8.
PRESENT STATUS OF LAND SNAIL DIVERSITY IN SRI LANKA

K. B. Ranawana* & Ironie Nagasena
Department of Zoology, Faculty of Science, University of Peradeniya.

ABSTRACT

Sri Lankan land snail fauna is considered as a unique group due to high species richness and endemicity. Of the 253 species of land snails recorded from the country,205 species (approximately 81%) are endemics. Further, five land snail genera namely *Ravana, Ratnadvipia, Acavus, Oligospira* and *Aulopoma* are also endemic to Sri Lanka.

Species belonging to endemic genera show a discontinuous distribution and are restricted to small habitat fragments in the wet zone. Lowland rainforest and the montane rainforest in Sri Lanka have distinctive snail faunas. Most of the Sri Lankan land snails are leaf litter inhabitants in the forest floor. Some species including pests such as slugs may burrow into top layers of forest soil including the topmost layer containing loose and partly decayed organic matter and the humus layer below it. Therefore, the distribution and abundance of land snails in an area is greatly dependent on properties of soil such as its moisture content, acidity and texture.

Removal of tree cover in a forest area exposing the forest floor is detrimental to the survival of land snails. Clearance of land for large scale development projects in the wet and dry zones, clearance of forest understory in the montane region like Knuckles range to plant cash crops like cardamom, annual fires in the grasslands and heavy use of agrochemicals in the human modified habitats such as home gardens are detrimental to the land snail fauna. Due to their low mobility, land snails have become models for studying the effects of human induced habitat alteration

INTRODUCTION

Lithosphere, the solid rocky crust composed of minerals, covers the entire surface of the earth. Lithosphere interacts with hydrosphere, atmosphere and the biosphere and these are collectively involved in the formation of the pedosphere which consists of soil, its biotic and abiotic components. Soils are composed of water, gases, mineral matter together with diverse organisms and biological materials (Ruiz *et al.*, 2008). The soil biota is considered as one of the major contributing factors on formation of soil. Other factors affecting soil formation are climate, parent material, topography and time. Different combinations and degree of expression of these factors result in the production of a variety of soils on earth surface (Figure 1).

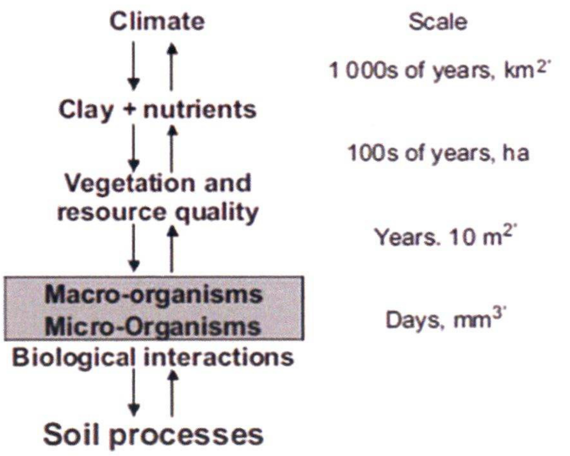

Figure.1.Hierarchy of determinants of soil processes that provide ecosystem services (Source: Lavelle *et al.*, 1993).

* Corresponding author:*ranawana2000@yahoo.com*

Soil fauna is involved in the process of breaking down organic matter and transforming them into nutrient elements and thus, play an important role in the soil ecosystem development and maintenance. Soil fauna are called "ecosystem engineers", as they are agents who control available resources and maintain habitats for others who live in soil. This in turn results in high species diversity (Lavelle and Spain, 2001). As an example, different activities of soil macrofauna such as burrowing and mixing (bioturbation) are important in aggregation of soil particles and the porosity. This creates suitable environmental conditions for other soil organisms affecting aeration and soil moisture.

Living creatures of soil form the soil biodiversity. This includes organisms that spend whole or part of their life cycles on the surface and upper few centimeters of soil or within the upper soil layers. Soil communities are considered as the species-richest areas of the terrestrial ecosystems, of which only a certain fraction is identified to date (Giller, 1996).

A typical soil profile is sectioned in to 5 master horizons, so called by the letters O, A, E, B and C from the top to the bottom. Therefore, 'O' is the surface horizon which is comprised of organic material at various stages of decomposition. In forested areas, debris from fallen trees is accumulated in this zone (Figure 2). This creates loose soil conditions with high aeration and soil moisture, favorable for soil inhabitants. Therefore, vast majority of soil inhabitants occupy this zone. This typical soil profile is not present in all locations on earth.

