

DISTRIBUTION AND ECOLOGY OF SQUIRRELS (RODENTIA: SCIURIDAE) IN PARAGUAY, WITH FIRST COUNTRY RECORDS FOR *SCIURUS IGNITUS*

ROBERT M. TIMM,* JOSÉ L. CARTES, MIRTHA RUIZ-DÍAZ, RODRIGO ZÁRATE, AND RONALD H. PINE

University of Kansas Natural History Museum, Dyche Hall, 1345 Jayhawk Boulevard, Lawrence, KS 66045, USA (RMT, RHP)
Asociación Guyra Paraguay, Gaetano Martino 215, CC 1132, Asunción, Paraguay (JLC, MR-D, RZ)

*Correspondent: *btimm@ku.edu*

ABSTRACT—We document for the first time that *Sciurus ignitus*, a medium-sized agouti-patterned squirrel with white venter, occurs in Paraguay, being found in the northern Chaco–Pantanal region of the country, where the borders of Paraguay, Bolivia, and Brazil come together. *Sciurus urucumus*, the only species of squirrel previously known with certainty to range into Paraguay, occurs in the Chiquitano Forest of the northeastern Paraguayan Chaco. We provide details of the Paraguayan habitats for the known specimens of both species. At present, we know of no localities where the two species co-occur. We critically evaluate some of the morphological characters used previously to characterize *S. ignitus*. Interviews with local hunters, including Aché indigenous ones, coupled with an earlier published account, indicate that the squirrel *Sciurus aestuans* also occurs in eastern Paraguay’s Departamento Alto Paraná, although no specimens are now available from the country.

RESUMEN—Documentamos por primera vez que *Sciurus ignitus*, una ardilla de tamaño mediano con pelo de patrón agutí y con el vientre blanco, ocurre en Paraguay, en la región Chaco–Pantanal del norte del país, donde se unen las fronteras de Paraguay, Bolivia y Brasil. *Sciurus urucumus*, la única especie de ardilla cuyo rango se conocía previamente con certeza de incluir Paraguay, se encuentra en el bosque Chiquitano del noreste del Chaco paraguayo. Proveemos detalles sobre los hábitats paraguayos de los especímenes de ambas especies. En el presente, no conocemos de ninguna localidad donde las dos especies concurren. Evaluamos críticamente algunas características morfológicas usadas previamente para caracterizar *S. ignitus*. Entrevistas con cazadores locales, incluyendo indígenas Aché, en conjunto con un reporte publicado anteriormente indican que la ardilla *S. aestuans* también ocurre en el este de Paraguay, en el Departamento Alto Paraná, aunque ningún espécimen se conoce aún del país.

The most recent compendia on the fauna of Paraguay list, collectively, 175 species of mammals, including three commensal Old World murid rodents (*Mus musculus*, *Rattus norvegicus*, and *R. rattus*) and one introduced Eurasian leporid (*Lepus europaeus*) (Myers et al., 2002; Smith, 2014; de la Sancha and D’Elía, 2015). Despite this diversity of mammals, only two specimens of squirrels have been reported with certainty from Paraguay (D’Elía et al., 2008). The genus *Sciurus* comprises many of the New World diurnal tree squirrels, with some 28–30 recognized and named species. Two of the seven subgenera of *Sciurus* are known to occur in Paraguay and/or adjacent

countries. The subgenus *Urosciurus* J. A. Allen, 1915 includes large and colorful species, with the ones found the farthest south being *S. spadiceus* Olfers, 1818, the southern Amazon red squirrel, and *S. urucumus* J. A. Allen, 1914, the Urucumu squirrel. Thorington and Hoffmann (2005) treated *S. urucumus* as a synonym of *S. spadiceus*; however, we herein provisionally treat *S. urucumus* as a separate species, following D’Elía et al. (2008). The subgenus reaching the farthest south is *Guerlinguetus* Gray, 1821, which, along with extralimital species, contains the medium-sized squirrels occurring east of the Andes and which generally have agouti fur and only moderately

bushy tails. Three species of *Guerlinguetus* are known to occur at least in the vicinity of Paraguay—*S. aestuans* Linnaeus, 1766, the “Guianan” or “Brazilian” squirrel; *S. argentinius* Thomas, 1921, the South Yungas red squirrel; and *S. ignitus* (Gray, 1867), the “Bolivian” squirrel. Some authors (e.g., Thorington et al., 2012) treat *argentinius* as a subspecies of *S. ignitus*, but Emmons and Feer (1997:189) recognized *argentinius* as a full species and wrote “... it does not seem closely related [to *S. ignitus*]. It is highly distinctive ...” We also regard *S. argentinius* as a separate species. It is known from a very restricted range in southeastern Bolivia and northernmost Argentina.

