

Effects of forest transformation to species composition of land snails in Gannoruwa Forest Reserve, Kandy, Sri Lanka

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Abstract: Land snails are models for studying the effects of pesticides and influence of the activities of man in altering the environment. The loss and fragmentation of natural forests is the most significant threat to Sri Lankan land snail fauna. In this study the authors have looked into how forest transformation into human habitations affect the distribution of land snails and their species composition. A plot sampling method for land snails was carried out along elevation gradients and the results suggested that more endemic species are confined to natural forests than home gardens. Exotic species were found only in altered home gardens. Species diversity and evenness were highest in the disturbed home garden habitat than natural forest. It was evident that both natural forests and home gardens can act as conservation sites for threatened land snail species. However, it is recommended that negative impacts of forest transformation into home gardens can be reduced if the home gardens are maintained in a manner which resembles the adjacent natural forest.

Keywords: Conservation, Endemic, Forest transformation, Home garden, Natural forest, Threatened.

I. INTRODUCTION

Sri Lanka has a rich land snail fauna (Raheem and Naggs, 2006). Two hundred and fifty three species of land snails are recorded from the country of which 205 are Endemic to the country. Among them 166 species belong to Sub class Pulmonata and is represented by 28 families. This indicates that the pulmonate group dominates land snails in Sri Lanka. The families Ariophantidae (mainly *Cryptozona* and *Euplecta*) with 50 species and Glessulidae with 22 species are the largest pulmonate families found in the country. Cyclophoridae (54 species) is the largest Prosobranch family. (Ranawana and Priyadarshana, 2012)

Nearly all of the island's land snails are restricted in their distribution to particular parts of the island but does not have a continuous distribution (Raheem and Naggs, 2006). Species richness and endemism are high among Sri Lankan land snails (Naggs *et al.*, 2003). Studies done by Raheem *et al.* (2000) and Ranawana (2005) has shown that the lowland rainforest zone and the montane rainforest zone in Sri Lanka have distinctive snail faunas. The land snail fauna of natural forest is composed almost entirely of endemic and non-endemic native species. Exotic species are rare in natural forests. In contrast, only a relatively small number of endemic and non-endemic native land snails occur in non-forest and cultivated habitats such as home gardens. In such habitats the diversity and abundance of exotic land snails is greatest. Further, the diversity and abundance of non-endemic native and endemic snails are greatest in home gardens that are in close proximity to natural forest (Raheem and Naggs, 2006).

Although there is a growing interest on ecological research on land molluscs in Sri Lanka little is known of the ranges of distribution and population sizes of a large proportion of the fauna (Raheem *et al.*, 2000). Land snails are models for

studying the effects of pesticides and influence of the activities of man in altering the environment. Therefore, information on the distribution and ecology of land snails is an important prerequisite for monitoring habitat quality (Ranawana, 2006). The loss and fragmentation of natural forests is the most significant threat to Sri Lanka land snail fauna (Raheem and Naggs, 2006). This study was carried out to study the diversity and distribution of land snail fauna in Gannoruwa area and also to study how forest transformation into human habitations have affected the distribution of land snails in the area.

II. BODY OF ARTICLE

Study site:

This study was carried out in the Gannoruwa Forest Reserve (7° 17' – 10° 51' N and 80° 35' and 35° 88' E, elevation 1899 ft asl) and its adjacent home gardens in Kandy district of Central Sri Lanka (Fig. 01). The Gannoruwa forest area is one of the main natural habitats surrounding Kandy District in Central Province of Sri Lanka and is an isolated natural forest patch. The forest covers about 267 hectares of the Gannoruwa hills and is separated from the Hanthana hills via the River Mahaweli from the South eastern side of the Gannoruwa hills. The forest is entirely surrounded by home gardens. This protected forest is administrated under the Department of Forest Conservation of Sri Lanka.

