and is found in both wet and dry zones including the Thar desert, swarming occurs during the monsoon (July-August) in broad day light. Imagoes with wings are 12.1-17.4 mm; soldiers with mandibles, 3.10-4.15 mm.

7. *Odontotermes obesus* (Rambur): A common species widely distributed in Pakistan, Bangladesh, India and Burma. In Rajasthan it is confined to Jodhpur, Ajmer, Bhilwara, Jaipur, Jhunjhunu, Nagaur, Pali, Sikar and Udaipur districts. It occurs both in the arid areas (Thar desert) and wetter zones. Whenever subsoil moisture is available, it builds earthen mounds upto 2.5 metres in deciduous forests of U.P. and M.P. In desert areas no mounds are built. Swarming occurs during monsoon (July-August) in desert. Imagoes with wings measures 23.5-27.6 mm and soldiers with mandibles, 3.80-5.95 mm.

8. *Odontotermes guptai* (Roonwal and Bose) : Western India (widely distributed in Rajasthan in both dry and wet districts, viz. Jhunjhunu, Bikaner, Nagaur, Jodhpur, Ajmer and Udaipur) and Pakistan.

9. *Odontotermes latiguloides* (Roonwal & Verma): Widespread in Rajasthan as follows : Jhunjhunu, Sikar, Jaipur, Jodhpur, Bhilwara, Sirohi, Banswara and Dungarpur. Apparently confined to moist forest or gardens and areas where the vegetation is rich due to large quantities of sub-soil water. Absent in the very arid western areas of Rajasthan (Jaisalmer, Barmer, Bikaner).

10. *Odontotermes brunneus* (Hegen) : It is mostly distributed in peninsular India, north upto Rajkot (Gujarat and east up to Bengal. In the region of the Thar desert it occurs just near the border in Gujarat (Rajkot), Rajasthan (Jodhpur). Imagoes without wings are 12-14 mm; soldiers, 5.8-6.5 mm and workers, 4.5-6.6 mm.

11. *Odontotermes gurdaspurensis* (Holmgren & Holmgren) : Widely distributed in western and northern India (Punjab, Haryana, Rajasthan, Kashmir) and Pakistan (Punjab, Baluchistan). In Rajasthan, it has been observed as a severe pest of *Eucalyptus camaldulensis* trees. It is widely distributed in Rajasthan (Jodhpur, Ajmer, Bharatpur and Banswara districts).

12. *Microcerotermes tenuignathus* (Holmgren) : It is soil-dwelling species, and it sometimes occurs in association with *Odontotermes* sp. and also in roots of bushes and on *Acacia arabica*. It occurs from western Indian to Pakistan. In Rajasthan it is known from the districts of Barmer, Jaisalmer, Jodhpur, Jaipur and Kota.

TERMITE PESTS AND THEIR MANAGEMENT

Some basics of termite control

One of the most important factors in the termite control operation is its cost worthiness. It will depend on the method which is the cheapest and most effective in a given area and given species. The answer also depends largely on an accurate estimate of losses and size of termite population and on the magnitude of reduction of their population after a control operation. Other important principle is the knowledge about the biology of pest species, their feeding habits, daily activity, which can explicitly enhance the control efficiency. It is also important to time the control operation to achieve most fruitful results. The damaging activity of termites is at its maximum during August to December (Parihar, 1979) and this period is the most appropriate for longer control. Being soft-bodied, termites are fairly susceptible to the action of insecticides and other toxicants, and also to such processes as desiccation due to dry atmosphere. Since they mostly live in hidden quarters, they are often difficult to be detected and opproached but once reached by means of injected dusts. solution. and emulsion or fumigants, they succumb easily to the poison.

No promising methods of biological control having hitherto been found (Predators like ants, spiders mantids, etc. have been used). The advent of the chlorinated hydrocarbons has radically changed the picture. Not only have they been found to be highly effective against termites in extremely low dosage but they are also not deadly poisons for man and domestic animals; furthermore they are longlasting in their effect, often persisting for years.Thus for agricultural purposes the chlorinated hydrocarbons have proved to be highly successful for termite control and have completely replaced older toxicants.

For control purposes it is useful to keep in mind the time schedule, i.e. the duration for which control is required to be effective. Specific control methods are given under individual crops, but generally speaking for short-season crops (*bajra,* wheat, ete). A single application suffices, whereas for providing year long protection relatively higher dosages and repeated applications may be required. In full grown trees, individuales branches may be attacked. In such cases, protection to the trunk by painting bottom two metres of it with such insecticides as BHC or aldrin, etc. suffices to keep off the attack for a year or longer.

Soil insecticides: Since for termite control, insecticides are generally applied to the soil, it is obvious that the relationship between insecticides and soil structure is of prime importance for successful control (Harris, 1972). as follows : (i) The chemical structure and properties of the insecticide itself (ii) The extent of its vaporisation and degradation in soil, and (iii) The length of time it will remain biologically active in soil This will depend on soil moisture and temperature and also on formulation of the insecticide The half-life in soil of the more long-lasting chlorinated hydrocarbons, as evaluated by Menzie (1972) which are suitable for termite control, are as follows :

Insecticide	Approx. half-life in soil (Years)
D.D.T.	3–10
Aldrin	1–4
Dieldrin	1–7
Endrin	4–8
Heptachlor	7–12
Chlordane	2–4
Toxaphene	10
B.H.C.	2

TERMITES OF AGRICULTURAL CROPS AND THEIR CONTROL

In Rajasthan following crops are susceptible to termite attack.

I Wheat *(Triticum aestivum)* : Termite is one of the major pests of this crop throughout the rainfed and irrigated regions. The most important species of termites attacking wheat crop are : *Odontotermes obesus, Microtermes obesi, Microcerotermes tenuignathus* (Parihar, 1978). Loss of wheat crop has been reported 7.15% by Parihar (1978). In western Rajasthan, on the whole, infestation is more severe in the rainfed light soils than in the irrigated heavy soils. The infested plants wither and dry up; they lose their anchorage and get dislodged. Sometimes attack also occurs in the earhead stage, resulting in chaffy earheads with little or no grain.

