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Invabiome

A newsletter on Invasive species

First edition

Indian Forum for Invasion Biology (IFIB)

WHO WE ARE

The Indian Forum for Invasion Biology (IFIB) is India's premier network of researchers, practitioners, and stakeholders dedicated to understanding and combating invasive alien species. We are a collaborative platform that brings together expertise from across the country to address one of the most pressing environmental challenges of our time.

Why IFIB needs to exist

Invasive alien species (IAS) pose one of the greatest threats to global biodiversity and economic stability. As globalization accelerates and climate patterns shift, emerging economies like India face unprecedented challenges from biological invasions. Despite this growing threat, many countries lack the knowledge, coordination, and awareness needed to mount an effective response. Recognizing that fragmented efforts cannot tackle this complex problem, IFIB was created to unite expertise, coordinate responses, and build the capacity needed for effective action.

Our Origin Story

The Indian Forum for Invasion Biology was born from a groundbreaking national meeting at Azim Premji University, Bhopal, on February 21-22, 2025. This historic gathering brought together 34 researchers and practitioners from diverse backgrounds, geographies, and career stages—all united by a common mission to combat invasive species in India.

The meeting concluded with an inspiring vision: to create India's first national forum dedicated to invasion biology, fostering collaboration between academia, policy makers, and practitioners while bridging the critical gap between science and real-world application.

Our Mission

We foster collaboration between academia, policy makers, and practitioners while bridging the critical gap between scientific research and real-world conservation action. Through coordinated efforts, shared resources, and collective expertise, IFIB aims to build India's capacity to prevent, detect, and manage biological invasions effectively.

WHAT WE DO

The forum has three primary focus areas: creating resources like fact sheets and checklists of the invasive species; providing services like developing projects and advising interested students; and organizing workshops and webinars for capacity development for invasion biology in India. Some of these services are active, while we are working on others.

- **Checklists**: A national-level invasive species checklist provides the foundational knowledge necessary for a coordinated, strategic, and effective response to the growing challenge of biological invasions. The forum is working on creating a dynamic checklist of alien species.
- **Factsheets**: The invasive species factsheets serve as a vital tool for education, advocacy, and action, helping to protect native ecosystems, economies, and human well-being from the threats posed by invasive alien species.
- **Learning materials**: The forum members have archived the full texts of their publications (last 3 years) in the website. If interested in the data (and sometimes, code), contact the members (not only the corresponding author of the publication).
- **Projects:** The forum and its individual members are working on several projects. If interested in joining any of them, please feel free to reach out.

- **Advisory:** The forum members have diverse expertise in the invasion biology domain. If needed assistance to clarify doubts regarding your research, you can contact the members. Consider it as a networking opportunity.
- **Sharing resources:** The forum curates a list of available resources in different institutes and universities across India that can be helpful for invasion biology research (members and non-members). You can contact the designated person for more information.
- **Webinar:** Focused online seminars addressing the multifaceted field of how invasive species establish, spread, and impact native ecosystems. Expect discussions on the ecological and evolutionary mechanisms driving invasions, the role of human activities in these processes, and the consequences.
- **Hands-on Workshop:** Workshops will emphasize active participation, skill-building, and collaborative problem-solving. Expect our workshops to cover the following topics and beyond: monitoring, risk assessment, management, modelling, policy and regulations, and effective communication.
- **Academic Course Development:** The forum is engaged in developing a course that will provide a comprehensive academic exploration of the invasion process. The course will delve into the ecological and evolutionary principles that govern biological invasions, and the susceptibility of different environments.

Biological Invasion and Stakeholder Engagement in India held on February 21-22, 2025

The Forum on Biological Invasions: Inaugural Meeting at Azim Premji University, Bhopal

The first meeting of the Forum on Biological Invasions was successfully held at Azim Premji University's Bhopal campus. Established in 2010 in Bangalore, the University strives to build a just, equitable, humane, and sustainable society.

The meeting was structured around diverse and interactive formats: expert presentations, lightning talks, roundtables, and "birds of a feather" discussions. This variety enabled participants to share knowledge, present new findings, and exchange ideas in both formal and informal settings, encouraging active participation across career stages and disciplines.

Keynote Address

The event opened with an inspiring keynote by **Dr. Sankaran**, former Director of the Kerala Forest Research Institute. He reminded participants of the continuing global threat posed by invasive alien species (IAS) and cautioned that the risks will escalate if invasion pathways are not blocked and management approaches remain unsuitable. Drawing on the IPBES report on IAS, he emphasized that effective decision-making frameworks and tools already exist and need to be deployed strategically across all stages of invasion.

Mr. Aseem Shrivastava, Principal Chief Conservator of Forests (PCCF), Madhya Pradesh, shared valuable insights and case studies from his experiences with emerging plant invaders. He emphasized the need for national-level databases and regular assessments of plant invasions. He also highlighted the potential of cost-effective, nature-based approaches—such as controlled burning and herbivore exclusion—that should be explored and carefully tested.