The first mention of a Paraguayan squirrel, or the possibility of there being such, is that of A. de W. Bertoni (1939), who identified the animal in question as “*Sciurus ingrami*” Thomas, a name currently regarded as a synonym of *S. aestuans* Linnaeus. He listed it as species number 35 in his list of 131 nominal species of mammals that he recognized in the fauna of Paraguay. Bertoni stated that this species occurred in Misiones Province, Argentina, but had not been found on the Paraguayan bank [of the Río Paraná], although it was known to the Indians of the Upper Río Monday farther inland, and he gave the name used for this animal by these Indians. He noted that he had a specimen and that it was gray. All of this, the name he gave to the squirrel, the geographic area occupied by the Indians who knew of it, and the color, argue for the identity of this animal as being *S. aestuans*. However, on the basis of Bertoni’s account, the extent and nature of his evidence that this squirrel occurs in Paraguay is problematic. For one thing, he listed the name “*Sciurus ingrami*” without using italics, by which he meant that an animal was either from a doubtful locality (but presumably one in Paraguay) or that the animal had not yet been confirmed as occurring in Paraguay. For all we know, his specimen may have been from another country. Without a contemporary Paraguayan specimen of *S. aestuans*, its recent or present occurrence in the country should be listed as only highly probable.

In addition to “*Sciurus ingrami*,” Bertoni also noted that Indians had a name for a second species of squirrel found in Paraguay. He speculated that if this squirrel actually occurred in Paraguay, it should be “*S. variabilis* Isidore Geoffroy” of Brazil and Bolivia, but that its presence needed confirmation before it could be included as a member of the Paraguayan fauna. *Sciurus variabilis* Isidore Geoffroy St. Hilaire is now considered by us and others to be a synonym of *S. granatensis* Humboldt, a species found only in southeastern Central America and extreme northwestern South America. *Sciurus granatensis* is a larger animal than members of the subgenus *Guerlinguetus* that could occur in Paraguay, and it is a brightly colored squirrel, so by *S. variabilis* Bertoni presumably meant a member of the subgenus *Urosciurus*, such as *S. urucumus*.

Barquez et al. (2006), in their recent *Mamíferos de*

Argentina, reported, like Bertoni, that *S. aestuans* occurred in Misiones Province, Argentina, and also stated that “*S. ignitus argentinius*” occurred in Jujuy and Salta provinces. They give no indication that the larger *S. spadiceus* or *S. urucumus* might occur in Argentina.

Previous authors who have written on squirrels in Paraguay and/or have compiled lists of species of mammals have either overlooked or chosen to not mention Bertoni’s account, which deals with subjects in a confusing sequence that may have obscured his intention to list his *S. ingrami* as a possible or perhaps even certain member of the fauna, and of which he had a specimen (but perhaps from Argentina or elsewhere), and a second species as clearly merely hypothetical for the country. His use of the term “costa paraguaya” to mean the bank of a river may be confusing to those who do not speak the regional Spanish, as was his description of his specimen (which must have been of *aestuans*) as being gray, immediately after his mention of the hypothetically Paraguayan “*S. variabilis*.”

Diurnal tree squirrels are often easy to observe and the larger ones are frequently hunted in rural areas; so it might be supposed that their distributions are well known. However, that is not the case for squirrels in Paraguay. The only contemporary localized records for any Paraguayan sciurids were reported by D’Elía et al. (2008), who examined two specimens of *Sciurus* from Departamento Alto Paraguay in northern Paraguay. They identified a 352-g adult female from Parque Nacional Río Negro as *S. urucumus*, and reported on a specimen deposited at the University of Kansas, stating, in part, “W Bank Río Negro, 8 km above mouth ... seems to be a juvenile individual, appears not to be referable to *S. urucumus*; however, we are unable to determine its specific identity” (D’Elía et al., 2008:52).

In conjunction with identifying a new specimen of a medium-sized squirrel obtained from Departamento Alto Paraguay, we examined the specimen at the University of Kansas. Herein, we describe both specimens, identify them as *S. ignitus*, provide comparisons with other species of *Sciurus* from the region, and summarize the ecological information we now have on squirrels in Paraguay. A review of what was known previously about *S. ignitus* was provided by Merrick et al. (2014). [While the present paper was in press, an account by de Vivo and Carmignotto (2015) appeared, and treated *S. ignitus* as a subspecies of what they called *Notosciurus pucheranii* (Fitzinger, 1867)].