Control

Seed dressing : The seeds should be sprayed with aldrin emulsion at 400 ml of 30 EC per quintal seeds with the help of a hand sprayer and simultaneously they get dried on surface for 16 hours duration before it is sown in the field. It is not only very effective control the termites but also enhances wheat yield. Some-times the treatment resulted in 98.8 per cent increase in wheat yield over untreated seeds depending upon the severity of termite infestation.

Soil teratmsnt : Apply in furrows aldrin or heptachlor 5 per cent dust @ 1.25 kg a.i./ha or BHC 10 per cent dust @ 2.5 kg a.i./ha at the time of sowing the crop.

Treatment of standing crop : Aldrin 30 EC @ 1.25 kg a.i./ha should be applied by pouring over running water in channels for irrigating the crop. It can provide effective relief to the infested crop.

I. *Bajra (Pennisetum typhoides)* : In Rajasthan, *bajra* or pearl millet is subjected to attacks by termites, the culprit species being *Microtermes obesi.* The roots, and later on the stem are attacked, resulting in the wilting and ultimate drying of the plants (Fig. 3A).

II. *Guar (Cyamopsis tetragonoloba)* : The termite species responsible for damaging *guar* crop are : *Microcerotermes baluchistanicus* (Ahmad), *Odontermes*

guptai (Roonwal and Bose), and *Microtermes obesi* (Holmgren). They attack the crop both at germination and flowering and fruiting stages in the months of August and September (Parihar, 1977, 1978). At the germination stage, they nibble the roots while at the flowering and fruiting stages they also enter the base of the stem by making a hole in it (Fig. 3B). They completely devour the inner portions, leaving only the rind, thus depriving the stem of the nutritional supply. The termite infestation varies between 12.3% to 16.3% of the plants.

III. Castor *(Ricinus communis):* It is attacked by *Microtermes mycophagus* (Desneux) both at the seedling and the growth stages of the plant. In the seedling stage, the attack is more on the roots, while the stem remains unaffected. Termites nibble the tap root; in the grown up plants the termites are seen around the root zone and in certain cases upto 3 feet of the stem (Parihar, 1977). The bark of the roots, in each case, was found to be quite intact while the hard cores were mostly tunnelled through. The fine roots (more than 20-40 mm in diameter) showed more damage. When severely damaged, the roots show galleries which were rather (Fig. 2) irregular and ran almost parallel to the length of the roots. The larger galleries are occasionally filled with the earth and the excreted wood.

IV. Chillies *(Capsicum annum) :* In Rajasthan, chillies in various stages of growth are attacked by termites. The plants, both at and below ground level are attacked, A loss of 10-45 per cent has been recorded at Mathania (Jodhpur). The culprit species were *Odontotermes obesus* and *Microtermes obesi.* The attack is at the transplanting stage of the crop, when the termites nibble the growing regions of the roots. At the flowering stage they also enter at the base of the stem and devour its inner portion by filling it with the earth and the excreted saliva.

Control : Aldrin 30% EC @ 5 litre/ha with irrigating water can protect the standing crop very effectively.

V. Pulse crops : Important crops like *moong (Phaseolus radiatus), moth (Phaseolus aconitifolius,* cowpea *(Vigna sinensis)* are some times attacked by termites *Odontotermes obesus* and *Odontotermes parvidens.* The plants are attacked at the various stages of growth. Losses ranging between 25-30 per cent in cowpea, 10-15 per cent in *moth* and 5-17 per cent in *moong* have been observed at Jodhpur.

Control : By treating planting furrows with 5 per cent aldrin dust @ 20 kg/ha provides significant improvement in the yield.

TERMITES OF FOREST TREES AND THEIR CONTROL

Termite damage in extreme arid areas like Jaisalmer, Bikaner and Barmer is higher than that in the semi-arid areas of Rajasthan. In the western Rajasthan due to poor soil fertility, deficient soil moisture and other environmental causes, termite infestation to young plantations is severe and some times, total loss of plantation has been observed.

Damage to seedlings or young plantations : Both the indigenous and the exotic species of the plants are susceptible to the termite attack. Exotic species like *Eucalyptus camaldulensis* and *Acacia tortilis* are attacked by *Odontotermes gurdaspurensis* (Holmgren) and *O. lantiguloides* respectively, indigenous species like *Prosopis cineraria* by *Odontotermes obesus* and *Azadirachta indica* by *O. gurdaspurensis*. The attack on the indigenous species is severe in dry season (November-June). The plants are exclusively attacked at their roots (Fig. 4). Because of destruction of the tap root, the upper plants get no nutrition and as a result, leaves become yellowish and when the root system is completely devoured the plant ultimately dies. The intensity of damage to newly transplanted seedlings of both exotic and indigenous plantations was as follows :

Plant species	Termite species	damage (%)
Leucaena leucocephala	*Microtermes mycophagus*	26.26
Zizyphus nummularia	*Microtermes obesi*	47.08
Eucalyptus camaldulensis	*Odontotermes gurdaspurensis*	33.00
E. hybrid	*O. obesus*	56.66
E. atriodora	*O. obesus*	52.00
Salvadora oleoides	*Microtermes mycophagus*	22.00
Capparis decidua	*Psemmotermes rajasthanicus*	50.00

CONTROL

Prior to plantings in 0.3 cu metre pit in ground, 10-15 gram dust of aldrin 5% or heptachlor 5% should be mixed theroughly with the soil; these insecticides which have a residual toxicity of about 2-10 years will protect the plants for long period effectively.

