

TAXONOMIC DIVERSITY AND HABITAT PREFERENCES OF EARTHWORMS IN THE INDO-BURMA BIODIVERSITY HOTSPOT: A REVIEW AND QUANTITATIVE SYNTHESIS

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ABSTRACT

The Indo-Burma biodiversity hotspot is one of the most biologically diverse regions of the world and supports highly heterogeneous tropical and subtropical ecosystems. While its above-ground biodiversity has received considerable scientific attention, knowledge of below-ground fauna, particularly earthworms, remains fragmented. Earthworms are important ecosystem engineers that regulate organic matter decomposition, nutrient mineralization, soil aggregation, aeration, infiltration and microbial activity. The present study reviews and quantitatively synthesizes available information on the taxonomic diversity, biogeographical status and habitat preferences of earthworms in the Indian component of the Indo-Burma biodiversity hotspot, with particular emphasis on north-eastern India. Published inventories report 128 earthworm species/subspecies belonging to 26 genera and nine families, including 72 endemic, 18 near-endemic, five native peregrine and 32 exotic taxa. More recent ecological synthesis has documented approximately 125 species representing 28 genera and 10 families across north-eastern India, with recorded richness varying considerably among states and habitats. Forest ecosystems generally support greater species diversity and a higher representation of native taxa, whereas agricultural, plantation and anthropogenically disturbed habitats are frequently characterized by adaptable and peregrine species. In Assam, reported earthworm densities ranged from approximately 65 to 238 individuals m^{-2} and biomass from 1.1 to 5.4 g m^{-2} across different habitats.

*Comparative observations in Manipur recorded 12 species in natural mixed forest compared with only four in an oak plantation. Mixed forests across the region have reported Shannon diversity values of approximately 1.76–2.72, whereas highly disturbed municipal waste habitats may show values as low as 0.42. Recent discoveries of previously unknown *Eutyphoeus*, *Metaphire*, *Perionyx* and *Drawida* species further demonstrate that the region's earthworm diversity remains inadequately explored. Soil moisture, organic carbon, pH, temperature, litter quality, vegetation heterogeneity, elevation and land-use intensity emerge as important determinants of earthworm distribution. The findings highlight the importance of integrating morphological taxonomy, DNA barcoding, ecological monitoring and habitat conservation to protect soil biodiversity in the Indo-Burma hotspot.*

Keywords: Earthworms¹; Indo-Burma biodiversity hotspot²; soil biodiversity³; habitat preference; earthworm taxonomy; north-eastern India; endemic species; land-use change; ecosystem engineers

1. INTRODUCTION

Biodiversity conservation has traditionally concentrated on visible components of ecosystems such as plants, mammals, birds, reptiles and amphibians. However, a substantial proportion of terrestrial biodiversity occurs below ground. Soil organisms regulate numerous ecological processes that ultimately determine ecosystem productivity, resilience and nutrient availability[1]. Among the most ecologically influential components of soil macrofauna are earthworms. Earthworms are widely described as ecosystem engineers because their activities physically and chemically modify the soil environment. Through burrowing, feeding, casting and incorporation of plant residues into mineral soil, earthworms influence soil structure, porosity, water movement, nutrient availability and microbial processes (Lavelle, 1988; Edwards & Bohlen, 1996; Brown et al., 2000). The Indo-Burma biodiversity hotspot provides a particularly important geographical setting for the study of earthworm diversity. Tropical and subtropical forests, montane ecosystems, grasslands, wetlands, plantations, agricultural fields and rapidly expanding human settlements occur within a relatively compact but environmentally heterogeneous landscape[2]. North-eastern India is especially significant from an earthworm biogeographical perspective. A comprehensive checklist documented 128 species and subspecies belonging to 26 genera and nine families from the region. Among these, 72 were considered endemic, 18 near-endemic, five native peregrine and 32 exotic.

This degree of endemism indicates that the region represents not merely an area of high numerical diversity but also an important evolutionary reservoir of geographically restricted lineages. Despite this importance, knowledge remains uneven. Some habitats and localities have been comparatively well studied, while remote forest and mountainous landscapes have received little systematic sampling[3]. A recent regional review noted that information on earthworm biodiversity in north-eastern India remains fragmented despite the recording of approximately 125 species belonging to 28 genera and 10 families. Earthworms are also highly responsive to environmental variation. Soil moisture, temperature, organic matter, vegetation, soil texture, pH and land-use practices can influence their abundance and community structure. Different ecological groups respond differently to these variables, resulting in marked habitat-specific assemblages[4]. The present paper therefore synthesizes the available taxonomic and ecological evidence concerning earthworms of the Indo-Burma

biodiversity hotspot, particularly its Indian component, and evaluates relationships between diversity, habitat characteristics and anthropogenic disturbance[5].

