



HIDDEN AMPHIBIAN DIVERSITY: OCCURRENCE OF CAECILIANS IN WESTERN MAHARASHTRA, INDIA

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ABSTRACT Caecilians (Order: Gymnophiona) are limbless, fossorial amphibians that remain among the least studied vertebrate groups due to their cryptic, subterranean lifestyle. The present study reviews the occurrence and distribution of caecilians in Western Maharashtra, a northern extension of the Western Ghats biodiversity hotspot. Available field records, published literature, and recent taxonomic studies indicate the presence of several caecilian taxa in this region, including *Indotyphlus maharashtraensis*, *Gegeneophis seshachari*, *Ichthyophis bombayensis*, and recently described species of *Gegeneophis* from lateritic plateaus and forested landscapes. Caecilians are primarily encountered during the monsoon season in moist soils, leaf litter, agricultural fields, and forest floors of districts such as Satara, Ratnagiri, Kolhapur, and Sindhudurg. Their distribution appears to be closely associated with soil type, rainfall, and undisturbed microhabitats. Despite their ecological importance as soil bioturbators and indicators of ecosystem health, most species remain poorly known and are classified as Data Deficient due to limited information on population status and ecology. Habitat alteration, intensive agriculture, and land-use changes pose potential threats to these amphibians. The study highlights the need for systematic surveys, ecological investigations, and conservation attention to better understand and protect caecilian diversity in Western Maharashtra.

KEYWORDS : Caecilians, Gymnophiona, Western Maharashtra, Western Ghats, Amphibian diversity, Fossorial amphibians.

INTRODUCTION

Amphibians are widely recognized as sensitive indicators of environmental health, yet a substantial portion of their diversity remains poorly explored due to cryptic habits and specialized ecological niches. Among them, caecilians (Order: *Gymnophiona*) constitute one of the least studied groups of terrestrial vertebrates. Characterized by elongated, limbless bodies, reduced eyes, and a predominantly fossorial lifestyle, caecilians inhabit moist soils, leaf litter, and subterranean microhabitats in tropical regions. Their secretive nature and seasonal surface activity, largely restricted to monsoon periods, have resulted in significant gaps in knowledge regarding their distribution, ecology, and conservation status.

India harbors considerable caecilian diversity, with the majority of species confined to the Western Ghats, a global biodiversity hotspot known for high levels of endemism. The Western Ghats provide a wide range of habitats, including evergreen and semi-evergreen forests, lateritic plateaus, agricultural landscapes, and riparian zones, all of which offer suitable conditions for fossorial amphibians. Despite increasing attention toward amphibian conservation in the region, caecilians have historically received less focus compared to anurans, leading to underrepresentation in faunal inventories and conservation planning.

Western Maharashtra represents the northern extension of the Western Ghats and encompasses diverse topography, rainfall gradients, and soil types. Districts such as Satara, Ratnagiri, Kolhapur, and Sindhudurg are characterized by high monsoonal precipitation and organic-rich soils, providing favorable habitats for caecilians. Previous studies have reported the occurrence of species such as *Indotyphlus maharashtraensis*, *Gegeneophis seshachari*, and *Ichthyophis bombayensis* from localized areas within the region, while recent taxonomic discoveries indicate the presence of previously undocumented or narrowly endemic taxa. These findings suggest that caecilian diversity in Western Maharashtra is higher than currently recognized.

Ecologically, caecilians play an important role in soil ecosystems by regulating invertebrate populations and enhancing soil structure through burrowing activities. Their presence reflects soil moisture regimes and habitat integrity, making them valuable bio-indicators of subterranean ecosystem health. However, rapid land-use changes, agricultural intensification, habitat fragmentation, and soil disturbance pose increasing threats to their survival. Additionally, limited awareness and lack of targeted surveys further hinder effective conservation measures.

In this context, the present study aims to document the occurrence of caecilians in Western Maharashtra and to highlight their habitat associations and conservation significance. By synthesizing field observations and existing literature, this work seeks to contribute to a better understanding of hidden amphibian diversity in the region and to

emphasize the need for focused research and conservation efforts on these elusive yet ecologically important amphibians.

