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Microhabitat use by land snail's assembly of the tropical karstic forest at Escaleras de Jaruco, Cuba

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Abstract: A survey of the microhabitat used by land snails in the tropical karstic forest at Escaleras de Jaruco, Cuban was carried out. A total of 30 plots of 9 m^2 in three low hills (ten in each) were sampled during four months of the wet season (from August to November 2009) and four months of the dry season (from January to April 2010). In the rock microhabitat it was reported the highest values of absolute abundance, following by litter and vegetation. The highest values of absolute snail abundance occurred in the rock microhabitat in the wet season, while in the dry season litter show the highest absolute abundance. *Farcimen tortum* was most abundant in litter microhabitat, *Chondropoma pictum* was the most abundant in the vegetation and *Torrella inmersa* was most abundant in the rock microhabitat.

Keywords: terrestrial molluscs, substrate used, season dry and wet.

Resumen: *Uso del microhábitat por ensamblaje de moluscos terrestres del bosque tropical cársico de Escaleras de Jaruco, Cuba*. Se realizó un estudio del uso del microhabitat por los caracoles terrestres en el bosque tropical cársico en Escaleras de Jaruco, Cuba. Un total de 30 parcelas de 9 m^2 en tres elevaciones de baja altura (diez en cada uno) fueron muestreadas durante cuatro meses de la temporada húmeda (desde agosto a noviembre de 2009) y meses de la temporada seca (desde enero a abril de 2010). En el microhabitat de roca se registraron los valores más altos de abundancia absoluta, seguido de la hojarasca y la vegetación. Los valores más altos de abundancia absoluta se detectaron en el microhabitat de roca en la temporada lluviosa, mientras que en la temporada de seca la hojarasca mostró la abundancia absoluta más alta. *Farcimen tortum* fue más abundante en el microhábitat de hojarasca, *Chondropoma pictum* lo fue en la vegetación y *Torrella inmersa* en el microhábitat de roca.

Palabras claves: moluscos terrestres, uso del sustrato, temporada lluviosa y seca.

Studies of microhabitat use of Cuban land snails have been largely based on their occurrence in a given microhabitat and the height of the substrate used. These have focused mostly on charismatic ground–dwelling and arboreal species such as: *Polymita picta nigrolimbata*, *Coryda alauda*, *Caracolus sagemon* (see Bidart and Espinosa 1992), *Polymita muscarum* (see Fernández *et al*., 2000), *Liguus fasciatus* (see Álvarez and Berovides, 1989), *Polymita muscarum*, *L. fasciatus achatinus* and *Hemitochus lucipeta* (see Bidart *et al*., 1992). Tropical karstic (calcareous) forest at the Paisaje Natural Protegido Escaleras de Jaruco-Tapaste-Cheche is home to a number of non-charismatic species whose ecologies are poorly understood. This paper investigates the use of three different microhabitats (rock, litter and vegetation) by the land snails of Escaleras of Jaruco during two contrasting climatic periods in late 2009 and early 2010 comprising wet and dry season respectively.

The study was carried out in the Escaleras of Jaruco Tapaste Cheche Natural Protected Area (23° 00' 00" N y 82° 01' 27" W y 23° 03' 27" N y 82° 08' 20" W) which consists predominately of hard limestone outcrops. The area in which the study sites were located is a calcareous outcrop of Miocene age approximately 15 km long and 3 to 7 km wide with hills approximately 300 m a.s.l. The study was carried out in three low hills: Beluca, La Chirigota and La Jaula. Vegetation at each site was tropical karstic forest Borhidi (1991).

The study was carried out monthly in the wet season from August to November 2009 and in the dry season from January to April 2010. In each locality, ten plots measuring of 9 m^2 separated by more than 20 m were selected, and visited during each of these periods. In all plots, rock, litter and vegetation microhabitats were surveyed and the number of individuals and species of land snail were recorded. Each microhabitat was analyzed independently since the microhabitats of the different areas were not directly comparable. Variables used were the absolute and proportional abundance of snails. Active and inactive individuals were counted and analyzed in each of the two seasons.

SIMPER analysis (Similarity/distance Percentages) was conducted on the findings for which the species were the variables and the samples were the combinations of factors: hill, period and microhabitat; using Primer software (Version 6.1.6). The results of this analysis showed which species contributed most to the similarity between the two seasons (only those species whose summed contributions reached over 80 %, were considered), when comparing the same microhabitat A Student "t" test was applied to compare the absolute abundance of the species within each of the microhabitats between the two periods using Statistica version 8.0.

In order to identify the specimens Potamidae and Urocoptidae families were used the catalogs of Torre and Bartsch (1938; 1941; 2008). Also, land snails section of the zoological collections of the Academy of Sciences of Cuba (CZACC) deposited at Ecology and Systematics Institute were consulted. The taxonomic arrangement used herein follows Bouchet *et al*. (2005).