Specimens listed in the specimens examined (see Appendix) are deposited at the University of Kansas Natural History Museum, Lawrence, Kansas (KU) or are currently in the custody of Robert D. Owen (Raúl Casal-Ex Agustín Barrios–2230, Barrio Republicano, Asunción, Paraguay). The KU specimen was compared with examples of *S. ignitus* and other species of *Sciurus* in the KU collections. Additional specimens of *Sciurus* were exam-

ined at the National Museum of Natural History (USNM), Washington, D.C.. Mass ranges reported herein were taken from Emmons and Feer (1997) and Thorington et al. (2012). This project was undertaken with the approval of the University of Kansas Institutional Animal Care and Use Committee. All animal handling protocols were in accordance with guidelines of the American Society of Mammalogists (Sikes et al., 2011).

On 3 October 1999, Kristof Zyskowski, an ornithologist associated at that time with the University of Kansas Natural History Museum, prepared a standard museum study skin of a female *Sciurus* that had been shot earlier in the day. The specimen consists of a well-made skin (KU 165551) and without skull or associated external measurements. The locality of acquisition is Paraguay: Alto Paraguay; west bank of the Río Negro, 8 km (via river) above mouth ($20^{\circ}06'S$, $58^{\circ}09'W$), elevation 81 m (Fig. 1). This locality is 15 km north of the community of Bahía Negra. Although no external measurements, skull, or recorded mass are available, we are convinced that the specimen is of an adult, or nearly so, because of its size, lack of molt, and fused epiphyseal cartilages in the digits, and we have also concluded that the animal was nulliparous, because of the minute teats. Zyskowski informed us that he believed that this squirrel species was rather local in the area because he observed it only along one trail going out from his base camp. He saw one or two almost daily and they were usually foraging on or close to the ground in a grove of the karanda'y palm (*Copernicia alba*, Arecaceae). His sightings of *S. ignitus* took place during 27–28 September and 1–3 October 1999. He did not observe the larger *S. urucumus* anywhere in the region.

In 2010, a local hunter from Bahía Negra shot a squirrel NW of Bahía Negra. Cartes examined a photograph of the animal and believes it was *S. ignitus* because it was similar in color and size to the specimen collected in 2011 from the same locality. Unfortunately, the squirrel was not saved as a specimen.

On 14 August 2011, Rodrigo Zarate was given a squirrel that had been shot earlier in the day by the same hunter from Bahía Negra and at the same locality where he had shot the squirrel in 2010. This adult male specimen (José L. Cartes no. 151) is prepared as a study skin and skull (broken), with tissues saved in ethanol. The locality of acquisition is Departamento Alto Paraguay; 17 km NW of Bahía Negra ($20^{\circ}09.40'S$, $58^{\circ}19.17'W$), elevation 88 m. This locality is about 19 km SW of the Río Negro locality where Zyskowski obtained the first specimen in 1999. Its external measurements are: total length, 480; tail length, 238 mm; hind foot, 46 mm; ear, 22 mm; mass, 194 g; and scrotal testes 33×17 mm. The hunter related that he was waiting for game in the morning when he saw the squirrel in the canopy of a labon tree (*Tabebuia nodosa*, Bignoniaceae) and that he shot as it moved down, presumably to drink at a small pond. He also mentioned that he had sometimes observed two or three squirrels at the same