Soil biota can be classified into three main groups, macrobiota, mesobiota and microbiota, according to their size range (Swift *et al.*, 1979). Microbiota, range from 20 to 200 µm in length (<0.1mm diameter) and include diverse organisms such as algae, bacteria, cyanobacteria, fungi, small collembolans, mites, nematodes, protozoans *etc*., They are able to decompose available natural material and transform organic matter into a form that could be absorbed by plants and utilized by other organisms. Therefore, microbiota initiates the detritus food web in the soil, thereby providing food sources for larger fauna. Mesofauna, range in size from 200µm to 10mm and depends on organic matter, microflora and microfauna and those living within soil pores. Microarthropods such as pseudoscorpions, protura, diplura, springtails, mites and small myriapods belong to this category.

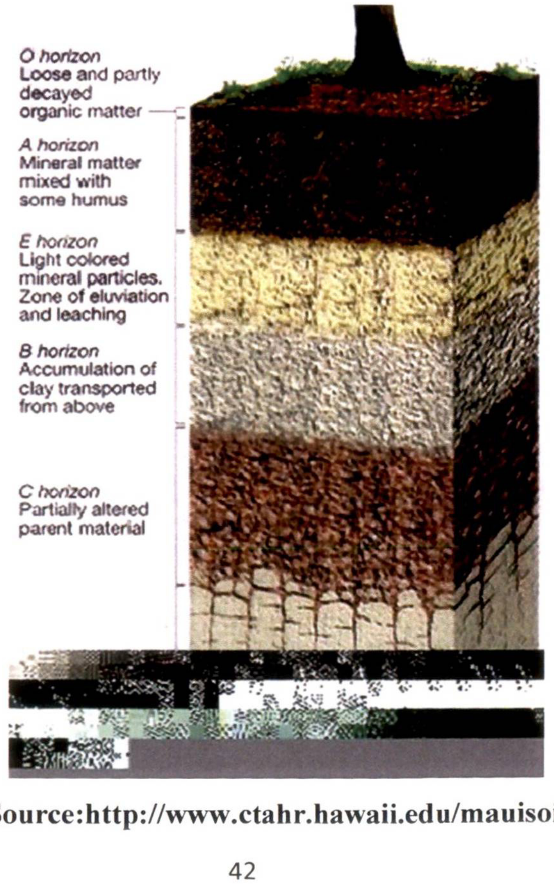

Figure 2. A typical soil profile (Source:http://www.ctahr.hawaii.edu/mauisoil/a_profile.aspx)

Soil macrofauna is defined as invertebrates with a diameter of >2mm in size, and 90% of these individuals are visible to the naked eye (Brown *et al*, 2001). This category includes most of the invertebrates such as snails, earthworms, ants, termites, millipedes, centipedes, caterpillars, cicadas, crustaceans, coleopteran larval stages and adults, larvae of flies and wasps, earwigs, silverfishes, spiders, scorpions, crickets and cockroaches. They are essential inhabitants of leaf litter and the upper soil layer and perform specific ecological roles in the soil. Some authors define vertebrates in soil ecosystem as "megafauna". Gastropods (snails and slugs) can be classified as macro invertebrates because they lack a backbone and an internal skeleton and are visible to the naked eye. Furthermore, they are also classified as epigeic invertebrates, because they survive and feed on soil surface and contribute to the litter breakdown and nutrient release. Arthropods such as ants, beetles, cockroaches, centipedes, millipedes and grasshoppers are also included in to this category. Slugs, insect larvae and mesofauna are also involved in gallery formation in soil. Galleries act as drainage systems that facilitate flow of water, air and soil penetration paths for other surface dwelling invertebrates.

Snails and slugs are a molluscan group of invertebrates that occupy vast habitats on land and aquatic ecosystems. On land, snails are recorded from top layers of soil and above the tree line (Pearce and Orstan, 2006). One of the most important requirement of land snails is moisture (Riddle, 1983). This is because land snails are like leaking bags of water who survive at harsh environmental condition on land. Therefore, they have adapted for mechanical or behavioral strategies for dealing with temporary periods of dryness. Another important requirement of snails is a source of Calcium for the development of their shells. Slugs, who do not possess shells require a less amount of Calcium. Snails that possess a shell act as a Calcium source for small rodents and a certain bird species.