Expert Presentations: Perspectives from the Field

A series of expert talks provided deep insights into the multifaceted challenges of biological invasions in India:

- **Dr. Ankila Hiremath (ATREE)** reviewed the wide-ranging ecological and human impacts of invasive species, noting how IAS threaten biodiversity and disrupt ecosystem services.
- **Dr. Bibhuti Prasad Lahkar (Aaranyak)** highlighted the invasibility of Assam's Manas National Park, where invasive plants threaten grassland ecosystems crucial for water security, climate mitigation, and endangered species.
- **Dr. Rajeev Raghavan (Kerala University of Fisheries and Ocean Studies)** explored the under-researched issue of freshwater fish invasions in India, where over 600 non-native species have been introduced.
- **Dr. Puja Ray (Presidency University)** addressed persistent challenges in aquatic weed management, advocating integrated strategies with a strong role for biocontrol agents.
- **Dr. Anzar Ahmad Khuroo (University of Kashmir)** presented his decade-long research on alien plants in India, covering species inventories, invasion drivers, and ecological impacts across biodiversity, soils, and microbiomes.
- **Dr. Malvika Chaudhary (CABI)** shared insights from CABI's Plantwise program, which uses digital tools to promote sustainable pest management among smallholder farmers, reaching over 1.8 million users.
- **Dr. Sudhakar Reddy (ISRO-NRSC)** demonstrated how earth observation and UAV-based tools can revolutionize the monitoring and mapping of invasive species.
- **Dr. P. Sujanapal (Kerala Forest Research Institute)** presented data on 246 naturalised angiosperms in the Deccan, highlighting regional distribution and invasive trends across forest types.
- **Dr. Gyan Prakash Sharma (University of Delhi)** reflected on the trajectory of invasion biology research in India, stressing

the need for stakeholder collaboration in management.

- **Dr. Alok Bang (Azim Premji University)** drew attention to the emerging denialism of biological invasions, urging evidence-based engagement to counter misinformation.
- **Ms. T.V. Padma**, a renowned science and environment correspondent, added a refreshing dimension by training participants in communicating invasion science to diverse audiences beyond academia.

Contributory Sessions and Engagement

In addition to invited talks, 15 lightning presentations covered invasion issues across ecosystems—from forests to freshwater and marine systems—and included global perspectives on invasion processes and context-specific management solutions. Discussions after each session were lively and constructive, with valuable inputs from both senior experts and early-career researchers.

Roundtables provided a collaborative space for teams to deliberate on pressing challenges, including effective management practices and research/data gaps. One of these very sessions also witnessed the conceptualisation of the forum itself—a testament to the importance of open, collective dialogue. An interactive role-play session led by **Ms. Padma** encouraged participants to tailor invasion-related messages for NGOs, policymakers, and the media, strengthening communication strategies for wider impact.

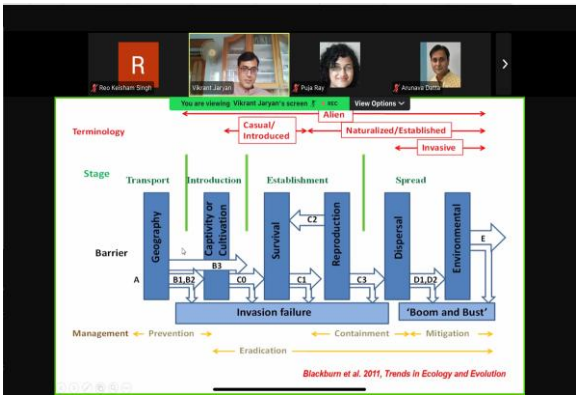
Towards the Future

The meeting concluded with a panel discussion featuring Dr. Sankaran, Dr. Khuroo, Dr. Raghavan, and Dr. Bang. They synthesized the meeting's discussions and laid out a roadmap for the forum's future. With optimism and enthusiasm, the meeting closed with a shared commitment to reconvene soon and continue advancing India's response to the growing challenge of biological invasions.

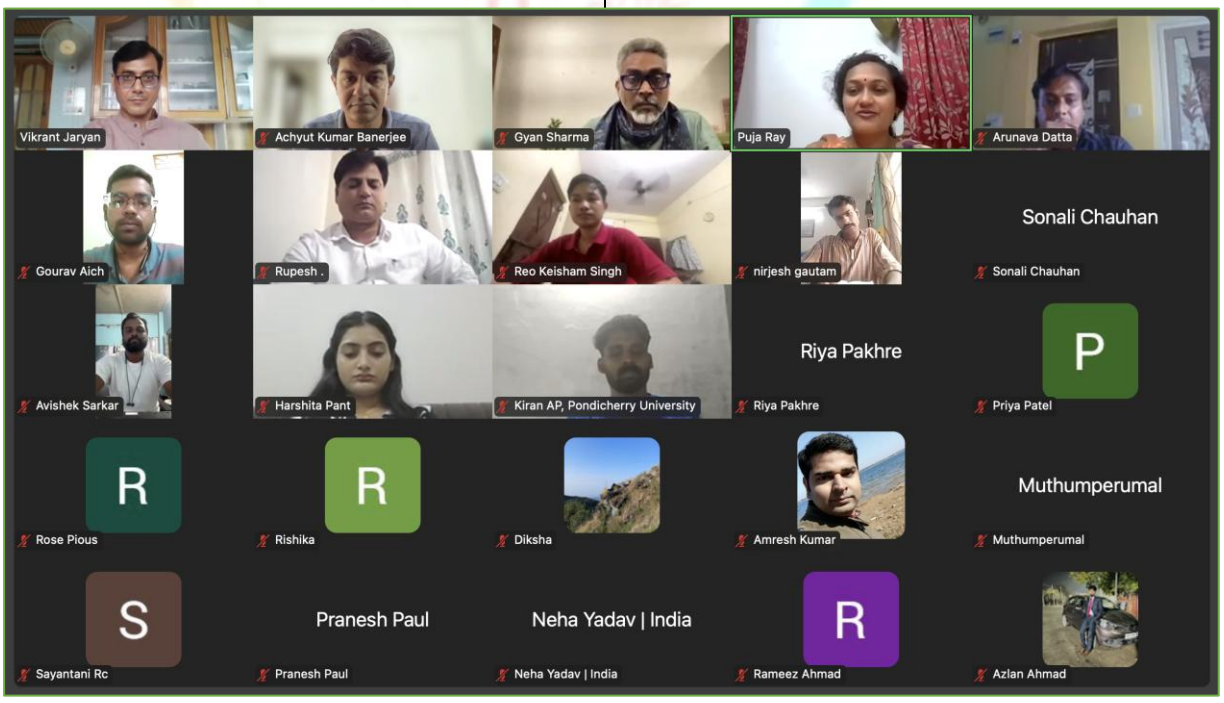
This inaugural meeting at Bhopal marked not just the launch of the forum but also a collective pledge: to foster collaboration, bridge knowledge gaps, and work towards a resilient ecological future for India.

