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THE ROLE OF AVIAN COMMUNITIES IN THE REGENERATION AND CONSERVATION OF NON-TIMBER FOREST PRODUCT SPECIES IN THE FORESTS OF CHHATTISGARH

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ABSTRACT

The tropical deciduous forests of Chhattisgarh constitute an important reservoir of Non-Timber Forest Products (NTFP). Given the economic significance of these resources and the dependence of forest-dwelling tribes on them, ensuring tree regeneration in this ecoregion is a crucial policy concern. This article focuses on the role of the native avifauna communities in facilitating forest regeneration in Chhattisgarh. Classified into functional guilds based on their roles, birds shape the spatial organization of commercial tree species and aid their recruitment and establishment by altering genetic structure among fragmented populations. Physiologically, birds facilitate germination by removing inhibitory seed pulp and exerting mechanical pressure on the endocarp during digestion, shortening the time required for dormancy release. Additionally, certain avian species create 'nucleation sites' of regeneration, reversing the degradation of forest edges, while generalist species exert density-dependent effects on host tree populations and lower competitive exclusion. This article reviews the contribution of such avian-mediated mechanisms to the regeneration of commercially important NTFP species in the state forests of Chhattisgarh.

Keywords: Non-Timber Forest Products (NTFPS), Endozoochory, Chhattisgarh, Functional Guilds, Avifauna

INTRODUCTION

The forests of Chhattisgarh are ecologically and economically important. Not only does the state host exceptionally high levels of biodiversity, they also possesses a large number of endemic species. Despite this natural gift, Chhattisgarh's forest cover is threatened by anthropogenic activities and climate change, leading to altered forest dynamics. For forest-reliant tribal communities, forests are a source of livelihood, providing crucial products such as food, shelter, and medicine, as well as economic benefits Jha et al. (2018). The value of forests is particularly evident in Chhattisgarh, home to one of the richest reservoirs of Non-Timber Forest Products (NTFP) in India. The NTFP sector is deeply integrated with the livelihoods of local tribal populations, as a large proportion of their income comes from products such as Tendu leaves, Mahua flowers, Chironji fruits, and Harra fruits Chhattisgarh State Minor Forest Produce Co-Operative Federation. (2025). For these communities, the economic viability of the NTFP collection depends on the recruitment and subsequent establishment of these commercial tree species. Understanding the mechanisms that maintain forest recruitment and regeneration, particularly those that are biologically controlled, is crucial to ensuring the sustainability of both the forest resources and the dependent tribal populations.

The recruitment and regeneration of tree species depend on intricate relationships among the plant and animal species that constitute the forest ecosystem. In the forests of Chhattisgarh, several bird species serve as key ecosystem engineers. Frugivorous,

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omnivorous, and granivorous birds play an important role in maintaining forest structure and promoting regeneration processes by distributing propagules of commercially important tree species Kullu et al. (2021). The birds interact with plant species in multiple ways, such as creating favorable microsites for germination, shortening seed dormancy, and eliminating density-dependent mortality. Additionally, birds influence the genetic structure of host tree populations by interacting with their seed dispersal kernels and altering the spatial distribution of seeds across the landscape. This study, therefore, reviews the contributions of avian species to forest resource regeneration, with a particular focus on the recruitment and establishment of economically important tree species.

FUNCTIONAL GUILDS AND SPATIAL DISPERSAL PATTERNS

The ecological organization of Chhattisgarh's tropical deciduous forests is derived from the distribution patterns of native bird species that can be grouped into guilds based on their functional roles. These avian groups differ in body size and foraging behavior, occupying different forest stories and serving as important determinants of the distribution and genetic diversity of economically valuable NTFP species. This information can be used to prioritize conservation efforts based on the specific roles these bird species play in the forest ecosystem.