Damage to old trees (Fig. 5)

In the arid and the semiarid regions of Rajasthan, the dead bark of almost all trees is attacked by termites. The attack usually occurs under earthen galleries which covers the bark (Fig. 4A) and under which workers and soldiers travel to and fro from the ground connection leading sometimes to tree branches or inside the tree trunk. Generally, workers eat away the bark surface, but this type of damage is negligible. Sometimes, however, the damage can become serious when it extends to sap wood or heart wood. The common trees of Rajasthan damaged by termites are listed in Table 1. *Delonix regia* is infested by *Odontotermes obesus*, *Parkinsonia aculeata* by *Microtermes mycophagus* and *Albizzia lebbek* by *M. obesi*. The infestation is observed on root, stem and bark of the plant. On stem it starts at the base of the trunk and makes irregular, slightly parallel tunnels. In the higher trees, the colony originates at the base of the trunk, later penetrates the trunk. This is followed by an extensive hollowing out of the heart wood. Sometimes trees fall due to severe attack at roots and base of main trunks of *Eucalyptus camaldulensis* and *Prosopis cineraria* trees. The galleries on trees are present upto 90-240 cm and even on the branches of trees.

Control

1. Paint the trunk with a brush liberally upto a height of 15 cm with emulsion of 0.1-0.2 per cent aldrin, BHC, D.D.T. and chlordane in kerosene oil or fuel oil. Treatment should be given after scrapping off the earthen encrustations and runways made by termites on tree trunks.

2. Dusting : After making a shallow pit, 5-10 gm of BHC, aldrin or heptachlor should be applied around the base of trunk in ground.

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3. Spraying of the emulsion concentrations of 0 03 aldrin or 0 04% chlordane @ one litre per tree in a shallow channels in ground around each tree can effectively control the termites.

TERMITES ATTACKING GRASSES AND THEIR CONTROL

Some prominent grasses used as fodder for goat, sheep and cattle are attacked by termites in Rajasthan. Grass species like *Cenchrus ciliaris, C. setigerus, Lasiurus sindicus, Panicum antidotale* and *Cymbopogon schoenanthus* are susceptible to termite attack. Two types of damage are observed on grasses. Firstly by foraging of grass blades and secondly by constructing shelter tubes on the grasses. Damage in both the cases is due to the activity of worker caste. Workers of *Anacanthotermes macrocephalus* are mainly responsible for foraging and grass gathering. This species nests underground but forms small conical structures (mound) on the ground surface. The individuals come out for foraging at about 4-6 p.m. in winter and from 11 p.m. to 5 a.m. in summer and gather blades of dried leaves and carry them back to underground storage chambers. A few other species of termites, e.g. *Odontotermes obesus, Eremotermes paradoxalis* construct covertubes on dried clumps of grasses. The green parts of leaves are less affected. Cover-tubes are loose, made of excreted saliva and soil. Control : The following methods have been applied for the control of harvester termite, *Anacanthotermes macrocephalus.*

1. While the pest is in the ground : After destruction of the mounds pour 0.03% aldrin or 0.04% chlordane emulsion at the rate of 250 ml per hole in the mound.

2. When the pest is on the ground foraging : Spray of 0.05% quinalphos or 0.04% endosulfan emulsion in water can protect the fodder grasses.

BIOLOGICAL CONTROL

Almost nothing is on record about the parasites of termites, but a lot of informations on their predators are available in India. In Rajasthan following predators have been observed : Ants (Formicidae)- *Monomorium longi* Forel and *Pheidole smythiesi, Dorylus labiatus* Shuck are observed predating upon *Odototermes obesus* and *Microtermes mycophagus.* Mantid *(Humbertiella indica,* Sauss) attacking upon the termites, *Odontotermes obesus.*

Birds: The common house crow *(Corvus splendens* Vieillot*)*, the house sparrow *(Passer domesticus* Linn *)*, the common myna *(Acridotheres tristis tristts* Linn.*)* are seen to collect the termites at places where termites are swarming and prey upon them. Other birds e.g. the grey partridge *(Francolinus pondiceriauus* Gmelin*)*, the jungle babbler *(Turdoides stratus* Domont*)*. dig up termites with the help of their pointed bills or by scratching the ground several centimeters below the soil surface.

Lizards (Reptiles) : The geckos, *Hemidactylus* spp are commonly seen on the wall along side the bungalow lamps and feed voraciously on winged termites attracted to lights in the evening and at night. Their capacity to devour termites is incredible. Garden lizard, *Calotes versicolor* and *Ophiomorus tridacty lus* feed upon the swarm of *Microtermes mylophagus* as they come out from the holes in the ground.

Mammals : Five striped squirrel *(Funambulus pennati* wroughton*)* was recorded to feed upon a swarm of *Microtermes obesus.* The imago which could not fly on emergence, became easy prey to them. Mammals, like Hedgehog *(Hemiechinus auritus collaris* Gray*)*, *Tatera indica indica,* Desert fox *(Vulpes vulpes pusilla* Blyth*)*, Indian desert cat *(Fellis libyca arnata* Gry*)*, Indian grey mongoose *(Herpestes edwardsi ferrugineus* prey upon Harvester termite, *Anacanthotermes macrocephalus.*

ACKNOWLEDGEMENTS

I am extremely indebted to Dr. H.S. Mann, Director, Central Arid Zone Research Institute, Jodhpur, for his unfailing advice and encouragement throughout the course of termite studies and during the preparation of this monograph and to Dr. Ishwar Prakash, Coordinator and Principal Ecologist, who critically read the manuscript and made several useful suggestions. Sincere thanks are also due to the Head, Division of plant Studies in this Institute, for offering valuable suggestions and for providing facilities. The photographs were taken by Shri B.L. Tak, my colleague Shri M.P. Singh, Scieniist S-1 (Agr. Ent.) helped me in various ways. My thanks are due to both of them.

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Table- 1. Termites injurious to agricultural and plantation crops and fruit and other trees in Rajasthan.

