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Habitat use of small terrestrial rodents in the Costa Rican highlands

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Abstract: Small terrestrial rodents were studied in five habitats in the highlands of the Talamanca Mountain Range, Costa Rica. Species diversity, richness, and number of individuals increased from primary forest to non-forested habitats. *Peromyscus nudipes* was primarily a forest species and along with *Scotinomys xerampelinus* was found in all habitats sampled. *Reithrodontomys creper* was almost exclusively present in old fields and *R. sumichrasti* around buildings and in the cattle pasture. Rodent populations increased with the beginning of the rainy season, but the degree of fluctuation differed among species and habitats.

Key words: habitat, rodents, species richness, species diversity.

Change from primary forest to agriculture influences species composition as humans promote the growth of one or more plant or animal species. The ecosystem is converted from a high biomass accumulation ratio (Whittaker 1975) to lesser amounts of standing crop and production of protein and carbohydrates for human use. Plant communities are altered in species composition and structure, which in turn influences the animal community. In tropical countries, where deforestation is proceeding at a rapid rate, effects on animal species are not well documented (Vaughan 1984).

In western Ghana, Jeffrey (1977) found extensive changes in rodent populations when the primary forest was removed and replaced with agricultural land. While some work has been done on Costa Rican small terrestrial rodents at lowland and middle elevations (Fleming 1974a, 1974b, Bonoff and Janzen 1980, Lumer 1980), little is known about high mountain rodent faunas. This paper presents information based on a one-year study in the Costa Rican highlands looking at the abundance and distribution of small rodent species in five habitats ranging from primary forest to cattle pasture.

MATERIAL AND METHODS

The study was conducted between March 1982 and January 1983 in San Gerardo de Dota, a valley located within the Los Santos Forest Reserve in Central Costa Rica (9° 35' N, 83° 48' W). The study area ranges in elevation between 2400 and 2700 m above sea level and includes both lower Montane Rain and Montane Rain Forest life zones (Holdridge 1967). Rainfall averages 2500 mm per year with over 90% from early May to mid December. Mean daily temperatures range from 6 to 9°C (Schwerdtfeger 1976).

Extensive oak forests *(Quercus copeyensis)* dominated the study area. Some patches had been cleared for agricultural use in the previous 20 years by the slash and burn method, while others were in different stages of clearing or

abandonment. The process of slash and burn in primary forest usually had various phases which took several years to complete. These steps included: cutting the understory below about 15 m, felling most of the taller trees and burning dried-out undergrowth. Then grass was often planted subsequently and the land used for grazing cattle, except for widely scattered sites used for human dwellings. Abandoned pastures were replaced by brushy second-growth within two years.

From this land-use mosaic five typical habitats were chosen for study: primary forest, undercut forest, cattle pasture, old field, and around buildings. The undercut forest, having the appearance of a tree farm, was a primary forest of large oaks (*Quercus* spp.) where the understory had been eliminated three years earlier. The cattle pasture, cleared ten years earlier, was dominated by grasses (*Graminea* spp.). Vegetation in the pasture, rarely over 2-3 m tall, was probably controlled by occasional grazing. Felled trees and tree stumps were common in the pasture. Buildings included a milking shed, house, pig pen, and small flower and vegetable garden, all surrounded by pasture. A small stream and dirt road ran through the site. The old field, a two and a half-year-old abandoned cattle pasture, was covered by brushy vegetation about 2 m in height.

To relate rodent distribution and abundance with habitat characteristics, four parameters were measured for each site during Abril 1982. Ground debris, the number of logs (>10 cm radius), branches (<10 cm radius), exposed rocks, tree roots, and tree stumps were counted along three randomly chosen 75 m transects. Foliar coverage, the percent cover 10-160 cm and >160 cm was estimated with a periscope (Daubenmire 1968) at 10 random points. Mean height of dense vegetative ground cover was measured at ten random points. Ground litter was collected from six random 40 cm radius circles and dry weighed. Plant species were identified, counted, and separated into four height categories: 0-1m, 1-10m, 10-20 m and >20 m in random 3 m radius circular plots. The number of plots varied per habitat, with additional plots being sampled until few new species were encountered. Plant diversity was estimated using the Shannon-Weiner diversity index (Lloyd and Ghelardi 1964).

