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Termites in Sericulture and its Management

Rajesh Kumar, Nang Sena Manpoong and N.I. Singh
Central Muga Eri Research and Training Institute, Central Silk Board,
Ministry of Textiles: Govt. of India, Lahdoigarh 785700, Jorhat, Assam, India

(Corresponding author: Rajesh Kumar)
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ABSTRACT: Termites are better known as destroyer of wood and wood products. However, several plants of economic importance are also victims of depredation by termites. Among the sericulture plants commonly damaged by termites are Mulberry, Arjun, Asan, Sal, Oak, Som and Soalu plants. Mulberry plants are also attacked by this pest. The species of termites commonly served damaging these plants are *Odontotermes obesus, Microtermes obesi* (Hols), *Coptotermes heimi* (Wasm). Sericulture industry provides employment to tribal people of many countries in rural and semi-urban areas and plays an important role in the GDP of a country. Termites have also been reported to damage various sericultural infrastructures and host plants in the field. Termite's damage in sericulture of cellulose material in human dwellings has assumed serious proportions in recent years primarily due to advancement of civilizations and clearance of areas that form natural sources of food for termites. Only few paper has been published on the termites available in sericulture. In this chapter, new method of control has been added through light.

Keywords: Sericulture, muga, eri, mulberry, oak tasar and tasar, termite species

INTRODUCTION

Termites (Order: Isoptera) considered as serious pests of agricultural, horticultural and plantation crops including forest trees, especially in the semi-arid and sub-humid tropics and cause significant yield losses (over one billion dollars in the United States alone). Termites attack roots and above ground parts, attack wooden structures, timber and paper. More than 2800 species in about 200 genera distributed over nine families and fourteen subfamilies is presently recognized and in India approximately 300 species, 37 genera from seven families are reported (Murthy *et al.*, 2015). Termites are an important component of Seri-ecosystem in India. Termites act as important herbivores and decomposers in the tropics (Wood & Sands, 1978). India has the unique distinction of being the only country producing all the five known commercial silks, namely, mulberry, tropical tasar, oak tasar, eri and muga, of which muga with its golden yellow glitter is unique and prerogative of India.Sericulture plays an important role in programmes of poverty alleviation in the rural areas. The current production of about 28708 MT during 2014-15 is not adequate to meet the demand for silk in the country. Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen and inherent affinity for dyes, high absorbance, light weight, soft touch and high durability and known as the "Queen of Textiles" the world over. On the other hand, it stands for livelihood opportunity for millions owing to high employment oriented, low capital intensive and remunerative nature of its production. The very nature of this industry with its rural based on-farm and off-farm activities and enormous employment generation potential has attracted the attention of the planners and policy makers to recognize the industry among one of the most appropriate avenues for socio-economic development of a largely agrarian economy like India. Silk has been intermingled with the life and culture of the Indians. India has a rich and complex history in silk production and its silk trade dates back to 15th century. Sericulture industry provides employment to approximately 7.65 million persons in rural and semi-urban areas in India. Of these, a sizeable number of workers belong to the economically weaker sections of society, including women. India's traditional and culture bound domestic market and an amazing diversity of silk garments that reflect geographic specificity has helped the country to achieve a leading position in silk industry.

A. Termites' species in Sericulture

Sericulture is the most important industry in India, which produces five types of silk *viz*., mulberry, tasar, oak tasar, eri and muga. Muga is endemic silkworm species of North Eastern India due to its climatic condition and costliest silk in the world. As it is known that sericulture industry is the part of forest ecosystem, because most of the host plants of silkworms (mulberry, tropical tasar, temperate tasar, muga, eri). Mulberry silkworm and eri silkworm are domesticated species. India is rich in termite diversity, harbours 300 species belonging to 37 genera under seven families representing near about 10% of the world's termite fauna (Murthy *et al.*, 2015).