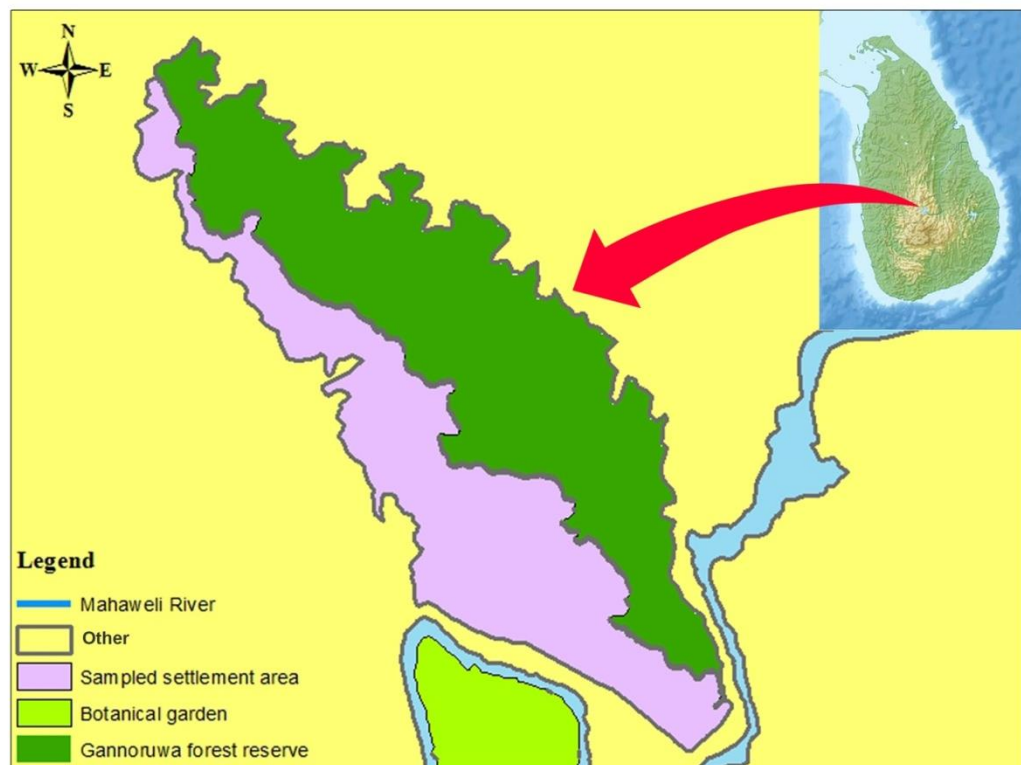


Figure 01: Map showing the Gannoruwa Forest Reserve and adjacent home gardens.

The vegetation of the area is dominated by lowland evergreen forest. Mid and upper areas of the forest are relatively less disturbed. More than 110 tree species are recorded from the area and consists mainly of *Artocarpus nobilis*, *Mangifera zeylanica*, *Nothopegia beddomei*, *Neolitsea cassia*, *Pometia tomentosa*, *Diospyros racemosa*, *Hydnocarpus ventata* and *Myristica dactyloides*. The forest also consists of some exotic tree species such as *Michelia champaca*, *Alstonia macrophylla* and *Swietenia macrophylla* (Ilangasinghe *et al.*, 1999). The forest provides fuel and timber for the local people residing around the area.

A significant number of home gardens surround the Natural Forest. These home gardens often consist of a mixture of annual and perennial crops, sometimes including small livestock. On account of the vertical structure, different canopy depths of various plant species can be observed in these home gardens. Important tree Spices occurring in these home gardens are *Myristica fragrans*, *Syzygium aromaticum* and *Piper nigrum*.

Method:

Land snails were sampled at night in both the Natural forest as well as the adjacent home garden habitats. Snail sampling was carried out in 2m×10m quadrats along five transect lines laid along the altitudinal gradient. The transects crossed the Home garden habitat as well as the forest habitat. Each transect line consisted of nine 2m×10m quadrats of which four plots in home garden habitat and another four in the Natural forest and the remaining plot in the forest margin overlapping both habitat types. Altogether 45 quadrates were sampled in five line transects. The number of land snail species present was counted and the vegetation characters were recorded inside the sampling plots.

III. RESULTS

Nineteen species of land snails in 10 families were recorded from the study area, out of which 13 snail species are endemic to Sri Lanka (Table 01). Eleven species of land snails belonging to six families were recorded in Home Garden Habitat while Natural Forest also accounted for 11 species in six families. Home garden habitat consisted with six endemic species while Natural Forest harbored nine endemic species. Only three species (*Beddomea albizonatus*, *Cryptozonia chenui*, *Euplecta emiliana*) were common to both Home gardens and the Natural Forest and all others were found either in Home garden or Natural Forest.