Sciurus species in Paraguay

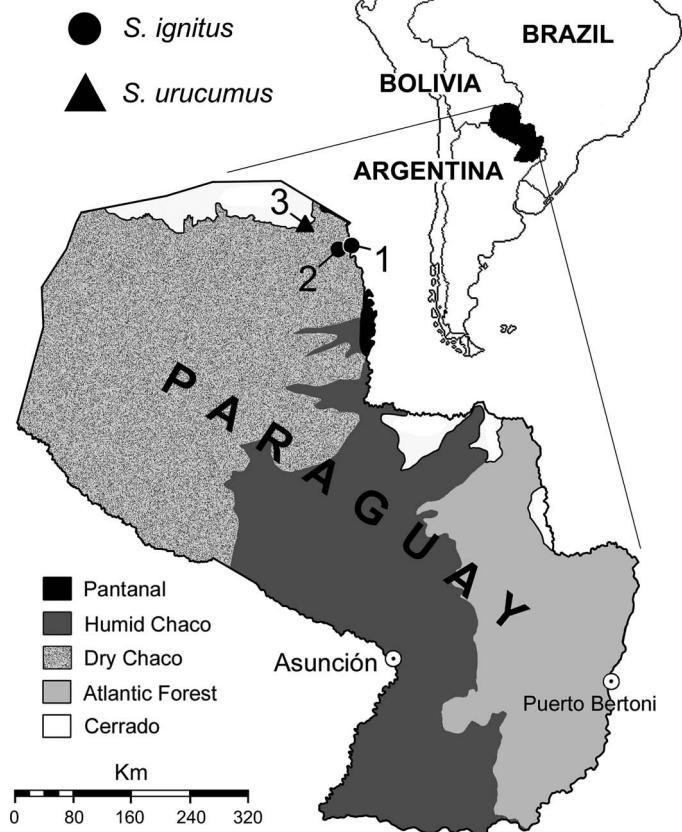


FIG. 1.—Map showing all known localities where specimens of squirrels have been obtained in Paraguay. Locality 1 is along the Río Negro where *Sciurus ignitus* KU 165551 was obtained. Locality 2 is where the new specimens of *S. ignitus* were obtained near Bahía Negra. See text for details on localities and habitats. *Sciurus aestuans* may occur in the vicinity of Puerto Bertoni, marked in the lower right. The five major biomes in Paraguay—Atlantic Forest, Cerrado, Dry Chaco, Humid Chaco, and Pantanal—are indicated.

time in that area and that they feed on nuts of the karanda'y palm. Other common trees in this area include: palo rosa (*Aspidosperma cylindrocarpon*, Apocynaceae), quebrachillo (*Athyana weinmannifolia*, Sapindaceae), quebracho colorado (*Schinopsis balansae*, Anacardiaceae), mandiyura (*Pseudobombax tomentosum*, Bombacaceae), yva hái (*Hexaclamys edulis*, Myrtaceae), paratodo (*Tabebuia aurea*, Bignoniaceae), mbavy pyta (*Coutarea hexandra*, Rubiaceae), urundey para (*Astronium balansae*, Anacardiaceae), and lapacho (*Handroanthus impetiginosus*, Bignoniaceae) (Guyra Paraguay, unpubl.). Local names given herein for tree species are either Spanish or Guaraní.

We identify the specimens obtained by Zyskowski and Zarate as of *S. ignitus* on the basis of their medium size, the agouti dorsum, white venter, and moderately fluffy tail similarly colored to the dorsum and with hairs with tan

tips. The feet of *S. ignitus* from Paraguay are the same color as the dorsum. There is no mid-dorsal dark stripe. There is a distinctive, narrow, tan-orange eye ring. The two specimens are similar in color; however, the venter of the adult male is considerably brighter white and the white more broadly distributed. The ventral hairs of both specimens have a gray basal band. The female from the Río Negro has three pairs of mammae.

Both the male and female from Paraguay have conspicuous orange ear patches. These are generally referred to as "postauricular patches" or "postauricular tufts." Emmons and Feer (1997:187) stated that *S. ignitus* has a "small buff patch behind ear near base," and most authors use this character to distinguish *S. ignitus* from other medium-sized agouti-patterned squirrels of the greater Amazon Basin. On the specimens of *S. ignitus* we have examined, most of the orange hairs are on the posterior/medial surface of the pinna itself and are thus better considered as "auricular." On the female from Paraguay, the orange patch extends posteriorly from the pinna ca. 10 mm, and its hairs are of a more silky texture rather than being more coarse as are the surrounding agouti hairs. On the male from Paraguay, the orange patch is less conspicuous but also extends posteriorly perhaps 10 mm. On specimens we have identified as *S. ignitus* from both northern and southern Peru, the patch is highly variable, and, when present, is restricted to the posterior/medial surface of the pinna. Some specimens have a small but distinct orange auricular patch and other specimens from the same localities have no patch. Thus, the auricular patch is a variable character both geographically as well as within populations, and as a diagnostic character to identify *S. ignitus* it is best used in combination with other characters.

Given the combination of characters shared by the male and female discussed above, and the geographic proximity to localities for Bolivian specimens critically examined by Anderson (1997), we classify the subspecies found in Paraguay as *S. i. boliviensis* Osgood, 1921.