Termite species	Plant damaged	Reference
1. *Microcerotermes tenuignathus* Holmgren	Wheat crop, *Calotropis procera*	Parihar (1978)
2. *Odontotermes obesus* (Rambur)	Cotton, jowar, barley, groundnut, *Khejri (Prosopis cineraria)*, Gulmohar *(Delonix regia)*	Kushwaha (1960) Bhatnagar (1962) Sharma (1964) Parihar (1978)
3. *Microtermes obesi* Holmgren	Wheat *bajra*, barley, gram, sugarcane, chillies. *Guar* crop	Narayanan & Ratanlal (1952) Kushwaha (1961) Parihar (1977-78).
4. *Microtermes mycophagus* (Desneux)	*Parkinsonia aculeata*, Castor crop	Parihar (1977 and 1978)
5. *Microtermes laxmi*	*Prosopis juliflora*	Roonwal (1976 and 1979)
6. *Microcerotermes baluchistanicus*	Guar	Parihar, (1978)
7. *Amitermes belli*	*Bersera dapechiaa*	Parihar, (7978)
8. *Odontotermes gurdaspurensis*	*Eucalyptus camaldulensis. Azadirach indica*	Parihar, (1978)
9. *O. lantiguloides*	*Acacia tortilis*	Parihar, (1978)
10. *O. brunneus*	*Dalbergia sissoo*	Parihar, (1978)
11. *Odontotermes guptai*	Gaur crop	Parihar, (1978)
12. *Anacanthotermes macrocephalus*	*Cenchrus ciliaris. Lasiurus sindicus*	Parihar, (1978)
13. *Psammotermes rajasthanicus*	*Tecomella undulata*	Parihar, (1978)
14. *Eremotermes paradoxalis*	*Eragrostis paoeoides. Dichanthium annulatum*	Parihar, (1978)

APPENDIX—1

PESTICIDES (TERMITICIDES)- USES AND SAFETY

It is always wise to be cautious about handling, storing and using the termiticides. The following precautions should be taken at the time of handling and using these termiticides.

1. Read the entire label on the termiticide container and follow the directions and precautions.

2. Discard any termiticide container without label or with damaged label.

3. Keep all termiticides away from food or feed stuffs.

4. Use termiticides only at the recommended dosages and timing to keep residues on crops and animals below permissible limits.

5 Termiticides should be stored in a locked cupboard where they are out of reach of children, pets or livestock.

6. Do not eat or smoke when working with termiticides. Wash hands and face and change clothing after handling termiticides.

7. Wear protective masks and clothing if so directed on the label.

8. Avoid spilling termiticides on skin or clothing. If spilled, wash off at once with soap and water. Particles or drops of termiticides which may accidently get into the eyes should be flushed out immediately with large volume of clean water.

9. Be particular in filling and emptying spray equipment and spraying on sloping land to avoid contaminating streams, ponds or other bodies of water.

10. Destroy all empty termiticide containers.

11. If symptoms of illness occur during or shortly after the spraying or dusting the patient should be hospitalized in nearest hospital.

APPENDIX—2

FIRST AID MEASURES AND ANTIDOTES

In case of poison swallowing :

1. Empty stomach immediately by giving ematic warm salt solution (ground mustard one tea-spoonful in a glass of warm water). OR Insert the index finger or press the tongue for down the throat to make the patient vomit. After emptying stomach give raw eggs or milk.

2. Skin contamination : Wash the skin with soapy warm water several times.

3. Eye contamination : Hold the eyelid open, wash the eyes gently with water immediately.

4. Poisoning by inhalation : Remove the patient to open air and apply artificial respiration.

All the plant protection workers are, however, advised to note the following simple method of first-aid in case of poisoning.

1. Vomitting mechanically either by finger or by giving common salt solution (2 teaspoonful of common salt, NaCl in a glass of water).

2. Wash by soda bicarb solution

3. Give universal antidote if possible

4. Manage artificial respiration (for more details, vide Hays (Jr.) (1963).

For reference : Clinical Hand Book of Economic Poisons (1963) by W.J. Hays (Jr.)

Antidotes for Termiticides

They are of two types :

1. General or Universal antidotes.

2. Specific antidotes.

I. *Universal antidote :* It is used as mixture of the following as :

1. Activated Charcol–2 parts

2. Magnesium oxide–1 part

3. Tanic acid–1 part.

2. *Specific antidote :* To neutralize the effect of the poisoning caused by chlorinated hydrocarbon termiticides give a dose of universal antidote described above followed by Magnesium sulphate (Epsom salt) in a glass of water and if necessary inject 10 cc of 10% calcium gluconate.

Physician may administer phenobarbital or pentabarbital to control convulsions.

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APPENDIX—3

TERMITICIDES AND THEIR APPROXIMATE COST

(BASED ON AVAILADLE INFORMATIONS)

Firms manufacturing or formulating the common termiticides are :

1. Bharat Pulvering Mills Private Ltd. Hexamar House, 28 Sayani Road, Bombay 400025.
2. Hindustan Insecticides Ltd. (A Govt. of India Enterprise) E 3 Defence Colony, New Delhi-110024
3. Union Carbide India Ltd. (Agr. Products Division) Kalla Parade, Beresia Raad, Bhopal.
4. Croplife Chemical Private Limited. 2 Sooterkin Street, Calcutta-13 (W. Bengal).
5. Annapurna Pulverising Mill, Industrial Estate Eluru, W.G. Dist. (A P.)
6. Sandoz (India) Ltd. Agrochemical Division, Sandoz House, Dr. Annie Besant Road, Worli, Bombay-400018
7. National Organic Chemical Industries, Mafatlal Lal House, Backbay Reclamation, Bombay-1
8. Ankar Industries, Pesticides Department 16/1 Ganesh Chowk, Avenue, Calcutta-13
9. I.C.I. (India) Pvt. Ltd. 34 Chowringhea, Calcutta-16
10. Rallis India Ltd., 21 A Ashok Marg, Lucknow-226001
11. Prakash Pulverising Mills, Industrial Area, Alwar (Raj.)
12. Pesticides India, Post Box 20, Udaisagar Road, Udaipur (Raj.)
13. Mysore insecticide company Pvt. Ltd. Post Box No. 18356, Linghi Chetty Street, Madras-60001.

