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THE ROLE OF TERMITES IN TROPICAL FORESTRY

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Introduction.

Isoptera are widely distributed in all the warmer regions of the world, in particular in the Tropics where subterranean termites form a significant element of the soil macrofauna.

The food of termites is plant material, principally wood, though specialization within the many genera has led to a wide range of feeding habits. Some termites feed directly on the wood of living trees, while at the other extreme there are those which depend on humus in soil; some are able to digest dry timber and others need wood that has already been broken down by fungi or bacteria. In the treeless steppes, harvester termites collect and store dry grasses and herbs.

Since termites do not produce enzymes for breaking down cellulose, they depend on outside assistance in digesting their food. The manner in which this is achieved provides a useful division of the *Isoptera* into two groups. The first group possesses an intestinal fauna of flagellate protozoa which initiates the digestion of cellulose within the termite host, and here belong the more primitive families, the *Kalotermitidæ* or dry-wood termites, and the *Rhinotermitidæ* and *Termopsidæ* or damp-wood termites. The second group, which is the larger of the two, depends on fungi and bacteria acting on the food supply before it is actually eaten. This group is made up of one family, the *Termitidæ,* with a diversity of food preferences. One sub-family of these subterranean termites, the *Macrotermitinæ,* collects sound wood and stores it within the nest under conditions which permit it to be worked on by specific fungi—the so-called fungus combs. Another sub-family, the *Termitinæ,* dépends on the humus present in soil for its nourishment, and utilises the resultant large amounts of excreta in the construction of more or less elaborate mounds.

The intimate connection existing between termites, trees and the soil has an interest for the forester in the Tropics which goes beyond the more widely recognised damage to constructional timbers. The influence which termites exert on tropical forestry has a positive aspect as well as a negative one, depending on local conditions.

Termites and natural regeneration.

Large termite mounds are a feature of the landscape in many parts of the Tropics, particularly in savanna woodlands and cultivation steppes. In Africa and Asia these mounds are the work of *Macrotermitinæ,* a sub-family of the *Termitidæ* characterised by the presence in the nest-system of fungus combs sponge-like structures of woody material permeated with specific fungi which are continually being eaten by the community and replenished by foraging worker termites. Such mounds are of direct ecological significance on account of their size affecting the local topography, and because the soil used in their construction is brought up from below and may differ in composition from the surrounding surface soil. In Australia and South America there are no fungus-growing termites, and large mounds are the work of other sub-families including *Amitermitinæ* and *Nasutitermitinæ.* Such mounds tend to be smaller and have steeper sides than those of the *Macrotermitinæ,* and to have less influence on vegetation in consequence. In South America there are ants which build large, low mounds and have a type of fungus comb within the nest. The ant mounds produce an effect on vegetation corresponding to that of termite mounds in Africa.

The term « Termiten Savannen » was used by TROLL (1936) for an African parkland formation composed of sharply delimited woodland islands in grassland free from trees, or with at most a light scattering of them (fig. 1). These islands are based on the mounds of *Macrotermes* spp., and their vegetation is composed of specialised trees from gallery forest formations and not of the usual savanna woodland species (fig. 2). Under suitable climatic conditions, and freedom from intense burning the outward spreading of this mound vegetation can be expected to produce in time closed-canopy forest. In a study of the vegetation of the Sese Islands in Lake Victoria, East Africa, THOMAS (1941) traces the regeneration of the original forest in a sequence beginning with the colonising of termite mounds by grasses, followed by the growth of tall trees, and ultimately the coalescence of the woodland islands thus formed into a continuous forest canopy.

Three species of *Macrotermes* are responsible for large mounds in Africa—*bellicosus, goliath* and *natalensis*—and these are savanna dwellers. They invade suitable clearings as the forest cover is removed and die out if the forest returns again, leaving the uninhabited mounds as irregularities on the forest floor. Describing the spread of the

FIG. 1. — Development of woodland islands on mounds of *Macrotermes goliath* in western Tanzania, as a first step in the return of the forest cover.