The Asian tropical forests are known for their rich fauna particularly the termites due to the role they play in the recovery of forest ecosystems (Davies *et al.* 1999). They provide a range of ecosystem services: decomposition, carbon and nitrogen cycling, soil structuring and the stimulation of microbial activity (Wood and Sands 1978; Donovan *et al.* 2002; Sugimoto *et al.* 2000). The termite assemblages in forests are very sensitive to habitat disturbances like fire, forest clearance (Davies *et al.* 2003; Eggleton *et al.* 1995, 1996). Indian sub-region comprising as whole India, Pakistan, Nepal, Bhutan, Bangladesh, Burma and Sri Lanka, 337 species of termites in 59 genera have been listed and comprehensively described by Roonwal and Chhotani (1989) and Chhotoni (1997), Bose (1984) and reported 95 species of termites in five families and their distribution in Southern India. Termite diversity generally declines with increased elevation like temperature, is an important factor for termites. Various termites' functional groups respond differently to temperature, due to their different feeding habits (Davies *et al.* 2003; Inoue *et al.* 2006). Although temperature is often considered the key factor influencing termite's diversity, rainfall can have negative effect on termite's species richness and abundance in tropical rain forest systems (Bignell and Eggleton 2000). Termite damage to living trees in forest ecosystem is relatively poorly described.

Termites are better known as destroyer of wood and wood products. However, several plants of economic importance are also victims of depredation by termites. Among the sericulture plants commonly damaged by termites are Mulberry, Arjun, Asan, Sal, Oak, Som and Soalu plants. Mulberry plants are also attacked by this pest. The species of termites commonly served damaging these plants are *Odontotermes obesus*, *Microtermes obesi* (Hols), *Coptotermes heimi* (Wasm). Termites have also been reported to damage various agricultural and plantation crops in the field. Termite's damage to cellulose material in human dwellings has assumed serious proportions in recent years primarily due to advancement of civilizations and clearance of areas that form natural sources of food for termites. In addition to decorative panels on the walls, termites destroy building contents like carpets, furniture, documents, depositors in archives etc. among subterranean termites, the most important are *Heterotermes indecola*, *H. malabaricus*, *Coptotermes heimi*, *Odontotermes obesus*, *O. indicus*, *O. feae*, *O. redemanni* etc. these termites attack unprotected buildings even within three years after construction (Table 1).

Table 1: Commercially exploited silkworm and their food plants.

S. No.	Commercially exploited silkworm species	Vernacular name	Primary food plants	Secondary food plants
1	*Bombyx mori*	Mulberry silkworm	*Morus alba*	In wild condition, Wild *Morus* spp.
2.	*Antheraea pernyi*	Oak tasar	*Quercus serrata, Q graffiti, Q. florigunda*	*Quercus alba, Q. macrocarpa, Q. lyrata, Q. stellata, Q. palustris, Q. falcata, Q.phellos Q. mongolica, Q. griffithii, Q. acuttisima, Q. robur*
3.	*Antheraea assamensis* Helfer	Muga	*Persea bombycina* Kost and *Litsea monopetala*	*Actinodaphnae obovata, A. anquistifolia, Celastrus monosperma, Cinnamomum glaucescens, C. glanduliferum, Gmelia arborea, Magnolia sphenocarpa, Michelia champaca, Xanthozylum rhesta*
4.	*Antheraea mylitta*	Tasar	*Terminalia arjuna*	*Quercus alba, Q. robur* and other Unspecified *Quercus* species
5.	*Samia ricini* Anonymous	Eri	*Ricinus communis* Linn. *Manihot utilissima* Phol. *Heteropanax fragrans* Seem. *Evodia flaxinifolia* Hook. *Ailanthus grandis* Roxb. *Ailanthus excels* Roxb. *Ailanthus altissima* Miller.	*Plumeria acutifolia* Poir. (Gulanch) *Sterculia colorata* Roxb. (Waljem)

B. Life cycle of Termite

Termites are social insects and live in colonies consisting workers, soldiers, a queen and a king. New termite colonies are usually starts during monsoon when sexually matured males and females emerge in more numbers come out from their colonies. After shading their wings start copulating and a female burrow into the ground for building a nest.

They attain maturity within a year or two when they fly out and build a new colony. Based upon their habitat, the termite can be grouped into following four types.