Rainfall in this region of Departamento Alto Paraguay is highly seasonal, with a marked rainy season from November to February. The average annual precipitation is 1,000 mm, with the wettest period in December and January (B. Grassi, pers. comm., 2002). This region lies within the Cerrado biome, but where elements from the Humid Chaco are interspersed with Chaco-Pantanal transitional mesoxerophytic forest. Gallery forest along the river is bordered by palm savanna that is seasonally flooded and remains flooded for months, in part because of the clay soils, the heavy summer rains in the central Chaco, and autumnal flooding of the Río Paraguay. There is a humidity gradient from the humid and rainy east to the dry and xerophytic west. The dense woodlands have a canopy height up to 25+ m and may contain as many as 74 tree species, including some reaching 80–100-cm-diameter breast height (Guyra Paraguay, unpubl.).

Along the Río Negro, where the first specimen was obtained in 1999, riverine flooded forest is surrounded by palm savanna with clay soils as fluvisol (river-associated soils) and gleysols. Common tree species associated with the Río Paraguay watershed in the Southern Pantanal ecoregion include: timbo'y (*Albizia inundata*, Fabaceae), jakare pito (*Crataeva tapia*, Capparaceae), timbo colorado (*Enterolobium timbouva*, Mimosaceae), ñandypa (*Genipa americana*, Rubiaceae), vyrya ne (*Microlobius foetidus paraguensis*, Fabaceae), casita (*Sapindus saponaria*, Sapindaceae), villetana (*Triplaris gardneriana*, Polygonaceae), and kuati'y (*Vochysia tucanorum*, Vochysiaceae) (Guyra Paraguay, unpubl.).

Sciurus ignitus occurs in the western Amazon Basin, including southeastern Peru, southwestern Brazil, northern and eastern Bolivia, and extreme northern Argentina, and is now documented as occurring in northern Paraguay. This squirrel is found in mature and disturbed lowland and mid-elevational forests. Timm (pers. obser.) found them to be locally common in southeastern Peru. Emmons and Feer (1997) reported an elevational range from 200 to 2,700 m; the new specimens we report herein are from 81 and 88 m.

Thorington and Hoffmann (2005:761), following Cabrera (1961), recognized five subspecies of *S. ignitus*—*S. i. argentinus*; *S. i. boliviensis*; *S. i. cabrerai* Moojen, 1958; *S. i. irroratus* (Gray, 1867); and the nominate *S. i. ignitus*. Anderson (1997:378–379), in his comprehensive monograph on the mammals of Bolivia, wrote that both *S. ignitus* and *S. spadiceus* occurred there. He recognized three subspecies of *S. ignitus* in Bolivia—*S. i. argentinus*, *S. i. boliviensis*, and *S. i. ignitus*, with *S. i. argentinus* occurring in extreme south-central Bolivia, *S. i. boliviensis* being widely distributed from the northwest through the central, eastern, and southeastern portions of the country, and *S. i. ignitus* occurring in a small portion of the northwest. As stated above, we treat *S. argentinus* as a full species.

Sciurus ignitus is one of several species of medium-sized agouti-patterned squirrels of the Amazon Basin. It is among the smallest species of *Sciurus* in southern tropical and subtropical South America, with less than half the mass of the large red squirrels *S. spadiceus* and *S. urucumus*. For *S. ignitus*, Emmons and Feer (1997) reported a range of mass from 225 to 240 g and from 600 to 650 g in *S. urucumus*.

The squirrels with which *S. ignitus* could be most easily confused are other members of the subgenus *Guerlinguetus*—*S. aestuans*, which is found throughout much of eastern South America from the coastal Guianas south to southern Brazil and extreme northeastern Argentina; *S. argentinus*, in a narrow zone from south-central Bolivia to northwestern Argentina; and *S. sanborni*, which is found in a restricted area of southeastern Peru. Documenting differences between the South American squirrels, Emmons and Feer (1997) stated that *S. aestuans* is smaller and darker than *S. ignitus*, and that mass ranges from 159 to 218 g in *S. aestuans* and 222 to 261 g in *S. argentinus* and that *S. ignitus* has three pairs of mammae and *S.*