Termiticides	*Available from firms (SN) enlisted above*	*Approx. cost Rs.*
1. Aldrin 5% dust	1, 4, 6, 7, 8, 11, 12	65/- per 10 kg
2. Dieldrin 18% E.C.	1, 4, 7, 8, 11, 13	60/- per one litre
3. BHC 10% dust	2, 4, 5, 6, 8, 9, 10, 11, 12	60/- per 50 kg
4. Heptachlor 10% dust	4, 5, 12, 13	60/- per 10 kg
5. D.D.T. 10% dust	2, 4, 5, 6, 8, 10, 11, 12, 13	60/- per 50 kg
6. Chlodane 5% dust	1, 6	57/- per 10 kg
7. Sevin (Carbaryl) 50% W.P.	3, 6	72/- per kg

APPENDIX—4

Known Families of Rajasthan Termites
(Example of the more common species are mentioned against each.)

Family I. Kalotermitidae
II. Hodotermitidae
III. Rhinotermitidae

Sub-family (i) Heterotermitinae
(ii) Coptotermitinae

Family IV. Termitidae
Sub-family (i) Amitermitinae
(ii) Termitinae
(iii) Macrotermitinae
(iv) Nasutitermitinae

Family I. Kalotermitidae

1. *Incisitermes didwanaensis* (Rooawal and Verma)
   Family II. Hodotermitidae
2. *Anacanthotermes macrocephalus* (Desneux)
   Family III. Rhinotermitidae
   Subfamily (i) Psammotermitinae
3. *Psammotermes rajasthanicus* (Roonwal and Bose)
   Sub family (ii) Heterotermitinae
4. *Heterotermes indicola* (Wasmann)
   Family (iii) Coptotermitinae
5. *Coptotermes heimi* (Wasmann)
   Family IV. Termitidae
   Sub family (i) Amitermitinae
6. *Speculitermes cyclops cyclops* (Wasmann)
7. *Amitermes belli* (Desneux)
8. *Synhamitermes quardriceps* (Wasmann)
9. *Eremotermes neoparadoxalis* (Ahmad)
10. *E. paradoxalis* (Holmgren)
11. *Microcerotermes laxmi* (Roonwal & Bose)

12. *M. palestinensis* (spaeth)

13. *M. raja* (Roonwal & Bose)

14. *M. sakesarensis* (Ahmad)

15. *M. tennignathus* (Holmgren)

16. *M. baluchitanicus* (Ahmad)

Sub Family (II) Termitinae

17. *Anguliitermes jodhpurensis* (Roonwal & Verma)
Sub family (iii) Macrotermitinae.

18 *Odontotermes brunneus* (Hagen)

19. *O. dehraduni* (Snyder)

20. *O. distans* (Holmgren and Holmgren)

21. *O. feae* (Wasmann)

22. *O. giriensis* (Roonwal & Chotani)

23. *O. guptai* (Roonwal & Bose)

24. *O. gurdaspurensis* (Holmgren & Holmgren)

25. *O. kushwahai* (Roonwal & Bose)

26. *O. latiguloides* (Roonwal & Verma)

27. *O. obesus* (Rumbur)

28. *O. parvidens* (Holmgren & Holmgren)

29. *O. wallonensis* (Wasmann)

30. *Microtermes mycophagus* (Desneux)

31. *M. obesi* (Holmgren)

32. *M. uniculor* (Snyder)
Sub family (iv) Nasutitermitinae

33. *Trinervitermes biformis* (Wasmann)

□

PLATE–1

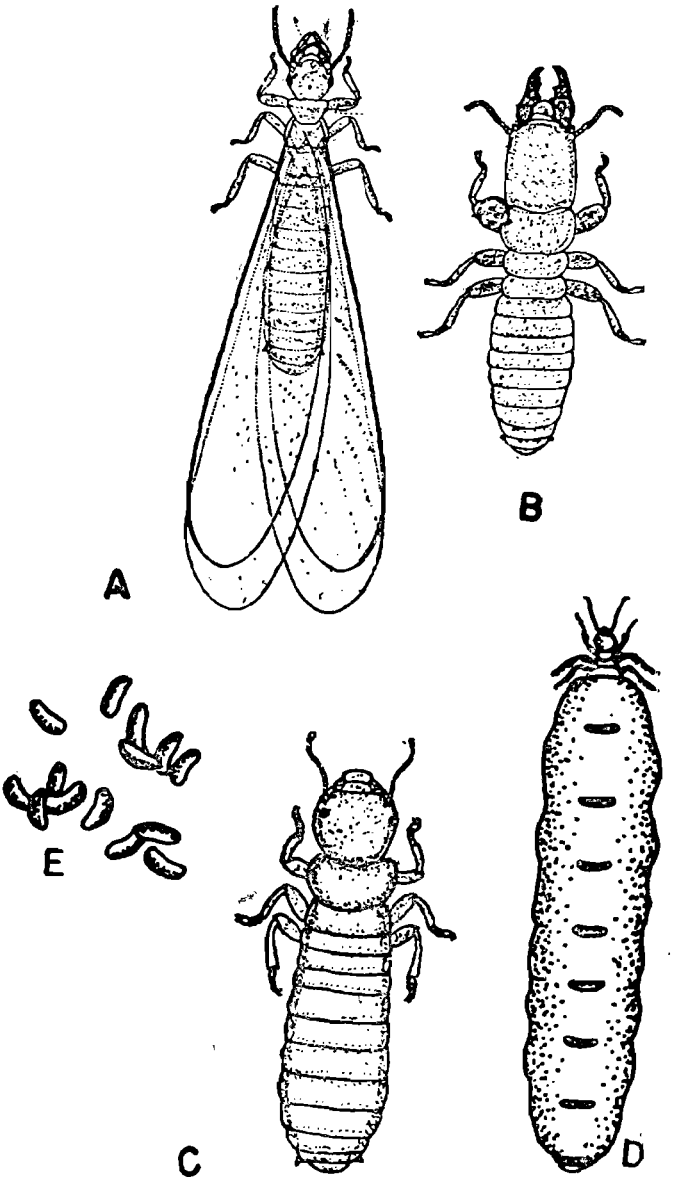

Fig. 1. Termite castes : (A) A winged imago with the two pairs of wings folded over the body in a stage of rest. (B) A soldier with strong chitinized mandibles (C) pseudoworker (D) queen (E) Eggs.