Table 01: List of Land snail species recorded from the Gannoruwa Forest Reserve and the adjacent Home Gardens

Family	Species	National Status	Natural Forest	Home Garden
Acavidae	<i>Acavus phoenix*</i>	NT		+
Achatinidae	<i>Lissachatina fulica</i>	NE		+
Ariophantidae	<i>Cryptozonia chenui*</i>	VU	+	+
Ariophantidae	<i>Euplecta emiliana*</i>	EN	+	+
Ariophantidae	<i>Mariaella dussumieri</i>	NE		+
Ariophantidae	<i>Ratnadvipia edgariana*</i>	DD		+
Ariophantidae	<i>Euplecta hyphasma*</i>	VU	+	
Camaenidae	<i>Beddomea albizonatus*</i>	VU	+	+
Charopidae	<i>Ruthvenia clathratula*</i>	EN	+	
Corillidae	<i>Corilla carabinata*</i>	CR	+	
Cyclophoroidea	<i>Aulopoma grande</i>	VU	+	
Cyclophoroidea	<i>Aulopoma itieri*</i>	EN	+	
Cyclophoroidea	<i>Theobaldius cratera</i>	DD	+	
Cyclophoroidea	<i>Theobaldius layardi*</i>	VU	+	
Glessulidae	<i>Glessula capillacea</i>	CR		+
Glessulidae	<i>Glessula ceylanica*</i>	EN		+
Pupinidae	<i>Tortulosa haemastoma*</i>	EN	+	
Subulinidae	<i>Allopeas gracile</i>	NE		+
Subulinidae	<i>Subulina octona</i>	NE		+

*Endemics

Home garden consisted of a single Critically Endangered (CR) land snail species (*Glessula capillacea*), two Endangered (EN) species (*Euplecta emiliana*, *Glessula ceylanica*) and two Vulnerable (VU) species (*Cryptozonia chenui*, *Beddomea albizonatus*). In contrast the Natural forest consisted of a single Critically Endangered (CR) land snail species (*Corilla carabinata*), four Endangered species (*Euplecta emiliana*, *Ruthvenia clathratula*, *Aulopoma itieri*, *Tortulosa haemastoma*) and five Vulnerable (VU) species (*Cryptozonia chenui*, *Euplecta hyphasma*, *Beddomea albizonatus*, *Aulopoma grande*, *Theobaldius layardi*) (Figure 02).

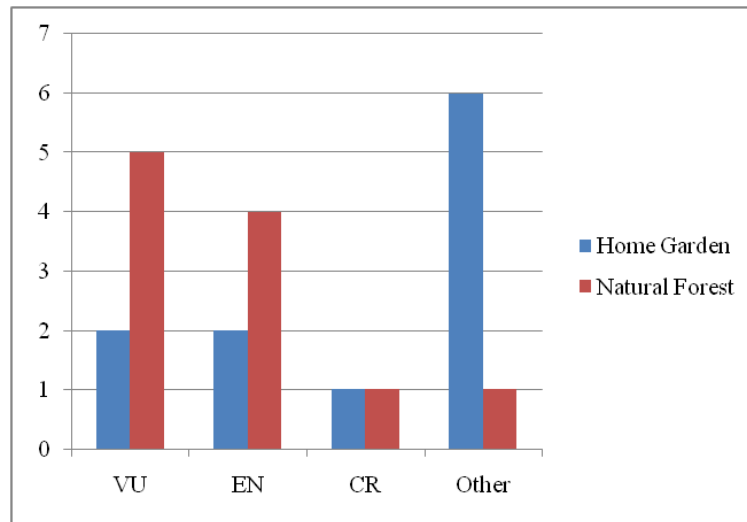


Figure 02: IUCN Threat status of the Land snail species recorded from the Home Garden.

However, Shannon Diversity index and Shannon evenness values were contrasting to above observed data. Shannon diversity index was 2.017 for the Home garden while it was 1.836 for the Natural forest. Shannon evenness values were 0.643 for the Home Garden habitat and 0.557 for the Natural Forest.

