ISSN No. 0974-7087

Environmental Information, Awareness, Capacity Building and Livelihood Programme (EIACP)

Programme Centre-Hub

Department of Environment
Chandigarh (U.T.)

Supported by

Ministry of Environment,
Forest & Climate Change
Government of India, New Delhi

paryavaran patra

TERMITE TERRORS:

Unveiling Urban Wood-Wreckers in Chandigarh's Ecosystem

Vol. 19.1.0

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Background

Termites are eusocial insects classified under the order Isoptera, characterized by their pale coloration and soft bodies. These insects form colonies and primarily feed on wood and cellulose, making them significant pests capable of causing extensive damage to buildings and timber structures. While most termite species target dead wood, certain species can infest living trees, which can weaken the tree's structure, making it more susceptible to breaking during storms. Such infestations often indicate the presence of dead or decaying parts of the tree, such as the cambium layer, which, if not addressed, can lead to the tree's decline.

In urban environments, trees offer numerous benefits, including improving air quality, enhancing the microclimate, reducing noise, mitigating wind, and reducing stress for people. Trees also contribute to the aesthetic appeal, structural design, biodiversity, and recreational aspects of urban areas. However, cities continue to face challenges, including pest infestations that lead to a range of ecological problems. These issues can include basic pest infestations and more severe incidents like trees collapsing onto roads, streets, and open spaces, resulting in accidents of varying severity. Additionally, the loss of tree cover due to infestations can have cascading effects on groundwater levels, heating and cooling costs, and overall quality of life.

One of the major issues in urban settings of developing countries like India is the lack of attention given to monitoring and evaluating tree health and related risks, particularly termite infestations. In India, the prevalence of subterranean termites in urban landscapes is increasing every year. The country is home to a significant diversity of termites, with 286 species across 52 genera in six families, representing about 10% of the global termite population. Termite infestations often start at the root and spread to the upper parts of the tree, gradually hollowing out the stem and eventually killing the plant. However, certain tree species, like Eucalyptus, are less prone to termite attacks.

Termite foraging is a highly organized activity, allowing these insects to establish nests, search for food, and return to their nests efficiently, often causing significant harm to trees in the process. Termites that infest trees are widespread, with various predominant species in different regions. Recent studies have identified termites as a major secondary cause of the decline in the health of avenue trees. The extent of termite infestations and their impact are critical factors in the decline of urban trees, particularly in tropical and subtropical regions. Globally, out of the 2,937 species of termites in nine families, 28 are recognized as invasive. These invasive species are mainly nuisances in urban areas, with only a few spreading into natural forests. Among these 28 invasive species, 10 have expanded their geographic range since 1969, and three are currently found in India. However, detailed information about their specific distribution, the extent of damage they cause, and the economic losses they incur in the Indian subcontinent is still lacking.

The interaction of climate change, urbanization, and globalization is expected to exacerbate the ecological and economic impacts of termite infestations. Despite the significant environmental benefits provided by urban trees, there is a notable lack of research on the causes of ornamental tree decline in India. The present study focuses on documenting the extent of termite infestations and their role in the increasing decline of various woody species in Chandigarh. Known for its extensive tree canopy, Chandigarh is one of India's most environmentally conscious and modern cities. While the city lacks a climax ecosystem and natural forests, it boasts a rich, structured green environment with its avenues of horticultural trees and shrubs. However, the health of these trees is increasingly threatened by termite infestations, which undermine the region's ecological services and the overall environmental quality.

Types of Termites

Gaining insight into the behaviour of various termite species is essential for implementing efficient management and control tactics, particularly in urban environments where they pose a risk to trees. Every species of termite exhibits distinct nesting, eating, and social activities, which are taken into consideration while developing pest management strategies (F. Oi et al., 2022). Various termite species have different behaviours and levels of damaging influence on urban trees. Research conducted in Lahore has identified *Odontotermes obesus* and *Coptotermes heimi* as the primary pests that negatively impact the health of trees (Afzal & Rasib, 2021). These plants actively invade both non-native and indigenous trees, resulting in substantial tree harm, especially in urban parks and green areas (Afzal & Rasib, 2021). Termites can be categorized into many categories according to their social organization and

dietary preferences. There are two primary classifications of termites: subterranean termites, which need moisture and typically reside in nests underground or in wood, and drywood termites, which infest dry, non-decayed wood (Bobadilla et al., 2020).