There are several microhabitat requirements for snails such as the amount of moisture, altitude, topography, type of rock and soil composition which in turn influence their distribution in different habitats (Coney *et al.*, 1982). In general, forested areas with shade and leaf litter on the floor are favourable for the living of land snails than cleared disturbed areas. Primary forest patches specially in tropical areas contains large abundance of snail fauna than secondary forests (Clench, 1974). Snails living in soil can be found in areas with continuous supply of moisture throughout the year such as deep piles of leaf litter, depressions, underside of logs, cracks among rocks and moisture loving plants such as ferns. Slugs could be found in the outer few centimeters of the rotten wood, specially in forested areas (Ruiz *et al.*, 2008). In vegetable crop fields, especially in high lands of Sri Lanka, where loose top soil exist, some pest snails and slugs can be found. During day time they burrow into deep layers and tend to come out and feed during the night. These behavioral adaptations have made them difficult pests to be controlled by the farmers.

Litter decomposers include a variety of organisms that range from litter feeding microorganisms to large soil macrofauna such as milipedes, gastropods and earth worms (Bowker *et al.*, 2011). Gastropods are efficient at accessing physically tough material with their radula and they have the ability to synthesize digestive enzymes. Detritivorous gastropods play a major role in nutrient cycling (Ruiz *et al.*, 2008). Saprophagus snails feed and grow well on plant litter material (Ruiz *et al.*, 2008).

Size, limited mobility and propensity to spend their entire lives at a single location due to lack of migratory behaviour are the factors that cause micro-snails to become susceptible to changes in land use, thus considered as faunal indicators that determine the rate of disturbances.

Snail diversity, associated with high levels of snail endemism, is concentrated in tropical rainforest. Habitat change due to fragmentation, loss and transformation of tropical forests, and climate change, and introduction of alien species are the main drivers responsible for the wave of snail extinctions that are taking place at present and have pushed many other snails to the brink of extinction (Douglas *et al.*, 2013).

Snails possess a muscular foot and a shell in which internal organs are stored. Slugs are evolved from snails by reducing and internalizing the shell. The shell may reduce to a flat plate, to a few calcareous granules or it can be completely lost. Their internal organs are in a hollow cavity in which a large portion of the foot resides in. Semi slugs possess a small external shell which the animal can not enter in to and they occupy a position in between snails and slugs. Their internal organs are located as a hump on the back. The muscular foot is partly hollowed to accommodate internal organs (Pearce and Orstan, 2006).

PRESENT STATUS

There are 253 land snail species recorded from the country (MOE 2012) of which 166 species belong to the subclass Pulmonata and the remaining 87 species belong to the subclass Prosobranchia. Thus, the pulmonate group dominates land snails in Sri Lanka.

Vast majority of Sri Lankan land snails spend their entire life in the soil leaf litter layer. However, there are few species (10 species) which are adapted for arboreal life. This includes three species of the endemic genera *Acavus*, four species of *Beddomea* and three species of *Eurychlamys*. Rest of the species (243 species) inhabits leaf litter and top soil layers.

The eight species of slugs found in Sri Lanka (Table 1) generally burrow into deep soil layers in order to escape from harsh environmental conditions such as bright sunlight during the day time and extreme cold during the nights. This behavioral adaptation is especially seen in slugs inhabiting highland agricultural crop fields where loose top soil exists.

Table 1. Slug species found in Sri Lanka

Family	Species	Common English Name	Category
Family: Ariophantidae	*Mariaelladussumieri* (Gray 1855)	Common Shelled Slug	Exotic
Family: Milacidae	*Milaxgagates* (Draparnaud, 1801)	Smooth Jet Slug	Exotic
Family: Agriolimacidae	*Derocerasreticulatum* (Muller 1774)	Grey Field Slug	Exotic
	Deroceraslaeve (Muller 1774)	Marsh Slug	Exotic
Family: Arionidae	*Arionintermedius* (Normand, 1852)	Hedgehog Slug	Exotic
Family: Veronicellidae	*Laevicaulisalte* (Férussac 1821)	Leatherleaf Slug	Exotic
	Semperulamaculata (Templeton 1858)	Tropical Leatherleaf Slug	Native
	Semperulasiamensis (Martens 1867)		Native

Three species of the Acavids belonging to the endemic genera *Oligospira* are known to occupy the top humus layer of the soil (Table 2), while three other members of the same family belonging to *Acavus*genera are adapted for an arboreal life. All three members of *Oligospira* are listed as threatened species that are restricted to few forest fragments in the wet zone. Presence of a loose humus rich top soil layer is essential for their survival.

