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Interspecific variability in the abundance of small rodents in the highlands of Chiapas, Mexico

Laura E. Cruz[1], Consuelo Lorenzo[1], Oscar G. Retana[2] and Eugenia C. Sántiz[1]

Abstract

We provide data on small rodent species abundances and community composition over a one year period at four locations comprising two contrasting habitats, agricultural areas (corn fields) and ecological reserves, in the Municipality of San Cristóbal de Las Casas, Chiapas. 469 captures of nine species of murid rodents were recorded in total, the most abundant of which included *Reithrodontomys fulvescens*, *Sigmodon hispidus*, and *Peromyscus levipes*. The highest number of captures (272) was recorded during the dry season, and the highest species richness (7) during the rainy season in an agricultural area. We found significant statistical differences in number of captures between the dry and wet seasons only for the Ecological Reserve Moxviquil.

Key words: Diversity, relative abundance, small rodents, agriculture areas, natural reserves, Chiapas, Mexico.

Resumen

En este estudio proporcionamos datos sobre la abundancia y composición de especies de pequeños roedores durante un ciclo anual en cuatro localidades representadas por dos hábitats contrastantes: cultivos de maíz y Reservas Ecológicas, en el Municipio de San Cristóbal de Las Casas, Chiapas. Se registraron en total 469 capturas de nueve especies de roedores múridos, de las cuales las más abundantes fueron *Reithrodontomys fulvescens*, *Sigmodon hispidus* y *Peromyscus levipes*. El mayor número de capturas (272) se registró durante la época seca y la mayor riqueza de especies (7) durante la época de lluvia en un área agrícola. Encontramos diferencias significativas en el número de capturas en época seca y de lluvia solamente para la Reserva Ecológica Moxviquil.

Palabras clave: Diversidad, abundancia relativa, pequeños roedores, áreas agrícolas, reservas naturales, Chiapas, México.

Introduction

Mammals are very important in the maintenance of diverse ecosystems, including the forest (Ramírez-Pulido and Briton 1981). Unfortunately, the progressive and continuous perturbation of natural habitat by human activities is causing both the loss of animal and plant diversity (Fey-Alvarado 1976; Sánchez-Hernández 1981), and changes in

[1]Departamento de Ecología y Sistemática Terrestres, El Colegio de la Frontera Sur. Carretera Panamericana y Periférico Sur s/n. San Cristóbal de Las Casas, Chiapas. México CP 29290, E-mail: clorenzo@ecosur.mx (CL)
[2]Centro de Estudios de Desarrollo Sustentable y Aprovechamiento de la Vida Silvestre, Universidad Autónoma de Campeche. Av. Agustín Melgar s/n Ciudad Universitaria, Campeche. México, CP 24030, E-mail:retana1967@yahoo.com.mx (OGR)

the distribution, abundance, and food habits of many native rodent species (John and Morales 1991). Therefore, species may adapt to new conditions, move to other suitable areas, or become locally extinct.

In the last decades, the highlands of Chiapas have been exposed to a severe process of change in land use that has resulted in heavy soil erosion, overgrazing, and fragmentation of natural habitats (Alemán-Santillán 1989; Mera-Ovando 1984, 1989). Similarly, annual fluctuations of rodent abundances on agricultural areas are a common phenomenon related with seasonal and annual variations, where temperature and precipitation play important roles (Emmel 1975).

Some mammals populations in tropical regions require adequate rainfall, temperature, and quantity and quality of food resources in order to grow (Bonaccorso and Humphrey 1984; Dinerstein 1986). Within the rainforests of Montes Azules Biosphere Reserve, Chiapas, above a certain limit of rainfall and below a critical level of latitude and altitude, mammal species richness seems to reach an asymptotic maximum (Medellín 1994). In contrast, during dry periods, decreases in population density might be caused by diverse factors such as food scarcity and predation (Mills et al. 1991). Populations might time their reproductive strategies to coincide with resource availability as well (e.g., occurring concurrently with seasonal crops; Kotler et al. 1988).