aestuans four pairs. For both color and size, these differences are probably not sufficient to allow these species to be distinguished in the field. In *S. ignitus*, we found a considerably greater range in mass than had been reported previously—a series of four adult *S. ignitus* from the same locality in southeastern Peru range in mass from 200 to 260 g. Thus, *S. ignitus* and *S. aestuans* cannot be reliably distinguished on the basis of mass alone. We also exclude *S. aestuans* as a possibility for our specimens from both Paraguay and Peru because our female specimens clearly have three pairs of mammae, all have a white venter, and the other combination of characters listed above. The venter of *S. ignitus* in the southernmost populations is white, whereas it is tan to yellow/orange in the more northern populations. Olrog and Lucero (1980) reported, however, that *S. aestuans* and *S. ignitus* have different-colored venters in different seasons, and Canevari and Vaccaro (2007) stated that *S. aestuans* sometimes has the ear patch. *Sciurus sanborni*, like *S. ignitus*, is a small, long-tailed tree squirrel with dorsally grizzled pelage. *Sciurus sanborni* is smaller than *S. ignitus* in all dimensions, but not so noticeably that size would be useful as a field character; however, *S. sanborni* has a more distinct, orange-yellow eye ring, the dorsal color is more olivaceous than in *S. ignitus*, and both forefeet and hindfeet are considerably paler than the back. In *S. sanborni*, the venter is yellow/white, contrasting sharply with the sides and dorsum. An easy way to separate the two species is on the basis of skull shape. *Sciurus ignitus* has a very rounded, squat skull with a rostrum that seems disproportionately short, whereas *S. sanborni* has an elongate skull with pointed rostrum.

Species of *Microsciurus* may be confused with *S. ignitus* and other members of the subgenus *Guerlinguetus*. *Microsciurus* species are similar in color to the three species of *Guerlinguetus* discussed here; however, they are considerably smaller, have short ears that do not extend to the level of the crown of the head, and very short tails, shorter than the head plus body length (comparisons made from examination of specimens at KU and USNM and in part adapted from Emmons and Feer 1997).

Sciurus ignitus is common in at least some localities in Departamento Madre de Dios, southeastern Peru, where it is sympatric with the larger *S. spadiceus*, although it is less abundant than the latter or is not as easily spotted (Timm, pers. obser.). *Sciurus spadiceus* and *S. ignitus* were among the most common diurnal mammals along the Río Madre de Dios and there appeared to be no habitat segregation between the two. Timm observed juvenile *S. ignitus* during both the dry and rainy seasons there. He observed both *S. ignitus* and *S. spadiceus* feeding on nuts of the palm *Astrocaryum* (Arecaceae). Additional ecological information on *S. ignitus* in Peru was provided by Woodman et al. (1991, 1995, 1996).

The only previous reports of squirrels from known localities in Paraguay were of the specimen obtained

along the Río Negro in 1999 that we now identify as *S. ignitus*, and the single specimen of *S. urucumus* obtained by Ismael Mora in January 2003, near the Río Negro in Parque Nacional Río Negro and reported by D'Elía et al. (2008). This just-mentioned single specimen of *S. urucumus* was obtained in the Chiquitano Forest, northeastern Paraguayan Chaco, just to the west of Pantanal habitats, at a place dominated by the palms *Acrocomia* and *Copernicia* and at an elevation of ca. 100 m.

The hunter from Bahía Negra who obtained the *S. ignitus* we report herein clearly described two species of squirrels, and said that the very red/larger one occurs in the Chovoreca region (Cerrado with sandy soils) and that the smaller, gray-agouti squirrel is found close to Bahía Negra, and that both can be locally common. We have no evidence that the two species are locally sympatric as *S. ignitus* and *S. spadiceus* are said to be by L. Emmons (pers. comm.) in Peru and in the Santa Cruz Department, Bolivia.

Recent biodiversity assessment research conducted by Guyra Paraguay identified several sites where *S. aestuans* is likely to occur, all within Paraguay's Atlantic Forest (see Fig. 1) in Departamento Alto Paraná. On the basis of interviews with local residents and hunters, including Aché indigenous hunters, who describe a small, dark squirrel occurring in the region, *S. aestuans* might be found in Estancia Muxfeldt, Parque Nacional Ñacunday, and the Puerto Barra Aché indigenous community region. In Departamento Alto Paraná, *S. aestuans* might occur in Monumento Natural Puerto Bertoni and the complex of reserves of the Itaipú Dam, including Refugio Biológico de Tatí Yupi, Reserva Biológica Itabó, and Reserva Biológica Limoy. However, the Itaipú Dam reserves have been fairly well studied, with no reports of squirrels or specimens taken. There was an intensive wildlife rescue effort when the impoundment was filling in the 1980s, but no squirrels were reported.