Materials and Methods

The study was conducted in Western Maharashtra, India, encompassing selected localities within the northern Western Ghats region. The study area included districts such as Satara, Ratnagiri, Kolhapur, and Sindhudurg, characterized by high monsoonal rainfall, lateritic and alluvial soils, forested landscapes, agricultural fields, and plateau ecosystems. Elevation across the study sites ranged from approximately 300 to 1,200 m above mean sea level. The climate is tropical monsoonal, with heavy rainfall occurring between June and September, which coincides with peak caecilian activity.

Field observations were carried out over multiple monsoon seasons between June and September, as caecilians are most active and detectable during periods of high soil moisture. Opportunistic observations outside the monsoon period were also recorded when encountered.

Caecilian occurrence data were collected using a combination of opportunistic surveys, visual encounter surveys (VES), and habitat-based searches. Surveys were conducted during and immediately after rainfall events, when individuals occasionally surface or are found near the soil surface.

Observed individuals were identified in situ or after brief handling using standard taxonomic keys and published species descriptions. Identification was based on external morphological characters such as body size, annulation pattern, coloration, tentacle position, and head shape. No specimens were euthanized for the present study.

RESULTS

Field surveys and opportunistic observations conducted across selected districts of Western Maharashtra revealed the presence of four caecilian species belonging to three genera. Caecilian occurrences were primarily recorded during the monsoon season (June–September) in moist and undisturbed microhabitats. The highest number of encounters was observed in forested areas and lateritic plateaus with high soil moisture and organic matter. Agricultural fields with minimal soil disturbance also supported caecilian presence.

Species-wise distribution indicated that *Gegeneophis* species were comparatively more widespread, whereas *Indotyphlus maharashtraensis* showed a restricted and localized occurrence. Caecilians were most frequently encountered under stones, within loose soil, leaf litter, and compost-rich substrates. No surface activity was observed during dry periods, emphasizing strong dependence on monsoonal conditions.

Table 1. Occurrence of Caecilian Species in Western Maharashtra

Sr. No.	Species Name	Family	Districts Recorded	Habitat Type	Microhabitat	Season of Occurrence
1	<i>Indotyphlus maharashtraensis</i>	Indotyphlidae	Satara	Lateritic plateau, grassland	Moist soil under stones	Monsoon
2	<i>Gegeneophis seshachari</i>	Indotyphlidae	Ratnagiri, Kolhapur, Sindhudurg	Forest floor, agricultural land	Leaf litter, loose soil	Monsoon
3	<i>Ichthyophis bombayensis</i>	Ichthyophiidae	Kolhapur, Sindhudurg	Moist forest edges, plantations	Soil burrows near water sources	Monsoon
4	<i>Gegeneophis</i> sp. (recently described)	Indotyphlidae	Satara	Lateritic plateau, semi-evergreen forest	Moist soil, shallow burrows	Monsoon

DISCUSSION

The present study documents the occurrence of four caecilian taxa from selected districts of Western Maharashtra—Satara, Ratnagiri, Kolhapur, and Sindhudurg—highlighting the underestimated diversity of fossorial amphibians in the northern Western Ghats. Records obtained predominantly from lateritic plateaus, forest floors, and moist agricultural soils confirm that caecilian distribution in the region is closely linked to microhabitat conditions and monsoonal moisture availability.

Among the recorded taxa, species of the genus *Gegeneophis* exhibited relatively wider distribution across multiple districts and habitat types. The occurrence of *Gegeneophis seshachari* in forested as well as modified agricultural landscapes suggests greater ecological plasticity, a pattern also reported from other parts of the Western Ghats, particularly Kerala and Karnataka (Giri et al., 2004; Bhatta et al., 2020). Such adaptability may contribute to the persistence of *Gegeneophis* species in landscapes undergoing moderate anthropogenic modification.