The brief classification of types of termites is given below:

Subterranean termites

Subterranean termites are regarded as the most pernicious variety due to their construction of enormous subterranean tunnels, which can result in substantial structural harm to buildings, trees and other wooden structures (Ngo et al., 2021). With the ability to house millions of individuals, these colonies demonstrate exceptional efficiency in locating cellulose-based materials as a food source (Ngo et al., 2021)

Drywood Termites

Drywood termites, in contrast, do not need to come into contact with the soil and can thrive in dry wood. This makes them especially troublesome in houses that have wooden constructions (Ignacio Bobadilla et al., 2020). They tend to internally devour wood, resulting in concealed damages that only become apparent when substantial infestations take place (Cornelius et. al., 2012).

Dampwood Termites

Another category is represented by dampwood termites, who exhibit a preference for wood that is both moist and rotting. These termites are commonly found in regions characterized by elevated levels of humidity and primarily infest deceased trees or stumps (Obi et al., 2008).

Formonsan Termites

The Formosan subterranean termite is a species that invades new habitats and is recognized for its highly assertive behaviour and significant capacity to cause destruction. These termites are known for their enormous colonies and have been observed to inflict substantial damage in urban areas, which complicates termite control efforts (Indrayani et at., 2022).

Role of Termites

Termites have a crucial function in the recycling of nutrients and the breakdown of organic matter in their native habitats. They decompose cellulose present in wood and plant debris, thereby restoring essential nutrients to the soil and improving soil fertility (Afzal & Rasib, 2021).

Ecological Importance

Termites play a crucial role in maintaining ecosystem health by promoting plant growth and fostering biodiversity. Their excavating endeavours enhance soil aeration and water infiltration, so promoting root systems and overall plant well-being (Afzal & Rasib, 2021). The provision of this ecological service is crucial for preserving the equilibrium within forest and savanna ecosystems, since it facilitates the process of nutrient production and recycling (Afzal & Rasib, 2021).

Termites as Pests

Termites can provide a substantial pest problem when they infest urban settings, especially in relation to urban trees. Infestations can cause significant harm to both living and deceased trees, which can endanger urban forestry and the ecological benefits it provides. Specifically, particular types of termites have been recognized as significant factors in the deterioration of the health of trees in urban areas (Zheng et al., 2011). This can lead to financial losses and a decrease in the variety of living organisms in urban environments (Zheng et al., 2011).

Impact of Termites on Trees in Chandigarh

In Chandigarh, a survey of a total of 166 woody tree species belonging to 56 families was conducted. Termite infestation was discovered at the wood level, leading to internal damage within the trees and ultimately resulting in their demise. The frequency of infestation was calculated in three different categories (Table 1) viz. category A i.e., number of trees affected up to bark level, category B i.e., number of trees affected up to wood level and the last category C i.e., number of trees completely dead due to termite infestation. The similar kind of methodology was followed by Gould et al., 1993. In category A, the highest frequency of infestation was found in the species viz. *Millingtonia hortensis, Diospyros malabarica, Grevillea robusta, Butea monosperma* and *Cassia javanica,* respectively. In category B, the frequencies of infestation were higher in *Cordia sebestena, Senna siamea, Pterospermum acerifolium, Morus indica,* respectively. The highest mortality of individuals which was represented by category C encompasses tree species such as *Aegle marmelos, Morus Indica, Pterospermum acerifolium, Senna siamea* and *Neolamarckia cadamba.* respectively. (Fig 1, Fig 2, Fig 3, Fig 4, Fig 5).