A Webinar on "EcoWars: Causes, Mechanisms, and Consequences of Biological Invasions"

On 21st June 2025, a webinar was held online in the evening from 5:00 pm to 6:00 pm. We thanked the speaker, Dr. Vikrant Jaryan, Associate Professor, HoD Agriculture, Sant Baba Bhag Singh University, Jalandhar. He has published 24 publications, 1 book, 2 chapters in national and International Journals and attended more than 20 seminars and conferences, including 2 international conferences in Beijing (China) and Dubai. He is also a reviewer of prestigious journals such as PLOS ONE, 3 Biotech, Natural Hazards, Heliyon, and National Academy of Sciences Letters. In this webinar, Dr. Vikrant Jaryan first introduced the topic and briefed the audience about biological invasion, how the invasion is occurring in India, and how people are interacting with these species. Further, he also explained mechanisms contributing to invasion success—such as Enemy Release, the Novel Weapons Hypothesis, Rapid Adaptation, Competitive Dominance, and Disruption of Mutualistic Relationships—allow invasive species to establish, proliferate, and



outcompete native organisms. He used the Blackburn model to explain species establishment and becoming invasive. He shared his work on the species *Sapium sebiferum* (L.) Roxb. in Himachal Pradesh, Western Himalayas. *Sapium sebiferum* is a highly invasive species that can be seen growing in the sub-Himalayan tracts. *S. sebiferum* had occupied 4,611 km^2 of surface area. He had sampled 245 flowering plant species in the stands of *S. sebiferum* that belonged to 200 genera in 65 families. At the end of the webinar, the audience interacted with Dr. Vikrant Jaryan, where he addressed their questions. He also shared his experience during the field sampling. The webinar ended with a thank-you note from the IFIB team.



Lightning talks: "The Invasion Hour"

The session featured three engaging talks. The session started with a talk by **Neha Yadav**, an undergraduate student from Azim Premji University, who highlighted the significance of ground-level observations in studying invasive species such as Lantana camara, while stressing the need for broader public awareness to encourage informed decision-making on plant invasions. Then, **Purnima Singh** (University of Delhi) discussed plant interactions, focusing on host shifts and host preferences. And finally, **Dr. Kanhaiya Shah**, faculty member at the University of Delhi, shared experiences from his Ph.D. journey, emphasizing the Driver–Passenger model and the importance of keen observational skills in field ecology.

The interactive format of Invasion Hour encouraged openness and curiosity, allowing participants to raise questions related to their own research interests. Discussions touched upon diverse topics including butterfly visitation patterns, plant–pollinator networks, and how invasive species exploit habitat disturbances.

The webinar shed light on ongoing research while sparking thoughtful questions from participants, making it a vibrant exchange of knowledge and ideas in the field of invasion ecology.

Global Conferences to Explore

NAISMA Annual Conference 2025 (Click for more details)	3- 6 Nov 2025	Lake Tahoe United States
British Ecological Society Annual meet 2025 (Click for more details)	15-18 Dec 2025	Edinburg, Scotland
International Conference on Invasive Species and Management (ICISM) (Click for more details)	18-19 Dec 2025	Rome, Italy
XVII International Symposium on Biological Control of Weeds (Click for more details)	8-13 March 2026	Rotorua, New Zealand

Faded pages hold the guilt: How archival records rewrote the introduction history of *Mikania micrantha*

Achyut Kumar Banerjee
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Back in 2020, as I was starting my PhD, I first heard about the invasive alien species. An alien species is an organism introduced to a new environment, and if it causes economic or environmental harm, it's considered an invasive alien species (IAS). I chose to focus my research on *Mikania micrantha*. Over seven years, I studied its distribution, environmental and economic impacts, and even its potential control measures. However, the most fascinating discovery I made—and will share with you—was the journey of *Mikania micrantha* from its home in Latin America to India.

The Journey Beyond Borders

Google will tell you that the species was introduced to India in the 1940s for use as ground cover in tea plantations in northeast India.