FIG. 2. — Close-up of forest vegetation on mound of *M. goliath*, western Tanzania.

Budongo rain forest in Uganda, EGGELING (1947) states that evidence of forest expansion is provided by « the presence of relict *Terminalia velutina* trees, and of the derelict termite mounds of a grassland type well within the forest, and is confirmed by a comparison of old and present day maps. » The mounds are those of *Macrotermes bellicosus*, and the development of colonising forest around the base of the mounds is described. CUFODONTIS (1955) enlarges on this theme of termite mounds and forest regeneration. He notes the tremendous problems, both technical and financial, in making good the widespread deforestation by organised tree planting, and suggests that there is

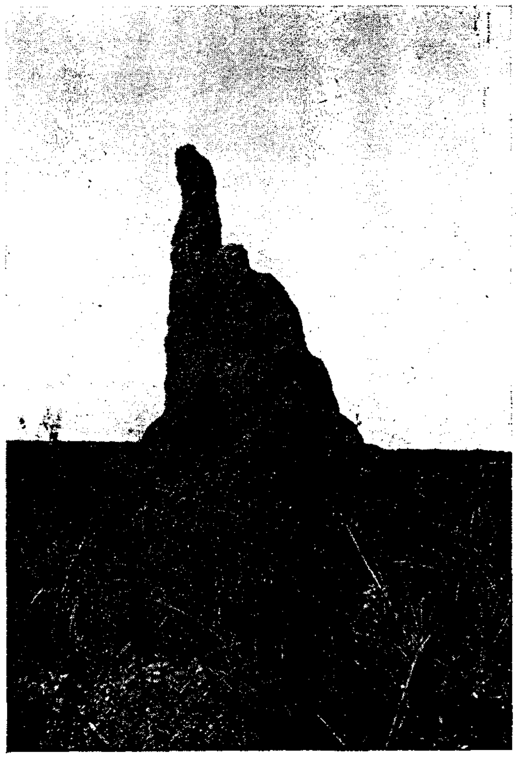

FIG. 3. — Inhabited mound of *Macrotermes bellicosus* without vegetation, northern Tanzania.

some hope for the processes of natural regeneration based on termite mounds.

In areas of grassland caused by seasonal flooding and impeded subsoil drainage, *Macrotermes* mounds provide scattered areas above water-level where thicket vegetation develops, producing a further example of TROLL's termite savanna.

Under the drier climatic conditions which favour woodlands of the *Brachystegia* type rather than forest, the presence of termite mounds leads to the development of islands of evergreen vegetation in advance of the main body of invading deciduous trees. One factor operating is topographical, as the elevated mound is less affected by grass fires. While the « termite savanna » phase may be relatively short lived, the differences in vegetation persist after the woodland has become established, no doubt due to chemical differences in the soil. BURTT (1942) describes the flora of termite mounds in the dry woodlands of Tanganyika. In Rhodesia, WILD (1952) finds that the mound flora is related to that of lower altitudes (fig. 3 and 4).

FIG. 4. — Abandoned mound of *M. bellicosus* with evergreen thicket, near fig. 3.

Macrotermes mounds in Africa and Asia usually provide a soil with a higher mineral content, richer in clay and silt than the surrounding land, and this fact is widely exploited by local cultivators (HARRIS, 1961). Tree growth has been found to be faster on mounds; for example in Uganda *Cassia siamea* grew to a height of 34 feet on mounds as compared with 26 feet on the flat, with little intergrading in size between the sites (STEPHENS, personal communication).

Under more arid conditions, subterranean termites—smaller members of the *Macrotermitinæ* not building conspicuous mounds—are likely to hinder natural regeneration of woodland and thicket by their attack on seedlings and coppice shoots (fig. 5). Vegetation suffering from water strain during periods of drought is more liable to termite attack, and at a time when food shortages drive termites to unusual lengths in their search for food. The species of termites commonly associated with damage to young trees is given in HARRIS (1961).