Table 1

Table 1 Structured Avian-NTFP Interaction Matrix

Avian Vector (Scientific & Common Name)	Functional Guild / Feeding Style	Targeted NTFP Flora Dispersed	Estimated Dispersal Distance	Primary Forest Strata Occupied
Anthracoceros coronatus (Malabar Pied Hornbill)	Large Canopy Frugivore	Diospyros melanoxylon (Tendu), Ficus benghalensis (Banyan), Schleichera oleosa (Kusum)	Long-range (1.5 – 5.0 km)	Upper Canopy & Emergent Layer
Gracula religiosa (Common Hill Myna - State Bird)	Arboreal Frugivore / Omnivore	Madhuca longifolia (Mahua), Syzygium cumini (Jamun), Lannea coromandelica (Gunj)	Mid-range (500 – 1,500 m)	Upper to Mid-Canopy
Psilopogon zeylanicus (Brown-headed Barbet)	Specialized Frugivore	Ficus racemosa (Gular), Cordia dichotoma (Lasora), Ziziphus mauritiana (Ber)	Short-range (100 – 500 m)	Mid-Canopy
Pycnonotus cafer (Red-vented Bulbul)	Generalist Frugivore / Insectivore	Buchanania lanzan (Chironji), Ziziphus oenoplia (Makoi), Carissa carandas (Karonda)	Localized (50 – 300 m)	Understory to Mid-Canopy
Psittacula eupatria (Alexandrine Parakeet)	Granivore / Destructive Disperser	Tamarindus indica (Imli), Terminalia chebula (Harra), Aegle marmelos (Bel)	Mid-range (200 – 1,000 m)	Upper Canopy
Treron phoenicopterus (Yellow-footed Green Pigeon)	Nomadic Canopy Frugivore	Ficus religiosa (Peepal), Madhuca longifolia (Mahua), Mangifera indica (Wild Mango)	Extensive (2.0 – 8.0 km)	Upper Canopy
Dicrurus macrocercus (Black Drongo)	Insectivore / Accidental Vector	Emblica officinalis (Aonla), Diospyros melanoxylon (Tendu)	Localized (50 – 200 m)	Mid-Canopy to Open Edges
Eudynamys scolopaceus (Asian Koel)	Canopy Frugivore	Santalum album (Chandan), Syzygium cumini (Jamun), Ficus spp.	Mid-to-Long range (800 – 2,500 m)	Mid to Upper Canopy

CANOPY SPECIALISTS AND LONG-RANGE DISPERSAL

The forest canopy specialists of Bastar and Surguja play a critical role in maintaining tree species diversity in the region's upper story through their effective long-range seed dispersal capability. Large canopy dwelling frugivores such as the Malabar pied hornbill (Anthracoceros coronatus) are among the few animal species capable of consuming and subsequently propagating the large-seeded Diospyros melanoxylon (Tendu) and Schleichera oleosa (Kusum). Due to the long retention time of these seeds, hornbills, which engage in extensive foraging flights, pass them through the digestive system and travel an average distance of 1.5–5.0 km before discarding them. This not only facilitates an emergent insurance policy against density-dependent seed mortality caused by a conclave of hyper-specialized pathogens and seed predators that gather in large numbers beneath mother trees, but also enables unprecedented levels of genetic exchange between disparate tree populations.

MID CANOPY GENERALISTS AND SEASONAL CONGREGATIONS

While the canopy specialists take center stage in the ecological theatre of the forest overstorey, the mid- and lower-canopy layers belong to the realm of generalist frugivores. These opportunistic feeders display remarkable behavioral flexibility in exploiting temporal variations in fruit abundance by synchronizing their nomadic movements with the annual fruiting cycles of the region's NTFP (Non-Timber Forest Product) flora. During the summer, the Common Hill Myna (Gracula religiosa) and the Yellow-footed Green Pigeon (Treron phoenicopterus) congregate in great numbers around the mast seeding events of the Madhuca longifolia (Mahua) and Syzygium cumini (Jamun) – two keystone tree species of the region. T. phoenicopterus in particular, with its extraordinary nomadism and incredible home range of 8.0 km, acts as an effective long-range seed disseminator by virtue of its nomadic movements. By depositing intact seeds during its foraging flights or even while roosting, this pigeon serves to connect distant patches of forest, providing much-needed demographic and genetic connectivity to isolated tree populations.

UNDERSTORY NUCLEATION AND LOCAL RECRUITMENT

While the canopy and under-canopy layers are dominated by generalist feeders, smaller generalists and a few highly adapted specialists occupy the mid-story and undergrowth. The Red-vented Bulbul (Pycnonotus cafer) and the Brown-headed Barbet (Psilopogon zeylanicus) are typical understorey frugivores that exhibit remarkable behavioral plasticity in their foraging ecology. Typically feeding on a diverse range of small-seeded NTFP such as Buchanania lanzan (Chironji) and Ziziphus mauritiana (Ber), these avian gardeners employ a unique microhabitat nucleation strategy to facilitate local recruitment of desired plant species. By feeding on the fruits and subsequently defecating the seeds below large bushes or even old trees that provide favorable microhabitats, these bulbul and barbet create small clusters or 'islands' of target vegetation. This not only aids the rapid restoration of degraded forests but also enables the reversion of heavily depleted tribal collection areas to natural forests with remarkable speed.