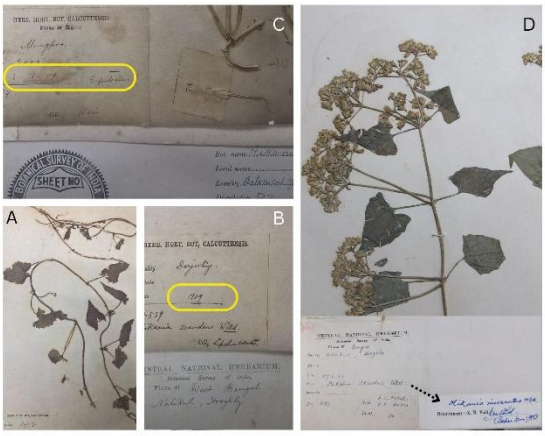
Let me serve you another narrative, a story that remained hidden in the pages of old botanical explorations. Two disclaimers: Archival sources can help us know how a species 'possibly' reached a new place, but never with certainty. I am also not going into the details of 400-odd species of *Mikania* here, unless necessary, to keep the complexities away from its eventful arrivals in India.

The Eastern Gateway

Meet Henry Harpur Spry, the secretary of the Agricultural and Horticultural Society of India. In 1839, Spry recommended *Mikania* to be cultivated in the Calcutta Botanical Garden for their medicinal values in *Suggestions for the Introduction of Useful and Ornamental Plants into India*.

Mikania micrantha is a creeper. It creeps over the plants (and other structures), deprives them of sunlight, and smothers them to death. It wreaks havoc in (from bottom left) tea gardens, commercial plantations, and urban green spaces. *Photo by: AKB*

Among the species Spry recommended, *M. guaco* was known for its anti-bacterial activity and was introduced to the Kew Botanical Garden from Jamaica in 1886. This species looks very similar to *M. micrantha*; in fact, one of the common names of *M. micrantha* is *falso guaco*. It is possible that this *falso guaco*, in place of the true guaco, was introduced from Jamaica to the Calcutta Botanical Garden, either directly or via Kew.



Photographs of the herbarium specimens of the plant: (A) the earliest specimen housed in the Central National Herbarium, Calcutta; note the year of collection boxed in yellow in (B) and (C); (D) The species was often misidentified, and later rectified. *Photo by: AKB*

Such misidentifications were common at that time (and continue today, as seen with the frequent confusion of *Mikania micrantha* with Mikania scandens, a species with a restricted distribution to North America), when botanical imperialism in India was at its zenith. In his book *Hortus Suburbanus Calcuttensis* (1845), Joachim Otto Voight, a Danish surgeon-turned-botanist, recorded *Mikania* in the Calcutta Botanical Garden. But the three species he identified as *Mikania* were later found to be of a different plant (*Eupatorium*).

The introduction of *Mikania* probably happened in the late 1800s or early 1900s. In 1903, Sir David Prain, a Scottish Botanist at the Calcutta Botanical Garden, recorded the plant from Central Bengal (Calcutta and surrounding regions) in his book *Bengal Plants*. Henry Haselfoot Haines (1867-1945), then in charge of the imperial forests, also recorded *Mikania* in his book *The Botany of Bihar and Orissa* in 1922. By 1944, the plant became abundant in and around Calcutta.

Himalayan foothills infiltrated

When Henry Spry was recommending *Mikania* for cultivation in Calcutta, a 30-year-old young man was leaving England to study the Himalayan plants. Sir Joseph Dalton Hooker started his expedition from Darjeeling, and travelled to Sikkim, Nepal, and Assam, before leaving India in 1850. In *The Flora of British India* (1882), he mentioned *Mikania* to be present in Arunachal Pradesh. In 1876, Charles Baron Clarke, a British botanist and a recognized authority on Indian flora, also recorded *Mikania* from eastern Assam in his book *Compositae Indicae*.

In the Central National Herbarium, I found two herbarium sheets of *Mikania* collected in 1909 from Mungpoo. This is the place where Sir Clements R. Markham, a British geographer and explorer, introduced the cinchona plants from their native Peruvian forests in 1862 to combat the malaria problem among the workers in the tea plantations. At about the same time, in 1851, Alexander von Humboldt, the German polymath, and Aimé Bonpland, the French botanist, recorded the anti-malarial properties of *Mikania* and its use by the local people of South and Central America in their *Personal Narrative of Travels to the Equinoctial Regions of America*.

It is possible that *Mikania* was brought to India intentionally (for anti-malarial properties) or it hitchhiked its way to India with the cinchona plants in the late 1800s or early 1900s, at about the same time when it reached Calcutta.

Passing through the latex groves

While the botanical gardens in the east and the cinchona plantations in the northeast paved the way for *Mikania* to the country, the rubber plantations facilitated its arrival in South India, albeit much later.

Commercial rubber plantation started at Thattekad, Kerala, in 1902 by John Joseph Murphy (1872-1957), an Irish agricultural entrepreneur. In 1955, the Rubber Research Institute of India (RRII) was formed in the Kottayam district. Just after 13 years of RRII's establishment, *Mikania* was observed at one of its experimental stations. How?

