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The bionomics of the pests infesting *tectona grandis linn, f* and its impact on biodiversity

Raga Malika[1*], M Madhavi[2]
[1] Department of Zoology, University College of Science, Osmania University, Hyderabad, Telangana, India
[2] Professor, Department of Zoology, University College of Science, Osmania University, Hyderabad, Telangana, India

Abstract
The indisputable world leader in premium tropical woods is teak (*Tectona grandisL.f.)* from the Verbenaceae family, Known for its high-quality wood, teak is a truly Indian plant with vast teak forests). Tectona grandis Large, papery leaves with often hairy undersides are characteristic of linn, f trees. Newly milled teak wood is highly valued for its resistance to wear and water, and it smells like leather. One of Hyblaea. puera's forty-six replacement food plants is teak. Wood is utilized for veneer, furniture, turnings, boat building, exterior construction, carving, and other modest tasks.When teak wood is first milled, it smells like leather and is prized for its water resistance and durability. The wood is utilized in furniture, boats, exterior building, turnings, carvings, and a variety of tiny tasks. Insect pests pose a serious danger to the species in natural forests, plantations, and nurseries. Major teak pests that cause extensive damage in nurseries, man-made forests, and natural forests) are teak defoliator (Lepidoptera: Hyblaeidae), white grubs (Coleoptera: Scarabaeidaeand leaf skeletonizer (Lepidoptera: Pyralidae) *Eutectona machaeralis* (Walker). They have detrimental impacts on seed production, blooming, germinating, defunct seedlings, and growth retardation. This study has provided a concise overview of the pest profiles. They have detrimental impacts on seedling mortality, growth retardation, reduced blooming, poor fruit setting, and decreased seed yield. Eliminating these insect pests may have significant financial benefits. The main insect pests of teak have been briefly covered in this publication, along with their characteristics.

Keywords: Teak, tectona grandis, major insect pests, defoliator, eco-friendly

Introduction
According to the literature assessment, India's first teak plantation was established in Kerala, in 1846. It is extensively spread throughout India. It grows in the wet and dry deciduous woodlands below 240 N latitude, as well as in the states of Kerala, Tamil Nadu, Karnataka, Telangana, Andhra Pradesh, Maharashtra, Gujarat, Chattisgarh, Madhya Pradesh, Rajasthan, Uttar Pradesh, Manipur, and Orissa. Over 8.9 million hectares of teak-bearing forest cover India (Tewari, 1992), and the country receives 800–2500 mm of precipitation a year. There are around 50,000 hectares and 1.5 million hectares of teak plantations in India, respectively. In the last thirty years). It has been observed that around 187 distinct insect species feed on live teak trees in India (Mathur and Singh, 1961; Hutacharern and Tubtim, 1995).

Damage Caused by Insect Pests
The damage caused by the pests, impacts teak tree vigor and development, resulting in anomalies that caused a reduction in both the amount and quality of timber output (Beeson 1941; Kulkarni *et al*. 1996; Nair 2007). Up to 65% of wood losses in Indian plantations are caused by this pest (Baksha & Crawley 1998; Shukla & Joshi 2001).

Method of Study
Two yearly rounds of sampling will be conducted. At regular intervals, a quadrat measuring 10 m by 10 m was randomly placed out in each division of the several teak plantations located in Sathupally District, Telangana. The primary meteorological parameters at each location—temperature, relative humidity, and rainfall—were noted every two weeks along with the observations. A basic correlation was determined using this data. noted that using the normal sample methods of sweep netting, light trapping, and visual observations, monthly sampling of insects associated with Tectona grandis Linn.f. was conducted. During the day, between 8 am and 1 pm, when major pests were most active in quest of food, direct insect trapping using a hand net was used.

Table 1: Food-plant specificity

Sr. No	Scientific Name of Insect	Common Name	Family	Part of plant (Tectona grandis Linn.f) Invasion
1	*Hyblaea puera*	Leaf defoliator	Hyblaeidae	Leaf
2	*Eutectona machaeralis*	Walker.	Crambidae	Leaf
3	*Zeuzera coffeae*	Red borer	Cossidae	Bark
4	*Alcterogystia cadambae*	Moth	Cossidae	Stem and Bark
5	*Dihammus cervinus*	Longhorn beetle	Cerambycidae	Stem and Bark

Hyblaea puera- Leaf defoliator
Known as the teak defoliator, Hyblaea puera is a cryptic species complex of moths native to South and Southeast Asia. Pieter Cramer gave the first description of it in 1777. There have also been recent reports of the species' presence in Africa and Central America. Teak and other trees are the caterpillar's food source. It is regarded as one of the most significant teak pests globally. Hyblaea puera.
On teak plantations, the teak defoliator is always there, but at different densities. In November, December, and January,

when teak naturally sheds its leaves, there was a relatively little (endemic) insect activity. Every year, in late May or early June Teak defoliator high-intensity outbreaks occur immediately following premonsoon rains. Due to climate change there was a shift of Pre-monsoon rains when compared to earlier times.