In each habitat, 30 folding Sherman live traps (8 x 9 x 23 cm) were arranged in six by five grids spaced at 15 m intervals. A minimum of 30 m was left between the grid and the habitat edge except in the undercut forest where the area allowed only a 10 m border on one side. Although there were several two or three day trapping sessions, habitats were generally trapped four consecutive nights at three-month intervals. Traps were set between 1300 and 1630 h and examined between 0600 and 0900 h. Bait consisted of a mixture of rolled oats and peanut butter.

Each captured rodent was uniquely toe clipped and released at the capture site. For each rodent species voucher specimens were collected from nearby areas and identified at the National Museum of Natural History, Washington, D.C.

To estimate rodent abundance, a mean nightly trapping success ratio was calculated for each session, resulting in the mean number of rodents captured per 30 trap nights. We assumed that each species was equally catchable, although species may have had different responses to the bait, traps, or to handling. Significant differences among habitats and time of year in the number of rodents captured were determined by analysis of variance. Rodent diversity was estimated using the Shannon-Weiner diversity index.

RESULTS AND DISCUSSION

Habitat characteristics: Numerous studies have demonstrated that vegetation characteristics influence rodent diversity, density and species composition (*i.e.* Price 1978, Dueser and Shugart 1978, Hallet 1982, Patterson *et al.* 1990). Changes in habitat may occur either naturally, as along elevational gradients, or as the result of human alterations. The physical characteristics of the five habitats in this Costa Rican highland area were dramatically different (Table 1). As primary forest was replaced by cattle pasture and buildings, the amount of foliar coverage >10 cm in height decreased from 93% to 0.0%, accompanied by a decrease in the number of plants >1 m tall. The decrease in the amount of upper story cover was accompanied by corresponding increases in height of dense ground cover and plants < 1 m tall. These changes in the structure of the plant community

TABLE 1

Physical characteristics of five habitats at San Gerardo de Dota, Costa Rica

	Primary forest	Undercut forest	Cattle Pasture	Around buildings	Abandoned field
Ground debris: Number / m	0.11	0.13	0.32	0.08	0.15
Percent foliar coverage:					
Above 10 cm (mean ± SE)	93.0 ± 3.5	77.5±23.0	0.0±0.0	0.0±0.0	68.5±24.0
Above 160 cm (mean ± SE)	92.0 ± 4.3	77.5 ± 23.0	0.0 ± 0.0	0.0±0.0	5.0±12.4
Height dense ground cover:					
cm (mean ± SE)	0.0 ± 0.0	0.0±0.0	5.9±2.3	4.6±3.4	18.2±6.21
Detritus: g/m² (mean ± SE)	656 ± 232	769 ± 134	69 ± 33	62 ± 37	235 ± 103
Plant species:					
Number 1-m-radius circles sampled	5	6	6	4	6
Number of species	19.00	42	26	23	54
Diversity index	3.01	4.97	2.03	3.04	3.61
Number of plants / m²					
< 1 m tall	250	80	1340	390	1370
1 - 10 m tall	100	20	5	16	300
10 - 20 m tall	20	8	0	0	0
> 20 m tall	4	6	0	0	0

TABLE 2

Rodent population characteristics in five habitats at San Gerardo de Dota, Costa Rica

	Primary forest	Undercut forest	Cattle pasture	Around buildings	Abandoned field
Mean number rodents / 30 trap nights	7.3	5.5	7.1	10.1	14.9
Species richness	2	3	3	4	4
Shannon-Weiner diversity index	0.54	0.77	1.10	1.28	1.48

alter the availability of food, escape cover, and nesting sites for rodents.

Plant diversity was greatest in the undercut forest and old field habitats and lowest in the cattle pasture (Table 1). The old field also had the most plant species. Felled logs, rocks, tree roots and stumps, which are important nesting and escape sites, were greatest in the pasture and least around buildings. Buildings perhaps provided other forms of cover which were not quantified.

Rodent characteristics: Rodent abundance and diversity increased following forest and the introduction of cattle pastures and human dwellings (Fig. 1, Table 2). Mean number of rodents captured per 30 trap nights and species richness were higher around buildings (10.1 rodents/30 trap nights, four species) than in the undercut forest (5.5 rodents/ 30 trap nights, three species) or primary forest (7.3 rodents/ 30 trap nights, two species). Jeffrey (1977) found a similar increase in small rodent numbers and diversity after the replacement of primary forest by agriculture and housing. She attributed part of this change to an increased abundance of food and nesting sites.

