

## AN ILLUSTRATED GUIDE TO THE LAND SNAILS OF THE WESTERN GHATS OF INDIA

Dinarzarde C. Raheem<sup>1</sup>, Fred Naggs<sup>1</sup>, N.A. Aravind<sup>2</sup> & Richard C. Preece<sup>3</sup>

Photography and image editing Harold Taylor<sup>1</sup>

### The Diversity and Ecology of Land Snails

The Western Ghats, the chain of mountains running along the western coast of the Indian peninsula, has a rich land-snail fauna. Scientific studies carried out during British Colonial times, mainly in the 19<sup>th</sup> and early 20<sup>th</sup> century, have recognized 279 land-snail species from the Western Ghats. These species were mostly described by pioneering collectors such as William Benson, William and Henry Blanford, Richard Beddome and Henry Godwin-Austen. However, many species remain to be discovered and scientifically described. This is strongly suggested by the recent discovery of approximately 50 new land-snail species from Sri Lanka, an island that is considered to be a zoologically well-studied part of South Asia and shares ancient and remarkable affinities in its flora and fauna with the Western Ghats. Extending for a distance of 1600 km across six Indian states (Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu), the Western Ghats (see Map) are topographically and climatically highly varied. This is reflected in the diversity of the region's vegetation, which ranges from scrub and dry deciduous forest at lower elevations to moist deciduous forest, montane rainforest and grassland at higher altitudes.

The land-snail fauna of the Western Ghats falls into three broad groups: endemic species (species unique to the Western Ghats), non-endemic native species (species with a natural distributional range in India extending beyond the Western Ghats and/or ranging into other parts of South and Southeast Asia) and exotic species (species that have reached India through human agency). Endemic species dominate the land-snail fauna: approximately 76% of the known land snails are unique to the Western Ghats. Our understanding of the geographical distribution of land-snail species in the Western Ghats is patchy and incomplete. Nevertheless, it is clear that most species are restricted in their distribution to particular parts of the Ghats. Most striking is the fact that many of the land snails inhabiting the central and northern Western Ghats, are different from those of the southern Western Ghats, the mountains south of the 30-km-wide Palghat Gap (see Map). Snails often possess very narrow ranges of ecological tolerance, and in contrast to many other invertebrates, have very limited mobility. These attributes make them



Left-right: panoramic and interior views of montane rainforest, Kalakad, Tamil Nadu.

particularly sensitive to environmental change, and thus remarkably vulnerable to human-driven forest loss and fragmentation (i.e. the break up of contiguous areas of forest into numerous, small isolated patches). Despite the scarcity of recent data, it is likely that most of the snails of the Western Ghats, like those of Sri Lanka, are entirely dependent on natural forest for their survival, and that many species are restricted to particular forest types. The loss and fragmentation of natural forest, therefore, poses the single most significant threat to these species.

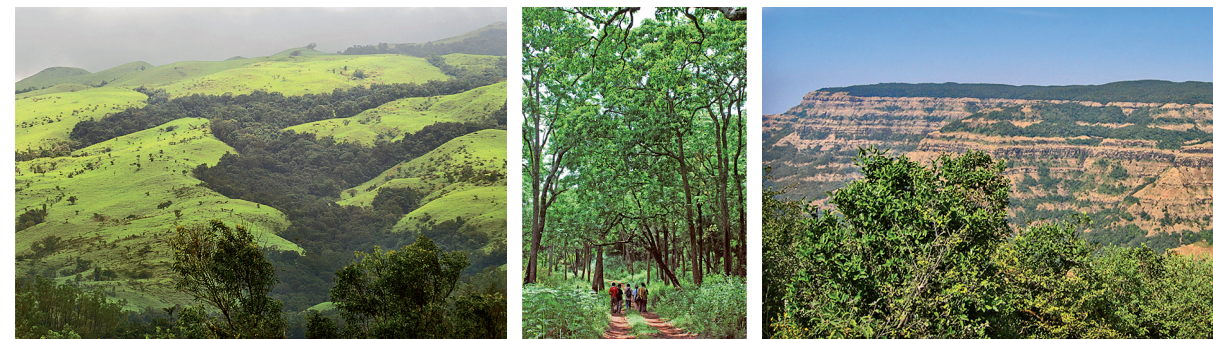
Our objective with this guide is to provide a brief introduction to the rich and fascinating land-snail fauna of the Western Ghats. All genera native to the Western Ghats are featured, as well as a few genera that are native to other, drier parts of India, but may occur in cultivated habitats (e.g. home gardens, monoculture commercial and forest plantations) or degraded forest in the Western Ghats. With the aid of this guide it should be possible to identify most of these genera in the field, as well as to recognize some of the more distinctive native species (exotic species are not included). We hope that this publication will raise awareness and interest in this amazing, but neglected group of animals, which many people think of only in the context of damage to crops and garden plants. In fact our studies in Sri Lanka show that it is exotic species and not native snails that cause such damage.

