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NEOTROPICAL PYGMY SQUIRRELS (*SCIURILLUS PUSILLUS*) SHARE TERMITE NESTS

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INTRODUCTION

Nest-site selection is important for reproduction (Benson *et al.* 2008) and also provides a place for other activities such as resting and shelter or protection from weather and predators (Sealander Jr. 1952, Steele & Koprowski 2001). Nesting habits are also influenced by level of sociality, and can confer fitness advantages (Alexander 1974). Communal nesting is an example of increased sociality found in mammals, including tree squirrels (Wolff & Lidicker Jr. 1981, Layne & Raymond 1994, Koprowski 1996, Ebensperger *et al.* 2004). Sociality among tree squirrels is poorly understood and communal nesting occurs only rarely in some species of tree squirrels in temperate forests (Halloran & Bekoff 1994, Layne & Raymond 1994, Koprowski 1996).

Tree squirrels in temperate regions nest in cavities of trees, dreys (arboreal bolus structures constructed of twigs and leaves), and occasionally also in burrows (Steele & Koprowski 2001, Thorington Jr. *et al.* 2012). Diversity of tree squirrels is highest in the tropics, with 19 species occurring in the Neotropics, but few studies have been conducted in these areas (Koprowski & Nandini 2008). Little is known about nesting habits of Neotropical tree squirrels but they appear to use drey and cavity nests (Emmons & Feer 1997). Many Neotropical tree squirrels are believed to be solitary (Emmons & Feer 1997) but some species, such as northern and southern Amazon red squirrels (*Sciurus igniventris, S. spadiceus*), and Neotropical pygmy squirrels (*Sciurillus pusillus*, Geoffroy 1803), forage in groups of ≤ 4 individuals (Heymann & Knogge 1997, Eason 2010, R. Jessen, pers. obs.). Neotropical pygmy squirrels are diurnal and the smallest tree squirrels in the western hemisphere, but there is a substantial lack of information about their life history and ecology (Emmons & Feer 1997, Koprowski & Nandini 2008). Here we report our observations of Neotropical pygmy squirrels using termite nests to nest communally.

METHODS

Our study area is characterized by a mix of primary and secondary lowland forest that floods seasonally, also known as *igapó*, located in the Tamshiyacu-Tahuayo Reserve in Loreto, Peru (4°39'S, 73°26'W; Newing & Bodmer 2003). During 2010 and 2011 we conducted observations at sunset and sunrise to document nest activity of Neotropical pygmy squirrels. Because in 2010 we found Neotropical pygmy squirrels using a termite nest, in 2011 we surveyed 42 two-km transects for termite nests to estimate the number of nests in the area and to determine whether the nests were being used by squirrels. For morning emergence data we began 30 minutes before sunrise and observed the nest until all individuals exited the nest and left the area. For evening immergence observations we began one hour before sunset and remained close to the nest until all squirrels had entered the nest and closed the entrance. In the case of inactive nests we remained in the area for one hour after sunrise or sunset to make sure squirrels were not entering or exiting the nest later. Observations were

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made between 10 to 15 m away from the nest. We used a clinometer, tape measure, and a compass to record physical characteristics of the nest (height above ground and aspect), to measure characteristics of the nest tree (height, diameter at breast height [DBH], size of the canopy, and condition of tree [live or dead]), as well as habitat characteristics in a 10-m radius circular plot centered on the nest tree (Edelman & Koprowski 2005). For the habitat characteristics we determined total number, species, condition, and DBH for all stems ≥ 3-cm DBH within the plot to estimate basal area and Shannon-Wiener diversity, and estimated canopy cover with a spherical densitometer (Strickler 1959).

RESULTS

We documented two Neotropical pygmy squirrel nests, one on 25 July 2010 (Nest A) and another on 18 July 2011 (Nest B). In 2011, we found a total of 11 termite nests with evidence of previous occupation by squirrels based on the presence of old nesting material. One of the 11 nests was occupied by squirrels at the time, we saw or heard squirrels around three of the nests but never saw the squirrels entering or emerging from the nest, and one of the nests was destroyed a few days later. The two occupied nests found in 2010 and 2011 were both inside abandoned termite nests that were attached to the trunk on the northwest side of a tree, *ca*. 2 m above ground. The dimensions of the termite nests were 2.0 m long and 0.6 m wide (Nest A) and 1.4 m long and 0.6 m wide (Nest B). The nests had two entrances and both entrances were blocked by fibers of the machimango tree (*Eschweilera* sp.). Squirrels pulled strips of fibrous bark from the machimango tree, shred them into balls of fine fibers, and used them to block the entrances and line the inside of the nests. When squirrels changed the nesting material, they removed the inner lining of the nest and dropped the old fibers onto the ground at the base of the nest tree; later the squirrels carried fresh fibers in their mouths and placed the fibers in the nest.