The life cycle of H. puera lasts between two and four weeks, with the temperature being the main determinant, the female moths lay between 500 and 600 eggs over the course of a week. The eggs are laid singly on delicate leaves, and the first and second instars feed mostly on the leaf surface. The larva begins to eat from inside when it chops out a leaf flap in the third instar and secures it with silk. Five larval instars exist, with the fifth one reaching pupation. As per Beeson (1941), pupation can occur within a triangular leaf fold that has been tightly and meticulously woven together, or it might occur between juxtaposed leaves or leaf skeletons joined by silk.

Adult - Hyblaea puera

Fig: Complete defoliation caused by H. puera

***Eutectona machaeralis*-Walker**

Larvae with a light brown head and greenish-white color. Adult moth with bands on the hindwings and transverse patterns on the forewings. Larvae inflict harm to the point that leaves skeletonize, and severe injury causes the leaves to brown.

After a week or so of piling up, the green parts of every leaf are consumed. The leaf skeletons remain on the trees for a few days before they fall off and heavily blanket the ground. These breakouts' remarkable emergence suggests that trees have been seriously harmed. but in a week or two, there is an abundance of fresh leaves once more.

Larva of *E. machaeralis*

Damage incurred

Adult - *Zeuzera coffeae*

Larva of *Z. coffeae*

The medium-sized, speckled wings and orange hue of an adult moth are indicative of its identity. Caterpillars penetrate into the stem or branches in order to eat the wood. Young plants or braches exhibit withering in the early stages of the disease. Larval feces that resembles pellets hangs out and gathers at the base of the plant. In severe situations, the branch stops growing. Internal boring caused twigs and branches to wilt fast, get brittle, and break off easily; the holes show where the frass is exuding. The eggs are deposited in bark fissures and stay there for nine to thirty days. the larvae cause the host plant's leaves to wither and maybe even die by tunneling within its twigs and branches. Attacks on the main stem have the potential to destroy seedlings. When completely developed, the larvae spend the winter inside the stems. The duration of the larval stage is 73–205 days. The pupa is located in the feeding area as well. There are 19–36 days in the pupal stage (Chang, 1984).

***Alcterogystia cadambae*- Moth**

The teak wood borer, Alcterogystia cadambae, is important from a commercial standpoint because it causes severe damage to teak heartwood.A. cadambae Moore is a relatively new insect pest in India. It has spread to several plantations in Karnataka, Tamil Nadu, and Kerala, where it has become a severe problem. It is a member of the Cossidae family of lepidopterans, which are sometimes referred to as "goat moths" because of their distinctive odor and "carpenter worms" because of their larval habit of burrowing into wood. R. Veeranna and O. K. Remadevi. Every single member of this family lives inside the woody tissue of plants as an internal feeder. Despite the relatively small number of documented species, species are widely spread and belong to several genera. Although the eggs are located beneath the bark of the main stem and its branches, the larvae were visible beneath it and did not appear to be threatening. With increasing feeding, the symptoms become more apparent in the larva. One of the earliest indications of a borer infestation and the cause of dieback is the girdling of side shoots caused by larval feeding.

After first settling on the sapwood and beginning to eat, the second instar larva progressively makes its way toward the heartwood. The larva completes its third and fourth instars at this time, as evidenced by the head capsules seen inside the tube. The larval tube is about 0.8 and 1.2 cm long and wide. The tunnel's inside surface takes on a burned appearance. Generally, 6–8 larvae per 1 m of log were seen. At this point, wood fragments were gathered at the tunnel's mouth. Sometimes these pieces of wood fall below the tree and become tangled in the visible spider webs on the bark. During the rainy season, the larval tube sites are evident as dark, moist patches covered with frass. Close-up of the borer holes in the teak tree. Heartwood Teak The larva of the borer Alcterogystia cadambae rests within the "C"-shaped pod. The larva goes quickly along the tube and releases a pink liquid that has a nice smell when it is disturbed. Numerous tunnels are created inside the heartwood as a result of the larvae's eating.

