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# THE DARWIN INITIATIVE PROJECT ON SRI LANKAN LAND SNAILS: PATTERNS OF DIVERSITY IN SRI LANKAN FORESTS

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***ABSTRACT.*** **–** Concern about loss in biological diversity led to the International Convention on Biological Diversity and Britain's Darwin Initiative. Land snail diversity in Sri Lanka was assessed as part of a Darwin Initiative project involving an island-wide survey. The rainforests of south-western Sri Lanka are centres of land snail diversity and endemism.

***KEY WORDS.*** **–** Convention on Biological Diversity, Darwin Initiative, Sri Lankan snails, rainforest, high diversity, endemism.

## INTRODUCTION

It is widely considered that we are currently witnessing extinctions at levels unprecedented since the K/T boundary. This assertion that there is a 'biodiversity crisis' is based on incontrovertible evidence that tropical wet forests contain most of the world's terrestrial living diversity and the irrefutable fact of tropical deforestation (Myers, 1989). For many years there has been a growing recognition that traditional funding sources and established institutions were failing to address this issue adequately. The case for research and conservation priorities had largely been based on the biocentric moral argument that living diversity was something to be understood and cherished in its own right. At the Twelfth General Assembly of the International Union for the Conservation of Nature and Natural Resources in Zaire in September 1975 there was strong support for the view that development plans for tropical countries should incorporate biological principles. This was subsequently recognised as a key development by the USA National Research Council Committee on Research Priorities in Tropical Biology (Raven et al., 1980). Although ethical considerations continue to motivate many biologists (Ehrlich, 2001), by the early 1980s the idea developed that more could be achieved by promoting a self-interest argument. Biological diversity was presented as a valuable resource that requires managed exploitation (Anon, 1986). Whether or not this will prove to have been a wise course of action, or is even founded on sound reasoning, is debatable but the economic argument proved to be a powerful force that appears to have irrevocably drawn biodiversity into a discrete niche of the political arena. One of the outcomes was the 1992 Convention on Biological Diversity (CBD) http://www.biodiv.org, which is a far reaching international agreement with a powerful agenda that is likely to form the basis for international co-operation in biodiversity for many years to come. In addition to setting a framework by which nations exercise control of biological resources, the CBD recognises obligations for nations to record, conserve and understand their living diversity and seeks to promote international co-operation to that end. Thus the traditional role of natural history museums of recording and striving to understand biological diversity is central to the CBD's objectives.

At the launch of the CBD the British Government demonstrated a clear commitment to the convention's objectives by announcing the Darwin Initiative (DI) http://www.nbu.ac.uk/darwin. The DI, administered by the Department for Environment, Food & Rural Affairs (DEFRA), seeks to assist those countries that are rich in biodiversity but poor in financial resources to meet their obligations under the CBD by harnessing British resources and expertise.

The Natural History Museum (NHM) in London holds a rich resource of biological reference collections and library facilities and is well placed to respond to the DI's objectives. This particularly applies to resources for countries that came under the control of Britain's nineteenth century colonial system when the process of describing fauna and flora was at its peak. Using the criteria of high diversity, high levels of endemism, a threatened environment and close historical ties, reflected in the NHM's resources, Sri Lanka was identified as an obvious choice for a DI project on land snails. Sri Lanka possesses an extensive system of higher education and a high level of environmental awareness but its capacity to carry out systematic work on a group such as land snails is greatly hindered by a lack of appropriate literature resources and adequate specimen reference collections. The project "Land Snail Diversity in Sri Lanka" sought to address these constraints by using DI funding and NHM resources to support a survey-based programme in Sri Lanka.

Of the global biodiversity hotspots Sri Lanka has the highest category of human population pressure (Cincotta et al., 2000). Its land snail fauna is the most distinctively South Asian in composition, with many more Gondwanan relict taxa than are to be found in India (Naggs & Raheem, 2000). With only 12% of the area of Sri Lanka's wet, rainforest zone currently under forest cover (Green, 1993) there is an urgent need to record, understand and conserve this unique biota. Land snails are ideal subjects for addressing high priority questions relating to rainforest biotas and have long been recognised as possessing a number of attributes that make them particularly suitable subjects for studies in evolutionary biology.