PLATE–2

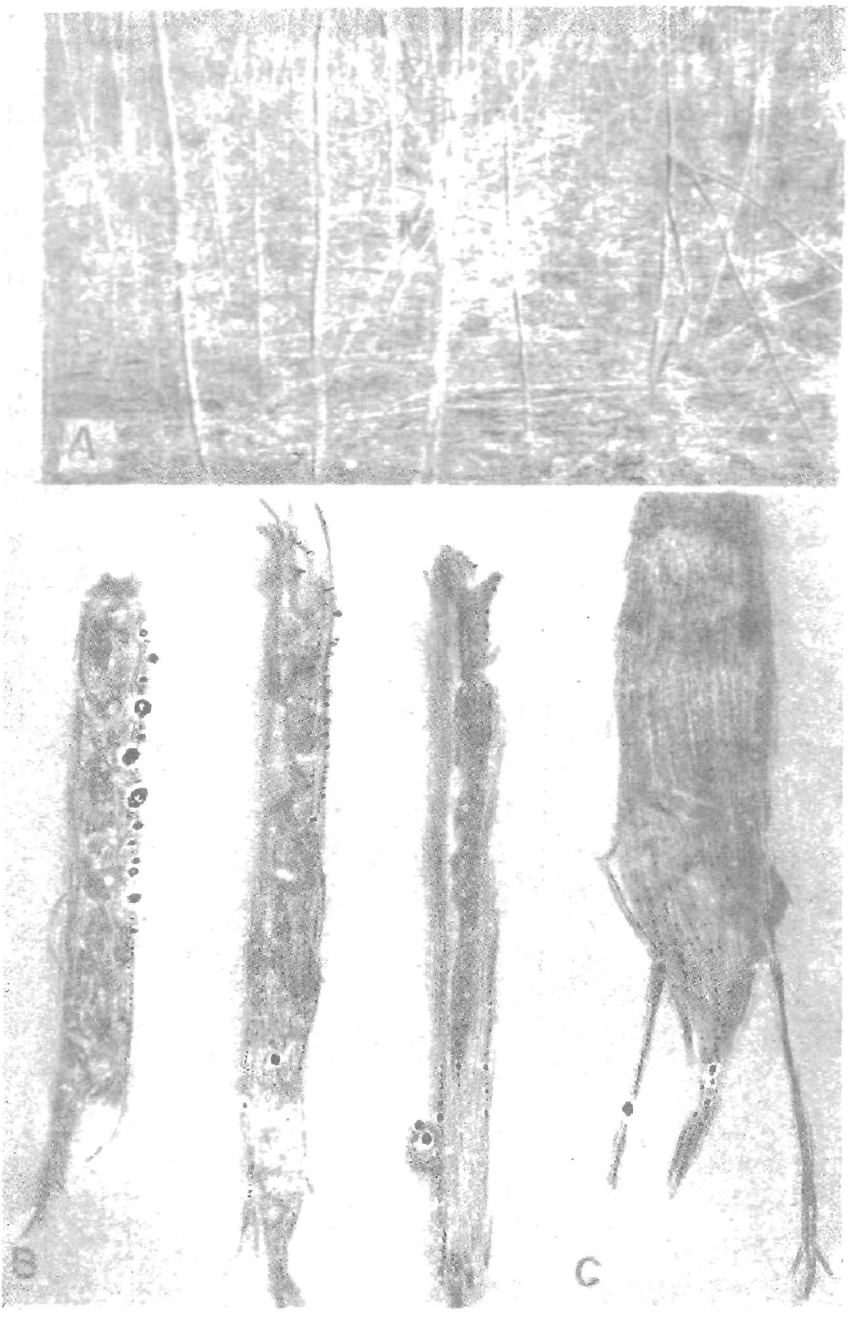

Fig. 2. Infested castor crop showing damage by termite. *M. mycophagus*. (A) Damaged castor field crop. (B) A portion of stem exhibiting galleries some of them filled with earth and excreted wood. C. Damaged root.