The three-dimensional structural complexity of the tropical forests of Chhattisgarh is governed by interactions between native birds and the propagules of woody plant species. The avian species can be classified into functional guilds based on their roles in seed dispersal and the spatial scales at which they operate. Differences in bill morphology, diet, and foraging behavior enable bird species to interact with seeds of varying sizes, thereby influencing the distribution of individual tree species. For instance, the large-bodied canopy specialists such as the Malabar pied hornbill exhibit large gapes that allow it to consume and thus disseminate the large-seeded species such as Diospyros melanoxylon and Schleichera oleosa across great distances of up to one to five kilometers Kullu et al. (2021). By traveling long distances to carry seeds and drop them at their destination, these birds influence the genetic diversity of the receiving populations by introducing sexually compatible seeds from distant, related populations. At the same time, small-bodied, highly motile generalist species such as the Yellow-footed green pigeon and Common hill myna utilize the fruiting cycles of various tree species to maintain year-round seed dispersal Sahu and Marcot (2023). The dispersal of economically important species such as Madhuca longifolia and Syzygium cumini is facilitated at a larger scale during the summer season when these passerine species travel several kilometers in search of fruiting trees.

The birds foraging in the mid- and lower-canopy strata play a significant role in facilitating local recruitment and regeneration of economically important tree species. By feeding on the fleshy fruits of desired species such as Buchanania lanzan and Ziziphus mauritiana , small insectivorous and granivorous birds such as the Red-vented bulbul and Brown-headed barbet create localized clusters of potential recruits within a fifty to five-hundred-meter radius of their perching sites Pande et al. (2020). Because they prefer to perch on prominent objects such as outcrops and isolated trees, these birds create dense clusters of seeds beneath them. This behavior creates localized patches of potential recruits that eventually develop into favorable microsites for establishing forest cover. Other passerine species, such as the Alexandrine parakeet andBlack drongo, facilitate local forest recruitment by dropping the fruits of desired species while on the wing or by preying on tree-damaging insects such as mealy bugs Verma and Singh (2019). Collectively, the avian species influence the recruitment and regeneration of woody plant species by distributing and concentrating their propagules across suitable habitat patches.

ECOLOGICAL MECHANISMS OF REGENERATION

The germination of economically important tree species is often hindered by inhibitory substances and tough endocarps, which prevent successful seedling emergence. Endozoochorous seed dispersal by birds facilitates germination of these species by removing these barriers through physiological and mechanical means. As the fruit travels through the digestive tract of the avian species, mechanical breakdown of the endocarp occurs due to peristaltic movements of the gut against ingested grit Sahu and Marcot (2023). Additionally, highly acidic digestive juices break down the hydrophobic coating that often prevents water absorption in seeds Sahu and Marcot (2023). Furthermore, digestion removes the fleshy and nutritive seed pulp that provides a conducive environment for parasitic molds to thrive. Compared with seeds deposited directly beneath the parent tree, the removal of toxic pulp by birds increases germination success in species such as Madhuca longifolia and Syzygium cumini while shortening the period of dormancy Kullu et al. (2021). These physiological changes to the seed greatly enhance the likelihood of successful establishment of new recruits.

Figure 1

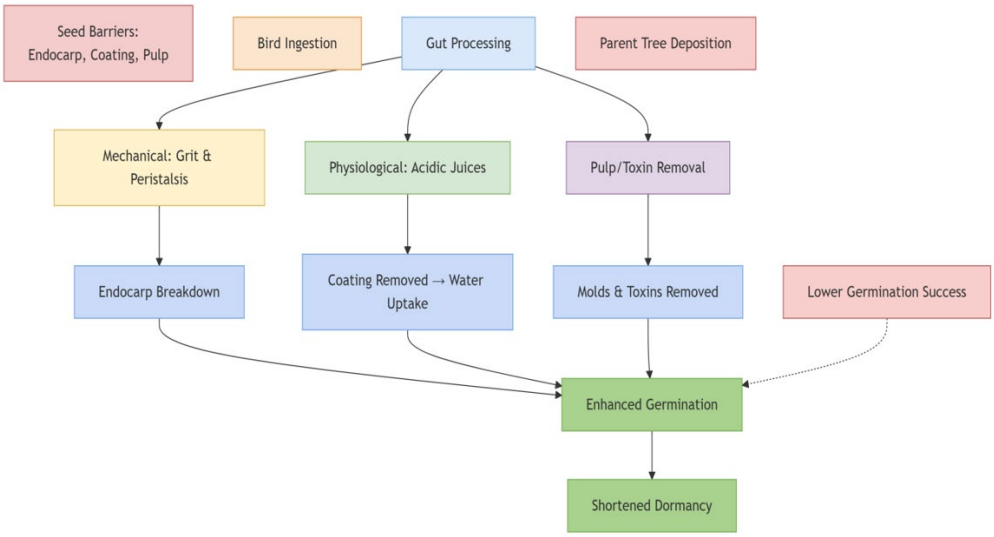

Figure 1 Endozoochorous Seed Dispersal by Birds: Physiological and Mechanical Mechanisms that Overcome Dormancy Barriers

This diagram shows a chain of events initiated by bird digestion that leads to the breakdown of barriers to the germination of recalcitrant seeds. Mechanical breakdown by grit, acidification of hydrophobic coatings, and removal of pulp all contribute to the ablation of physical and physiological barriers to seedling emergence. Compared with seeds that fall to the ground near the parent tree, bird-dispersed seeds had higher germination rates and shorter dormancy periods, thereby facilitating the recruitment of economically important species, including Madhuca longifolia and Syzygium cumini.