## AIMS AND METHODS

From the launch of the project in October 1999 a number of investigations were carried out by teams based at the Department of National Museums in Colombo and the University of Peradeniya, near Kandy. The key focus of the Darwin Project was to develop a basic understanding of the distribution and conservation status of Sri Lanka's endemic and indigenous land snails through exploratory surveys of natural forests and synanthropic habitats. A survey of a range of forest habitats across Sri Lanka's three major climatic regions, the wet, dry and intermediate zones, was carried out during the first year of the project (1999–2000). This was complemented by intensive investigations of the land-snail faunas of two discrete areas within the island, the tropical lowland rainforests of the wet lowlands (2000–2002) and the climatically and vegetationally diverse forests of the Knuckles range of hills (1999–2002).

The Darwin surveys utilised a standardized method of sampling based on 2 × 100 m belt transects to permit direct comparison between different sites. In addition to transect-based sampling of living snails and of shells, we carried out life-history studies of selected species and initiated a preliminary survey of the exotic and pest species of synanthropic habitats (Mordan et al., 2003; Naggs et al., 2003). The following is a brief account of the preliminary findings of the surveys carried out across the island during the first year of the project; a detailed account of the methodology and findings of all our surveys will follow in later publications.

The main aim of the first year's 'island-wide' survey was to develop an understanding of the broad distributional patterns of Sri Lankan land snails with respect to climatic and vegetational zonation. Natural forest sites in the four major climatic zones (dry, intermediate, lowland wet and highland wet) and across nine districts (Anuradhapura, Badulla, Galle, Kandy, Kurunegala, Matale, Moneragala, Nuwara Eliya and Puttalam) were sampled (Fig. 1). Four major forest types were sampled: dry monsoon forest (dry zone), moist monsoon forest (intermediate zone), lowland evergreen rainforest (lowland wet zone) and montane rainforest (highland wet zone) (Fig. 5).

## RESULTS

Approximately 150 morphospecies were recorded for the three years as a whole including 110 endemic species, at least 50 species new to science, several exotic species and several unidentified genera. In addition, a number of species complexes were recognised but these are treated here as single species.

A simple analysis of the 99 species recorded in the first year of the project, when an approximately equivalent amount of sampling effort was expended for the four climatic zones, shows that the vast majority of species were recorded from the wet zone (Fig. 2). Of the 99 species recorded during the 'island-wide' survey nearly 80% were recorded from the wet zone (lowland and highland wet zone). Land-snail diversity as recorded for the other two zones was much lower: 32% of species recorded in the first year were found in the intermediate zone and 21% in the dry zone.

An investigation of species ranges across climatic zones shows that more than 60% of species were recorded only from the wet zone (Fig. 3). Species restricted to one of the other two zones make up a relatively small proportion of total diversity as do species ranging across two or three climatic zones. This pattern demonstrates that the wet zone is the centre of land-snail diversity and endemism and is therefore of great importance to the conservation of the Sri Lankan land-snail fauna.

A closer examination of the 61 species recorded only from the wet zone shows that they fall into two discrete categories: species recorded only from the lowland wet zone or the lowland rainforest zone and species recorded only from the

