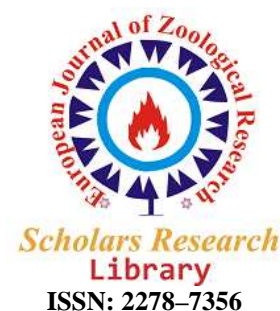




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A study of terrestrial molluscs with respect to their species richness, relative abundance and density in Toranmal Reserve Forest, North Maharashtra, India

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ABSTRACT

Toranmal reserve Forest is located in Nandurbar district of Maharashtra, India. It is situated around 21° 52' North Latitude and 74° 27' East longitude at an altitude of 1143 m AMSL. in the Satpura ranges. Species richness, relative abundance and density of terrestrial molluscs were studied over two year period in various microhabitats of the area. Total five species of terrestrial molluscs were observed during study having different relative abundance in various habitats. Maximum species richness and density were observed during monsoon while minimum in summer. It is observed that seasonal variation not only links with seasonal dynamics but also with various factors such as rainfall, humidity, etc. (abiotic), cattle grazing (biotic) and also structure of habitat (e.g. soil, leaf litter, etc.).

INTRODUCTION

Molluscs are highly successful invertebrates in terms of ecology and adaptation and are found nearly in all habitats ranging from deepest ocean trenches to the intertidal zones, and freshwater to land occupying a wide range of habitats. Much of the molluscan diversity occurs in the tropical world. Despite this great diversity, very few studies on molluscs have been carried out in the tropical world. The rich land snail diversity from tropical rain-forest is mainly found in the leaf litter and the soil [1]. Most of these tropical molluscs remain to be described due to their minute sizes [1]. Recently a couple of compilation works on land snails have been published by the Zoological Survey of India. Endemic land molluscs of India were published by [2]. An attempt to address the diversity, endemism and geographical distribution patterns of land snail of Western Ghats has been made by [3]. Till date 1487 species of land snails belonging to 32 families and 140 genera have been reported in India [2]. With their biomass this diversity is of great ecological significance.

Land snails are regarded typically as generalist herbivores, frugivores and detritivores [4]. Previous studies on land molluscs have shown that molluscs are influenced by various environmental factors. They have specific habitat preferences [5]. and are influenced by rainfall via primary productivity[6]. As their habitat preference is strongly associated with vegetation and leaf litter on the forest floor [7]. the soil texture, moisture and temperature are the predictors of composition of molluscs [5]. However, the predation pressure as well as habitat degradation due to human activities are also reported to affect molluscan diversity [7].

While studying biodiversity of Toranmal area in North Maharashtra an attempt is made to document density and diversity of the land molluscs present in the surrounding tropical forest at higher altitude Toranmal Reserve Forest.

MATERIALS AND METHODS

Study Area

1) Khadki area (LmKh)

It is located at 21° 51' 56" N and 74° 27' 07" E and at 1003 m AMSL, extreme northwest of Toranmal plateau. It is plain area with degraded forest, very few tall trees such as *Phyllanthu emblica*, *Terminalia arjuna*, *T. bellirica*, *Butea monosperma*, *Acacia chundra*, etc. and many herbs, shrubs and grasses that start drying from post-monsoon. Cattle grazing is frequently observed in the area. The soil is mainly dry.

2) Kalapani area (LmKp)

It is located at 21° 51' 04" N and 74° 28' 07" E and at 824 m AMSL. 10 Km before Toranmal. It is a forested and hilly area. Natural vegetation is of dry deciduous forest type mainly comprising *Tectona grandis* with many herbs, shrubs and grasses. The wild weeds *Achyranthus aspera*, *Cassia tora*, *Vernonia cinerea*, *Tridax procumbens* and *Andropogon spp* are abundant. The ground is moderately covered with leaf litter and cattle grazing is also observed in this area.

3) Yashwant Lake area (LmYL)

The habitat is located on western side of Yashwant Lake at 21° 52' 47" N and 74° 27' 17" E and 980 m AMS with mix vegetation. Large trees present include *Madhuca longifolia*, *Phyllanthus emblica*, *T. arjuna*, *T. bellirica*, *Syzygium heyneanum* and *Mangifera indica*. Ground is covered with various herbs and shrubs like *Lantana camera*, *Tridax procumbens*, *Plectranthus mollis*, *Cassia obtusifolia*, etc. The soil is slightly damp due to dense vegetation cover. The area showed low level of cattle grazing and anthropogenic activities.

Sampling Method

Quantitative and qualitative estimation of land molluscs were carried out by using quadrat method [8, 9]. At least six quadrat (1 × 1m) were sampled from each of the habitat. The average of these was considered as density and species richness per m² for that habitat. The specimen not identified in the field were preserved in 4 % formalin and carried to the laboratory and identified by using standard keys and monographs [10, 11, 12, and 13].

Analysis

The data of the two year study (from December-2006 to November-2008) was pooled for three months and four seasons and analyzed for seasonal variations. The Mean and Standard Error of Mean (SEM) were calculated for each season and applied to One-Way ANOVA to find out seasonal variations. The Pearson correlation was calculated by keeping mollusc as dependent variable and abiotic factors as independent variables.