$$\text{Frequency of Infestation} = \frac{\text{Number of Infested Individuals of Species}}{\text{Total Individual of Species}} \times 100$$

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Table 1. Frequency of termite infestation on highly infested woody species in Chandigarh

Sr. No.	Species	Family	A (%)	B (%)	C (%)
1	*Aegle marmelos (L.) Correa*	Rutaceae	40.00	20.00	20.00
2	*Azadirachta indica A.juss.*	Meliaceae	30.11	0.28	0.00
3	*Butea monosperma (Lam.) Taub.*	Fabaceae	66.67	33.33	0.00
4	*Callistemon viminalis (Sol. Ex Gaertn.) Don.*	Myrataceae	39.62	16.98	3.77
5	*Cassia javanica L.f.*	Fabaceae	66.67	0.00	0.00
6	*Cordia sebestena L.*	Boraginaceae	0.00	100.00	0.00
7	*Dillenia indica L.*	Dilleniaceae	44.44	22.22	0.00
8	*Diospyros malabarica (Desr.) Kostel.*	Ebenaceae	100.00	0.00	0.00
9	*Ficus virens Aiton.*	Moraceae	11.30	1.00	0.00
10	*Grevillea robusta A.cunn. ex R.Br.*	Proteaceae	71.59	11.88	0.39
11	*Mangifera indica L.*	Anacardiaceae	19.96	6.84	0.37
12	*Millingtonia hortensis L.f.*	Bignoniaceae	100.00	0.00	0.00
13	*Moringa oleifera Lam.*	Moringaceae	33.33	0.00	0.00
14	*Morus indica L.*	Moraceae	39.34	27.87	3.28
15	*Neolamarckia cadamba (Roxb.) Bosser.*	Rubiaceae	44.83	6.03	0.86
16	*Pterospermum acerifolium (L.) Willd.*	Sterculiaceae	51.35	22.30	1.35
17	*Schleichera oleosa (Lour.) Oken.*	Sapindaceae	45.52	8.62	0.34
18	*Senna siamea (Lam.) H.S Irwin & Barneby*	Fabaceae	27.66	45.74	3.19

A = Number of individuals affected up to bark level, B = Number of individuals affected up to wood level, C = Number of individuals completely dead.

