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DISTRIBUTION PATTERNS OF THE GENUS *Paludomus* (GASTROPODA: THIARIDAE: PALUDOMINAE) IN MAHAWELI, KELANI, KALU, GIN AND MAHA-OYA RIVER BASINS OF SRI LANKA

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Abstract
Since the publication of Preston's *Fauna of British India – Freshwater Gastropoda and Pelcypoda* in 1915, a vast amount of knowledge has accumulated on the fresh water molluscs. Starmühlner (1974) published a monograph on the fresh water gastropods, in which he listed 31 species of freshwater snails from Sri Lanka. Until the early 20th century, malacologists used mainly conchological characters to describe species. However, the shells of freshwater gastropods are highly variable, show ecological plasticity, and are known to suffer from convergence and homoplasy, and therefore do not always reliably reflect systematic boundaries.

It is already known that other groups of freshwater organisms in Sri Lanka including fish and crabs show high levels of endemism within individual river basins. It remains to be discovered whether molluscs too, show such basin-level endemism. These studies also found that there was significant altitudinal stratification and basin-level endemism of species, a factor that remains to be assessed for aquatic molluscs.

In order to address these questions, and assess the diversity of this fauna, we surveyed the freshwater mollusc fauna (focusing mainly on the genus *Paludomus*) in the Mahaweli, Kelani, Kalu, Gin and Maha-Oya River basins of Sri Lanka. A total of 10 morphospecies were recorded, based on examination of 20 specimens of each species from 20 locations in the altitude range 100-2000 m above mean sea level. Species-level identification is in progress, and further surveys are needed to assess the full diversity of this important fauna.

Key words: freshwater gastropods, distribution, aquatic conservation

Introduction

Sri Lanka bears many geological similarities with parts of the Indian peninsula. The apparent biotic affinities between the mainland and the island in the Western Ghats–Sri Lanka biodiversity hotspot have been interpreted as the result of frequent migrations during recent periods of low sea level. Despite several extended periods of land connection during the past 500,000 years, Sri Lanka has maintained a fauna that is largely distinct from that of the Indian mainland (Bossuyt *et al*., 2004; Cooray, 1967; Somasekaran, 1988). Responding to the diverse ecological conditions and as a result of past history, the biota of Sri Lanka includes a remarkable admixture of elements that are Indian, Indo-Malayan, African, and Eurasian, and also includes a large portion of elements that may be described as endemic to the island. Sri Lanka is now one of the global hotspots for biological diversity (Bossuyt *et al*., 2004; Myers et al., 2000).

The subfamily Paludominae is represented in Sri Lanka by about 50 available names belonging to genus *Paludomus* (Mendis & Fernando, 1962) though some of the names were more recently synonimized. The genus occurs in Sri Lanka, India, the Malay Peninsula and Borneo (Seshaiya, 1934). The genus is characterized by having shells oblong-globes, strong spire shorter than the aperture, and inner lip very thick (Preston, 1915). Exploration of the non-marine molluscs of Sri Lanka commenced long ago. The taxonomic status of the snail fauna is in need of significant revision, taxonomic diversity is likely far greater than was previously recognized (Naggs *et al*., 2003). Since the publication in 1915 of Preston's *Fauna of British India – Freshwater Gastropoda and Pelcypoda*, a vast amount of knowledge has accumulated on the freshwater molluscs (Subba Rao, 1989). Starmühlner (1974), in his monograph on the freshwater gastropods listed 31 species from Sri Lanka (see also Starmühlner, 1977, 1984). Until the early 20th century in most cases conchologists described only shells. However, the shells of fresh water molluscs are highly variable, depending on the ecological features of the local aquatic environment (Starmüehlner, 1974).

It is already known that other groups of freshwater organisms in Sri Lanka including fish (Pethiyagoda, 1991) and crabs (Bahir *et al*., 2005), show high levels of endemism within individual river basins. It remains to be discovered whether molluscs too, show such basin-level endemism. The aim of this study is primarily to assess the distribution patterns of freshwater prosobranch Gastropods in five principal river basins in Sri Lanka: Mahaweli, Maha Oya, Kelani, Kalu and Gin basins.

Materials and Methods

Observations were made especially in Mahaweli, Maha Oya, Kelani, Kalu and Gin basins at 20 sites varying altitudes (as relevant): 100 m, 500 m, 1,000 m, 1,500 m, 2,000 m (Fig. 01).