Exotic snails and slugs can be a serious problem because they are often difficult to control and can be locally highly abundant.

Next to being asked how to kill garden snails, the question we are most often asked is 'what use are they?' This implies that the existence of organisms needs to be justified in terms of human values and human exploitation; it is not a view we share. Living diversity is thought to have evolved over the past two and a half thousand million of the earth's four-thousand-million-year history and we are currently experiencing extinction levels unprecedented in the past 65 million years. The Earth's biological diversity is something to be cherished in its own right, and humanity will be the poorer for its loss. Every ecosystem is made up of a diverse array of organisms and we are largely ignorant of the importance of individual species for ecosystem functioning and stability. Snails have diverse and important ecological roles. Some groups, such as the streptaxids, are carnivorous and feed on invertebrates, often other molluscs. Some are specialist feeders of fungi, whereas others feed on a restricted range of living plant matter. The vast majority of snail species, however, are primarily detritivores, feeding on dead and decaying plant material, thereby directly contributing to the recycling of nutrients.

### The Evolution of Snail Diversity

When studying the fauna or flora of a locality or region the first questions to ask are what species are present and where are they found. The serious study of the Western Ghats' snail fauna has just begun and many new species remain to be discovered, so there is a long way to go. Nevertheless, it is useful to step back and look at the wider picture of how species came to be where they are. Snails had a long history in the sea before several groups independently made the transition from aquatic to terrestrial environments. Worldwide, the fossil record for land snails is very patchy and poorly studied. The earliest records of land snails date from the Carboniferous, about 360-290 million years ago (Ma), but they do not show up again as fossils for about 100 Ma and rich fossil deposits are not known until after 20 Ma. The earliest snail fossils from India date from the Mesozoic (90-67 Ma). These fossils are thought to be the direct ancestors of the modern snail genus *Corilla*, which at present is found nowhere else in the world but in the southern Western Ghats and Sri Lanka. Most of our current understanding of snail evolution is based on studies that have used the morphological and/or genetic characters of living snails, in combination with distributional data, to understand how different species are related to each other and how they



Left-right: montane shola-grassland mosaic, Kudremukh, Karnataka, moist deciduous forest, Biligirirangan Hills, Karnataka, and the Ghats near Mahabaleshwar, Maharashtra, showing layers of Deccan Trap lava flows.

may have evolved. Snails are ideal organisms for studying evolution. They are extremely rich in species, with over 20,000 described species known worldwide. They are ecologically diverse, occurring in habitats ranging from temperate woodland and tropical rainforest to desert habitats and high-elevation alpine environments. Many snails possess a shell that remains intact after death, allowing their presence to be detected even when living snails are not observed. The development of molecular biology has provided powerful new tools for studying the evolution of snails and other plant and animal groups.