Termite colony: Termites burrow into the ground, constructing a series of complex tunnels and nests with or without mound. The nest is the most remarkable structure consisting of numerous chambers and galleries. It is about 1-2 feet in diameter. The situation of nests varies with the species. The nests of many termites grow fungus garden in the center, near about the "Royal Chamber". The fungus grows into a comb like structure and is fed to the royal pair the larvae. Reproductive castes and sterile castes of subterranean termites live in the soil. Colonizing individuals are winged and are produced in large number during rainy season. The wings are meant for nuptial flight only and when they have mated, the wings usually drop off. She attains a much larger size. She is a phenomenon "Egg Laying Machine" laying one egg per second or 70,000 to 80,000 eggs in 24 hours. There is only one queen in one hive and she lives 5 – 10 years. The queen is feed by workers on the desired food and is housed in a special area referred to as "Royal Chamber", which is situated in the centre of the nest whereas the king develops from an unfertilized egg and becomes fully develops by consuming a superior diet. He is the father of the colony and is the constant companion of the queen living with her in royal chamber. The king's life is much shorter, and when he dies, he is replaced with a new one. The workers develop form the fertilized eggs but remain shunted as they are reared on ordinary food. They are most abundant in the colony but smaller than the soldiers. Their mandibles are well developed and are adopted to the gnawing of wood. The solders develop from unfertilized eggs and remain comparatively underdeveloped. They are the most specialized members of the community and can be readily recognized by the large head and strongly chitinized sickle shaped, mandibulate type. The former type of soldiers defends the colony but fighting the intruders and the later type repel them by spraying an obnoxious smelling fluid through the rostrum.

Subterranean termites: the colonies are partly located under the soil surface. They build nests consisting of small chambers connected with narrow passages and make superficial tunnels on the ground which attack growing plants, dry leaves and grasses.

Termite mounds: Mounds are made of different shapes and size. A typical mound has small chambers connected with numerous vertical and transverse galleries with opening to the surface and a large chamber for the queen.

Termites of dry wood: Their colonies partially inhabit on dry wood.

Termites of damp wood: They make colonies in dead trees or most dead trees.

Temperature and humidity: The atmospheric temperature and relative humidity are two major environmental factors that influence the termites profoundly. They are extremely sensitive to changes in the atmosphere, temperature and relative humidity. Many species ascend deep in to the soil in dry and hot seasons, thus escaping the extreme hit of the mid-day. However, active foraging occurs in the early morning hours. Most the North East Indian state is highly humid in summer season due to presence of dense forest and many rivers. The liability of human dwellings to be attacked by termite is more pronounced in damp locations than in dry locations. Every kind of aeration leads to desiccations unless the moisture content of the surrounding area is at the saturation point or the termites have direct access to water. The ability of certain termites to survive in air with low humidity thus depends on access to water sources. To some extent the water is provided as a metabolic end product of the breakdown of cellulose and other carbohydrates as in the case of dry wood termites. Several genera of termites do not however need free water source, as the relative humidity within their nests is constantly maintained near the saturation point. The mound building termites maintain almost constant temperatures and relative humidity notwithstanding the change in the atmosphere. The primitive termite *Achtermopsis wronghtoni* (Desn.) is capable of tolerating wide fluctuation of temperature. This species occurs in high altitude of the Himalayas where temperature often rises to 37 degree during the month of June and falls down almost zero during the winter months of December – February. Even though, these wide fluctuations of atmospheric temperature are difficult to explain. Under laboratory conditions, *Neotermis bosei* Snyder Prefers temperature of 28 degree, while the optimum temperature of *Heterotermes indica* (Wasm) a subterranean species lies between 28-32 degree *Microcerotermes beesoni* Synder is cultured in the laboratory best at a temperature of 29 degree. Much of information are available on the water relations and humidity tolerance of Indian termite. Most species prefer high humidity, almost near saturation point. Survival of subterranean termites depends on the water content of the soil which in turn is dependent on the water holding capacity of the soil. The optimum water content in the sandy soil is 2-4% and that of humus soil is 15-25%. In the humus soil the optimum feeding and survival rate occur in a broad range, but the same is not applicable in the case of sand which has low water holding capacity.

Heterotermes indecola prefers 20-30% water content of the culture medium and rate of feeding is also higher in case of wood with higher moisture content (80%). However, notwithstanding the above, *H. indecola*preers to feed near the surface soil, demonstrating a higher degree of acrotrophic behavior. In contrast, species of *Microcerotermes* feeds maximum when moisture content of the culture medium is 15-20%.