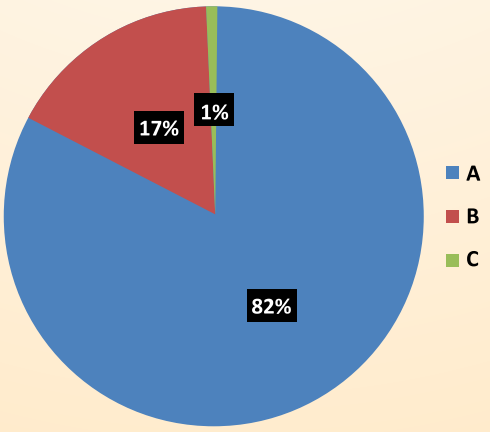

Fig 1. Percent distribution of infested individuals among three severity classes

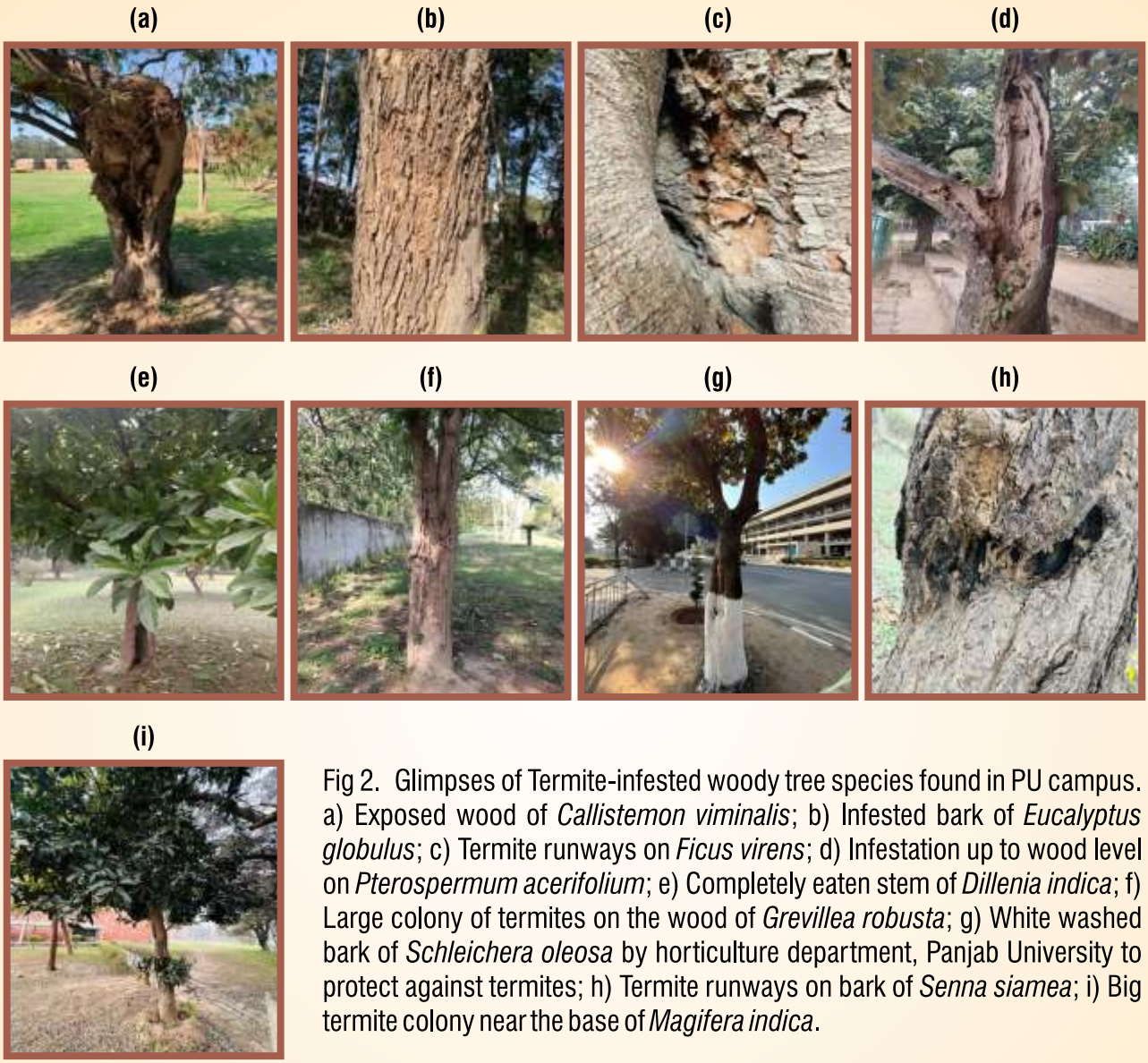

Fig 2. Glimpses of Termite-infested woody tree species found in PU campus. a) Exposed wood of *Callistemon viminalis*; b) Infested bark of *Eucalyptus globulus*; c) Termite runways on *Ficus virens*; d) Infestation up to wood level on *Pterospermum acerifolium*; e) Completely eaten stem of *Dillenia indica*; f) Large colony of termites on the wood of *Grevillea robusta*; g) White washed bark of *Schleichera oleosa* by horticulture department, Panjab University to protect against termites; h) Termite runways on bark of *Senna siamea*; i) Big termite colony near the base of *Magifera indica*.