The land snails of the Western Ghats along with those of Sri Lanka are of immense interest to understanding snail evolution, and to the wider issue of how biological diversity has evolved. India and Sri Lanka form part of the Indian Plate, a fragment of the ancient continent of Gondwana that extended across much of the southern hemisphere of the Earth. With the gradual break-up of Gondwana from about 200 Ma, the Indian Plate split from the South American and African Plates (c. 150 Ma) and later the Antarctic Plate (c. 130 Ma), and then moved northwards. After separating from the Madagascar Plate (c. 85-90 Ma), the Indian Plate collided with Eurasia

about 35 Ma. The land-snail fauna of the Western Ghats and Sri Lanka reflects this complex geological history. Many of this region's snail genera and most of the approximately 700 species are endemic to it, indicating that there has been substantial evolutionary diversification within this part of South Asia. Several snail genera such as *Corilla* and *Acavus* are thought to have a history that pre-dates the break-up of Gondwana, but are now largely or entirely restricted to the Western Ghats and/or Sri Lanka. A number of other groups (e.g. the genus *Glessula*, and the Ariophantidae, Macrochlamynidae and related snails) are represented by many species and range across much of the Indian subcontinent and into Southeast Asia; this pattern of distribution may be the product of events that occurred around the time of the collision of the Indian Plate with Eurasia. Some of these groups may have invaded Southeast Asia from the Indian Plate, having inhabited Gondwana before its break-up and survived on the Indian Plate during its subsequent journey northwards. Other groups, in contrast, may have colonized India from Southeast Asia after the collision of the Indian and Eurasian Plates.

### The Major Land-snail Groups: Pulmonates and Caenogastropods

The land snails of the Western Ghats belong to two major global taxonomic groups: pulmonates and caenogastropods. Most pulmonate snails have an upper pair of long tentacles with the eyes located in the bulbous tips and most also have a second, lower pair of shorter chemosensory and tactile tentacles. Pulmonate snails are hermaphrodites (a single individual possesses both female and male reproductive organs). Some Indian pulmonates such as *Beddomea*, *Mariaella*, *Mirus*, *Pupisoma*, *Rhachistia* and *Satiella* are arboreal (living in trees and low vegetation), whereas other groups including *Ariophanta*, *Cryptozona* and *Glessula* are ground-living (generally in leaf litter and on decaying wood).