RESULTS

Total five species of land molluscs, all gastropods, were recorded from Toranmal area over two year study (December 2006 to November 2008) belonging to five genera and three families (Annexure). These gastropods include two slugs and three snails.

Density and species richness

When three habitat of Toranmal are considered the density and species richness showed following trends (Table 1).

Relative abundance of Land Mollusc (Table 2)

Among five species of Land molluscs the relative abundance of *M. indica* was maximum 30.8 % at LmKh followed by *A. laevis* (25.8 %), *C. moussonianus* (19.3 %), *S. maculate* (12.5 %) and *L. alte* minimum 9.6 %. The trends were different at other two habitats with higher relative abundance of *C. moussonianus* (24.3 %), *A. laevis* (23.2 %), *M. indica* (21.8 %) and lower of *S. maculate* (16.4 %) and *L. alte* (14.3 %) at LmKp. At LmYL relative abundance of *A. laevis* (24.8 %) and *S. maculate* (23.2 %) were higher followed by *L. alte* (19.8 %) while that of *M. indica* (17.7 %) and *C. moussonianus* (14.5 %) were lower.

When **Pearson Correlation (Table3)** was performed, the density and species richness of Land mollusc showed positive significant correlation with humidity and rainfall at the 0.01 level, while (density and richness) established non-significant (negative) correlation with atmospheric temperature and wind. Significant positive correlation is established between density and species richness of molluscs.

Table: 1. Seasonal Variations in density (no/ m²) and Species richness (No. of species) of Land Molluscs of Toranmal area at different habitat during December 2006 to November 2008

Parameters	F value	Winter	Summer	Monsoon	Post-monsoon
Total density (LmKh)	F _{3 20} 26.91	3.41 ± 0.3	0.33 ± 0.16	6.33 ± 0.89	1.83 ± 0.33
Species richness(LmKh)	F _{3 20} 13.02	1.66 ± 0.33	0.17 ± 0.10	3 ± 0.26	1.16 ± 0.30
Total density (LmKp)	F _{3 20} 16.37	3.5 ± 0.34	0.66 ± 0.37	6.58 ± 1.08	2 ± 0.43
Species richness (LmKp)	F _{3 20} 16.46	2.5 ± 0.22	0.58 ± 0.42	3.33 ± 0.21	1.67 ± 0.21
Total density (LmYL)	F _{3 20} 52.75	4.25 ± 0.21	0.91 ± 0.45	8.91 ± 0.79	2.17 ± 0.25
Species richness (LmYL)	F _{3 20} 18.25	3.16 ± 0.17	0.83 ± 0.54	4.17 ± 0.30	2.10 ± 0.17

Habitat : Khadki area (LmKh); Kalapani area (LmKp); Yashwant Lake (LmYL); Land molluscs (Lm).

Table: 2. Relative abundance (%) of Land Molluscs of Toranmal area at different habitat during December 2006 to November 2008

Sr.No.	Name of the species	LmKh	LmKp	LmYL
1	<i>L. alte</i>	9.6	14.3	19.8
2	<i>S. maculata</i>	12.5	16.4	23.2
3	<i>C. moussonianus</i>	19.3	24.3	14.5
4	<i>A. laevipes</i>	25.8	23.2	24.8
5	<i>M. indica</i>	30.8	21.8	17.7

Table 3. Pearson Correlations: Land Molluscs(Lm) density and species richness with Abiotic parameter in Toranmal region during December 2006 to November 2008

	AT	DLM-Kh	DLM-Kp	DLM-YI	HUMI	RF	SPR Kh	SPR Kp	SPR YI	WIND
AT	1.000									
DLM1	-.152	1.000								
DLM2	-.142	.925**	1.000							
DLM3	-.055	.920**	.951**	1.000						
HUMI	.240	.721**	.725**	.711**	1.00					
RF	.279	.812**	.825**	.830**	.952**	1.000				
SPRL1	-.071	.805**	.701**	.772**	.627**	.662**	1.000			
SPRL2	-.279	.827**	.846**	.857**	.601**	.630**	.731**	1.000		
SPRL3	-.317	.802**	.736**	.802**	.557**	.597**	.812**	.874**	1.00	.060
WIND	.729**	.260	.226	.346	.394	.518**	.261	.069	.060	1.000

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed).

DLM , DLM , DLM : Density of Land Molluscs and SPR , SPR , SPR : Species Richness of Land Molluscs at Kh,Kp,YI (Khadki area,Kalapani area, Yashwant lake area respectively),AT-atmospheric temperature, Humi-Humidity, RF-rain fall.