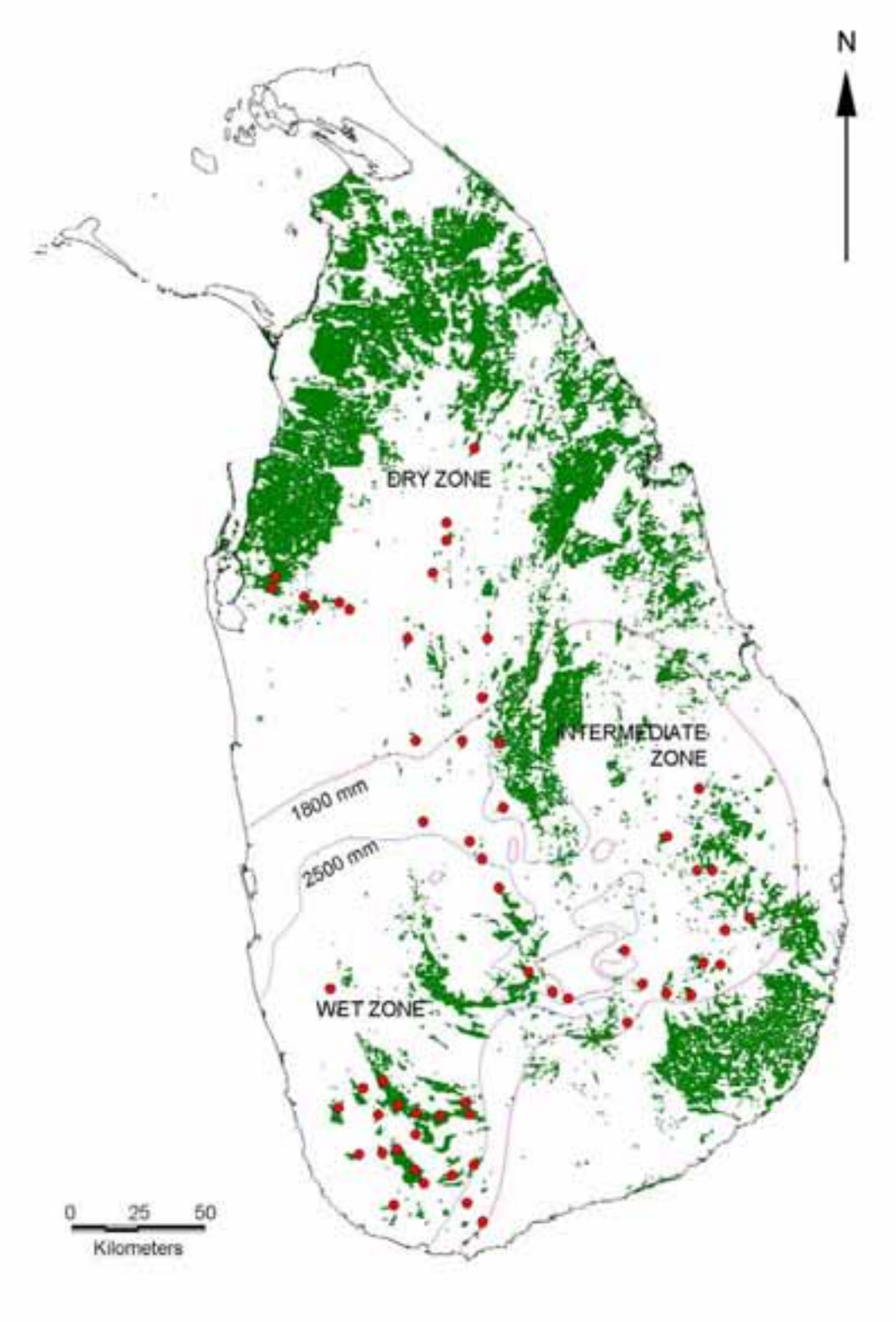


Fig. 1. Map of Sri Lanka's natural forests and climatic zones. Red dots show where Darwin Initiative land-snail surveys have been carried out but exclude the detailed Knuckles Range surveys and overlapping dots are not shown. The Wet Zone is bounded by the 2,500 mm isohyet and the boundary between the Intermediate and Dry Zones is the 1, 800 mm isohyet. Source of forest cover data: 1:50,000-scale forest map by Legg & Jewell (1992, 1995).