Soon after its establishment, RRII established a material transfer agreement with other rubber-producing Southeast Asian countries like Malaysia, Indonesia, and Sri Lanka. *Mikania* was already introduced in these countries (between 1949 to 1960) as a ground cover crop to help with soil erosion and weed suppression in rubber plantations. So, it is possible that *Mikania* was introduced intentionally (as a ground cover) or accidentally (as a weed of rubber plantations) to southwest India from these countries in around 1960s.

End note

This narrative reveals two key findings: *Mikania micrantha* was introduced to India on at least three separate occasions, and its arrival predates the commonly cited date of 1940. This work highlights the importance of using archival evidence (and further supported by genetic studies) to reconstruct the likely pathways of other invasive species, challenging existing assumptions, and closing knowledge gaps. History taught us the consequences of unregulated movements of plant species, and we should remain vigilant whenever transporting plants between locations, regardless of the purpose.

The Mangrove Isopod: A Tiny Crustacean, A Giant Lesson

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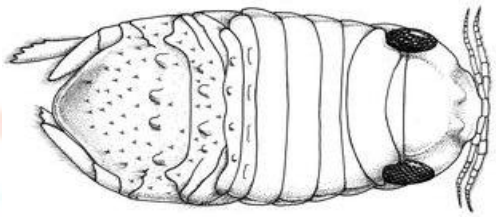
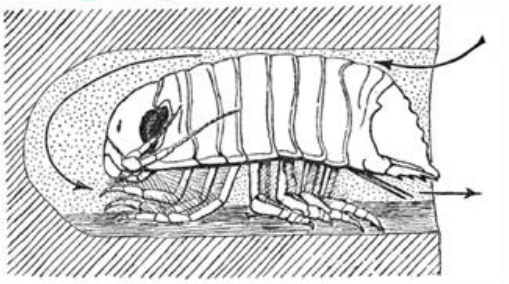
When we think about forces shaping our coastlines, our minds naturally drift toward storms, tides, rising seas or sprawling urban development. Rarely do we imagine a thumbnail-sized isopod quietly boring into mangrove roots, yet *Sphaeroma terebrans*, the mangrove isopod, reminds us that even the tiny creatures can sculpt the stability of entire ecosystems. This little crustacean, typically no more than a centimeter long, does not grab attention at first glance. Reddish-brown and elliptical, it looks rather unremarkable to the human eye. But beneath the calm waters of tropical and subtropical estuaries, it is relentlessly at work. By boring into the aerial roots of red mangroves (*Rhizophora mangle*) or the stems and rhizomes of marsh vegetation, *S. terebrans* literally hollows out the foundations of coastal forests. In some regions, infestation rates of mangrove roots reach nearly 100 percent, with a staggering portion of roots severed. What seems like an insignificant habit of hiding in wood burrows, in fact, reshapes mangrove ecosystems and by extension, the shorelines they protect.





At first, the impact appears entirely destructive. Mangroves are ecological guardians: they buffer storm surges, trap sediment and anchor shifting shorelines. To see their roots drilled, hollowed and sometimes destroyed by swarming isopods feels like nothing short of an assault. Indeed, such root damage has been linked to shoreline instability, erosion and cascading ecological consequences. In human terms, the isopod has also proven costly, boring into pilings, docks, buoys and even plastic floats. It feeds on plastic-based structures doesn't just cause economic damage but also contributes indirectly to microplastic pollution, further stressing marine ecosystems and yet, the isopod's story resists easy categorization. *S. terebrans* does not actually consume wood; it bores into it for shelter and filter-feeds on detritus and microorganisms. While weakening some mangrove roots, its presence drives curious ecological responses. Mangroves often

react by producing fresh lateral roots around damaged areas. In effect, the isopod's tunnelling induces more root branching, enhancing network density and, in some cases, improving resilience against currents and waves. What looks like destructive feeding becomes, paradoxically, a trigger for adaptive growth.

This nuisance role makes *S. terebrans* an "ecosystem engineer." It is not simply a pest. It recycles decomposing organic matter and aids nutrient cycling in coastal zones. By breaking down woody debris, it contributes to the renewal of mangrove forests. Its effect lies squarely in the grey zone between harm and benefit—both weakening and reinforcing mangroves in a dynamic interplay shaped by context.

Reflecting on this paradox feels like staring into a mirror. Just as *S. terebrans* bores into roots, humans burrow relentlessly into natural systems. Our cities expand into wetlands; our industries pollute rivers and coasts; our demands hollow out fisheries and forests. Like the isopod, our impact is often subtle, almost invisible in the moment, but accumulative over generations. One tunnel here, one cut mangrove there, one spill on a shoreline until suddenly an ecosystem teeters on collapse.

The isopod also teaches us humility about scale. We are trained to respond urgently to dramatic ecological disasters, such as oil spills, hurricanes, and bleaching events. Yet, what often undermines ecosystems is not catastrophe but constant, slow, incremental damage. Burrow by burrow, *Sphaeroma terebrans* destabilizes mangrove roots, just as human actions chip away at ecological resilience. The true challenge is noticing the quiet degradations before they accumulate beyond repair.

This should caution us against simplistic labels of "good" or "bad" species. Viewed narrowly, *S. terebrans* is a pest, undermining ecosystems and infrastructure. Viewed more broadly, it is a natural recycler and coastal engineer, contributing to the life cycle of mangroves. Context matters. What makes its presence particularly worrying today is not its biology but the compounding pressures of climate change, urban expansion, and pollution, which magnify the consequences of its burrowing.