Table 2. Soil inhabiting Acavids in Sri Lanka

Family	Species	Common English name	National Status (IUCN, 2012)
Acavidae (Sri Lankan Lustful Snails)	*Oligospirapolei* (Collet, 1899)	Sri Lankan White Lip Blunted Snail	EN
	Oligospiraskinneri(Reeve, 1854)	Sri Lankan Small Blunted Snail	EN
	Oligospirawaltoni (Reeve, 1842)	Sri Lankan Common Blunted Snail	VU

Soil fauna plays a vital role in agricultural ecosystems. Diverse soil organisms help in maintenance of a healthy productive soil. The present agricultural management practices are not sustainable because of the impacts caused to the soil fauna. Declining soil diversity due to poor agricultural practices may contribute to long-term degradation of soil, nutrient depletion, reduction in soil fertility, water scarcity, yield reduction and loss of productive land.

GAPS

Lack of awareness, knowledge and inappropriate management of natural biological processes of soil can be identified as the major drawbacks to retain a healthy and productive soil environment. This is mainly due to the decrease activity of soil macrofauna, especially in areas of intensive crop cultivations and fragmented forest areas. More attention should be given to manage natural soil biological processes *via* reinstatement of soil health and enhanced soil fertility that will promote a diverse soil macrofauna. Otherwise, it may adversely affect other soil organisms and people who depend on the productivity of soil.

REFERENCES

Bowker, M.A., Mau, R.L., Maestre, F.T., Escolar, C and Castillo-Monroy, A.P. (2011). Functional profiles reveal unique ecological roles of various biological soil crust organisms. *Functional Ecology***25**: 787-795.

Brown, G.G., Pasini, A., Benito, N.P., de Aquino, A.M. and Correia, E.F. (2001). Diversity and functional role of soil macrofauna communities in Brazilian no-tillage agroecosystems: A preliminary analysis. Paper based on an oral presentation at the " International Symposium on Managing Biodiversity in Agricultural Ecosystems" Montreal, Canada, 8-10 November, 2001. 1-20.

Clench, W.J. (1974). Land shell collecting. In: M. K.Jacobson, ed., *How to Study and Collect Shells*, 4thEd. American Malacological Union, Wrightsville Beach, North Carolina. pp. 67-68.

Coney, C.C., Tarpley, W.A., Warden, J.C. and Nagel, J.W. (1982). Ecological studies of land snails in the Hiwassee River basin of Tennessee, U.S.A. *Malacological Review* **15**: 69-106.

Douglas, D.D., Brown, D.R. and Pederson, N. (2013). Land snail diversity can reflect degrees of anthropogenic disturbance. *Ecosphere***4**(2): Pages?

Giller, P.S. (1996).The diversity of soil communities, the "poor man's tropical rain forest".*Biodiv. Cons.***5**: 135–168.
Lavelle, P., Blanchart, E., Martin, A. and Martin, S. (1993). A hierarchial model for decomposition in terrestrial ecosystems: Application to soils of the humid tropics. *Biotropica*, **25**: 130–150.

Lavelle, P. and Spain, A.(2001).*Soil Ecology*. Kluwer Academics, The Netherlands.

MOE 2012.The National Red List 2012 of Sri Lanka; Conservation Status of the Fauna and Flora.Ministry of Environment, Colombo, Sri Lanka.viii + 476pp

Pearce, T.A. and Orstan, A. (2006).Terrestrial gastropoda.Chapter 22. In. C.F. Sturm, T.A.

Riddle, W.A. (1983). Physiological ecology of land snails and slugs.*In:* W. D. Russell-Hunter, ed., *The Mollusca*, Vol. 6, Ecology. Academic Press, New York. pp 431-461.

Ruiz, N., Lavelle, P. and Jimenez, J. (2008).Soil macrofauna field manual-technical level.Food and Agriculture organization of the united nations, Rome, 2008.

Swift, M. J., Heal, O. W. & Anderson, J. M. 1979. *Decomposition in Terrestrial Ecosystems*. Blackwell Scientific, Oxford.

Web based references-http://www.ctahr.hawaii.edu/mauisoil/a_profile.aspx (accessed 08/07/2013).