2. OBJECTIVES OF THE STUDY

The study has the following objectives:

1. To examine the reported taxonomic diversity of earthworms in the Indo-Burma biodiversity hotspot, particularly north-eastern India.
2. To analyse the representation of endemic, near-endemic, native peregrine and exotic earthworm taxa.
3. To identify the major habitats occupied by earthworm communities.
4. To examine quantitative differences in earthworm richness, abundance, biomass and diversity among habitats.
5. To identify environmental factors governing earthworm distribution.
6. To evaluate the influence of forest conversion, agricultural activities and other anthropogenic disturbances.
7. To examine recent taxonomic discoveries and identify gaps requiring further investigation.
8. To assess the potential value of earthworms as indicators of ecosystem and soil health.

3. METHODOLOGY

3.1 Research Design

The study follows a review and quantitative synthesis approach. Published taxonomic inventories, habitat-based ecological studies, molecular-taxonomic investigations and regional reviews dealing with earthworms of north-eastern India and the wider Indo-Burma biogeographical region were examined[6]. Particular emphasis was placed on studies reporting:

- Species richness;
- Genera and family-level diversity;
- Endemism;
- Population density;
- Biomass;
- Shannon diversity;
- Habitat associations;
- Soil characteristics; and

- Occurrence of native and exotic species.

No primary field observations have been attributed to the present study. All numerical information represents previously published data and is identified accordingly[7].

3.2 Data Interpretation

Data obtained from different publications were compared to identify broad patterns rather than combined statistically where sampling methods differed. The following variables were considered particularly useful:

- Number of species;
- Population density in individuals m^{-2} ;
- Earthworm biomass in $g\ m^{-2}$;
- Shannon diversity index;
- Habitat type;
- Biogeographical status; and
- Dominance of particular taxa.

This approach allows ecological interpretation while avoiding inappropriate direct comparison among datasets generated through different sampling protocols.

4. EARTHWORMS AS ECOSYSTEM ENGINEERS

Earthworms affect soil through three principal mechanisms: ingestion, casting and burrowing. During feeding, soil and organic residues pass through the earthworm digestive system[8]. The resulting casts differ physically and chemically from surrounding soil and may contain relatively available plant nutrients and biologically active microbial populations.

Burrowing creates channels that can:

- Enhance soil aeration;
- Improve water infiltration;
- Influence root penetration;
- Redistribute organic matter;
- Decrease or modify soil compaction; and
- Connect different soil horizons.

Earthworms may consequently influence the functioning of entire terrestrial ecosystems rather than merely occupying soil as passive organisms.

The ecological effects of earthworms vary among functional groups and species. Community composition may therefore be more informative than total abundance alone[9].

5. ECOLOGICAL CLASSIFICATION OF EARTHWORMS

Earthworms are commonly divided into three broad ecological categories.

5.1 Epigeic Species

Epigeic earthworms occupy leaf litter and organic material near the soil surface. They are usually relatively small and active and depend substantially on decomposing plant residues[10]. Examples of ecological environments favourable to epigeic species include:

- Forest litter;
- Compost;
- Animal dung;
- Organic waste deposits; and
- Manure-rich agricultural systems.

5.2 Endogeic Species

Endogeic earthworms occupy mineral soil and produce predominantly horizontal burrow systems. They consume considerable quantities of mineral soil mixed with decomposed organic material[11]. They are especially important in:

- Soil aggregation;
- Nutrient redistribution;
- Development of soil structure; and
- Transformation of soil organic matter.

5.3 Anecic Species

Anecic earthworms generally construct deeper, relatively permanent burrows and frequently transport surface litter into deeper soil layers[12]. These functional classifications help explain why changes in vegetation, litter and soil structure may disproportionately affect certain components of an earthworm community.