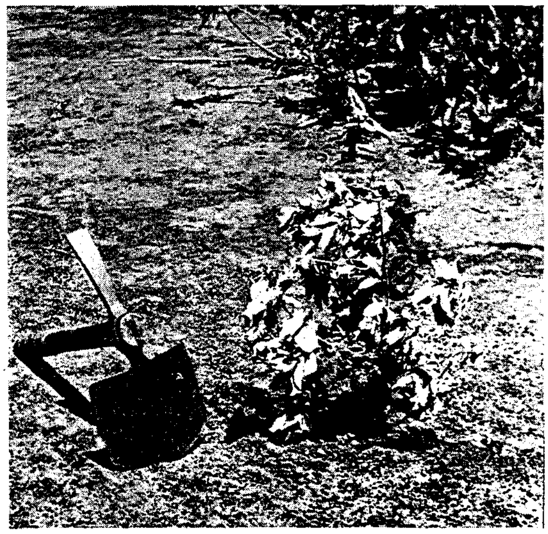

FIG. 5. — Tree seedling attacked by *Odontotermes* in semi-arid country, northern Kenya.

Termites and standing timber.

Assessment of losses caused by termite attack on mature trees is not easy, particularly in natural forest where selective felling is practised. As a rule there are outward signs of attack which enable the loggers to avoid damaged trees. Trees into which termites have penetrated and set up secondary nests in cavities hollowed out of the heartwood usually react by swelling in the vicinity of such nests. Otherwise when trees are felled and the cut surfaces show signs of termite galleries the logs are left lying in the forest, and do not figure in statistics of rejects at the mills (fig. 6).

Economic damage to standing timber is almost wholly due to termites which possess intestinal protozoa, the dry-wood and damp-wood termites, and in particular to members of the genus *Coptotermes*. Thus it is from those parts of the world where *Coptotermes* is most active that most damage is reported—to eucalypts in Australia, teak, *Shorea* and other trees in Indonesia, mahogany and pines in British Honduras and other Central American countries, and little or nothing elsewhere.

Concerning termites in Australian *Eucalyptus* forests, PENFOLD and WILLIS (1961) observe that « unlike other wood-boring groups, the feeding habits of which are adapted to tissues of definite moisture content, or show a decided preference for either pored or non-pored wood, the relatively few termites that derive cellulose from sound

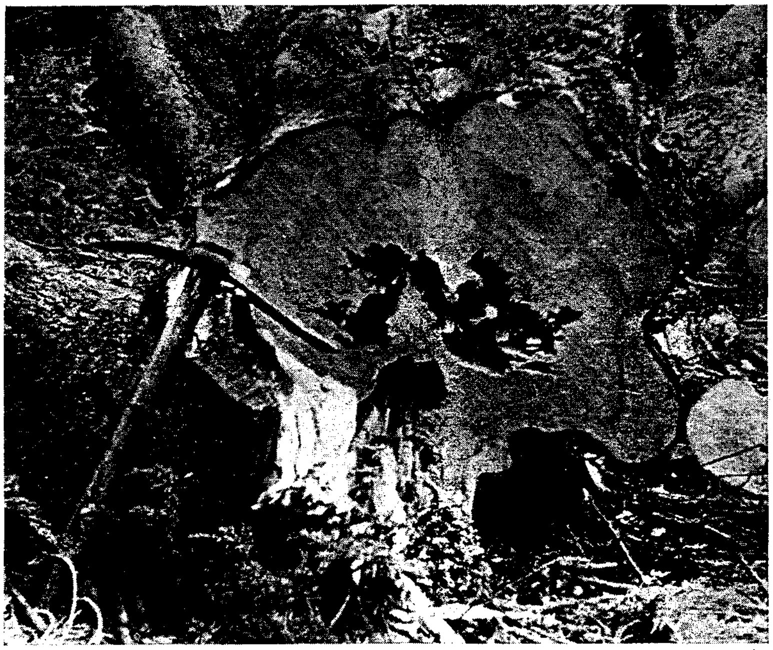

FIG. 6. — Recently felled *Cupressus* showing damage by *Heterotermes*, St. Helena.