Transition from cattle pasture to old field produced further changes in the rodent population (Fig. 1, Table 2). Mean number of rodents captured per 30 trap nights and rodent diversity was greater in the old field than the other habitats. Herbaceous shrub complexity in the old field, reflected by the stratification and the relatively high plant diversity, could account for higher rodent diversity. McCloskey (1976) found shrub volume diversity to be the most important variable affecting rodent diversity in open, shrubby habitats. Shrub diversity could benefit rodent populations in several ways. The increased diversity provided more structural diversity and different spatial niches for the small rodents to occupy. The

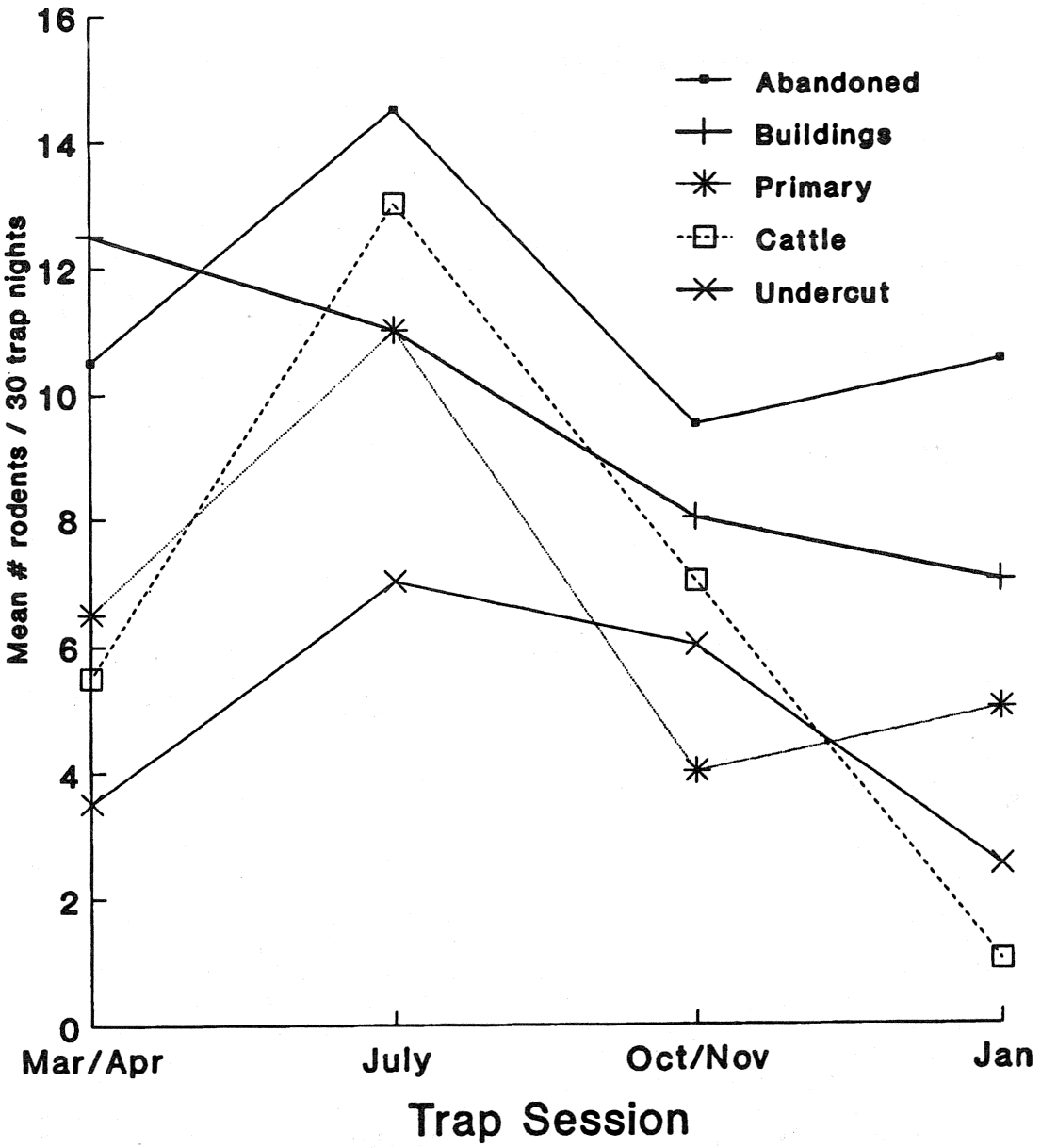

Fig. 1. Mean number of rodents captured by season in five habitats in San Gerardo de Dota, Costa Rica, from 1982-1983.