A clear distinction of the distribution of exotic and native and endemic land snail species was observed between the Natural Forest and the adjacent home garden. Exotic species such as *Mariaella dussumieri*, *Lissachatina fulica*, *Subulina octona* and *Allopeas gracile* were observed only in Home gardens. About 54.54% of the species in Home gardens were Endemics while the percentage of endemics was high as 81.81% in natural forest habitat. No exotic species were recorded from the natural forest habitat while 36.36% was found in home gardens. Both Home gardens and natural forest habitat contained 9.09% and 18.18 Native species respectively. When proportional species abundance was considered for Exotic, Native and Endemic categories 92.59% in Natural forests were endemic while only 19.64% in Home gardens were endemic. Relative abundance of exotic species were higher (75%) in comparison to native and endemic species in home gardens which means exotic species populations have dominated home garden habitats (Figure03 & 04).

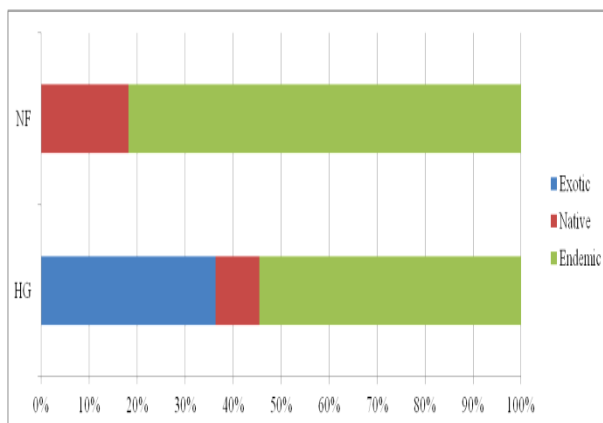


Figure 03: Percent species richness of Native, Exotic and Endemic species

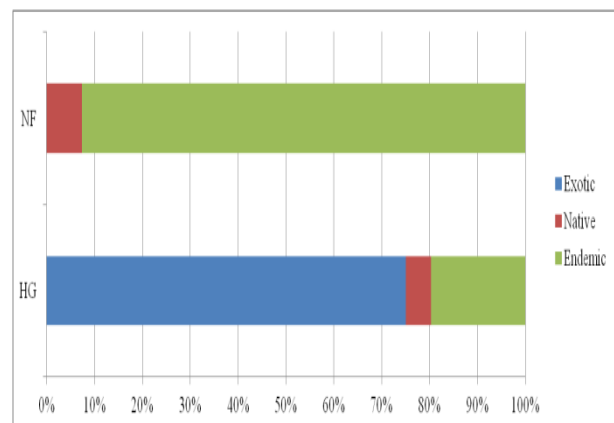


Figure 04: Proportional abundance of Native, Exotic and Endemic species

Furthermore, a note worthy feature was that the abundance and species richness was higher towards the forest margin where the home gardens and forest met. The relative abundance of species was higher towards the forest margin and it declined further up. A clear pattern could not be observed along the altitudinal gradient for species composition and abundance (Figure 05) except that the difference in types of species recorded. Since, these two different habitats were shared by different sets of land snail species doing a comparison would not be reasonable.