In this light, *Sphaeroma terebrans* symbolizes the fragility of the coastal balance. Mangroves, perhaps our most underappreciated ecosystems, safeguard human settlements, store vast amounts of carbon, and support fisheries crucial to livelihoods. Their struggle against rising seas, deforestation, and now the gnawing persistence of tiny isopods embodies the multifaceted threats to coastal resilience. If even these sturdy "coastal guardians" can be hollowed out by creatures smaller than a fingernail, what does that suggest about the subtle vulnerabilities of ecosystems everywhere?

The more I reflect on *S. terebrans*, the less I see it as a villain and more as an understated teacher. It forces us to recognize that ecological change is often cumulative and invisible, until one day it is not. By hollowing wood at minute scales, it reveals how stability can be undone slowly, quietly, from within. It is a warning for us to notice small forces our everyday habits, our casual degradations before they add up to crises we cannot reverse.

In the end, *Sphaeroma terebrans* is both destroyer and restorer, pest and engineer. Its legacy depends not only on its tunneling but on the larger context of human decisions. If mangroves are coastal guardians, perhaps this tiny isopod is best understood as their persistent challenger, reminding us that ecological resilience is never guaranteed, only earned and maintained.

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Pretty but Perilous: The Hidden Threat of Ornamental Fish Trade as a Pathway for Biological Invasion

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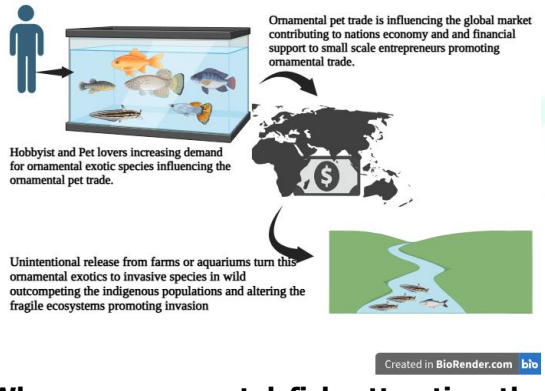
The ornamental fish trade represents an important commercial sector within global fisheries, catering to the aesthetic demands of hobbyists and pet lovers. Fish are generally classified as ornamental based on their attractive coloration, adaptability to confined spaces, peaceful temperament, interspecific compatibility, acceptance of artificial feed, and suitable size for aquariums (e.g., goldfish, angelfish, guppy, discus, tetra, gourami). Even simple morphological features such as dark streaks, blotch, or distinctive patterns such as stripes, spots, silvery sheen, or vibrant hues, can qualify a fish as ornamental. Additionally, traits such as slow or unique movements of the body, mouth, operculum, or fins add to their appeal. Beyond these conventional criteria, indigenous species may also be chosen for their unusual appearance (e.g., Devil catfish *Chaca chaca*), peculiar behavior (e.g., colorT-changing *Badis badis*), or rarity (e.g., rainbow snakehead *Channa bleheri*).



Why are ornamental fish attracting the global market?

Aquarium fish often fetch prices up to 100 times higher than food fish, with marine ornamentals valued about ten times more than freshwater species. Ornamental fish culture, whether on a large or small scale, is highly profitable if pursued scientifically with effective marketing. It offers viable opportunities for small entrepreneurs through short-term investments. Breeding selected species in glass tanks or farm setups under artificial conditions has gained prominence, reducing dependence on wild capture and significantly transforming the fishery industry.

Evolution of Ornamental Fisheries

Fish keeping dates back to ancient civilizations, with evidence from the Sumerians (2500 BC), Babylonians (500 BC), and Egyptians, who revered species like the Nile Perch, considering it sacred. The Chinese began selectively breeding carp during the Sung Dynasty (960–1279) for decorative purposes. By 1691, ornamental goldfish had reached Europe, where Samuel Pepys described the practice of keeping fish in bowls as "exceedingly fine."

Ornamental fish potential of India

India is endowed with rich marine ornamental fish resources, particularly in biodiversity hotspots such as the lagoons and coral reefs of Lakshadweep, Minicoy, Andaman and Nicobar Islands, Gulf of Kutch, Kerala coast, Gulf of Mannar, and Palk Bay. Freshwater resources are equally promising, with ornamental species thriving in hill streams, major river systems, reservoirs, and lakes. The northeastern rivers and Himalayan streams are especially rich, making the region a leader in India's ornamental fish trade. Over 150 commercial important indigenous freshwater species including loaches, eels, barbs, catfish, and gobies are collected from rivers, streams, and wetlands. Currently, about 90% of India's ornamental fish exports pass through Kolkata port, followed by Mumbai (8%) and Chennai (2%). Although India contributes less than 1% to the global ornamental fish trade, it is regarded as a "sleeping giant" due to its vast untapped potential.

Of the 300 freshwater fish species in the Western Ghats, 155 are ornamental, with 117 being endemic. However, only a small portion of this diversity is used in India's ornamental trade, which is dominated by exotic varieties. The region's fauna—barbs, rasboras, killifishes, glassfishes, catfishes, hill trouts, and danios—holds great potential for the trade. Overall,

India harbours over 100 indigenous ornamental freshwater species, some commanding high prices internationally.