Population dynamics: The total dynamics in *Odontermes obesus* varies from 4548 to 90961 individuals depending upon the size of the mound during non-mound building months.

In *Odontotermes redemanni*, proportion of workers, soldiers and nymphs are 81.33%, 14.15% and 2.42% in the fungus combs. Almost similar proportions are found in the *O. obesus*. Seasonal fluctuations in some of the termites viz., *Neotermesbosei*, *Microcerotermes beesoni* and *Nasutitermes dunensis* is well known. In the case of *M. beesoni* the total nest population which did not include the foraging individuals at the same time collection of nests ranged from 7000 to 45000 individuals depending upon the season and size of the colony. The proportion of workers, soldiers ranged from 63.43 to 98.08%, respectively. The population of immature forms was inversely proportional to residual worker population.

C. Economic damage by termites in sericulture

In tassar and oak tasar, the termite infests upto 20-30% in plantation viz., *Terminalia arjuna* and*Quercus serrata*, *Q graffiti*, *Q. florigunda,* respectively (Fig. 1).

Mulberry sericulture is fully domesticated culture to produce white and yellow colour of cocoons. In mulberry sericulture, termite damage rearing house, grainage house and other mud house used for keeping mulberry leaves. In-spite of these in mulberry growing areas of India, it also damage the systematic plantations, which affect the economy of mulberry sericulturists.

In Eri silkworm industry, this species is also a domesticated species and reared in indoor condition. The rearing housesare made up of bamboo and most of the time, if the bamboo is not treated with insecticides, gets infested by termites. Eri host plants are also infested by termites in the field, which are to be uprooted and plant new saplings. Termites cause 10-20% damage to sericulture industry.

In muga culture, termite cause damage to graiange houses (seed production house), plantations, cocoon storage boxes and cocoon mountages, which altogether cause damage upto 20-35% by *Odontotermes* sp. (Fig. 2-11).

D. Control measures

Cultural Practices: Farmers clean the mounds and spray extract of neem (*Azadirachta indica*) and *Calatropis procerra* for killing the termites.

Barrier control: Transparent plastic sheets, crushed stone, gravel aggregate, sand metal mesh etc. can be utilized as barrier.

Chemical control: Chlorpyriphos 0.2% of 36% EC aqueous solution, paste of methyl parathion 2% with fresh lime.

Biotermiticides: The herbal anti-termite wood preservatives (copperised anacardium pericarp extract etc.) are available in Indian Market for protection of wood and ply, timber, wooden pillars logs etc. *B. thuringeiensis* strains are widely used, but in sericulture, it can not be utilized.

Baiting system: The termite bait should be tasty enough for termites and consist of cardboard, paper or other palatable food combined with a slow poison lethal to termites.

CONCLUSION

Termites plays a pivotal role in sericulture industry, which cause 20-30% damage to plantation, rearing houses and grainage houses. Elevation in temperature is an important factor for termites' diversity. Various termites' functional groups respond differently to temperature, due to their different feeding habits (Davies *et al.* 2003; Inoue *et al.* 2006). However, temperature is the key factor, which influences the termite diversity and another side rain plays a negative role in tropical rain forest ecosystem (Bignell and Eggleton 2000). India is having all the climate zones temperate, tropical, sub-tropical and rain forest ecosystems. In forest ecosystem, termite is not considered as a problem, but it considered as a beneficial insects, which help in degradation of falling trees and composting. But, termites are major problem not even in sericulture but also in agriculture and horticulture. Most of the termites are controlled through cultural / mechanical control by using fire and plant extracts.

Fig. 1-6. Damage. 1. Oak Trees (Oak tasar), 2. Termite mound in Som Plantation (*Persea bombycina*), 3. Termite attack in Soalu (*Litsea monopetala*), 4. Termite attack in Soalu (*Litsea monopetala*), 5. Termite mound in Som Plantation (*Persea bombycina*), 6. Muga (*Antheraea assamensis*) Cocooning bmboo mountage infested by termite.