6. TAXONOMIC DIVERSITY IN NORTH-EASTERN INDIA

One of the strongest indications of the biological importance of the region comes from the comprehensive checklist prepared by Tiwari and colleagues [13]. A total of 128 species/subspecies belonging to 26 genera and

nine families were documented. Their biogeographical categorization included 72 endemic taxa, 18 near-endemic taxa, five native peregrines and 32 exotic taxa.

Table 1: Biogeographical Composition of Earthworm Fauna Reported from North-Eastern India

Biogeographical category	Number of taxa	Approximate percentage*
Endemic	72	56.7
Near-endemic	18	14.2
Native peregrine	5	3.9
Exotic	32	25.2
Total represented in categories	127	100

Percentage is calculated from the 127 taxa assigned to the four reported biogeographical categories; the checklist reports an overall total of 128 species/subspecies. The one-unit difference reflects the original categorization rather than a recalculation of the published checklist[14]. The most striking feature of the dataset is the dominance of endemic and near-endemic fauna. Together they account for approximately 71% of categorized taxa. This has important conservation implications. Loss of a geographically restricted species cannot necessarily be compensated for through populations elsewhere, unlike widespread peregrine species[15].

7. REGIONAL VARIATION IN RECORDED DIVERSITY

A more recent synthesis of ecological studies identified approximately 125 species belonging to 28 genera and 10 families in north-eastern India[16]. The review reported considerable geographical variation, including particularly high recorded richness in Meghalaya and comparatively low recorded richness in Nagaland. Such differences, however, should not automatically be interpreted as true biological gradients. Recorded diversity may be affected by:

1. Intensity of sampling;
2. Accessibility of study locations;
3. Number of taxonomic specialists working in the region;
4. Extent of habitat heterogeneity;
5. Historical collecting effort; and
6. Availability of molecular identification.

Consequently, states or localities with comparatively few recorded species may actually represent survey gaps rather than biologically species-poor regions[17].

8. EARTHWORMS AS INDICATORS OF SOIL HEALTH

Earthworms have considerable potential as biological indicators because they:

1. Are Directly exposed to soil conditions;
2. Respond to management changes;

3. Integrate physical, chemical and biological soil characteristics;
4. Are Relatively easy to sample;
5. Occupy different ecological niches; and
6. Are Functionally important.

However, Total Abundance Alone Is Insufficient. A meaningful indicator system should incorporate:

- Species richness;
- Population density;
- Biomass;
- Shannon diversity;
- Functional groups;
- Native/exotic ratio;
- Abundance of habitat specialists; and
- Soil physicochemical properties.

A diverse natural-forest community should not be rated as inferior merely because an organically enriched agricultural site contains greater total numbers of earthworms[18].

9. CONCLUSION

The Indo-Burma biodiversity hotspot supports an exceptionally important and incompletely documented earthworm fauna[19]. Evidence from north-eastern India alone includes approximately 128 species and subspecies belonging to 26 genera and nine families, with endemic taxa forming the largest biogeographical component. Habitat type plays a major role in determining earthworm community structure[20]. Natural mixed forests generally support greater species richness and diversity, whereas plantations, agricultural systems and highly disturbed environments often contain communities dominated by adaptable or peregrine species. Quantitative evidence makes this ecological contrast particularly clear[21]. Natural mixed forest in Manipur supported 12 recorded species compared with four in an oak plantation. Mixed forest Shannon diversity values reached approximately 1.76–2.72, whereas a municipal waste deposition habitat recorded a value of only 0.42. At the same time, agricultural habitat in Assam supported densities reaching 238 individuals m⁻², illustrating that numerical abundance and biodiversity are not synonymous[23].

Recent descriptions of new *Eutyphoeus*, *Metaphire*, *Perionyx* and *Drawida* species demonstrate that a substantial proportion of the regional earthworm fauna may remain undiscovered. This is especially important because rapid habitat transformation could result in the loss of localized taxa before their taxonomic identity and ecological functions are understood[24]. Future earthworm research in the Indo-Burma hotspot should therefore combine classical taxonomy, DNA barcoding, standardized ecological sampling, soil physicochemical analysis

and spatial modelling. Conservation strategies should likewise recognize below-ground organisms as integral components of biodiversity rather than focusing exclusively on visible flora and fauna. Earthworms perform fundamental roles in decomposition, nutrient transformation, soil aggregation and hydrological regulation. Protecting their diversity is therefore not simply an exercise in taxonomic conservation; it contributes directly to maintaining the ecological functioning and resilience of the Indo-Burma biodiversity hotspot.

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