International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Role of Insect-Pollinated Flora in the Gurguripal Forest: A Study of Biodiversity, Forest Regeneration and Entomophilic Interactions

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Abstract:
The Gurguripal Forest in West Medinipur, West Bengal, has experienced significant ecological transformation due to deforestation and overgrazing, leading to soil erosion and degradation in the early 1980s. Initially dominated by Shorea robusta (Sal) trees, the forest has gradually recovered through watershed management and afforestation efforts, such as gully modifications and earthen dam construction.
This study investigates the role of insect-pollinated flora (entomophilic plants) in the biodiversity and regeneration of the Gurguripal Forest. Insect pollination plays a vital role in plant reproduction, fostering biodiversity and ecological stability. A multidisciplinary approach combining literature review and on-site botanical surveys was carried out to assess plant and insect diversity, and to explore the relationship between forest regeneration and entomophilic interactions. The study identifies dominant plant families such as Fabaceae, Asteraceae and Dipterocarpaceae which depend on insect pollinators. In conclusion, exuberant entomophilic flora exemplify the dynamic relationships between plants and insect pollinators which includes significant success in rejuvenating the degraded forests.

Keywords: Gurguripal Forest, Insect Pollination, Forest Diversity, Entomophilic Flora.

Introduction

Forest ecosystems are the significant reservoirs of biodiversity, playing a vital role in maintaining ecological balance and harbouring an unparalleled diversity of life forms. The Gurguripal Forest, situated in the district of West Medinipur, West Bengal, stands as a remarkable example of such ecosystems. It has experienced large scale deforestation and overgrazing which poses a serious threat to biodiversity.
Initially, the Gurguripal area was dominated by abundant *Shorea robusta* (Sal) forests along with its traditional associates. Due to indiscriminate felling, the area became gradually denuded and soil erosion progressed at an ever increasing pace (Mallick and Chakraborty 2018). Till the early 1980's the whole zone of Gurguripal was an entirely drought prone barren area spotted with numerous gullies over the dry laterite topography.
In the 1990s, watershed management—mainly water conservation techniques—was implemented for the sustainable maintenance of the aforementioned forest. This included gully modification and the building of several earthen dams.
Among the various components of forest biodiversity, the entomophilic flora, which relies on insects for pollination, holds particular ecological importance.

Entomophily, or insect pollination, plays a pivotal role in the reproductive biology and evolutionary success of flowering plants. Wind and water are also agents of pollination, entomophily stands out due to its efficiency and co-evolutionary intricacies between plants and insects.

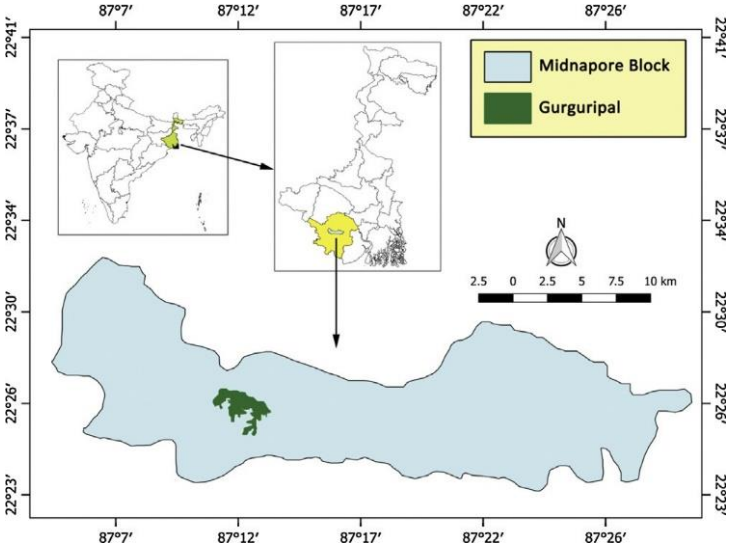
This paper aims to explore the concept of exuberant entomophilic flora, characterized by the abundance and diversity of plant species relying on insect pollinators for reproduction.