Twenty-one species of land snail were identified in all microhabitats in the three sites over the two seasons of sampling. In general, the absolute abundance (live individuals) of snails was highest in rock microhabitat (31 ± 30 SD), following by the litter (18 ± 4 SD) and the vegetation (5 ± 4 SD). In wet season, the absolute abundance of snails was highest in the rock (mean abundance for the season: 58 ± 24 SD), and decreased in the litter (21 ± 4 SD), vegetation (8 ± 4 SD) direction. During the dry season, absolute abundance of snails was highest in litter (15 ± 1 SD) followed by rock (4 ± 3 SD) and vegetation (2 ± 1 SD). The absolute abundance of active individuals in comparison with the inactive was higher in the rock and vegetation microhabitats, although this difference was not significant, while in the litter the abundance of inactive compared to the active individuals was higher and significantly different (Fig. 1).

Typically, limestone landscapes are characterized by the presence of a diverse fauna of land snails in terms of total number of species and abundance of individuals. Several papers have reported the high number of taxa and particularly the abundance of species that inhabit on rock compared to other microhabitats as the litter, vegetation and fallen trunks (Pérez, 1999; Schilthuizen, 2003; Sólymos *et al*., 2009; Schilthuizen, 2011). Similar performance in abundance over the two seasons was found in the present study, where the rocks exhibited the highest values of absolute abundance followed by litter and vegetation microhabitats, respectively. A similar pattern was observed in the wet season. However, during the dry season, litter showed the highest abundance.

Values of absolute abundance for species at three microhabitats in two seasons are showed in Table 1. The highest values of absolute abundance of snails occurred in the rock microhabitat for wet season, while for the dry season occur in the litter. In rock *Torrella inmersa*, *Rhytidopoma nodulatum* and *Chondropoma pictum* showed the highest values of abundance, while *Setipellis stigmatica*, *Helicina aspersa* and *Jeanneretia bicincta* were the least abundant. *Farcimen tortum* showed highest values of absolute abundance in the litter, follow of *C pictum*, *T. inmersa* and *R. nodulatum*, respectively. In vegetation microhabitat, the

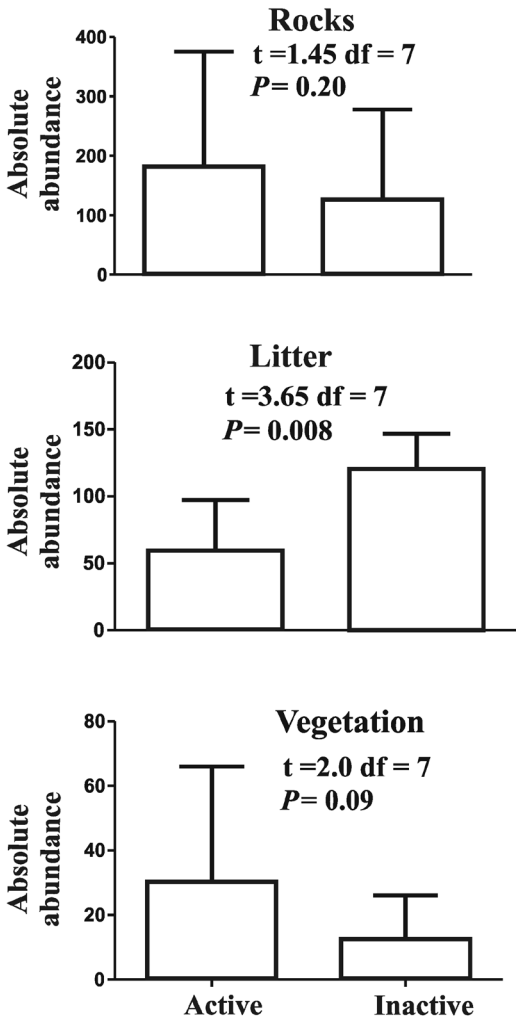

Figure 1. Mean and standard deviation of the absolute abundance of active and inactive individuals of three studied microhabitats at Escalera de Jaruco, Mayabeque, Cuba. Each panel shows values of the Student *t* test for *N*= 8.

Figura 1. Promedio y desviación estándar de la abundancia absoluta de individuos activos e inactivos de tres los microhabitats estudiados en Escalera de Jaruco, Mayabeque, Cuba. Cada panel muestra valores de la prueba *t* de Student para *N*=8.

abundance of the majority of the species was low. *C. pictum*, *J. bicincta*, *H. aspersa*, *C. auberianum* were the most abundant (Table 1). *H. aspersa* is known for its arboreal habits (Espinosa and Ortea, 2009), however, it was also observed (with lower abundance) on the rocks and litter. Observation in the field showed that this species displayed an active behaviour only on rocks adhering to dry leaves in the litter. However, it is possible that this species' presence on leaves in the litter may be due to it having been present on the leaves prior to their falling.