MICROHABITAT NUCLEATION AND SPATIAL CLUSTERING

The spatial distribution of birds facilitates the recruitment of woody plant species by creating nucleation sites through the activity of small passerine birds. Most small granivorous and insectivorous birds prefer to perch on prominent objects in order to avoid predation by larger avian species. While perched on these favored perches, these birds drop numerous seeds below them, creating dense concentrations of potential recruits beneath prominent objects such as outcrops and isolated trees Pande et al. (2020). For instance, species such as Buchanania lanzan and Ziziphus mauritiana often utilize these microsites created by the Red-vented bulbul to establish dense stands of young trees. These microsites differ from the surrounding landscape by having greater surface moisture and nutrient availability, owing to the accumulation of organic matter and nitrogen-rich waste beneath the perches Pande et al. (2020). As a result, these favorable microsites initiate canopy formation and forest recovery. The collective establishment of these patches facilitates natural regeneration of the forest and restoration of degraded forest edges.

SUPPRESSION OF DENSITY-DEPENDENT MORTALITY

The natural recruitment of many woody plant species is severely impeded by the Janzen-Connell hypothesis. According to this hypothesis, the mortality of recruits is highest near the parent tree owing to the buildup of density-dependent pathogens and insect herbivores. For instance, the accumulation of fallen fruits of Diospyros melanoxylon and Terminalia chebula beneath the canopy of the parent tendu and harra trees leads to increased incidence of insect pests and fungal infections Jha et al. (2018). Furthermore, dense seedbeds attract seed-eating rodents and insects, leading to intense competition among recruits for belowground resources such as moisture and nutrients Jha et al. (2018). However, density-dependent mortality can be prevented by avian-mediated long-distance seed dispersal. By feeding on the fruits of these species and flying long distances before dropping the fruit, the canopy-dwelling Malabar pied hornbill eliminates the risk of pest infestation and fungal infection that would have occurred if the seeds had fallen directly beneath the parent tree. Similarly, long-distance dispersal reduces competition by ensuring that the new recruits are established far from the parent tree and from other members of the same species.

AVIAN ROLES IN SUPPORTING TRIBAL COMMUNITIES

The economic well-being of tribal communities living in Chhattisgarh's forest region is closely linked to the ecological functions performed by the native birds. The livelihoods of these communities depend largely on the NTFP sector, as a substantial proportion

of their income comes from collecting products such as Tendu leaves and Mahua flowers Jha et al. (2018). Since the target tree species for these forest products depend on the avian species for propagule dispersal and germination, the income of these communities is intrinsically dependent on the health of the bird populations. Consequently, anthropogenic activities such as mining and forest fires that disturb forest canopies have adverse economic impacts on the forest-dwelling tribal populations by disrupting the delicate ecological relationships in the forest Verma and Singh (2019). To ensure the sustainability of these communities' livelihoods, it is important to conserve and protect Chhattisgarh's native avifauna.

To achieve this, the state government must formulate effective policies that promote coexistence between birds and forest resources to support sustainable local livelihoods. The policies could include promoting the natural recruitment of tree species by conserving fruiting canopy trees and facilitating the creation of migratory routes linking isolated forest patches. Moreover, the state government can promote community participation in the protection and management of forest resources, as demonstrated by the 'Myna Mitras' initiative of Kanger Valley National Park. Such community initiatives have the potential to raise awareness about the importance of bird conservation and reduce illegal mining and forest fires that threaten the bird populations. Additionally, integrating traditional ecological knowledge with scientific research will help develop effective frameworks for regulating forest use during breeding seasons, ensuring sustainable bird conservation and forest regeneration.

CONCLUSION

The forest cover and biodiversity of Chhattisgarh are deeply dependent on the native avifauna, which provide critical recycling and propagation services to the forest vegetation. Facilitating the recruitment and regeneration of economically important tree species, the avian species play diverse roles in the forests of Chhattisgarh. Categorized into functional guilds, birds influence the spatial distribution of propagules and facilitate the establishment of new recruits by creating favorable microsites and removing inhibitory seed pulp. Moreover, the long-distance dispersal by canopy dwellers such as the Malabar pied hornbill ensures low genetic overlap between recruits and parent trees, reducing the likelihood of density-dependent mortality. By regulating seedbed densities, birds reduce competition for belowground resources among recruits. This review highlights the varied contributions of avian species to the regeneration of forest resources of Chhattisgarh.

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