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Land snail diversity of India: Threats and conservation

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Abstract
Land snails are only six per cent of the molluscan species existing on the earth. They help in recycling nutrients and are the prey for higher taxa and carnivorous snails, a source of calcium for animals, an indicator of ecological conditions. About 35,000 species of land snails are documented in the world and only 1,487 species are known from Indian territory. Land snails are poorly studied in terms of their taxonomy and knowledge of their population biology, ecology and conservation status is scanty. In this paper we establish the importance of the diversity of land molluscs of India, their status in their respective habitats, reviewing their threats and conservation strategies.

Keywords: Molluscs, gastropods, anthropogenic pressures, management

Introduction

Land snails are important to forest ecosystems because of their functioning such as recycling nutrients, and prey for other animals including carnivorous snails (Sen *et al*., 2010). Besides, they are good sources of calcium for animals and are very sensitive to climatic and ecological change. Land snails are exclusively confined to class Gastropoda falling under two sub-classes namely, Prosobranchia and Pulmonata. Prosobranch snails possess an operculum which closes the shell aperture, whereas pulmonates lack an operculum (Ramakrishna and Mitra, 2002) [27]. More than 35,000 land snail species are known globally. They occur in varied habitats from tropical rainforests to deserted habitats and alpine forests at higher elevations (Raheem *et al*., 2009) [25]. Based on the shell size, land snails can be categorised into two types namely, macrogastropods and microgastropods. Macro-gastropods have shell diameter of >5mm. In India, micro-gastropods are known to represent 40% of the land snail diversity of the Western Ghats (Aravind *et al*., 2008).

Land Snail Diversity in India

Even though India has the Eastern Himalayas and Western Ghats as biodiversity hotspots, land snails are not studied comprehensively from these parts of India (Table 1). The oldest literature on land snails of the Western Ghats is by Blanford (1867) [8]. where the land snails from Peninsular India are described. Indian researchers like Annandale and Prashad (1919) [24], Rao (1925) and others have contributed to the records and memories of the Indian museum which is a large series of detailed systematic, anatomical papers on non-marine molluscs of Western Ghats. Most often snails remain unexplored because of their minute size or lack of information about them (Madhyastha *et al*., 2004) [16].

Information on land snails in north-eastern India is found in the Fauna of British India and reports of the Zoological Survey of India (Sen *et al*., 2012) [19]. In total, 12 species have been recorded from Assam (Kalita, 2022) [14]. Altogether 161 species of terrestrial molluscs are found in the western Himalayas. The land snail families, namely, Ariophantidae, Enidae, Planorbidae, and Lymnaeidae, contribute 45 per cent of the species known from the western Himalayas. About 70% of the land molluscs are endemic to the western Himalayan region (Ahmad *et al*., 2023).

Ramakrishna and Mitra (2002) [27] reported from 1487 land snail species from India and assigned to 140 genera and 32 families. They published a list of endemic land snails of India. Mitra and Dey (1990) recorded 23 species of land molluscs from Mizoram. Among these, 5 land snail species *viz. Plectopylis affnis, Girasla butri, Girasla radha, Staffordia daflensis* and *Chlorotis delibrata* are endemic to India and land snails such as *Macrochlamys petasus* and *Haploptychius burmanicus* were new records to India.

Satyamurthy (1960) gave an account of the land molluscs from the collection of the Madras government museum and recorded 11 new species of land snails from the Western Ghats. Land snails of Pune and neighbouring areas are studied (Tonapi, 1971; Subba Rao and Mitra, 1979). Later some studies have emerged on land snails of the Western Ghats (Aravind *et al*., 2005; Mavinkurve *et al*., 2005; Aravind *et al*., 2010) [2, 3, 18]. 309 species are confined to Western Ghats which includes 40% of microgastropods (Aravind *et al*., 2005) [2]. About 6 species of land snails have been reported to be present in the collections of Western Ghat Regional Centre, Kozhikode **(**Pati *et al*., 2014) [22].

Satpuda Mountains of central India are home to 11 species of land snails. Species richness of the family Ariophantidae has been observed and the need for conservation has been emphasized (Magare, 2015) [17]. Soundararajan *et al*., (2018) [29] studied the land snails from Tamil Nadu and reported 13 species (Table 2). But only basic information is known about their taxonomy and little is known of their population biology, ecology and their conservation status (Sen *et al*., 2012). In the last decade, studies in India explored snail faunas in state or protected areas but species description, phylogeny and taxonomic revision of different families or genera are yet to be known (Aravind *et al*., 2010) [3].