Material and method

Study Site

Gurguripal forest area is characterized as the home to tribal people who primarily rely on the forest for their subsistence. It is situated at latitudes 22°25´ - 35°8´ N and longitudes 87°13´ - 42°4´ E in the District of Paschim Medinipur, West Bengal (Fig. 1). Its elevation is approximately 65 meters above mean sea level. The region enclosed on the south by the Kangsabati River and on the north by the Silabati River (Mallick and Chakraborty 2018). The chosen forest-wetland belongs to the micro-watershed category (NRSC, 2014) and classified as secondary forest, having developed through the regeneration process of degraded forest. The average temperature of this area remains between 10 and 16 degrees Celsius in winter and in summer, it varies between 35 and 40 degrees Celsius. This region experiences 1500 mm of yearly rainfall on average, which is caused by the south west monsoon.

Figure 1: Study Site



Methodology

The study adopts a multidisciplinary approach, integrating literature review with on-site observation. From 1999 onwards multiple studies have been taken account by introducing several methods for studying the forest regeneration of a specific part of Gurguripal forest in West Medinipur district of West Bengal. Secondary data on species diversity have been collected from different studies to understand the floral and insect diversity of a grown forest. Data collection through on-site fieldwork involved conducting botanical surveys across multiple seasons to identify various plant species and examine the relationship between forest structure and the abundance of insect-pollinated flora. Local residents, drawing on their experience, identified plant species by their local names, which were then cross-verified by designated forest personnel using official records. These surveys primarily focused on documenting angiospermic species within the

forest, particularly those that rely on insect pollinators for reproduction. Key floral families identified in the study included *Fabaceae*, *Asteraceae*, *Dipterocarpaceae*, *Rubiaceae* etc. all of which play vital roles in forest regeneration and biodiversity. The scientific names of these plant families were gathered from online resources and various literature sources. In addition, insect species such as bees, butterflies, and beetles were also observed to understand the mutualistic relationships between plants and pollinators, which are crucial for the survival and reproduction of insect-pollinated flora. Main emphasis is to understand the diversity of growing forest where insects may act as an indicator through entomophilic pollination. This mutualistic interaction is significant for the maintenance of plant diversity of a healthy forest of Gurguripal and its ecosystem.

Results and discussion

Biodiversity of Gurguripal Forest

The Gurguripal Forest boasts an impressive array of plant species, ranging from towering hardwoods to delicate ferns. The rich biodiversity of this forest has been extensively documented by Mallick and Chakraborty (2018), which also assess the potential ecosystem services that could result from a rejuvenated forest-wetland. Singha, et al. (2017) examined the mushroom diversity and productivity within the Gurguripal Eco-forest and documented 743 mushroom specimens of which a total of 71 mushroom species across 41 genera and 24 families. Among these, 32 were identified as edible, 39 as inedible, and a total of 19 displayed potential medicinal properties.

Simpson's index of diversity yielded a species richness value of 0.92, while Shannon's diversity index indicated a relative species abundance of 2.206. Simpson's Diversity Index ranged from 0 to 1, signifying expressively higher values, thus emphasizing the importance of species abundance within the Gurguripal Eco-forest (Singha, et.al. 2017). The intricate web of life within the forest encompasses not only plants but also insects, birds, mammals, and countless other organisms, each playing a vital role in maintaining ecosystem balance.

The region comprises a blend of tropical evergreen and deciduous nature of forests, predominantly characterized by the presence of "Sal" trees. The diversity and abundance of mushroom species serve as valuable indicators of forest health (Stametes 2000). Information regarding mushroom diversity holds significant importance in the maintenance and management of forest ecosystems. Additionally, many mushroom species fulfil crucial ecological functions through symbiotic relationships, such as mycorrhizal associations with trees.