DISCUSSION

In the present study of land molluscs, the density and richness (pooled together for the three habitat studied) were significantly correlated positively with the rainfall. The probable explanation lies in the energy present in the ecosystem. The “more individual hypothesis” of [14] postulates that more productive areas have more individuals. Further [15]. argued that at the base of global web plant richness is limited ‘primarily by solar energy and water availability (*i.e.* water energy dynamics) indicating that productivity depends on water. The main driving component in the primary productivity around Lotus Lake is mainly governed by the southwest monsoon in the Toranmal area. Hence, the monsoon is one of the determinant factors in the density and distribution of vegetation in the area which in turn influences the higher taxa as is also reported by [6].In monsoon, rainfall also favours the decomposition of leaf litter favouring detritivorous species and hence leads to their higher density and richness Further, rainfall and moderate temperature together maintain higher humidity supporting vegetation, shelter and food supply to molluscs. Food and shelter are required for successful breeding of any organism. Hence, availability of food and shelter in monsoon may increase breeding performance of molluscs. Significant positive correlation is established between density as well as species richness of the molluscs with humidity. Atmospheric temperature showed non-significant negative correlation indicating that moderate temperature of monsoon is preferred by molluscan community on land.

Habitat of molluscs

Land molluscs were surveyed only at limited ecological (only three habitat sub types) and geographical (within 10 Km radius) scale around Lotus Lake in Toranmal areas. However, few significant correlations were established in the study. The three different habitats showed variation in richness, density and relative abundance of species. In monsoon, maximum density and richness of land molluscs were recorded which were highest around Yashwant Lake area (LmYL) and lowest in Khadki area (LmKh). The highest density of land molluscs in monsoon with highest density around Yashwant Lake indicates the dependency of these gastropods on soil moisture. Further the Mollusc species diversity and abundance has been reported to increase with the floristic diversity (Barker and Mayhill, 1999) which is true for Yashwant lake too where floristic diversity was also high (personal observation). [17] and [18] have reported that mollusc communities can differ between vegetation community types. Sites of high floristic diversity can be presumed to have higher fractional complexity and more varied inhabitable substrate (microhabitat differentiated) than sites of low floristic diversity. It is observed that although the floristic diversity of Kalapani area was also high the density and richness of mollusc were moderate. Kalapani area is hilly with slope and comparatively dry soil and low litter depth compared to LmYL. Snail communities are influenced primarily by the diversity of plant species making up the forest floor litter [19]. These factors may be correlated to the variations in relative abundance of species. At both LmKp and LmYl *A. laevipes* was one of the dominant species, whereas, at LmKp *C. moussonianus* and *M. indica* shared dominance almost at equal level while at LmYl only one species *S. maculate* dominated. Further, though *A. laevipes* was dominant at LmKp, *M. indica* had higher relative abundance at the site (Table 2). This indicates that species composition and relative abundance of different species differs in the three microhabitats studied. It is reported that the *A. laevipes* and *C. moussonianus* prefer wet rocks having algae or lichens and shady places [20] which were abundant at LmKP and LmYL in monsoon favouring these species. However *S. maculate* and *L. alte* known to be abundant near the horticultural crops in the field particularly associated with cucurbitaceae [20]. Khadki area which is a habitat characterized by very few trees and open ground covered with grasses and herbs. As the land molluscs are associated with vegetation, their lowest density and richness were noted at Khadki area. Sparse and low vegetation also lowers humidity and leaf litter layers. According to [5] soil moisture and sunlight levels influence land snail community composition with the driest and sunniest habitats (Upland grasslands) being most different in land snail composition from wet shaded lowland forests. Hence, at Khadki the shelled protected molluscs (*M. indica*, *A. laevipes* and *C. moussonianus*) appeared dominant over slugs (*L. alte* and *S. maculate*). At Khadki the layer of leaf litter was low. The leaf litter is a highly complex three dimensional, horizontally stratified habitat. Thus, the reduced habitat structure in this area may be attributed to overall lowest density and richness of the molluscs at Khadki. In addition, the influence of anthropogenic pressure and land use pattern cannot be ruled out. At Khadki, cattle grazing activity was seen frequently. Grazing may influence molluscs indirectly by altering the amount and quality of the food supply and by changing the microclimate, or directly by trampling the snail shells [21, 22].

CONCLUSION

To conclude, we can say that land mollusc density and richness were associated with abiotic factors such as rainfall and humidity as well as characteristic of soil, leaf litter distribution on ground and biotic factors such as vegetation cover and various anthropogenic pressure such as land use, cattle grazing etc. So from conservation point of view proper management of vegetation and land use pattern should be considered. Monsoon was favourable for land molluscs at Toranmal.

Annexure

Land Molluscs of Toranmal (Observed during December 2006 to November 2008)

Phylum :Mollusca

Class mesogastropoda

Order : Systellommatophora

Family: Veronicellidae

LM 1 *Laevicaulis alte* Ferussc

LM 2 *Semperula maculate* Templeton

Order: Stylommatophora

Family: Cerastidae

Sub-family: Napaeinae

LM 3 *Cerastus moussonianus* Petit

Family: Ariophantidae

Sub-family: Ariophantinae

LM 4 *Ariophanta laevipes* Muller
 Sub-family: Macrochlamydiae
 LM 5 *Macrochlamys indica* Godwin

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