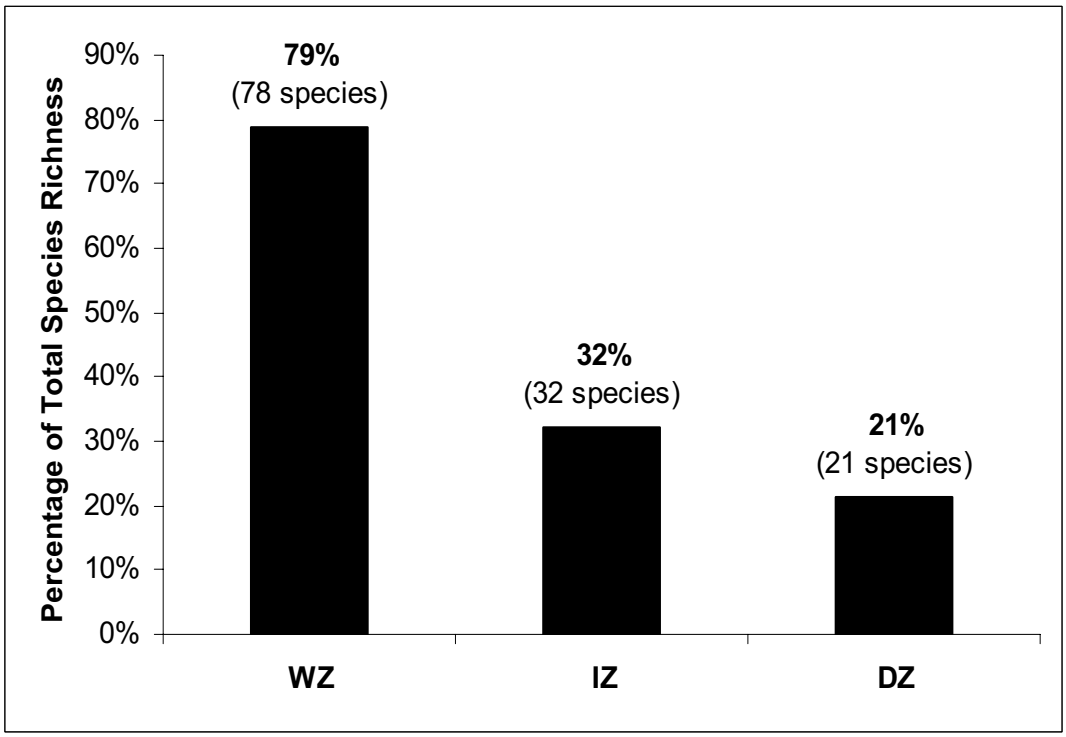


Fig. 2. A comparison of the land-snail species richness of Sri Lanka's wet (WZ) , dry (DZ) and intermediate (IZ) zones as recorded during the 'island-wide' survey in the first year of the Darwin Initiative Project.