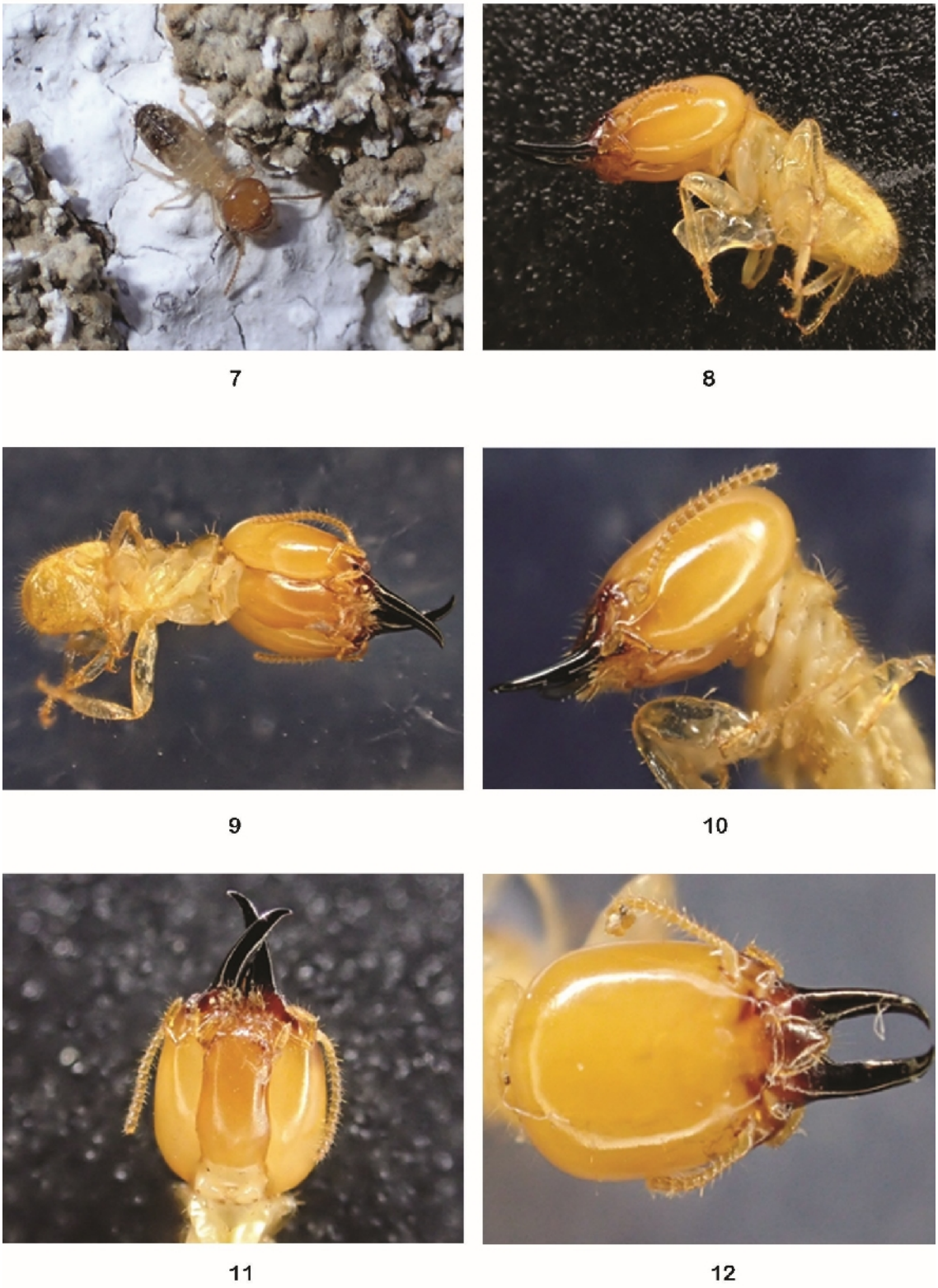

Fig. 7-12. *Odontotermes* sp. (Isoptera: Termitidae). 7. In the field, coming out from tunnel, 8. Lateral view (collected from mugagrainage room), 9. Ventral view, 10. Lateral view of head, 11. Ventral side of head, 12. Dorsal side of head.

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