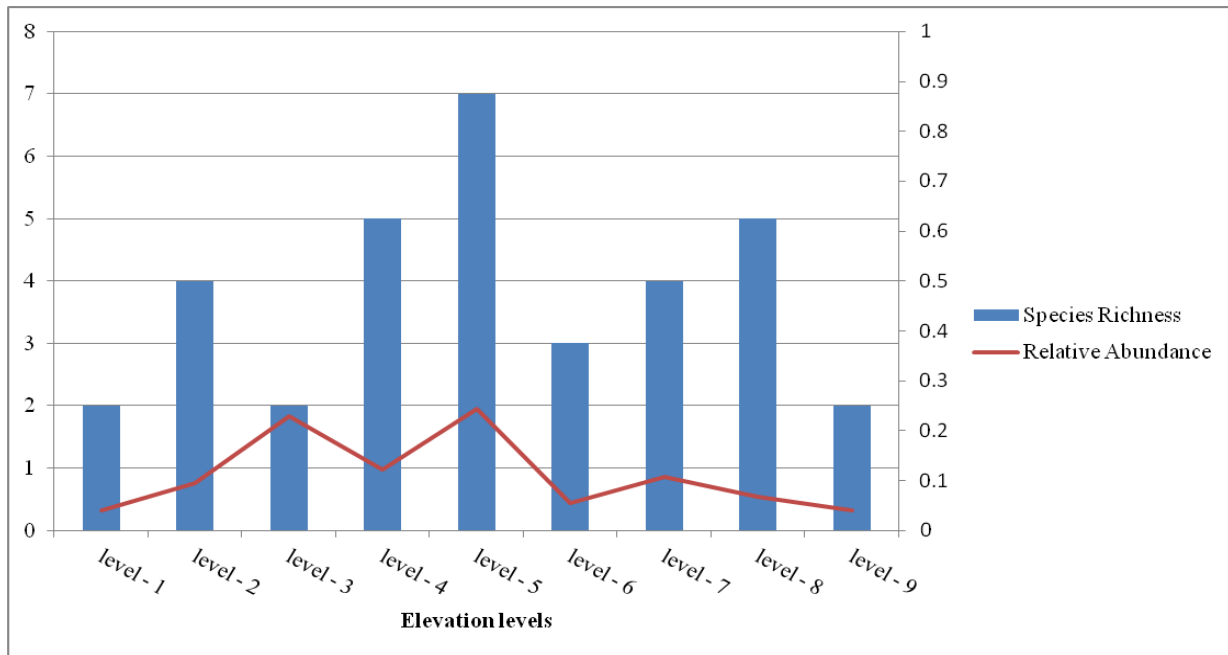


Figure 05: Species richness and Relative abundance along the altitudinal gradient of the study area. (Note: level 1 indicates pooled data in the quadrats of the lowest altitudinal level, level 2 is the next set of quadrates, level 3.....etc.)

IV. CONCLUSION

Transformation of forest habitats causes profound effects on fauna and flora of a region. Land snails are a suitable model species to study the effects of forest transformation, effect of pesticides and the influence of human activities due to their low mobility and sensitivity (Naggs *et al.*, 2003). In this study 19 species of land snails were recorded and they included mostly lowland rainforest species, few submontane rainforest species, few moist monsoon forest species and some common species in cultivated habitats according to the classification of Raheem and Naggs (2006). The endemism of land snails in the area is quite high.

Furthermore, it shows that both the Natural forest and home gardens support land snail species which belongs to IUCN threatened categories. Therefore these habitats act as conservation sites for threatened land snails. Unlike other urban home gardens, the home gardens in the Gannoruwa area are unique. Established settlement on this habitat poses no disturbance to the natural forest or any other flora or fauna in this area. These home gardens provide connectivity and linkages to other agricultural and natural landscapes, and this in itself is important for biodiversity conservation and adaptation, and will become more important under a changing climate, particularly as the risk of population fragmentation and the need for geneflow and species dispersal and migration increase.

The results suggest that the natural forest support more native endemic species while home gardens support more exotic species. It has been found that exotic species generally thrive in disturbed areas near human habitation, and may invade secondary forest, but they are absent from primary forests (Mordan *et al.*, 2003). Further, Shannon diversity index indicated a low diversity and evenness value for the natural forest than home gardens. However, for other species natural forest should possess higher diversity values than disturbed habitats. But for land snails in this study, the result has been inverted. It is interesting to check whether other sites also possess similar results for land snail diversity in home garden and natural forest habitats which are adjacent to each other. Further, proportional abundance of land snail species suggest that as the degree of disturbance increases the abundance of exotic species increase as well. With time this may even result in eliminating all other land snails from such disturbed habitats.

The four exotic species recorded during the study has not yet come up to the invasive level. But there is a risk that these species might invade the adjacent natural forest in the future. It is shown that some invasive species such as *Lissachatina fulica* have come up to the forest margin and they might move further up to the forest in the future. Therefore as a recommendation when constructing home gardens it is advisable to leave a buffer zone between the forest margin and the

home gardens. Ranawana (2006) has stated that although the exotic *Lissachatina fulica* occurs along the forest edges, no other exotic species have been found inside natural forests which is true for the gannoruwa forest as well. However, the threats from these exotics to the survival of the endemic land snail fauna in the country are not yet evaluated (Naggs et al., 2003). These exotic species are recent introductions and are important agricultural and horticultural pests. Interestingly, not a single native species of land mollusc can be considered as a serious pest in Sri Lanka (Mordan et al., 2003)

The results of the study did not show a significant variation along the altitudinal gradient. This may be due to the variation between the characteristics of the natural forest and the home garden did not differ much from each other. Therefore, this suggests that the negative impacts of forest transformation in to home gardens can be reduced if the home gardens are maintained in a manner which resembles the adjacent natural forest.

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