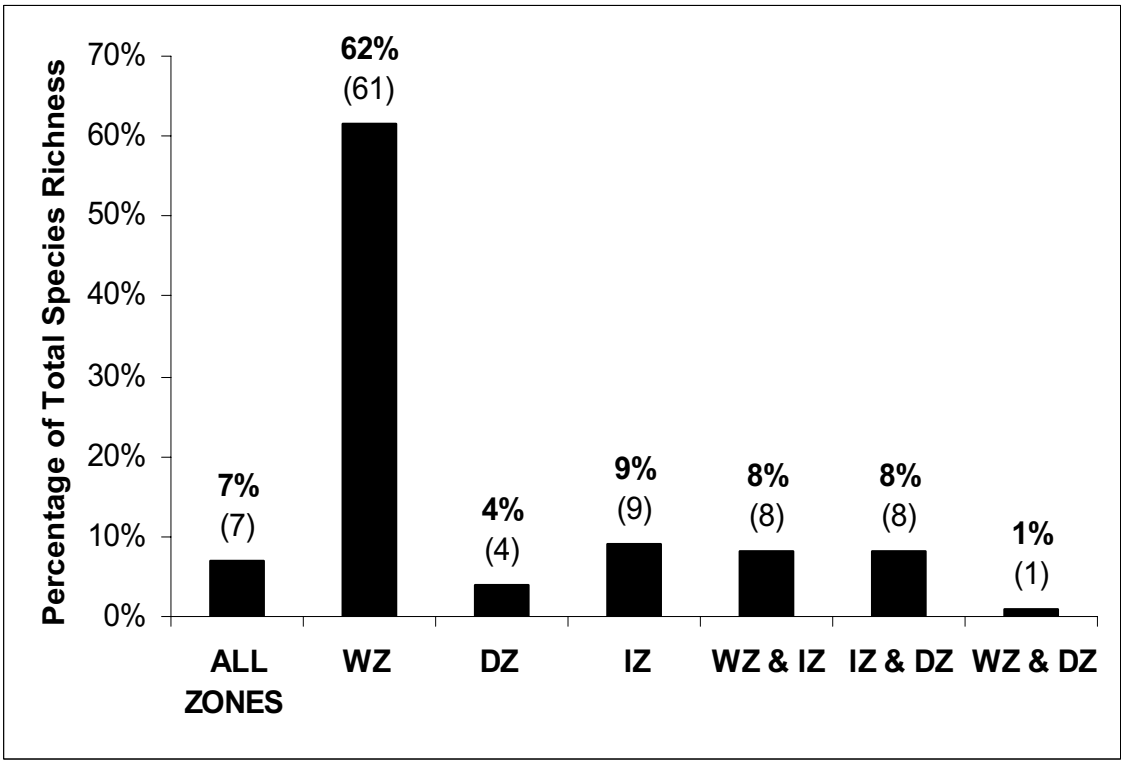


Fig. 3. Relative contribution of species ranging across one zone, two zones or three zones to total land-snail species richness as recorded during the 'island-wide' survey. Species fall into one of seven categories: those confined to either the dry (DZ), intermediate (IZ) or wet (WZ) zone; those confined to two zones, either the wet and intermediate zones (WZ & IZ), the intermediate and dry zones (IZ & DZ) and the wet and dry zones (WZ & DZ); and those ranging across the three zones (ALL ZONES).