Fig 3. *Eucalyptus globulus* infested by termites near the base of the stem (Panjab University, Chandigarh)

Fig 4. A termite colony comprising a soldiers and workers on *Moringa oleifera* tree at PU Campus

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Fig 5. Shelter tubes on *Grevillea robusta* tree (Panjab University, Chandigarh)

Ecological Consequences

Termite infestations have a substantial influence on urban ecosystems as they lead to the deterioration and death of urban trees. These trees are crucial for delivering a range of ecological functions, such as improving air quality and cooling urban areas. This loss can cause a disturbance in the local biodiversity and have an impact on the structural stability of green spaces in urban areas, resulting in a decrease in habitat availability for wildlife. In addition, termites have the ability to modify the process of organic matter decomposition, hence impacting nitrogen cycling in urban soil ecosystems. Termites have a role in breaking down dead plant material, but if there are too many termites, they can eat too much and injure living plants, which disrupts the supply of critical nutrients. This disparity can impede soil vitality and have adverse effects on urban vegetation.

Economic Consequences

In economic terms, the damage caused by termites to urban trees can result in significant financial losses due to decreased property value and higher expenses for care. Infestations necessitate substantial allocation of resources towards pest management procedures, which can exert financial pressure on municipal budgets and influence city development projects. Furthermore, the economic consequences also impact industries associated with urban forestry, such as landscaping and tourism, which may see a decline in the appeal of green spaces harmed by termite infestation. Urban regions dealing with pest infestations experience additional financial strain due to the expenses incurred in repairing and replacing damaged trees and properties. In addition, trees that are infested can pose a serious risk to people's safety by falling and causing severe injuries that may be life-threatening.

Steps to Manage Termite Infestation

- **Precautionary Measures**
- **Regular Inspections:** Perform regular inspections of urban trees, specifically before to and during the period of increased insect activity (spring and summer). Examine the bark and soil for the presence of mud tubes, areas of dead vegetation, or animal waste, and investigate the lower part of the tree for indications of hollowness.
- **Eliminate Wood-to-Ground Contact:** To prevent termites from directly accessing wood and to minimize moisture collection that attracts them, it is important to elevate any wooden components, such as tree trunks, in metropolitan areas by at least 6 inches above the soil.
- **Manage Mulch:** To avoid conditions that facilitate termite infestations, it is advisable to maintain a distance of at least 2 feet between the base of trees and mulch. This hinders termites' ability to easily reach cellulose components and encourages optimal moisture levels in the vicinity of the trees.
- **Reduce Moisture Accumulation:** Ensure that moisture does not accumulate at the bases of trees by effectively managing irrigation and drainage systems. These tasks encompass the upkeep of gutters, the sealing of cracks in buildings, and the assurance of proper ventilation in crawl spaces.
- **Remove Wooden Debris:** It is important to regularly clear away fallen tree branches, wooden debris, and old stumps near urban trees, as these can attract termites as a source of food. Maintaining a clutter-free environment decreases the probability of pest infestations.
- **Utilize Professional Pest Control:** If any indications of termite activity are observed, it is recommended to seek the expertise of pest control experts for thorough inspections and treatment alternatives. Professional services implement appropriate strategies to safeguard urban trees against significant termite damage.

- **Identifying Termite Infestation**

1. Common Signs of Termite Activity in Urban Trees

- **Mud Tubes:** Search for mud tubes along the lower portion or main stem of the tree. Termites construct these protective tubes, which are usually as wide as a pencil, to move safely. These tubes can be seen extending vertically from the ground or running along cracks in tree bark.
- **Hollow or Blistering Wood:** Inspect for regions that exhibit hollowness when probed with a screwdriver or a tool of similar nature. Termites consume the internal wood, resulting in substantial structural harm and creating a hollow appearance.

2. Swarmers and Visual Indicators

- **Swarming Termites:** During some seasons, particularly after rainfall, it is possible to detect winged termites (also known as swarmers) near the tree. These termites are capable of reproduction and might serve as an indication of a well-established colony. Search for the presence of a large number of insects gathering around exposed wounds or cuts in the tree's bark.
- **Termite Droppings:** Termite infestation can be identified by the presence of small, pellet-like droppings or frass found near the base of the tree. These excrements may bear a resemblance to sawdust or soil, indicating the presence of eating activities inside the tree.