Adult - *Alcterogystia cadambae*

Larva of *A. cadambae*

Stem borers, inflorescence and fruit feeders, sap feeders, and root feeders make up a smaller percentage of these insects. These insects are mostly leaf eaters. Among these pests, the most frequent and damaging is the teak defoliator, Hyblaea puera Cramer. In India, epidemics occur almost yearly across wide territories. During these outbreaks, trees usually undergo total defoliation in the early teak flushing phase; sometimes, partial defoliation happens later in the growth season (Beeson, 1941; Nair, 1988).

***Dihammus cervinus*- Longhorn beetle**

Adult -Dihammus cervinus

Larva of D. cervinus

Dihammus cervinus have large antennae, especially on the males, the beetles are known as longhorns. The general diagnostic features of these beetles for identification are their long antennae and somewhat elongated bodies. Longhorn beetles come in a wide variety of sizes, shapes, and colors; they even frequently mimic other families' unpalatable beetles, such as stinging ants or wasps, making it challenging to define the family. In terms of taxonomy and ecology, longhorns are quite varied and have intimate relationships with their host plants.

The needs of the larval host influence the behavior and methods of reproduction of adult cerambycids. Larvae penetrate into the stems, roots, twigs, and shoots of woody plants. Though it is unknown in the teak districts of the Indian Peninsula, the Longicorn, Dihammus cervinus, Hope, is a significant pest in areas of Japan, China, Burma, Assam, Bengal, and North India and south India that cultivate teak. With the arrival of the wet season in June, the beetles start to arrive. They create shallow, erratic areas on the fragile bark of saplings. The larvae pierce the sapwood and inner bark of the stem when the eggs are deposited down on it. By the next spring, a globular canker roughly twice the diameter of the stem forms as a result of damage to the cambium. So that there is only one generation each year, pupation takes place in July and August.

Management

According to Beeson (1941), Kulkarni *et al*. (1996), and Nair (2007), the teak skeletonizer defoliates teak trees, which negatively impacts their development and vitality and results in anomalies that cause both a qualitative and quantitative loss in timber production. Up to 65% of wood losses in Indian plantations are caused by this pest (Baksha & Crawley 1998; Shukla & Joshi 2001). Synthetic sex pheromones produced by Lepidoptera have been extensively employed in monitoring, mass capturing, mating disruption, and luring and killing adults of commercially significant moth species (Leal *et al*. 2003; Ma *et al*. 2014; Hoshi *et al*. 2016). However, A crucial factor in assessing a pheromone's effectiveness and ensuring successful manufacturing for field application is reproductive behavior in relation to sex pheromone production. As of right now, no information on the sex pheromone gland production and reproductive activity of female E. machaeralis has been published.

Control Measures

According to Joshi and Jamaluddin (2007), sandy soil should not be used to raise seedlings, immature FYM should not be utilized, and soil works should be avoided in the June–July monsoon season. Beetles can be collected using light traps, and then they should be destroyed by soaking them in kerosene oil.

Regeneration zones of pure teak should be split into commercially viable patches in order to reduce the outbreak of leaf skeletonizer (Beeson, 1941). To sustain the population of parasites and predators, teak should be cultivated alongside attractive plant species that serve as food for other defoliators. For a long-term remedy to leaf skeletonizer, use of teak seeds from genetically superior but comparatively resistant teak trees should be taken into consideration (Ahmad, 1991; Mishra, 1992; Roychoudhury and Joshi, 1996b; Roychoudhury *et al*. 1997 a, b, c; Roychoudhury, 2002; Roychoudhury and Mishra, 2020a). It has been demonstrated that foliar treatment of Bacillus thuringiensis at 1% is efficient in destroying this pest's larvae, regardless of toxins and products (Roychoudhury *et al*. 1994). It is recommended to apply 0.03% as a foliar spray for the control of E. machaeralis larvae based on the LC50 value of a biopesticide, ivermectin (Ivecop-12) (Roychoudhury and Mishra, 2020b, d). Similar to this, it is advised to use 0.0001% as a foliar spray for the suppression of E. machaeralis larvae based on the LC50 value of a biopesticide, Spinosad 45% SC (Spintor 45% SC) (Roychoudhury and Joshi, 2010b; Roychoudhury and Mishra, 2020c). From July to September, introduce the egg parasitoid Trichogramma sp. at a rate of 1.25 lakh/ha in teak woods (Patil and Thontadarya, 1983, 1984; Joshi *et al*. 2007; Roychoudhury *et al*.

Conclusion

Thus, in the Sathupally District of Telangana, the present study was carried out at the preliminary level, to ascertain the frequency and amount of insect pests associated with teak. it is imperative that management tactics be prioritized and that genetic research be made possible in order to ascertain the insect pest's relationship to forest vegetation.

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