Table 1: Land snail inventories from India

Place	Year	Number of reported species of molluscs	Reference
India	2002	1487	Ramakrishna and Mitra,
	2005	337	Aravind *et al*.,

Western Ghats	1960	11	Satyamurthy
	2008	309	Aravind *et al*.,
Mizoram	1990	23	Mitra and Dey
Satpuda mountains	2015	11	Magare
Madhya Pradesh	2012	1	Patil
Khozikode	2012	6	Pati *et al*.,
Tamil Nadu	2018	13	Soundararajan *et al.,*

Karnataka harbours 79 species of terrestrial gastropods belonging to 33 genera of which 61 species are endemic to Western Ghats hill chains. About 77% of the relative endemism of the land snails has been observed in Karnataka. Among 22 families of terrestrial gastropods of Western Ghats, thirteen families are represented in Karnataka. The highest species diversity is found in the Kodagu district as the forests provide good habitats for these snails (Mavinkurve *et al.,* 2005) [18]. Of the 24 families of land snails reported from the Western Ghats, 11 families are known to be present in the Sharavathi Valley (Madhyastha and Mumbrekar, 2006) [15]. Jayashanker *et al*., (2011) identified 6 species of pestilential snails and slugs from Bangalore. This involves the discovery of marsh slug from Southern India.

Pilarkan sacred groove of Karnataka was found to have rich molluscan diversity. Mumbrekar and Madhyashta (2006) recorded 15 species of land snails belonging to five families, 11 genera from the Pilarkan sacred groove of Karnataka (Table 2). They classified 10 taxa up to the species level and five taxa to the generic level. The majority of them were macro-gastropods except a few micro-gastropods. Among 10 species, seven species are restricted to the Western Ghats and peninsular India. The abundance of members of the family Diplommantinidae was observed in this sacred groove but *Alycaues expatriatus* was less in number (Mumbrekar and Madhyastha, 2006) [15]. They reported *Theobaldius ravidus, Nicidia lirincta* as a new species to South Canara and *Euplecta cacuminifera, Microcystina* spp. to Karnataka. D'Souza and Shenoy (2024) [11] documented 20 species of land snails from coastal Karnataka and discussed the effect of physiochemical parameters on the land snails. Narasimhaiah *et al.,* (2014) [21] reported the presence of 10 species of land snails from Mangalore. They observed the presence of *Mariaella dussumeri, Filicaulis frauenfeldi* and *Succuinea baconi* in farms and on decaying plant materials. *Glessula* has been identified at the genus level and this is the most difficult taxa to be identified to species level.

Table 2: Inventories of land snails from Karnataka

Place	Year	Number of reported species	Reference
Karnataka	2004	79 (Terrestrial gastropods)	Mavinkurve *et al*.,
Udupi	2006	15	Mumbrekar and Madhyashta
Bangalore	2011	6 (Pestilential snails)	Jayashankar *et al*.,
Coastal Karnataka	2024	20	D'Souza and Shenoy

Threats: The non-marine molluscs face higher level of threat than any other taxa of the world (Cummings *et al*., 2016) [9]. and level of threat is poorly documented. Moreover, land snails have the largest number of documented extinctions, compared to any other taxa.

Anthropogenic pressures are known to have negative impact on these delicate natural systems and biodiversity associated with them. Native land snails of India are threatened by habitat loss and fragmentation because of anthropogenic activities such as intense land use, construction of roads, dams, plantations, pollution and the spread of invasive species (Aravind *et al*. 2005) [2] due to which diversity and community structure of land snails will be affected (Aravind 2005) [2]. Poor dispersal and small distribution ranges of many land snails have led to their extinction. The gene flow of land snail population gets affected because of habitat preference and population fragmentation. Nevertheless, for the wild land snail species, home gardens and plantations can act as corridors between forest patches (Raheem *et al*., 2009) [25]. Land snails are vulnerable climate change (Sen *et al.,* 2012), and fluctuation in soil temperature leads to the death of juvenile snails and hampers their mobility.