PLATE–3

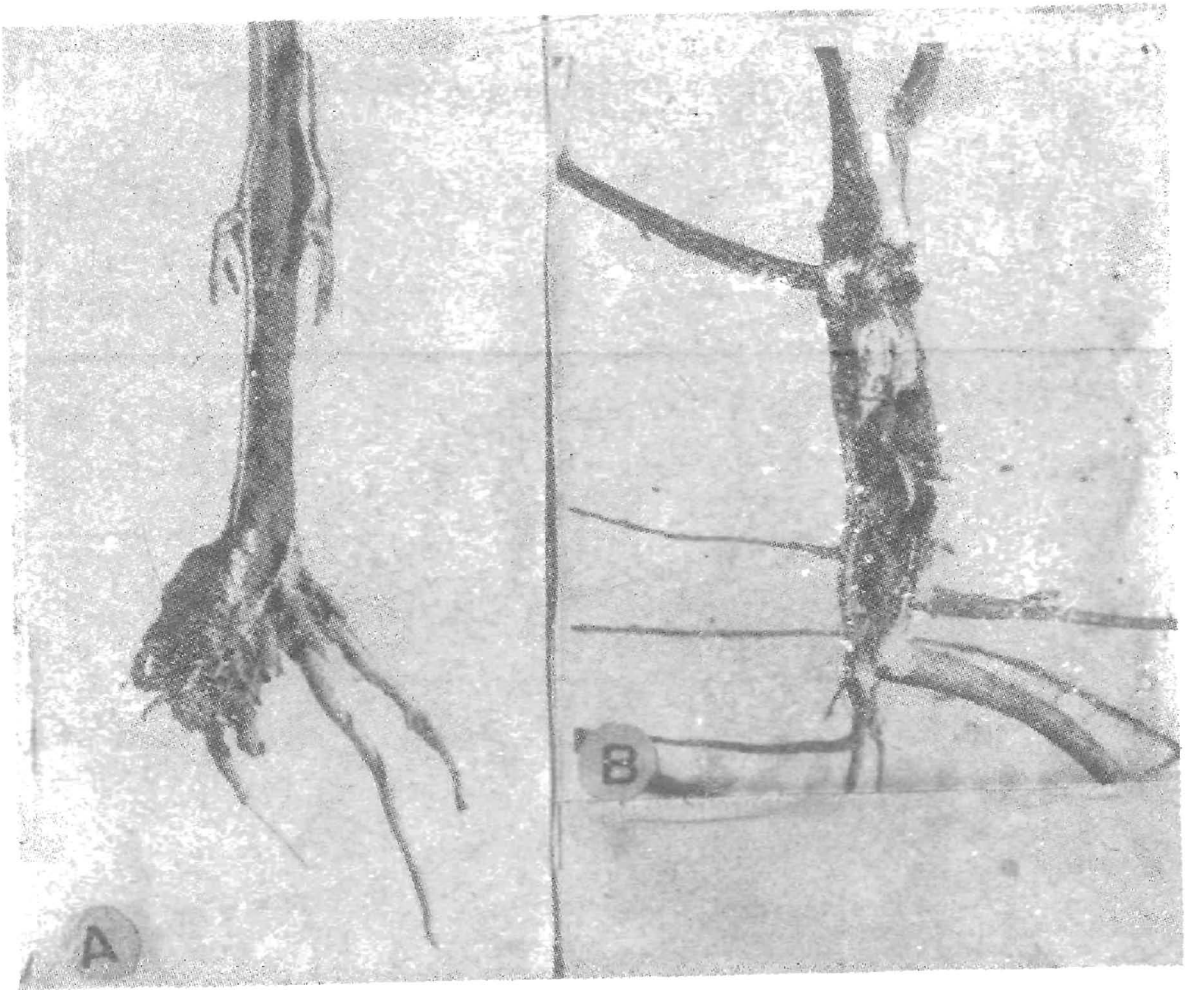

Fig. 3. A termite devouring *bajra* root (B) Some infestation on a *guar* root.

PLATE–4

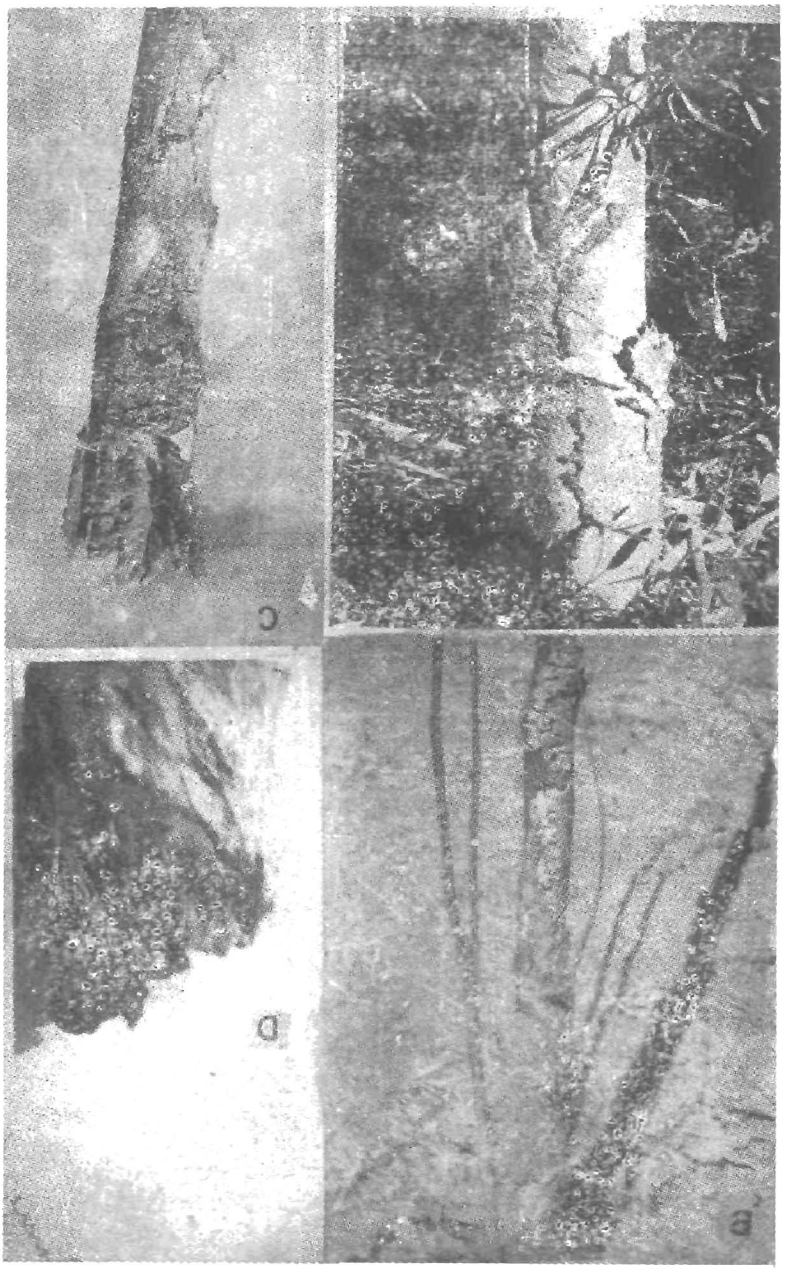

Fig. 4. *Eucalyptus camaldulensis* plantations showing termite attack. (A) Construction of cover tubes made from soil particles, excretion and saliva by this means they are able to move from the nest in ground upto trunk at considerable height (B) Completely damage to stem by termite. (C) Devouring of a root by termite, *O, gurdaspurensis*. (D) A cut portion of root, showing irregular tunnels.