ded seed and fruit eaters with a variable food supply throughout the year. For example, Brown (1973) attributed the higher desert rodent diversity, in comparison with mesic forest rodents, to the omnipresent availability of different seed sizes.

The presence of only two species in the primary forest may also reflect a shortage in food source variety throughout the year and the lack of structural diversity. More trapping at different heights in the canopy for arboreal rodents may have revealed added species, however.

These changes in small rodent numbers and diversity also fit the predictions of the intermediate disturbance hypothesis for species diversity (Connell 1978, Hubbel 1979, Pickett and White 1985), with the moderately disturbed habitat (abandoned field) having a higher species

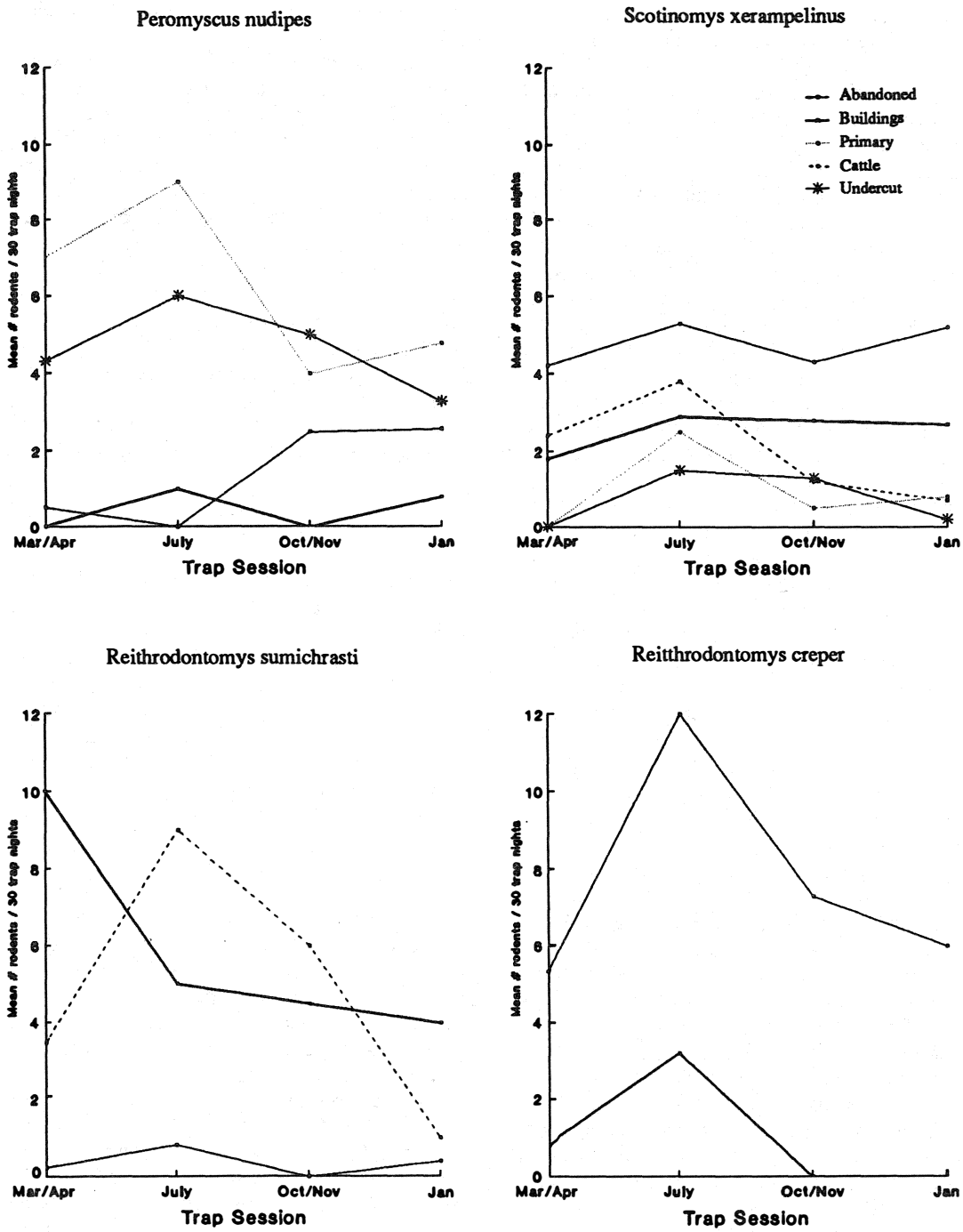

Fig. 2. Small terrestrial rodents captured in five habitats in San Gerardo de Dota, Costa Rica from 1982-1983.

and White 1985), with the moderately disturbed habitat (abandoned field) having a higher species diversity than the undisturbed habitat (primary forest) or the highly disturbed habitats (cattle pasture and around buildings).

Species description: The distribution and relative abundances of rodent species varied among habitats (Fig. 1, 2). *Peromyscus nudipes* (naked footed deer mouse) was one of only two rodent species found in all habitats. It was the most abundant forest species, captured significantly ($p < 0.01$) more often in forest habitats than in cattle pasture or around buildings. Important resources seemed lacking for *P. nudipes* in the undercut forest since there were more individuals ($p=0.09$) in the primary forest than the undercut forest. The most obvious difference between the two habitats was the scarcity of plants < 10 m tall in the undercut forest (100 compared with 350 plants/ 100 m2). Use of understory trees by *P. nudipes* has been documented by Lumer (1980). Lack of understory vegetative structure for the arboreal movement of this agile species may have contributed to the lower number of individuals found in the undercut forest.

Scotinomys xerampelinus (singing mouse) was present in all five habitats (Fig. 2). They contrasted with *P. nudipes* in being captured around buildings and in the cattle pasture significantly ($p < 0.01$) more than in the forest habitats. *S. xerampelinus*, which are insectivorous and primarily diurnal (Hooper 1972), were most abundant ($p < 0.01$) in the abandoned field.