We can now add *S. ignitus* to the known fauna of Paraguay. Both *S. ignitus* and *S. urucumus* occur in the same remote region of seasonally flooded Cerrado; however, the specific sites where the two species are now documented suggest that *urucumus* is more common in the Cerrado, areas of sandy, elevated, better-drained soils, and *ignitus* is more common in the Chaco–Pantanal seasonally humid transitional forests, in wet clay soils. Hunting still occurs in Paraguay, but subsistence hunters primarily pursue larger game species and not mammals as small as squirrels (Hill et al., 2003). The mammal fauna of Paraguay now includes 179 species of native mammals, with the addition of *S. ignitus*, the addition of *Cerradomys scotti* by Percequillo et al. (2008), of *Rhipidomys macrurus* by de la Sancha et al. (2011), *Myotis lavalii* by Moratelli and Wilson (2013), and *Cryptonanus unduaviensis* and *Philander opossum* by de la Sancha and D'Elía (2015). Additionally, the Old World *Mus musculus*, *Rattus norvegicus*, *R. rattus*, and *Lepus europaeus* occur as wild populations,

bringing the total to 181 species. The fragmentary knowledge of the squirrel species found in Paraguay highlights how much remains to be learned about the fauna of this country. More species of mammals will surely be added to the fauna with additional fieldwork.

The Secretaría del Ambiente provided permits for our research. Funding was provided in part by Parque Nacional Río Negro Rapid Biological Appraisal and Guyra Paraguay and sponsored by the Paraguay Silvestre Project. K. Zyskowski's efforts in preparing and making available to us the specimen obtained in 1999 and his assistance with the field data are most appreciated. K. M. Helgen, D. P. Lunde, and S. C. Peurach made specimens housed in the USNM available to us for study. We thank B. L. Clauson, G. D'Elía, R. D. Owen, C. Pizzurno, A. Romero, P. Smith, and M. de Vivo for assistance, and L. H. Emmons, R. Owen, N. U. de la Sancha, and R. Stevens for critical comments on the manuscript. D. Bennett's expertise in drafting the map used as Fig. 1 is greatly appreciated.