Studies of species richness, diversity, dominance, trophic structure and population abundance provide valuable information on the properties of communities and their interactions in space and time (Harris and Maser 1984). However, very few studies have examined these ecological aspects for Mexican rodent species.

Because farming is an important activity in the local economy, and the agricultural production is locally consumed, the species of small rodents associated with crops, should be determined. However, the distribution and diversity of rodents in agricultural systems (or their possible impact on crop production) has been a poorly explored subject in the tropical areas of Mexico, particularly in Chiapas.

With the aim of identifying the species of small rodents associated with crops, we estimated the rodent diversity and abundance (based on the number of captures) in highly disturbed areas (farms) of the Chiapas highlands. We compared our results with the diversity and abundance of rodents in undisturbed areas such as ecological reserves (mainly pine-oak forest) around San Cristóbal de Las Casas.

Materials and methods

We sampled small rodents (without marking them) from July 1998 through August 1999 monthly, using 30 to 33 Sherman live-traps per night along 300 to 330 m transects located on farms and ecological reserves. Each trap was baited with oats and vanilla essence. Farms were sampled four nights a month, while reserves were sampled four nights every two months. Locations and habitat characteristics were as follows: 1) Huitepec Ecological Reserve (Huitepec), which comprises pine-oak forests (2,340 m, 136 ha); 2) Moxviquil Ecological Reserve (Moxviquil) where oak forests predominate (2,314 m, 86 ha); 3) corn-squash plantations (C1; 2,153 m, 3 ha); and 4) corn-tomato-bean plantations (C2; 2,131 m, 10 ha; Fig. 1). The coordinates of our study area are 16º 35´- 16º 46´N, 92º 27´- 92º 43´W.

We identified rodent species using published taxonomic keys (Hall 1981; Reid 1997). Voucher specimens were deposited in the Mammal Collection of El Colegio de la Frontera Sur (ECO-SC-M) at San Cristóbal de Las Casas, Chiapas. The juveniles individuals were identified as not having the pelage of the adults, and for being comparatively smaller in size than the captured adult individuals of the same species. The parameters analyzed as indicators of the diversity and abundance of small rodents for each site

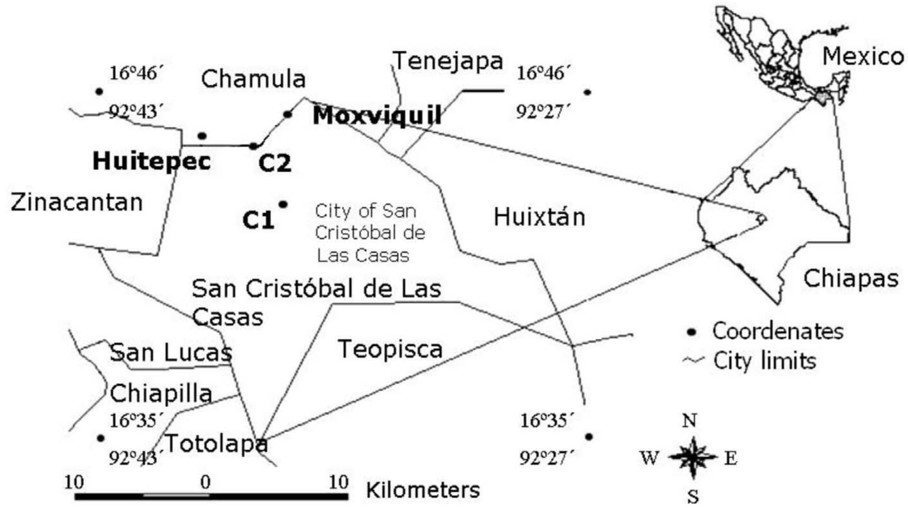

Figure 1. Study area within the municipality of San Cristóbal de Las Casas in Central Chiapas. C1 = corn-pumpkin plantations; C2 = corn-tomato-bean plantations.

were the number of species of small rodents captured in each trapping session and the relative abundance of the species as measured by the number of captures for each species divided by the total number of captures for all species in each trapping period (Pielou 1975). The Shannon-Wiener diversity index (H′), which is strongly influenced by the number of rare species (Krebs 1985; Magurran 2004), was calculated for each study site by dry and wet season. These variables commonly are used as indicators of the diversity and structure of a community (Medellín et al. 2000).