Reithrodontomys sumichrasti (Sumichrasti's harvest mouse) was most abundant around buildings and in the cattle pasture. In contrast *R. creper* (Chiriquí harvest mouse) was found primarily in the old field (Fig. 2), where more were captured than any other species ($p < 0.01$). These findings coincide with habitat use patterns of other *Reithrodontomys* spp., which eat seeds, insects, and green shoots, and nest in grass, low shrubs or small trees.

Only three *Heteromys demarestianus* were captured throughout the study. Being rare at this altitude, they were not considered in the analysis of seasonal variations.

Seasonal variations: Summing captures from all rodent species for each trapping period showed definite seasonal variation (Fig. 1). Significantly ($p < 0.01$) more rodents were captured during the July trap session, which coincided with the second month of the rainy season.

Individually, species did not show the same degree of seasonal variation (Fig. 2, Table 2). Only *S. xerampelinus* and *R. creper* had significantly ($p<0.01$) more individuals captured in July. Although no overall seasonal changes for *P. nudipes* were apparent, its number fluctuated seasonally in forested habitats as did those of the other three species.

In a similar manner, although *R. sumichrasti* had no significant seasonal variation ($p >0.05$), in the cattle pasture more individuals were captured during July. Numbers steadily decreased throughout the year around buildings, perhaps due to a seasonal food supply or other environmental factors, such as poisoning or kill trapping.

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RESUMEN

Se estudió la comunidad de roedores pequeños y terrestres en cinco hábitats de altura en la Cordillera de Talamanca, Costa Rica. La diversidad y riqueza de especies y el número de individuos aumentaron entre el bosque primario y los hábitats sin bosque. *Peromyscus nudipes* (principalmente de zonas boscosas) y *Scotinomys xerampelinus* aparecieron en todos los hábitats. *Reithrodontomys creper* estuvo exclusivamente presente en los charrales y *R. sumichrasti* se encontraba alrededor de edificios y en potreros. Las poblaciones de roedores aumentaron con el inicio de la época lluviosa, pero el grado de fluctuación fue diferente entre especies y hábitats.

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