Ornamental fishes are broadly categorized as **livebearers** (molly, platy, guppy, swordtail) and **egg layers** (goldfish, barbs, koi carp, gouramies, cichlids, oscars, discus). About 80% of ornamental species are freshwater, while the rest are marine or brackish. Most freshwater ornamentals (90%) are farmed, whereas marine species largely come from the wild.

The northeastern states dominate India's market, contributing ~85%, with the rest from southern states. Around 58 indigenous species from this region are exported, with notable examples including *Botia dario*, *Danio dangila*, *Puntius shalynius*, and *Schistura reticulofasciatus*. India's global market share has been modest, ranging from 0.12–1.16% between 1991 and 2009, peaking at 1.16% in 2007 but falling to 0.33% by 2015.

Marine ornamental fishes, especially reef species, are globally popular for their adaptability and striking diversity in shape, color, and behaviour. In the Gulf of Mannar alone, 113 species across 24 families have been recorded, with families such as Acanthuridae, Chaetodontidae, Pomacanthidae, Pomacentridae, and Syngnathidae showing high biodiversity value.

Between 2003 and 2009, about 70% of India's ornamental fish exports went to Singapore (43%), followed by Japan (14%), Malaysia (10%), and the USA and Hong Kong (7.5%). Domestically, the aquarium trade grew from INR 55 crore to INR 625 crore by 2021 and is projected to reach INR 5,000 crore by 2030. The number of aquarium shops has expanded from a few in major cities to over 8,000 nationwide.

Once concentrated in West Bengal and Maharashtra, ornamental fish farming is now practiced across coastal, inland, and even hilly states. Hobbyists have grown from less than 0.1% to 1.78% of the population and are expected to reach 5% by 2030. India's global export share, long below 0.5%, crossed 1% for the first time in 2021–22.

Ornamental fish trade pathway for Invasion:

India's ornamental fish trade targets endemic and keystone species from biodiversity hotspots for international markets. While this boosts GDP, it threatens fragile ecosystems. Simultaneously, exotic species released from aquariums or escaping from farms during floods disrupt native habitats. These invasive species, being generalists with high fecundity and lacking natural predators, quickly establish populations. They outcompete natives for food and space, spreading diseases (e.g., Koi herpesvirus), hybridizing, and preying on native fry. Mismanagement has led to escapes of large predators like *Arapaima gigas* and *Atractosteus spatula* in Kerala's waters post-2018 floods, and reports of red-bellied piranha (*Pygocentrus nattereri*) in the Godavari and Krishna rivers, Amazon sailfin catfish (*Pterygoplichthys* spp.) in widespread freshwater ecosystems, endangering native biodiversity. The ornamental fish trade, if left unchecked, poses serious threats to India's native fish diversity. Urgent regulation, including selective bans on harmful species, strict control on imports and exports, and effective management of exotics, is essential to safeguard indigenous resources and protect fragile aquatic ecosystems. Lack of proper knowledge amongst pet lovers and hobbyists regarding fish care and the consequences of releasing them into non-native habitats remains a crucial factor in the spread of these ornamental fish species in the wild.

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A road construction site with old pavement and road verges

A report on the prospect of invasion as the road network expands in Manipur, India

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The phrase "Roads as a conduit for invasive species" is well highlighted in the literature. In this globalized world, the developing nations are facing environmental challenges due to biodiversity loss. Biodiversity loss can be attributed to many reasons, including infrastructure development. The striking example of infrastructure development is the rapid expansion of the road network and the rapid spread of urban agglomerations. In a recent study, it was found and concluded that highways are expanding drastically in the biodiverse region of India, i.e., Manipur, impacting the land use and land cover change from 2012 to 2022 (Singh et al., 2024). The study also showed that the forest cover is decreasing, leading to habitat fragmentation. Also, the roads are the primary mode of transportation in Manipur compared to other modes of transportation. And there are many invasive non-woody plant species in this region, including highly invasive species like *Lantana camara, Mikania micrantha, Parthenium hysterophorus*, etc. (Singh et al., 2024). Thus, the possibility of a carrier by the anthropogenic factor through the roadways is very prevalent. The roads, especially the road verges, are susceptible to the probability of invasion by these non-native species and spreading them further. Hence, there is a need to first monitor the hotspots of invaded areas and identify the areas of spread through the spatial analysis, such as the remote sensing technology and species distribution modelling. Also, the areas of ecologically sensitive zones, like the higher elevation zones and forested regions, should be constantly monitored for any sighting of such species to stop the establishment and spread of any invasive species in those regions. Scientific communities and policymakers should collaborate to predict and mitigate the introduction of invasive species into non-invaded habitats.

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Where do they spread? Invasion across an urban protected area