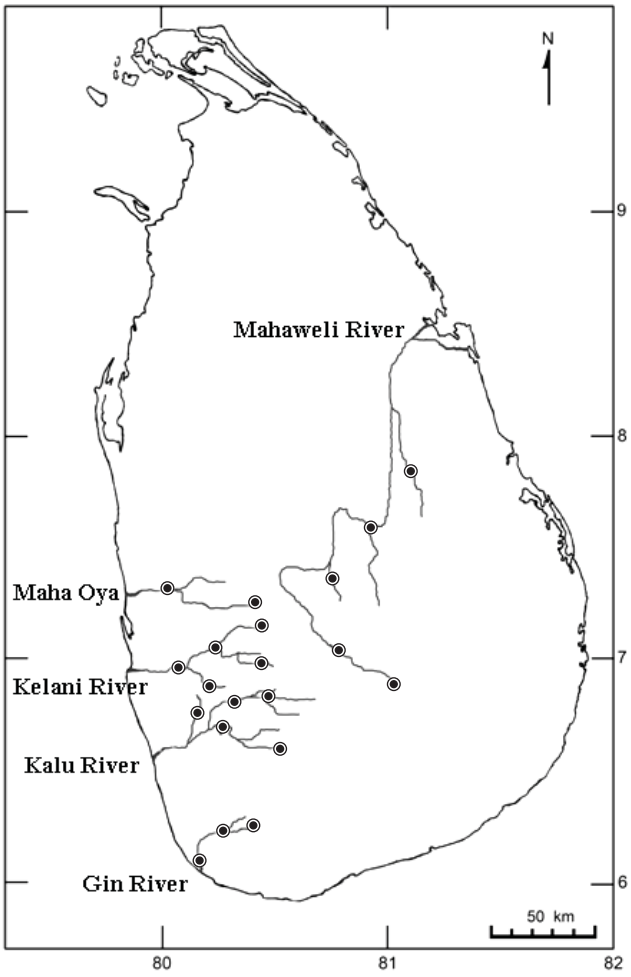

Fig. 01: Study sites in each river basin

Observations were made with the naked eye. Quadrate sampling method was used to determine diversity and abundance. A 1 x 1 m quadrate frame was placed randomly in three places at three depths. Leaf litter and all small stones are removed while counting gastropods. Likewise the same method used for 20 locations in various altitudes in various river basins. The Shannon-Wiener Index was used to determine the diversity: $H = - \sum s\ i = 1\ (Pi)\ (\log Pi)$. H = Diversity of species; S = Number of species; pi = Proportion of individuals in the total sample belonging to the i^{th} species. Diagnosis and descriptions are based on only external morphology (shells) and Mendis & Fernando, 1962; Preston,

1915; Starmüehlner, 1974, 1977, 1979, 1984; Subba Rao, 1989 were used for shell identifications.

Results & Analysis

Species Richness (see Table: 01)**:** 10 species of the genus *Paludomus* have been recorded in five major river basins of Sri Lanka.

Table 01: Species recorded by river basin.

Paludomus Species	River Basin				
	Mahaweli	Maha Oya	Kelani	Kalu	Gin
P. chilinoides	†	†	†		
P. sulcatus		†	†		
P. nigricans	†				
P. bicinctus	†				
P. tanschaurica	†				
P. loricatus			†	†	
P. violacea			†	†	
P. neritoides			†	†	
P. reevei			†	†	
P. regalis					†

Basin Level Endemism (Fig. 02)**:** According to the above distributions, three species (30%) are endemic to the Mahaweli basin; four species (40%) to the Kalu and Kelani basins and a single species (10%) to the Gin River basin. Eight species (80%) show basin-level endemism.

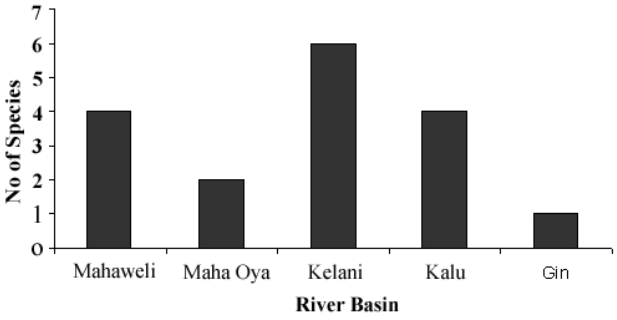

Fig. 02: Number of species recorded in each basin

Altitudinal Stratification (Fig. 03)**:** The greatest diversity of species (8) was observed at about 500 m altitude, while 70% of the total occurred at 1000 m. The highest numbers of taxa are stratified between the 500 m and 1000 m. Only two species (20%) are stratified at 2000 m and above. *Paludomus loricatus* (2000 m) and *P. nigricans* (2000 m) were represented at the highest altitudes while *P. chilinoides* (100 m), *P. sulcatus* (100 m), *P. tanschaurica* (100 m), *P. loricatus* (100 m) and *P. neritoides* (100 m) were represented at the lowest altitudes. Here *P. loricatus* (100 m – 2000 m) represented the lowest and highest altitudes. *Paludomus loricatus* shows a wide altitudinal distribution while *P. regalis* and *P. reevei* are restricted to a particular altitude, 500 m and 1000 m respectively. Most of the species are altitudinaly stratified in to contracted ranges; *P. chilinoides* (100 - 1000 m), *P. sulcatus* (100 – 500 m), *P. nigricans* (1000 - 2000 m), *P. bicinctus* (500 – 1500 m), *P. tanschaurica* (100 - 1000 m), *P. violacea* (500 – 1000 m) and *P. neritoides* (100 - 500 m).