Inventory of the study site identified 94 species of angiospermic plants from 47 families (Mallick and Chakraborty 2018). During the afforestation project in the 1990s, rows of Eucalyptus sp., *Gliricidia sepium*, and others were planted along the boundary. Planting *Acacia mangium* was deemed beneficial for soil conservation in conjunction with conventional miscellaneous species.

Present study documented the presence of numerous dominant species in this forest, with the major families represented being: Anacardiaceae, Apocynaceae, Asclepiadaceae, Asteraceae, Combretaceae, Convolvulaceae, Dipterocarpaceae, Ebenaceae, Fabaceae, Lamiaceae, Liliaceae, Meliaceae, Myrtaceae, Rhamnaceae, Rubiaceae, Rutaceae, Salicaceae, Sapindaceae, Sapotaceae, Zingiberaceae which are mainly insect pollinated and play significant roles in forest regeneration and biodiversity.

Restoration of forest cover

The forest cover has changed visibly, both quantitatively and qualitatively, as a result of joint forest man-

agement (JFM). In the past few decades, West Bengal has led the way in engaging tribal communities from the Medinipur and Purulia districts to safeguard local forests, fostering natural regrowth. The Medinipur (West) region, predominantly lateritic, confronts an urgent issue of declining productivity and water scarcity stemming from land degradation (Pradhan, et al 2012).

The area, originally, covered with coppice Sal (*Shorea robusta*) woods with related species. Due to biotic intervention and extensive felling, the area was totally devoid of exposed laterites. The soil layer was almost completely eroded away before the planting process began. The East Medinipur Forest Division initially planted the area in 1965–1966. Subsequently, in 1979–1980, Panchet Soil Conservation Division, Purulia effectively covered up the land with reforestation (Raha, et al 2014). Before the conservation efforts, there was sheet erosion, rill erosion, and gully erosion at the location.

Simultaneous effort has been executed for plantations and significant structural work such as gully plugs, check dams, and earthen dams. In order to effectively recharge groundwater and prevent silt build-up, a sufficient number of earthen dams were built. Additionally, gullies were altered to decrease horizontal seepage and enhance vertical water percolation, thereby raising groundwater levels as a reflection of the surface water table (Mallick and Chakraborty 2018).

As part of degraded forest regeneration, extensive plantations of Eucalyptus and *Acacia auriculiform* (Akashmoni) were established in the districts of Medinipur in the 1960s and 1970s (Raha, et.al 2014). In areas of degraded Sal forest, Sal (*Shorea robusta*) plantations were also attempted; however, their success was limited because of strong biotic pressure from fire and grazing in the early plantations. Beautiful patches of Eucalyptus and Akashmoni plantations offered ground cover to barren or degraded forest areas that would have been difficult to regenerate with slow-growing, varied species. The village farm forestry programs have also significantly improved the status of biodiversity conservation (Raha et al 2014).

The Forest Protection Committees actively participated in the management of the woods. With the assistance of the nearby local people, the land was started to be conserved and turned into a picnic park and nature resort. Endeavour had a generally good effect on the area in question regarding the risks associated with soil erosion and the value of afforestation and soil/moisture conservation for the socioeconomic advancement of the local populace. In January 2007, the forest was officially designated as an ecotourism park, complete with a lookout tower, picnic areas, and watercraft amenities for guests (Mallick and Chakraborty 2018).

Insect-pollinated floral species

The study documented the dominant floral species in Gurguripal forest that rely on insect pollinators for reproduction (Table 1). Insects such as bees and beetles are crucial for transferring pollen between the flowers of these trees, which facilitates fertilization and seed production. This interaction is key to the natural propagation of floral diversity in their native habitats.