PLATE–5

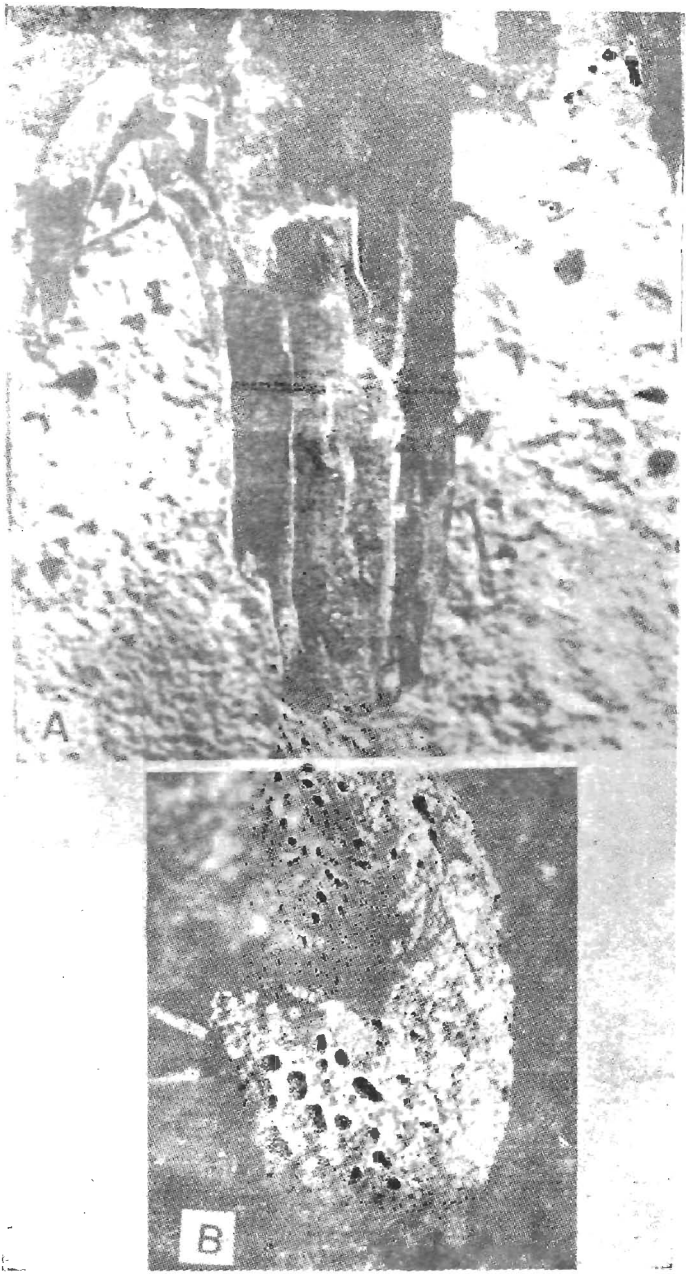

Fig. 5. Termite *(Microtermes mycophagus)*, damage to four year old *Parkinsonia aculeata* plants followed by the excavation of tunnels in the root. (B) Showing the infestation on the bark of the seme species.

PLATE–6

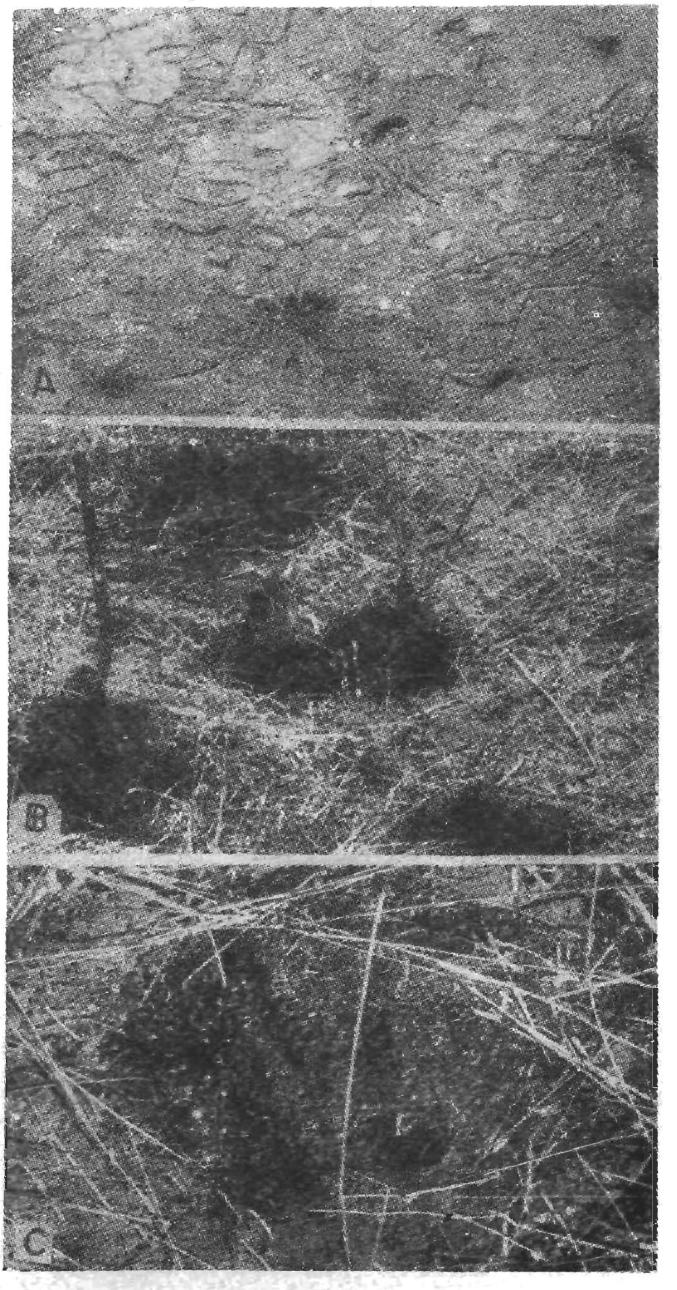

Fig. 6. Termite damage to grasses (A) Cover-tubes (run-ways) formation on grasses. (B-C) Earthen mounds built by *A. macrocephalus*.