A decrease in rainfall and global warming is known cause species extinction. The use of pesticides/herbicides in plantations is toxic to land snail species decreasing their population. Forest fires and reduction in vegetation cover are also major threats to land snails (Sen *et al*., 2012) [19]. Introduced land snail species such as *Rachistia* sp, *Achatina fulica*, *Subulina octona* and *Allopeas gracile* increase in number by foraging on native plants. Thus, introduced land snails are detrimental to the native land snails (Jayashankar *et al*., 2012) [13].

Conservation

1. Prioritising conservation areas

The forest ecosystems are declining at a faster rate, reforestation could help by providing refuge for the land snails. Snails can be protected by prioritising conservation areas. Selection of areas of high endemism as conservation reserves, community reserves and sacred groves would be useful for protecting these small creatures (Raheem *et al*., 2014) [26].

2. Public awareness

Land snails have a very poor image among the public, forest managers and policymakers and a lack of public support. Recently, an illustrated guide was produced by the Natural History Museum, London in association with ATREE, Bengaluru on land snails of the Western Ghats depicting its diversity (Raheem *et al*, 2009) [25]. This guide assists conservation biologists, amateur naturalists, students and the public in identifying land snails of the Western Ghats. Awareness needs to be created regarding the importance of these taxa in the ecosystem for their conservation also requires awareness. This can be achieved by communicating the importance of snails and their role in ecosystem health (Raheem *et al*., 2009) [25].

3. Species-specific conservation

Earlier studies on distribution, ecology and threats to land snails, were lacking, hampering the enforcement of conservation plans. However, studies are being carried out on the ecology of land snail species that may help in assessing their status and implementing conservation measures. Public awareness can be created by the captive breeding of selected species and the setting up of "snailariums" for breeding of endemic snails. This can be initiated by national parks and zoos for public interest.

4. Habitat specific conservation

Significant proportions of endemic species are distributed in these non-protected areas and hence are vulnerable to extinction. Most of the habitat conservation practice programmes are considered widely distributed/low-risk species. Conversely, biodiversity-rich habitats are not targeted. Land snails are indicators of habitats with rich diversity. Thus, snails thriving in biodiversity-rich habitats can be given conservation priorities.

The reserve forests of the southern Western Ghats have higher diversity of land snails but less protection (Aravind, 2005) [2]. The conservation importance can be given to regions of higher diversity lying adjacent to the protected areas such as Agumbe, and Hulikal of the southern Western Ghats. The endemic land snail species that are data deficient could be conserved by identifying sites with high diversity and protecting their habitat (Sen *et al*., 2012) [19].

5. Need for research

Studies focussing on Indian land snail distribution patterns, taxonomy and ecology are lacking. However, Das and Aravind (2021) [12] noted the presence of *Diplommatina* species from Sikkim. Detailed studies on land snail systematics, threats, on identification of endemic regions need to be prioritised for the implementation of conservation measures. Taxonomic expertise and funding are required for the research on these areas and the formulation of conservation policy (Sen *et al*., 2012) [19]. Developing databases on ecology, breeding behaviour, and distribution should be encouraged and made accessible in the public domain, which would give the status of land snails in their regions.

The impact of the invasive snails and slugs such as *Lissachatina fulica*, *Derocerus leave*, *Semiperula* sp. on native land snail populations needs to be monitored. The introduced snail species are agricultural/horticultural pests and are found in status-altered habitats posing a threat to native snails. However, the effect of the impact of invasive and pest species on regional land snails and economic damage to horticultural crops needs to be assessed. For the control of exotic invasive land molluscs their status in the wild needs to be evaluated. Taxonomy of certain genera such as *Glessula* can be resolved through molecular phylogenetic applications or DNA barcoding techniques (Sen *et al*., 2012) [19].

Conclusion

Of the land snails found in India, 76% are endemic to Western Ghats. Research on land snails has been confined mainly to the Western Ghats and spreading to the north-eastern Himalayas and specific to certain localities. Land molluscs are facing threats because of multiple reasons such as habitat loss and fragmentation, and invasive species. Awareness about native species will certainly help in recognizing newly introduced exotic species allowing effective control or management before they become invasive. Efforts should be made to establish snailariums in zoos to create awareness about snails among people. Priority should be given to conserve critical habitat for the conservation of land snails. Research needs to focus towards developing databases on ecology, breeding behaviour, distribution of land snail species, resolve the taxonomy of least known taxa.

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