Table 1: Floral Species at Gurguripal Pollinated by Insect Pollinator

Scientific name	Family name	Local name
Acacia auriculiformis	Fabaceae	Akashmoni
Acacia mangium	Fabaceae	Akashmoni – big leaf
Adenia codifolia	Zingiberaceae	Halud
Adina cordifolia	Rubiaceae	Karam
Aegle marmelos	Rutaceae	Bel

Anacardium occidentale	Anacardiaceae	Kaju tree
Asparagus racemosa	Liliaceae	Shatamuli
Butea purpurea	Fabaceae	Lata Palash
Cassia fistula	Fabaceae	Sondal
Cassia siemea	Fabaceae	Minjiri
Catotropis procera	Asclepiadaceae	Akanda
Dalbergia latifolia	Fabaceae	Sweti Sal
Dalbergia sissoo	Fabaceae	Sishoo
Delonix regia	Fabaceae	Krishnachura
Diaspyros melanoxylon	Ebenaceae	Kendu
Eucalyptus citridora	Myrtaceae	Eucalyptus
Eupatorium odoratum	Asteraceae	Asam Lata
Flacourtia indica	Salicaceae	Boinchi
Gardenia guminifera	Rubiaceae	Vurru
Gmelina arborea	Lamiaceae	Gamar
Holarrhena antidysenterica	Apocynaceae	Kudchi
Ipomea biloba	Convolvulaceae	Chhagal khuri
Lannea grandis	Anacardiaceae	Jeol
Madhuca latifolia	Sapotaceae	Mahua
Melia azadirach	Meliaceae	Thora Neem
Pongamia piñata	Fabaceae	Karanj
Schleichera oleosa	Sapindaceae	Kusum
Shorea robusta	Dipterocarpaceae	Sal tree
Soymida febrifuga	Meliaceae	Rahara
Syzygium cumini	Myrtaceae	Jam
Terminalia arjuna	Combretaceae	Arjun
Terminalia chebula	Combretaceae	Haritaki
Terminalia tomentosa	Combretaceae	Asan
Ziziphus minima	Rhamnaceae	Kul

Conclusion

The Gurguripal Forest has demonstrated remarkable ecological recovery, underscoring the resilience of forest ecosystems when subject to informed management practices. The forest, once degraded due to deforestation and overgrazing, has been gradually restored through effective watershed management techniques, afforestation efforts, and the active involvement of local communities. This restoration has not only revived the forest's ecological functions but also enhanced its biodiversity, particularly through the flourishing of insect-pollinated flora, which play a critical role in maintaining and enhancing the forest's plant diversity.

Entomophilic flora contributed significantly to the ecosystem functioning and biodiversity maintenance of Gurguripal forest. The presence of various dominant families, such as *Fabaceae, Asteraceae*, and *Dipterocarpaceae* highlights the ecological richness of this forest. Simpson's Index, which was calculated based on the relative abundance of species, yielded a diversity value of **0.92**, indicating high species

richness and a relatively balanced community. Shannon's Index, which measures species diversity by taking into account both abundance and evenness of species, returned a value of **2.206**, further emphasizing the forest's rich diversity. These indices provided quantitative measures of biodiversity, reinforcing the importance of insect-pollinated species in maintaining the forest's ecological balance.

The role of insect pollinators is inevitable for the reproductive success of many dominant floral species, reinforcing the interdependence within the ecosystem. Moreover, entomophilic plants played a significant role in stabilizing terrestrial ecosystems through the provision of ecosystem services such as pollination, seed dispersal and soil stabilization. The genetic diversity facilitated by insect-mediated pollination enhances the resilience of plant populations to environmental stressors and promotes evolutionary innovation. Moving forward, the Gurguripal Forest offers a model for the successful integration of ecological restoration with community development, demonstrating the profound potential of forest ecosystems to recover when managed thoughtfully and with respect for their natural processes.

Ultimately, the Gurguripal Forest not only supports an exuberant array of insect-pollinated flora but also highlights the broader importance of biodiversity conservation in forest ecosystems. The intricate relationships between flora and their pollinators in this forest offer valuable insights into the symbiotic links that sustain natural ecosystems, making the continued protection and study of this area critical for both local communities and broader ecological health.

In conclusion, exuberant entomophilic flora exemplified the dynamic relationships between plants and insect pollinators. Their diverse adaptations and ecological significance underscore the importance of conserving these mutualistic interactions in the face of escalating environmental pressures.

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