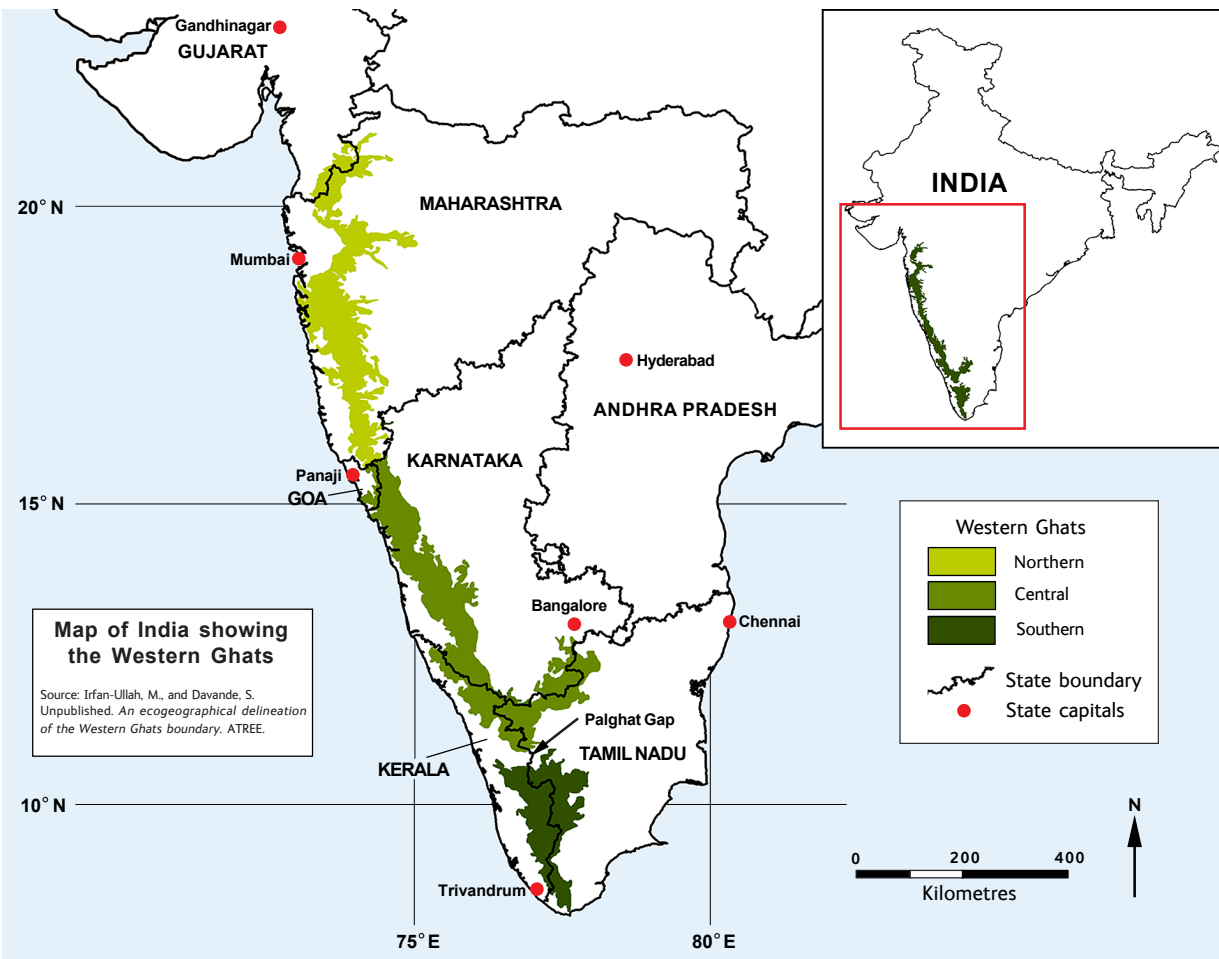
Live caenogastropod snails have a pair of tentacles with pointed tips and the eyes are positioned at the base of the tentacles. A circular plate, called the *operculum*, is attached to the dorsal surface of the tail. The operculum closes the shell's aperture when the snail retracts into the shell. In most Indian caenogastropods the operculum is a thin, horny, flat disc. In *Cyclotopsis*, however, the operculum is thick and chalky, and in *Pterocyclus* the outer surface of the operculum is ornamented with raised concentric ridges. Caenogastropods have separate sexes. Of the genera found in the Western Ghats most are ground-living.



View of the Western Ghats near Kolhapur, southern Maharashtra.

### Field Identification of Land Snails

The field identification of land snails is based largely on shell characters. The shells of most land snails are spirally coiled with each successive coil known as a *whorl*. Snail shells are composed largely of calcium carbonate and are covered at least for some period of their growth by a glossy, brown or transparent, proteinaceous covering, the *periostacum*. It is important to bear in mind that the shell of a juvenile snail may be very different in its proportions from that of an adult of the same species. Growth of the shell occurs at the *lip* of the shell and the adult shells of most Indian land snails show a thickened or expanded lip that is absent in juveniles. Indian caenogastropods tend to have solid shells. Although some pulmonate snails have very robust shells (e.g. *Beddomea*, *Corilla*, *Cryptozona*), other species have very thin or fragile shells (e.g. *Euplecta*). In a few species, the so-called semi-slugs, the shell is largely proteinaceous and the live snail can retract only partly into the shell (e.g. *Satiella*) or not at all (e.g. *Mariaella*, *Pseudautestia*). The shells of some land-snail species can be highly



Left-right: dry deciduous forest, Nagarhole, and Biligirirangan Hills, Karnataka.

variable in size, form and/or colour pattern (e.g. some species of *Beddomea* and *Cyclophorus*). Some species are represented by two or more named 'varieties' that differ in the size, form and/or colour pattern of their shells. As used here these names have no taxonomic status and have been applied in an informal sense for the convenience of description. Future studies may reveal these varieties to be either distinct species or to represent variation within single species.