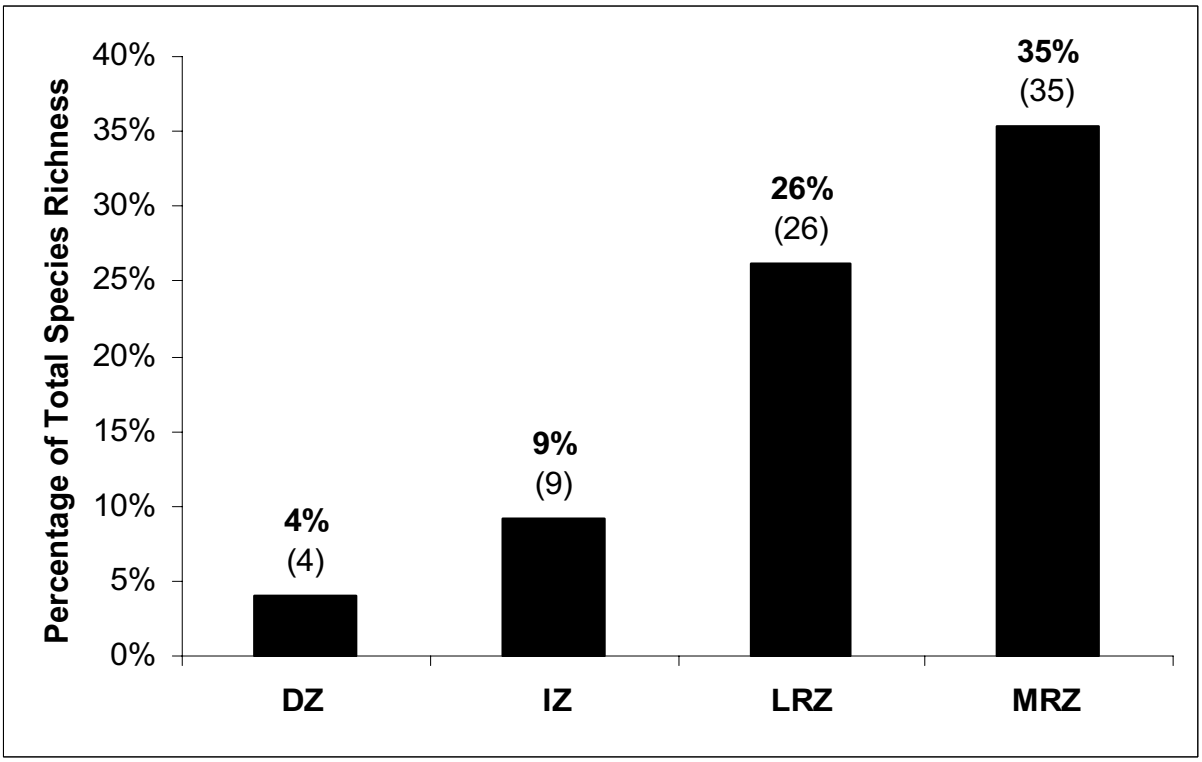


Fig. 4. Relative contribution of species restricted to the dry (DZ), intermediate (IZ), lowland rainforest (LRZ) and montane rainforest zones (MRZ) to total land-snail species richness as recorded during the 'island-wide' survey.

highland wet zone or the montane rainforest zone (Fig. 4). Of the exclusively wet zone species 35 were limited to the montane rainforest zone (> 3500 ft or 1067 m) and 26 were limited to the lowland rainforest zone (< 3500 ft or 1067 m). This underlines the point that not only are many Sri Lankan land snails restricted to the wet zone, but that they are restricted to particular parts of the wet zone.

## DISCUSSION

The findings of the Darwin Initiative project demonstrate that the two main ecological subzones of the wet zone, the lowland rainforest zone and the montane rainforest zone have distinctive faunas. The lowland rainforest fauna is composed of a widely distributed element and a localised or restricted-range component. Widely distributed lowland rainforest species include *Cryptozona chenui* (Pfeiffer), *Ratnadvipia irradians* (Pfeiffer), *Acavus phoenix* (Pfeiffer), *Corilla adamsi* Gude, *Beddomea albizonatus* (Reeve)-species complex and *Leptopoma semiclausum* (Pfeiffer). These taxa range across most or all of the forested area of the lowland wet zone; some species such as *Ratnadvipia irradians* occur in both forest and non-forest habitats. In contrast, the localised element is comprised of taxa with restricted ranges within the compass of the wet lowlands. Examples include forest species such as *Tortulosa aurea* (Pfeiffer) and the two acavids, *Acavus haemastoma* (Linnaeus) and *Acavus superbus* (Pfeiffer), both of which occur at very high densities in synanthropic habitats.

The fauna of the montane rainforest zone, as with that of the lowland rainforest zone, is separable into widely distributed and localised elements. Among taxa characteristic of the montane rainforest zone as a whole are *Cryptozona ceraria* (Benson), *Euplecta colletti* Sykes and *Euplecta gardeneri* (Pfeiffer). Species with localised ranges within the montane zone include *Mirus stalix* (Benson), *Euplecta isabellina* (Pfeiffer), *Oligospira skinneri* (Reeve), *Thysanota bicilliata* (Pfeiffer) and *Theobaldius bairdi* (Pfeiffer).

## CONCLUSIONS

While the results discussed above provide only a brief overview of the preliminary findings of the Darwin Initiative Project they indicate how crucially important the wet zone is as a centre for land-snail diversity and endemism. We now know that while the wet zone does have a substantial share of the island's land-snail diversity and endemism, many species are restricted to localised areas of the wet zone. This serves to underline that the conservation of Sri Lanka's unique and rich land-snail fauna is critically dependent on the conservation of practically all of the fragmented and highly threatened rainforest that remains in the wet zone today.

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Fig. 5. (a), view of montane rainforest in the central highlands of Sri Lanka, an important habitat for a large number of endemic land snails including, (b) *Mirus stalix* and (c) *Euplecta colletti*. (d) *Acavus superbus*, a Gondwanan relict, ranges across much of the lowland wet zone. (e) *Euplecta travancoria* and (f) *Beddomea albizonata* are characteristic species of lowland rainforest.

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