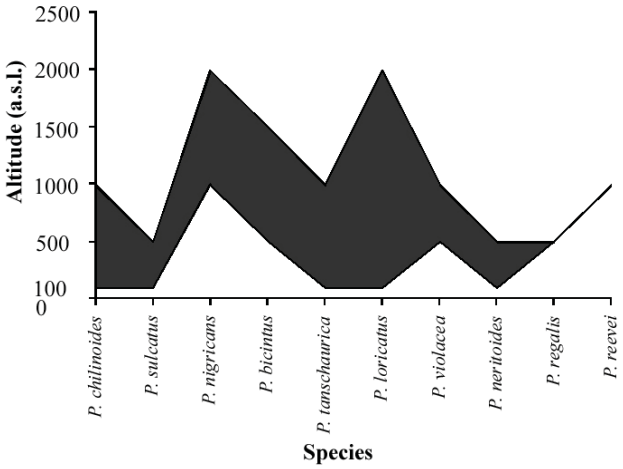

Fig. 03: Species recorded by altitude

Species Abundance**:** The abundance of *P. chilinoides* and *P. loricatus* is very high in comparison to other species. *Paludomus chilinoides* is most abundant in the Maha Oya and Kelani basins while *P. loricatus* is abundant in the Kelani and Kalu basins. When considering the abundance of *Paludomus* species at each altitude, the abundance of *P. chilinoides* and *P. loricatus* is very high comparatively to other species. *Paludomus chilinoides* is most abundant at 500 m a.s.l while *P. loricatus* is highest at 100 m a.s.l. According the recorded species, *P. loricatus* and *P. chilinoides* are the most abundant and *P. reevei* is the least abundant species.

Species Diversity**:** When considering the diversity in each basin, the Gin River basin (H=0) shows the lowest diversity while the Mahaweli (H=0.454) and Kelani (H=0.433) basins show the highest diversity. As a conclusion the diversity of *Paludomus* species in every basin is apparently low. When considering

the diversity at each altitude, the 2000 m a.s.l (H=0.178) shows the lowest diversity while the 1000 m a.s.l (H=0.604) shows the comparatively highest diversity. As a conclusion the diversity at every altitudinal stratum too, is very low.

***Relative Frequency*:** *Paludomus loricatus* and *P. chilinoides* show the highest relative frequency, nearly 90% of the total count of individuals. The least related frequency was represented by *P. reevei*, acounting for only 3% of the total individual count.

Discussion and Conclusion

After considering the distribution patterns of the genus *Paludomus* in each basin, there is a considerable variation of the number of species in each river basin. Species richness and distribution are likely affected by a number of factors, including the size of the river/stream system, depth of the river/stream, number of branched streams, forest cover, bottom formation of the river/stream, altitudinal variation of the river/stream, and agricultural runoff including fertilizer, persitcides, and herbicide chemicals. However, most *Paludomus* species show highest abundances in rocky-bottomed, narrow, shallow, shady, slow-moving rivers/streams. The same species was recorded with the same population sizes at various water pH and BOD levels. We therefore assume this group can tolerate a wide variety of water-quality conditions. Further, it appears that some *Paludomus* species can survive cessation of water flow, for periods of up to several days. Further, some species survive with considerable population sizes in polluted water bodies.

As with Sri Lankan arthropods and ichthyofaunal, basin-level endemism is evidently also high. All of the recorded *Paludomus* species except *P. loricatus* showed altitudinal stratification. The highest abundance and diversity was recorded within the range of 500 – 1000 m a.s.l. Also there is a considerable difference in relative frequencies of species. The species that showed wide distribution also showed high relative frequencies. And also these widespread species show clinal variations. Using only shell morphology it was very difficult to identify these species. Starmühlner (1974) also mentioned that the shells of freshwater molluscs were very variable, influenced by the ecological features of the local aquatic environment. The taxonomic status of a number of Sri Lankan molluscs poorly defined. The ecology and biology of only a few species have been investigated, thus making it difficult for their proper placement in the modern system of classification. However further observations and study, especially taxonomic review and application of molecular systematic techniques are needed to clarify whether this is a clinal variation or a distinct species. After critical taxonomic reviews these species may be changed.

Genus *Paludomus* is known to include both endemic radiations as well as highly invasive forms and there has been no recent work on the Sri Lankan freshwater snails. Therefore it is our hope that this study, while preliminary, may help to raise awareness and provide a comprehensive bibliography for the Sri Lankan freshwater molluscs, as well as providing data regarding the relative frequency distributions of species, across the five principal basins and at varying altitudes within each basin.

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