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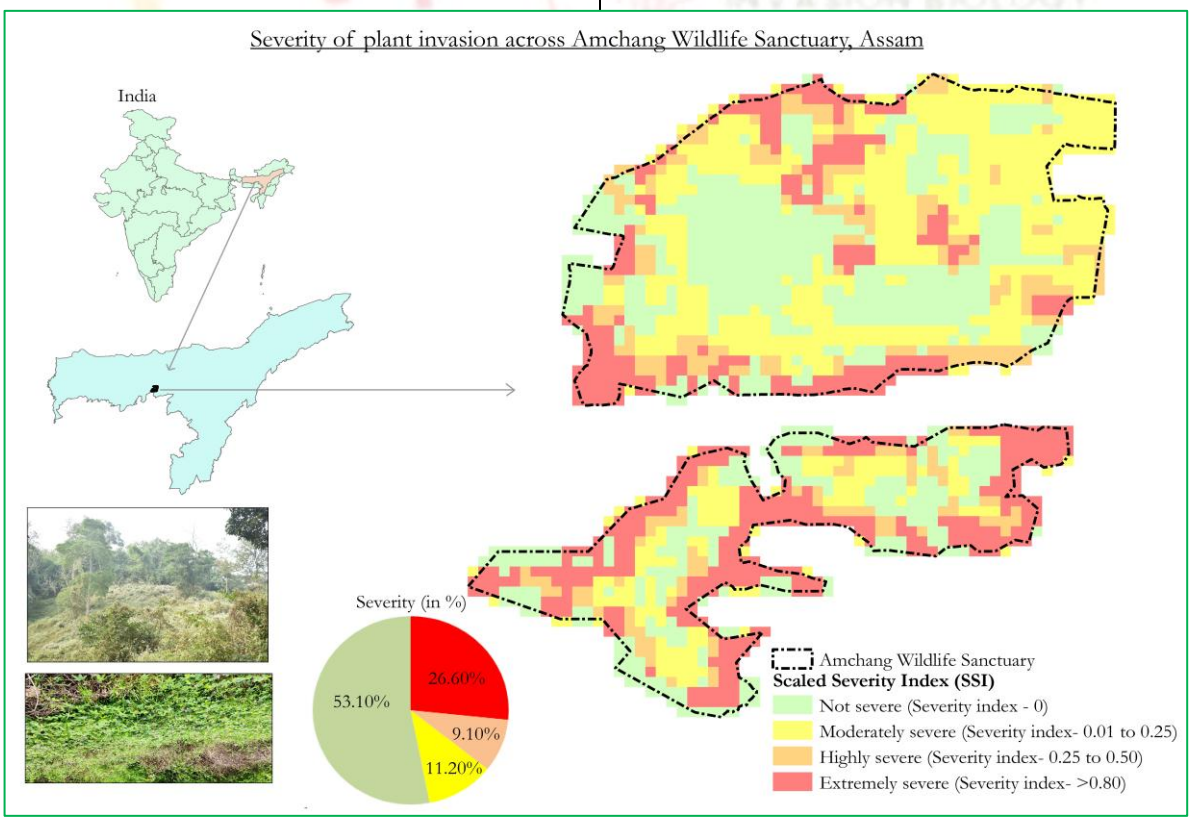
Urban expansion, encroachment, grazing pressure, and NTFP collection are among the various anthropogenic pressures faced by the forest ecosystem of Amchang Wildlife Sanctuary (AWLS), an urban protected area (PA) sharing its boundary with the Gateway of North-East India, Guwahati city. There are numerous instances of human-elephant conflict along the PA's periphery. Owing to the high anthropogenic disturbance, the PA suffers from high invasion severity by invasive alien plants (IAPs). 4-hectare grids were used during the post-monsoon of the year 2020 till pre-monsoon of the year 2021 to evaluate spatial patterns of invasion severity posed by *Ageratum conizoides*, *Chromolaena odorata*, *Lantana camara, Mikania micrantha*, and *Pontederia crassipes*. Invasion severity was computed by summing presence values across all invasive species per grid. These results were normalized by using a Scaled Severity Index (Archer et. al. 2012) to classify invasive species richness within surveyed grids.

Scaled Severity Index (SSI)= (Observed grid richness - Minimum grid richness)/ (Maximum grid richness - Minimum grid richness)

The PA, spread across 78.64 km^2, nearly 47% area was found to be invaded by IAPs, with 27% area being severely invaded, 9% highly invaded, and 11% moderately invaded. *Mikania micrantha* was observed to be the most frequently occurring IAP, while *Pontederia crassipes* was the least frequent. The occurrence of all the selected species was found to be positively correlated with canopy openness, being absent in pure patches of



very dense forest, pure Bamboo patches, and Sal and teak-dominated areas along the periphery. The Moran's I spatial autocorrelation analysis suggested strong clustering of *A. conizoides*, *C. odorata*, *L. camara* and *M. micrantha* with low spatial clustering of *P. crassipes*, while Ordinary Least Square and Geographically Weighted Regression analysis with severity as dependent variable and land use/cover, distance from road and distance from PA edge as independent variables yielded a heavy localized invasion from the selected species across the PA.

The spatial analysis of invasion severity indicates that LULC change, especially to lower biomass classes, is highly susceptible to invasion due to disturbed soil conditions, anthropogenic disturbance (Chytrý et al., 2008; Foxcroft et al., 2011). Negative coefficient for Distance to forest edge supports the theory of edge habitats being more prone to invasion due to increased light availability, disturbed microclimates, and reduced competition (Murcia, 1995; Harper et al., 2005). This PA plays a vital role in regulating the microclimatic and hydrological regimes of Guwahati city, making it important to manage the invasion pressure by manual removal and plantation of native fruit trees (palatable species of Asian elephant) along canopy breaks and forest edges.

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We are opening our invite for the Second edition of our newsletter INVABIOME

We invite short articles, essays, and announcements related to biological invasions, invasive species management, and broader issues in invasion ecology. Contributions from researchers, practitioners, students, and policy experts are welcome.
Further guidelines are available on our website (click here)

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