Differences in the number of species, average number of captures, capture success, diversity, and relative abundance for each location during dry (November-April) and rainy (May-October) seasons were compared using t-tests (Zar 1996). We compared the total number of captures registered per species between the two corn fields and the two ecological reserves during dry and rainy seasons with Wilcoxon test (rank sums; *Z*). The significance level for all tests was set at 95%.

Results

We obtained 469 captures of nine species in one family (Muridae) of rodents (Table 1) over the 14 month study. In the rainy season, trapping effort (number of trap-nights) was 30/33 traps x 4 nights x 8 months (July-Oct. '98 and May-Aug. '99) = 960/1056 trap nights per 32 nights. In the dry season, trapping effort was 30/33 traps x 4 nights x 6 months (November '98 –April '99) = 720/792 trap nights (for 24 nights). During the rainy season, capture success (number of captures per trap/night) was highest at Huitepec (71%) and lowest at C2 (16%). In the dry season, capture success was greatest at C1 (118%, there were two individuals per trap in some cases), and lowest at Moxviquil (32%). Among all captures recorded, 197 (42%) were found in the rainy season with a high proportion of adults, whereas 272 (58%) were found in the dry season with a predominance of juveniles. For a given site, we only found statistically significant differences for the number of captures between the wet and dry seasons at Moxviquil ($P = 0.058$; t-test).

In the rainy season, the corn-squash plantation (C1) had the highest species richness (7), followed by Huitepec (5), Moxviquil (4), and corn-tomato-bean plantations (C2, 4).

In the dry season, more species (*n* = 5) were found at C1, and Moxviquil and C2 (*n* = 4). The average number of captures for each species during the rainy-dry season at each

Table 1. Mean number of total captures for each species at a given site and season (n); relative abundance (RA), mean total captures per species (TI per species) and locations (TI per locality), and total species of small rodents at each locality (Total species). C1 = Maize-pumpkin field; C2 = Maize-tomato-bean field; ERH = Huitepec Ecological Reserve; ERM = Moxviquil Ecological Reserve; 1 = Rainy season (May-October); 2 = Dry season (November-April).

	Location																
	C1				C2				ERH				ERM				TI per species
	1		2		1		2		1		2		1		2		
Species	n	RA	n	RA	n	RA	n	RA	n	RA	n	RA	n	RA	n	RA	
Peromyscus levipes	0.3	2.1	1.0	1.9					6.6	34.6	5.3	47.3	12.5	85	6.9	81.0	32.6
Peromyscus zarhynchus									4.6	24.1							4.6
Peromyscus mexicanus	0.9	6.3	4.3	8.1					6.3	33.0	4.6	41.1	0.6	4.1	1.0	12.0	17.7
Peromyscus aztecus									1.3	6.81	1.3	11.6			0.3	3.5	2.6
Reithrodontomys fulvescens	5.9	42.0	21.0	38.9	3.9	27.9	4.3	23.4	0.3	1.57			1.3	8.8			36.3
Reithrodontomys sumichrasti	5.6	39.0	18.0	33.8	3.6	25.7	4.6	25.0					0.3	2.0	0.3	3.5	32.3
Sigmodon hispidus	0.9	6.3	9.2	17.4	4.6	32.9	5.6	30.4									20.3
Mus musculus	0.3	2.1			1.9	13.6	3.9	21.2									6.1
Rattus rattus	0.3	2.1															0.3
Totals	14	100	53	100	14	100	18	100	19	100	11	100	14.7	100	8.5	100	153
Total species	7		5		4		4		5		3		4		4		
TI per locality	67				32				30				23.2				153