On 25 July 2010 at 16:58 h we heard Neotropical pygmy squirrel vocalizations and saw three individuals (two juveniles, one adult female) approach Nest A. One juvenile tried to nurse from the adult female. At 17:06 h the adult female removed the machimango fibers from the entrance to the nest and went inside. At 17:07 h the two juveniles also entered the nest. Once inside, they closed the entrance with the same machimango fibers leaving no open entrance to the nest. At 17:12, 17:13, and 17:16 h three more adults came to the nest. Two of the new individuals went inside the nest, removing the machimango fibers one more time and closing the entrance from the inside. The third individual went into the nest but left again at 17:27 h, heading up the tree towards the canopy and was not seen again. The next morning at 06:07 h a squirrel removed the machimango fibers from the entrance and came out of the nest at 06:09 h followed by two individuals at 06:13 h and a fourth individual at 06:14 h (Fig.1). These individuals ascended the tree towards the canopy while making short vocalizations. At 06:26 h one of the squirrels came down from the canopy to the nest, started to call and entered the nest at 06:32 h, leaving the nest one more time at 06:34 h and disappearing in the canopy. On 18 July 2011 we observed just two individuals (one adult and one juvenile) occupying Nest B.

FIG. 1. Abandoned termite nest used by Neotropical pygmy squirrels (*Sciurillus pusillus*). One individual approaching from above nest and a second individual about to exit the nest (arrow). Notice machimango fibers (*Eschweilera* sp.) at opening used as nest material. Photograph by Geoffrey H. Palmer.

Nest A was located in a live 32.2 m-tall apacharama (*Licania* sp.) and Nest B was in a live 26.7-m

tall chuchuashilla tree (*Salacia cauliflora*), with DBHs of 63.2 and 45.6 cm respectively. Canopy cover was 96 and 97% with 73 and 82 stems of at least 34 tree and eight vine species. All vines and all trees except for one were alive. Basal area was 1780.15 and 1492.33 cm^2/ha, and diversity index for trees and vines was 2.77 and 2.75 respectively.

DISCUSSION

Neotropical pygmy squirrels are very small, fast, and usually found in large trees high in the canopy, making identification of sex and age of individuals by sight very difficult (Eason 2010, R. Jessen, pers. obs.). However, we are confident that two juveniles and four adults nested together in a single nest because of our close proximity to the squirrels during observations. In temperate regions, most co-nesting events occur during cold weather and co-nesting individuals can be related to one another (Koprowski 1996),but what is driving sociality and communal nesting in Neotropical pygmy squirrels is unknown. Litter size of Neotropical pygmy squirrels is one to two (Thorington Jr. *et al.* 2012) suggesting that the two young are likely the offspring of the one female from which they tried to nurse.

A great diversity of tree squirrels exists in the tropics (Koprowski & Nandini 2008, Thorington Jr. *et al.* 2012) and interspecific competition for nests could lead to the use of different nest types (Jessen *et al.* 2013). Arboreal termite nests are common structures used for shelter by other organisms. The tui parakeet (*Brotogeris sanctithomae*), the cobalt-winged parakeet (*B. cyanoptera*), and the black-tailed trogon (*Trogon melanurus*) as well as the white-throated round-eared bat (*Lophostoma silvicolum*) and fringe-lipped bat (*Trachops cirrhosus*) use termite nests (Kalko *et al.* 1999, Brightsmith 2000, Dechmann *et al.* 2004, Kalko *et al.* 2006). Neotropical pygmy squirrels might also use termite nests for protection from predators and weather, reduction of ectoparasites, and suitable microclimate, similar to some bats (Kalko *et al.* 2006).

Additional studies are needed to understand use and availability of termite nests. Whether termite nests used by Neotropical pygmy squirrels are first excavated by birds, or if squirrels create the cavities on their own like the white-throated round-eared bat, remains unknown (Dechmann *et al.* 2004). Similarly, it is unclear whether Neotropical pygmy squirrels select inactive versus active termite nests, if squirrels use multiple nest locations, and why and how often squirrels change nest material. We found 12 termite nests with machimango fibers within 400 ha, but confirmed squirrel activity at only two. White-throated round-eared bats use active termite nests that maintain stable warm conditions, permitting a 5% daily saving in energy expenditure (Dechmann *et al.* 2006). Although the reason for use of termite nests and communal nesting is not known in Neotropical pygmy squirrels, communal nesting occurs in Bangs's mountain squirrels (*Syntheosciurus brochus*; Wells & Giacalone 1985). Here, we provide additional documentation of increased sociality and communal nesting in Neotropical tree squirrels.

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