wood can attack both sapwood and heartwood of living softwoods and hardwoods, and green and seasoned timber even the most highly resistant of the eucalypts are not immune to the major tree-destructive termites. » It is not surprising, therefore, that GRIEVES (1965) considers that *Coptotermes* damage represents a potentially serious loss in new growths both under natural regeneration and under management plans.

In Indonesia, KALSHOVEN (1963) found that *Coptotermes curvignathus* showed a preference for leguminous trees both in forests and plantations. Infestation of teak was secondary to attack by dry-wood termites, while *Shorea* was damaged following tapping for resin. Some *Swietenia mahagoni* trees 52 years of age were killed by *Coptotermes*. It is interesting to note that these particular termites are not repelled by trees producing latex or resin.

In Japan, NAKAJIMA and SHIMIZU (1959) report that cedar, *Crypto-*

meria japonica, is attacked by *Coptotermes formosanus* with infestations of up to 53 per cent in trees of 25 years or more. Attack is confined to the heartwood, with the termites entering through the larger roots. This termite is also reported on timber trees on the mainland of China.

Coptotermes niger is found in pines and mahogany in Central America. A high proportion of standing timber in British Honduras is infested, with hollow pipes excavated in the heartwood. Affected logs are refused by the sawmills. As in Australia, massive infestations are indicated by swellings high up on the trunks, and over the years selective felling with avoidance of such trees has built up a high incidence in the remaining timber. Plans for afforestation introduced the question of possible termite damage to new plantings. WILLIAMS (1965) reports that in the case of *Pinus caribea* an essential precursor of termite attack is the presence of a brown-rot fungus, *Lentinus pallidus*, which in turn is secondary to mechanical injury, usually by fire. Sound pine heartwood is immune to termite attack on account of its high content of resin and turpentine, and only when these have been broken down by fungus can the wood be used by termites. In neighbouring Mexico and Guatamala it was found that the pines have a relatively low resin content in the heartwood and trees were found to be attacked by *Coptotermes* in the absence of brown rot fungus. In British Honduras, plantings of an introduced *Gmelina* sp. were attacked without any prior fungus infection.

Termites and young plantations.

Twenty years ago there began a wave of afforestation projects in the dry woodland and savanna areas of Africa, India and, to a less extent, South America with the intention of providing shelter belts, building poles and fuel for the rapidly expanding indigenous populations. In general the genus *Eucalyptus* was preferred to *Cassia, Albizzia, Gmelina*, and other genera previously employed, because of the rapid growth that could be expected from suitable species. It became apparent very soon that in many localities eucalypts as transplants and saplings were being killed by termites (fig. 7). Since it was widely believed that subterranean termites did not attack healthy plants, the primary cause of death was sought elsewhere; drought was commonly blamed, while in Zambia the Forestry Department concluded that ecological conditions which favoured the development of *Brachystegia* woodland were the cause of failure to establish eucalypt plantations. Some high losses were reported; in Cameroon they reached 100 per cent with *Eucalyptus saligna*, and from 60 to 80 per cent with other species; in the drier areas of Uganda between 50 and 70 per cent of young trees were lost; in Northern Nigeria, *E. camaldulensis* lost

68 to 74 per cent in the first eighteen months, and up to 86 per cent in thirty months. In all cases investigated, the termites involved were the smaller *Macrotermitinæ—Ancistrotermes, Microtermes* and *Odontotermes* in Africa; *Odontotermes* in India;—except in South America where certain Nasutitermitinæ were implicated.