location (*n*), relative abundance (RA), and total species at each locality are in Table 1. The highest and lowest diversity indices estimated in the dry season were for C2 (H´= 1.38) and Moxviquil (H´= 0.66), respectively. In the rainy season, C2 was the most diverse location (H´= 1.34), and the lowest was Moxviquil (H´= 0.56). No significant differences were recorded for the number of species between undisturbed areas (natural reserves) and disturbed habitat ($Z = 0.50$; $P = 0.617$) in both seasons.

In the rainy season the most abundant species were: *Reithrodontomys fulvescens* at C1; *Sigmodon hispidus* at C2; and *Peromyscus levipes* at Moxviquil and Huitepec. The least abundant species in the same season were: *P. levipes*, *Rattus rattus*, and *Mus musculus* at C1; *M. musculus* at C2; *R. fulvescens* at Huitepec, and *R. sumichrasti* at Moxviquil. During the dry season the most abundant species were the same at all four sites, whereas the least abundant were: *P. levipes* at C1; *M. musculus* at C2; *P. aztecus* at Huitepec, and *P. aztecus* and *R. sumichrasti* at Moxviquil (Table 1).

In general, the highest values of relative abundance were found in both seasons in natural areas, but we did not find statistical differences in relative abundances between the two ecological reserves ($Z = 0.474$; $P = 0.49$). *Peromyscus levipes* was the most abundant species at Moxviquil in the rainy season (RA = 0. 11 mean captures per 100 traps nights), and the dry season (RA = 0.12 mean captures per 100 traps nights).

Discussion

We found a similar number of rodent species in disturbed and protected areas. The highest number of species in the rainy season was observed at farm C1; however, two of those species were introduced (*Rattus rattus* and *Mus musculus*), and the higher number of species during the rainy season was due to the presence of *M. musculus* at farms C1 and C2. Two species were detected in reserves only (*P. zarhynchus* and *P. aztecus*). Farms are dynamic habitats that may not sustain species unable to adapt to a frequently changing habitat. This kind of habitat may favor more tolerant species or species associated with human activities, such as *M. musculus* (Mills 1995). Although *S. hispidus* is adapted to grasslands, clearings, and brush (Reid 1997), we observed it as a typical species in C1 and C2, and it was dominant at C2 during both seasons.

At the beginning of the rainy season there should be a high production of seeds and abundance of insects in corn crops (Coates and Estrada 1986). At that time we found species more abundant such as *Peromyscus mexicanus* and *P. levipes* (only in C1), which are largely insectivorous (Álvarez et al. 1984), as well as *Reithrodontomys fulvescens* and *R. sumichrasti* (occasionally found in protected areas), whose diet consists mainly of seeds, insects, and shoots (Spencer and Cameron 1982). Similarly, the most abundant species in both seasons at C2 was *Sigmodon hispidus*. Mixed crops possibly offered more food alternatives for rodents and therefore probably attracted a higher diversity of species (e.g. C1). In fact, mixed crops resulted in the greatest number of rodent species (7) and the greatest capture success (118%).

We only found a significant difference in the number of captures recorded between dry and rainy seasons at Moxviquil, which was probably due to the specific strategies used by rodents to optimize food consumption according to their seasonal distribution and abundance. However, it is necessary to increase trapping effort in the study area and accurately determine if there are seasonal differences in the number of species at all localities.

It would also be desirable in the future to replicate the agricultural sites according to the kinds of crops being grown. Finally, because of the small sample sizes reported here, the general finding of a lack of statistical significance among the sites may be the result of poor statistical power (type 2 error). Nevertheless, this study of seasonal variation of rodent species present in farms and ecological reserves generated information about the abundance and diversity of these species in different habitats. This information may help to improve the management of rodent species in economically important agricultural habitats in southern Mexico.

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