When identifying live snails the appearance and colouration of the body is often useful. The colour of the body may be black, dark grey or brown (e.g. *Eurychlamys platychlamys*, *Glessula*) or very pale (e.g. *Cryptozona solata*, white-bodied form of *Indrella ampulla*). Some species are very brightly coloured (e.g. red-bodied form of *Indrella ampulla*, the genera *Perrottetia* and *Satiella*), and in some snails the part of the body protected by the shell may be heavily marked with dark spots, blotches and/or stripes (e.g. *Euplecta travancorica*) and this may be clearly visible through the shell.

Small-scale, casual collecting of empty snail shells is unlikely to have a harmful impact on the environment because it involves the removal of only tiny amounts of calcium carbonate from a few highly-localized places. The collection and preservation of live snails is essential for serious and systematic scientific research, but should only be carried out as part of such work.

### Further information

Blanford, W.T. and Godwin-Austen, H.H. 1908. *The Fauna of British India, including Ceylon and Burma. Mollusca. Volume I: Testacellidae and Zonitidae*. Taylor and Francis, London.

Gude, G.K. 1914. *The Fauna of British India, including Ceylon and Burma. Mollusca. Volume II: Trochomorphidae-Janelidae*. Taylor and Francis, London.

Gude, G.K. 1921. *The Fauna of British India, including Ceylon and Burma. Mollusca. Volume III: Land Operculates (Cyclophoridae, Truncatellidae, Assimineidae, Helicinidae)*. Taylor and Francis, London.

Together the three volumes of the Fauna of British India series represent the only broad taxonomic account of the land snails of the Indian subcontinent. They cover all the land-snail genera and species scientifically described from the Western Ghats up to the end of the first quarter of the 20<sup>th</sup> century, and are now somewhat out of date. Many of the species descriptions are in latin and illustrations are few and far between. These volumes are difficult to use without access to a comprehensive reference collection of shells. Reprints are available from: Today and Tomorrow's Printers and Publishers, 4436/7, Ansari Road, Daryaganj, New Delhi 110002, India (phone: 91-011-23241021, 41041021, fax: 23242621, e-mail: ttp@vsnl.net).

A fully-illustrated list of the land-snail species scientifically described from the Western Ghats is currently in preparation. This will be available online at <http://nhm.ac.uk/tropicalsnaills> by the end of 2009. Other potentially useful publications available at this site include:

Naggs, F. and Raheem, D. 2000. *Land snail diversity in Sri Lanka. An illustrated guide prepared for the launch of the Darwin Initiative programme*. Department of Zoology, The Natural History Museum, London.

This species list includes photographs of the shells of all species formally described from the island up to the time the guide was compiled in the late 1990s.

Mordan, P., Naggs, F., Ranawana, K., Kumburegama, S., and Grimm, B. 2003. *A Guide to the Pest and Exotic Gastropods of Sri Lanka*. The Natural History Museum, London.

Many of the species featured in this guide also occur in India.

### About this guide

This guide has been funded by the UK government's Darwin Initiative (<http://darwin.defra.gov.uk>). The Darwin Initiative was launched at the 1992 United Nations Conference on Environment and Development (the Rio 'Earth Summit') as part of Britain's response to the resulting Convention of Biological Diversity (<http://www.cbd.int>). The Darwin Initiative seeks to help safeguard the world's biodiversity by drawing on British biodiversity strengths to assist countries that are rich in biodiversity but poor in financial resources.

From 2006 to 2009 the Darwin Initiative funded the project *Developing land snail expertise in South and Southeast Asia*, which was run by the Department of Zoology, The Natural History Museum, London, UK.

### Project partners:

1. The Natural History Museum, Cromwell Road, London SW7 5BD, UK. <http://www.nhm.ac.uk>
2. Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Srirampura, Jakkur PO, Bangalore 560064, India. <http://www.atree.org>
3. University Museum of Zoology Cambridge, Downing Street, Cambridge CB2 3EJ, UK. <http://www.zoo.cam.ac.uk/museum/index.htm>

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# CAENOLOGASTROPODA

# PULMONATA