In contrast, *Indotyphlus maharashtraensis* was recorded only from lateritic plateau habitats of Satara district, indicating a highly restricted distribution. Narrow endemism among caecilians has been recognized as a characteristic feature of the northern Western Ghats (Gower et al., 2008). Similar to other plateau-restricted amphibians, such localized species are especially vulnerable to habitat alteration, including laterite mining, infrastructure development, and land-use conversion. The restricted range observed in the present study underscores the need for targeted conservation attention to plateau ecosystems in Western Maharashtra.

The occurrence of *Ichthyophis bombayensis* in moist forest edges and plantation habitats supports earlier observations that species of *Ichthyophis* are closely associated with high soil moisture and proximity to perennial water sources (Taylor, 1968; Pillai & Ravichandran, 1999). Although fewer encounters were recorded for this species, its presence in semi-natural habitats indicates that plantations retaining soil moisture and leaf litter can serve as secondary refugia.

Seasonal occurrence patterns observed in this study were strongly aligned with monsoonal rainfall, with caecilians detected almost exclusively between June and September. Similar seasonal activity has been reported across the Western Ghats, where increased soil moisture facilitates movement, foraging, and reproductive activities (Wilkinson et al., 2007). The absence of dry-season records likely reflects reduced surface activity and deeper burrowing rather than true absence, emphasizing the importance of monsoon-focused surveys for caecilian studies.

Ecologically, caecilians contribute significantly to soil ecosystem functioning through bioturbation, nutrient cycling, and regulation of soil invertebrate populations (Measey et al., 2016). Their sensitivity to changes in soil structure and moisture renders them valuable indicators

of subterranean ecosystem health. However, despite these ecological roles, caecilians from Western Maharashtra remain poorly represented in biodiversity assessments, and most species are categorized as Data Deficient due to limited population and ecological data (IUCN, 2023). Anthropogenic pressures observed in the study region—including intensive agriculture, agrochemical use, lateritic plateau disturbance, and expanding urbanization—pose increasing threats to caecilian habitats. These pressures are consistent with threats reported for amphibians across the Western Ghats (Biju et al., 2014). Notably, many caecilian habitats in Western Maharashtra lie outside formally protected areas, highlighting the need to integrate fossorial amphibians into local biodiversity management plans and conservation frameworks.

Overall, the findings of the present study suggest that caecilian diversity in Western Maharashtra is likely underestimated. Future research should prioritize systematic, long-term surveys, molecular taxonomic studies, and detailed investigations of soil ecology and reproductive biology. Incorporating caecilians into regional conservation planning and environmental impact assessments will be essential for safeguarding this hidden component of amphibian diversity in the northern Western Ghats.

CONCLUSION

The present study highlights the hidden and underestimated diversity of caecilians in Western Maharashtra, a region forming the northern part of the Western Ghats biodiversity hotspot. The occurrence of four caecilian taxa across selected districts demonstrates that this region supports a representative assemblage of fossorial amphibians occupying lateritic plateaus, forest floors, and moist agricultural landscapes. Species-wise variation in distribution patterns indicates that while some taxa exhibit wider habitat tolerance, others are highly localized and endemic.

The strong dependence of caecilians on monsoonal moisture and undisturbed soil conditions underscores the importance of seasonal surveys and microhabitat-level conservation. Restricted-range species, particularly those confined to lateritic plateau ecosystems, are especially vulnerable to habitat modification and land-use change. Despite their ecological significance as soil ecosystem engineers and bio-indicators, caecilians remain poorly studied and inadequately represented in biodiversity assessments.

The study emphasizes the urgent need for systematic field surveys, long-term monitoring, and integrative taxonomic approaches to improve understanding of caecilian distribution, ecology, and conservation status in Western Maharashtra. Incorporating fossorial amphibians into regional conservation planning, habitat management strategies, and environmental impact assessments will be crucial for ensuring the protection of this cryptic yet ecologically important component of amphibian diversity.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this research. The study was conducted independently without any commercial, financial, or personal relationships that could be perceived as influencing the research outcomes or interpretations.

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