The development of persistant organochlorine insecticides, beginning with DDT, opened up the possibility of protecting seedlings and newly planted trees until they has outgrown the normal hazards of termite attack. Benzene hexachloride and chlordane, followed by dieldrin and aldrin, were found to give good results in nursery beds, and were then tried out in plantations to provide a protective ring of poisoned soil around each young tree. Encouraging results were reported from

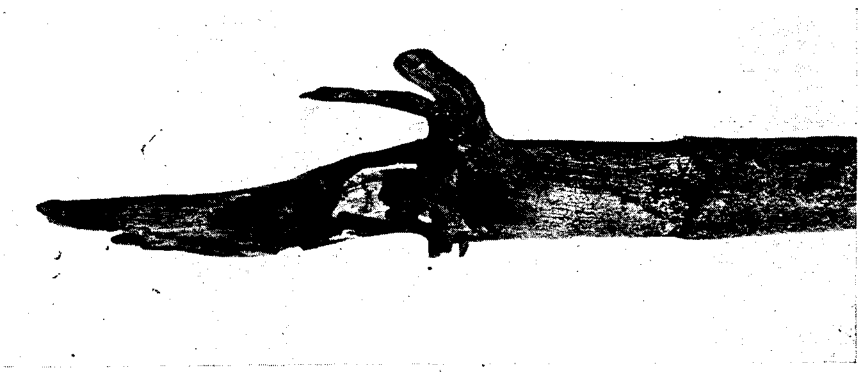

FIG. 7. — *Eucalyptus* sapling from two-year-old plantation destroyed by termites in Nigeria.

Brazil and parts of Africa, but there were also failures, as well as a lack of precision about the minimum effective dose of chemical required. Work to this end was carried out in Northern Nigeria jointly by the Forestry Department and the Termite Research Unit, details of which are given by SANDS (1962). It was fortunate that about the same time there was developed a system of growing eucalyptus seedlings in polythene tubes, which permitted their being planted out in the field with a minimum of root disturbance. This required the use of potting mixtures, and to these the insecticide could be added in accurate proportions. Simple mechanical aids to the mixing of potting soils added further to the efficiency of the protection which the insecticide gave to the young tree. The minimum effective dose was found to be 10 ounces of dieldrin 2 per cent dust to in 1 cubic yard of potting soil, enough for 500 pots; equivalent to 370 grammes in 1 cubic metre.

A review of recent developments in the control of termites of interest to foresters is given by HARRIS (1966).

Summary.

Tropical forestry is influenced by termites in widely differing ways. Large mounds constructed by *Macrotermes* in Africa and Asia are ecological factors which influence the natural regeneration of forests and the vegetation patterns of savanna woodlands and grasslands.

Economic losses in timber caused by termite attack on mature trees are restricted to those areas in Australia, Asia and Central America where particular species of *Coptotermes* are present.

Afforestation with *Eucalyptus* in less humid areas of Africa, India and South America has been greatly facilitated by the use of organochlorine insecticides to protect seedlings and saplings from attack by ground-dwelling termites.

Zusammenfassung.

Für die tropische Forstwirtschaft ist eine Reihe von Termitenarten in unterschiedlicher Weise bedeutsam.

Dis grossen Termitenhügel von *Macrotermes* sind in Afrika und Asien ökologisch von grosser Wichtigkeit, indem sie die Regeneration des Waldes und die Vegetationsverteilung in Trockensavannen und Grasland beeinflussen.

Wirtschaftliche Holzschäden durch Termitenangriff auf stehende Waldbäume beschränken sich in Australien, Asien und Zentralamerika auf solche Gebiete, in denen best-immte *Coptotermes*-Arten vorkommen.

Die Aufforstung mit Eucalyptusarten in Afrika, Indien und Südamerika ist wesentlich erleichtert worden, seitdem man dazu übergegangen ist, die Sämlinge und Jungbäumchen durch verschiedene organisch-synthetische-Boden-Insektizide zu schützen.

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