Values of SIMPER for every microhabitat during both seasons are shown in Table 2. On rock, unlike the rest of the substrates, a higher percentage of similarity (over 85 %) was attained for both season due to four species; *Torrella inmersa* was the more abundant and contributed most to the similarity between both seasons. On litter and vegetation *Farcimen tortum* and *Chondropoma pictum* are responsible for more than 75 and 80 %, respectively of similarity in both periods. In the three microhabitats the species

Table 1. Values of absolute abundance of the observed land snail species in each studied microhabitat in Escalera de Jaruco, Mayabeque, Cuba.

Tabla 1. Valores de la abundancia absoluta de las especies de moluscos terrestres en cada microhábitat estudiado en Escalera de Jaruco, Mayabeque, Cuba.

Species	Wet season			Dry season			Total
	Rocks	Litter	Vegetation	Rocks	Litter	Vegetation	
Alcadia hispida (Pfeiffer, 1839)	3	4	7	-	3	-	17-
Chondropoma auberianum (d'Orbigny, 1842)	-	3	15	-	-	5	23
Chondropoma pictum (Pfeiffer, 1839)	275	106	220	25	44	11	681
Emoda submarginata (Gray, 1824)	-	-	1	-	1	-	2
Eurycampta bonplandi (Lamarck, 1822)	-	-	1	-	-	-	1
Eutudora jimenoi (Arango in Pfeiffer, 1864)	158	2	1	12	20	-	193
Farcimen tortum (Wood, 1828)	104	510	-	9	438	-	1061
Gongylostoma planospira (Pfeiffer, 1855)	17	8	-	3	4	-	32
Helicina aspersa Pfeiffer, 1839	5	8	15	4	3	11	46
Hojeda boothiana (Pfeiffer, 1839)	1	-	2	-	-	-	3
Jeanneretia bicincta (Menke, 1830)	4	12	16	6	5	-	43
Liguus fasciatus (Müller, 1774)	-	-	3	-	3	-	6
Microceramus perconicus Pilsbry, 1904	-	-	1	-	-	-	1
Oleacina straminea (Deshayes, 1819)	23	16	2	1	3	-	45
Rhytidopoma nodulatum (Poey, 1851)	403	43	2	29	6	-	483
Setipellis stigmatica (Pfeiffer, 1841)	6	3	2	10	3	-	24
Torrella inmersa (Gundlach in Pfeiffer, 1857)	981	99	10	31	22	-	1143
Ustronia sloanei (d'Orbigny, 1842)	324	18	1	16	8	-	367
Veronicella sp.	-	4	1	2	2	-	9
Zachrysia auricoma (Férussac, 1822)	-	-	2	-	1	1	4
Zonitoides arboreus (Say, 1862)	13	20	13	2	16	-	64

Table 2. Values of abundance and percentage of similitude of land snail species for microhabitats among the wet and dry season at Escaleras de Jaruco, Mayabeque, Cuba. Only the species, whose summed contributions reached over 80 %, were considered.

Tabla 2. Valores de abundancia y porcentajes de similitudes de las especies de moluscos terrestres, así como su contribución entre las estaciones lluviosa y de seca en Escaleras de Jaruco. Se tuvo en cuenta las especies cuyas contribuciones sumadas alcanzaron más de 80 %.

Species	Abundance mean	Standard desviation	Contribution %	Acumulate contribution %
Rock				
Torrela inmersa	16.87	0.76	37.31	37.31
Chondropoma pictum	5.0	0.69	28.18	65.49
Ustronia sloanei	5.67	0.48	10.85	76.33
Rhytidopoma nodulatum	7.2	0.48	9.21	85.54
Litter				
Farcimen tortum	15.8	1.39	77.18	77.18
Chondropoma pictum	2.5	0.71	10.62	87.8
Vegetación				
Chondropoma pictum	3.85	0.56	81.52	81.52

that contributed most to the similarity between both seasons were operculates. This dominance may be due to the presence of an operculum that allows the snail to seal itself off from the changing environmental conditions between wet and dry seasons. Short-term aestivation does occur in some annulariids, such as Jamaican species of *Tudora* (see Russell-Hunter 1964). This event may be occurring in the annulariids reported here and explain their major contribution between both seasons (*T. inmersa*, *C.pictum* and *Rhytidopoma nodulatum*)

Torrella inmersa, *Rhytidopoma nodulatum* and *Ustronia sloanei* showed high abundance on the rock and litter, and rarely in the vegetation. Perhaps the selection of the rock is related to their small size, since it would be more beneficial for these species to withdraw to a place where ambient humidity is high. This is usually the case in rock and litter microhabitats and reduces the possibility of dehydration. *Farcimen tortum* was most abundant in litter microhabitat during the rainy months compared with the rest of species, and was also more abundant here during the dry season. The latter result may be due to an increase in litter (fallen leaves) creating favorable conditions of humidity. The high abundance of *Chondropoma pictum* in all the microhabitat suggests that this species is a generalist, which is a great advantage for exploiting the major part of the structural niche thus making the search for food easier (fundamentally mosses and lichens according to field observations recorded in this study).

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