- **Chemical Treatment and Control**

- **Termite baiting:** It is a method used to control and eliminate termite colonies. It involves placing bait stations with slow-acting chemicals in areas where termites are active. These baits contain substances like hexaflumuron or noviflumuron, which are toxic to termites but take time to kill them. Worker termites carry the poisoned bait back to their colony, sharing it with other termites, including the queen. Over time, this leads to the elimination of the entire colony.
- **Soil Treatment:** To protect trees from termites, 1-2 liters of a 0.2% Chlorpyriphos insecticide solution can be applied by digging a trench around the tree base and pouring the solution into it (ICFRE, 2020. A User Manual on Forest Insect Pests and Diseases Indian Council of Forestry Research and Education, Dehradun, India).
- **Bark Treatment:** To prevent termites from attacking the bark, paint is applied to the tree trunk with a 0.2% solution of Chlorpyriphos or Endosulfan. Before applying, mud or termite galleries from the tree base are need to be scrape off ((ICFRE, 2020. A User Manual on Forest Insect Pests and Diseases Indian Council of Forestry Research and Education, Dehradun, India).
- **Termite Mound Control:** Termite mounds are permanent homes where termites breed and spread, attacking nearby plantations. To destroy a mound, few holes are made in it and insecticide solution is poured through a funnel in it. This process takes about a week to kill all termites in the mound. Another effective method is using Aluminum Phosphide tablets. Placing 2-4 tablets in a 1-meter-high mound and seal all openings with wet mud. The termites will die from the fumes (mound poisoning) (ICFRE, 2020). A User Manual on Forest Insect Pests and Diseases Indian Council of Forestry Research and Education, Dehradun, India).

- **Other measures**

- **Community Awareness and Involvement:** Increasing community awareness about termite infestations and management methods in urban areas is essential to foster collective action. Engaging local residents in monitoring efforts and equipping them with knowledge about infestation indicators can significantly enhance the effectiveness of early detection and response strategies (Hernández-Teixidor et al., 2024). Working together with local communities can improve the success of tree management and restoration projects in urban settings. The Chandigarh administration promotes training programs for eco club members and other stakeholders to help monitor the health of trees in their neighbourhoods.
- **Research and Continuous Improvement:** Conducting ongoing study on termite habits, ecology, and new management approaches is crucial for creating successful solutions to combat

urban infestations (Hernández-Teixidor et. al., 2024). Engaging in collaboration with researchers and pest control specialists can augment knowledge and result in the development of innovative solutions specifically designed for urban environments (Hernández-Teixidor et. al., 2024).

Conclusion

In light of the significant impact that termite infestations have on woody tree species in Chandigarh, as evidenced by a survey of 166 species across 56 families, it is imperative to implement a structured and comprehensive approach to manage and mitigate these issues. Though efforts have been made to maintain the health of trees in Chandigarh, the findings reveal alarming rates of infestation and mortality among key species, with high frequencies observed in trees such as *Millingtonia hortensis* and *Aegle marmelos.*

To combat the ecological and economic consequences of termite damage-ranging from biodiversity loss to increased municipal costs-proactive measures must be increased. Regular inspections and community engagement are essential for effective monitoring and early detection. Implementing strategies like maintaining moisture levels, managing mulch, and utilizing professional pest control can significantly reduce the likelihood of infestations.

Furthermore, fostering community awareness and involvement in tree health monitoring will not only enhance the efficacy of management efforts but also empower residents to take part in preserving Chandigarh's green spaces. Continuous research into termite behaviour and management solutions will be crucial for adapting strategies to the unique urban environment of Chandigarh. By prioritizing these actions, Chandigarh can protect its urban forests, ensuring they continue to provide vital ecological benefits and maintain the city's aesthetic and environmental integrity.

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