LITERATURE CITED

- ANDERSON, S. 1997. Mammals of Bolivia: taxonomy and distribution. *Bulletin of the American Museum of Natural History* 231:1–652.
- BARQUEZ, R. M., M. M. DÍAZ, AND R. A. OJEDA. 2006. Mamíferos de Argentina: sistemática y distribución. Sociedad Argentina para el Estudio de los Mamíferos, Tucumán, Argentina.
- BERTONI, A. DE W. 1939. Catálogos sistemáticos de los vertebrados del Paraguay. *Revista de la Sociedad Científica del Paraguay* 4:3–60.
- CABRERA, A. 1960 [1961]. Catálogo de los mamíferos de América del sur. II. (Sirenia—Perissodactyla—Artiodactyla—Lagomorpha—Rodentia—Cetacea). *Revista del Museo Argentino de Ciencias Naturales “Bernardino Rivadavia,” Ciencias Zoológicas* 4(2):1–732.
- CANEVARI, M., AND O. VACCARO. 2007. Guía de mamíferos del sur de América del Sur. L.O.L.A. (Literature of Latin América), Buenos Aires, Argentina.
- DE LA SANCHÀ, N. U., AND G. D'ELÍA. 2015. Additions to the Paraguayan mammal fauna: the first records of two marsupials (Didelphimorphia, Didelphidae) with comments on the alpha taxonomy of *Cryptonanus* and *Philander*. *Mammalia* 79:343–356.
- DE LA SANCHÀ, N. U., G. D'ELÍA, C. J. TRIBE, P. E. PEREZ, L. VALDEZ, AND R. H. PINE. 2011. *Rhipidomys* (Rodentia, Cricetidae) from Paraguay: noteworthy new records and identity of the Paraguayan species. *Mammalia* 75:269–276.
- D'ELÍA, G., I. MORA, P. MYERS, AND R. D. OWEN. 2008. New and noteworthy records of Rodentia (Erethizontidae, Sciuridae, and Cricetidae) from Paraguay. *Zootaxa* 1784:39–57.
- DE VIVO, M., AND A. P. CARMIGNOTTO. 2015. Family Sciuridae G. Fischer, 1817. Pages 1–48 in *Mammals of South America, Volume 2: Rodents* (J. L. Patton, U. F. J. Pardiñas, and G. D'Elía, editors). University of Chicago Press, Chicago, Illinois.
- EMMONS, L. H., AND F. FEER. 1997. Neotropical rainforest mammals: a field guide. Second edition. University of Chicago Press, Chicago, Illinois.
- HILL, K., G. McMILLAN, AND R. FARIÑA. 2003. Hunting-related changes in game encounter rates from 1994 to 2001 in the Mbaracayú Reserve, Paraguay. *Conservation Biology* 17:1312–1323.
- MERRICK, M. J., S. L. KETCHAM, AND J. L. KOPROWSKI. 2014. *Sciurus ignitus* (Rodentia: Sciuridae). *Mammalian Species* 46:93–100.
- MORATELLI, R., AND D. E. WILSON. 2013. Distribution and natural history of *Myotis lavalii* (Chiroptera, Vespertilionidae). *Journal of Mammalogy* 76:650–656.
- MYERS, P., A. TABER, AND I. GAMARRA DE FOX. 2002. Mamíferos de Paraguay. Pages 453–502 in *Diversidad y conservación de los mamíferos neotropicales* (G. Ceballos and J. A. Simonetti, editors). Comisión Nacional para el Conocimiento y Uso de la Biodiversidad y Universidad Nacional Autónoma de México, México, D.F., México.
- OLROG, C. C., AND M. M. LUCERO. 1980 [1981]. Guía de los mamíferos argentinos. Ministerio de Cultura y Educación, Fundación Miguel Lillo, San Miguel de Tucumán, Argentina.
- PERCEQUILLO, A. R., E. HINGST-ZAHER, AND C. R. BONVICINO. 2008. Systematic review of genus *Cerradomys* Weksler, Percequillo and Voss, 2006 (Rodentia: Cricetidae: Sigmodontinae: Oryzomyini), with description of two new species of eastern Brazil. *American Museum Novitates* 3622:1–46.
- SIKES, R. S., W. L. GANNON, AND THE ANIMAL CARE AND USE COMMITTEE OF THE AMERICAN SOCIETY OF MAMMALOGISTS. 2011. Guidelines of the American Society of Mammalogists for the use of wild mammals in research. *Journal of Mammalogy* 92:235–253.
- SMITH, P. 2014. List of the mammals of Paraguay in FAUNA Paraguay. <http://www.faunaparaguay.com/listmammals.html>. Accessed 4 March 2014.
- THORINGTON, R. W., JR., AND R. S. HOFFMANN. 2005. Family Sciuridae. Pages 754–818 in *Mammal species of the world: a taxonomic and geographic reference* (D. E. Wilson and D. M. Reeder, editors). Third edition. Johns Hopkins University Press, Baltimore, Maryland.
- THORINGTON, R. W., JR., J. L. KOPROWSKI, M. A. STEELE, AND J. F. WHATTON. 2012. *Squirrels of the world*. Johns Hopkins University Press, Baltimore, Maryland.
- WOODMAN, N., N. A. SLADE, R. M. TIMM, AND C. A. SCHMIDT. 1995. Mammalian community structure in lowland, tropical Peru, as determined by removal trapping. *Zoological Journal of the Linnean Society* 113:1–20.
- WOODMAN, N., R. M. TIMM, N. A. SLADE, AND T. J. DOONAN. 1996. Comparison of traps and baits for censusing small mammals in Neotropical lowlands. *Journal of Mammalogy* 77:274–281.
- WOODMAN, N., R. M. TIMM, R. ARANA C., V. PACHECO, C. A. SCHMIDT, E. D. HOOPER, AND C. PACHECO A. 1991. Annotated checklist of the mammals of Cuzco Amazónico, Peru. *Occasional Papers of the Museum of Natural History, University of Kansas* 145:1–12.

Submitted 5 March 2013

Acceptance recommended by Associate Editor, Richard T. Stevens, 28 January 2015.

APPENDIX—Data on specimens of *Sciurus ignitus* listed here as “specimens examined” include the locality, sex, and number of specimens from the locality, and museum acronym and catalog number, if any.

Specimens examined (11).—Paraguay: Departamento Alto Paraguay; 17 km NW of Bahía Negra (20°09.40'S, 58°19.17'W), elev. 88 m [one male, José L. Cartes no. 151,

in custody of Robert D. Owen, Raúl Casal—Ex Agustín Barrios—2230, Barrio Republicano, Asunción, Paraguay)]; Departamento Alto Paraguay; W bank Río Negro, 8 km above mouth ($20^{\circ}06'S$, $58^{\circ}09'W$), elev. 81 m [one female, KU 165551]. Peru: Departamento Loreto; Nauta, Río Samiria, right bank, elev. 150 m [one male, KU 140173];

Nauta, Río Tigré, 1 km above Río Tigrillo, left bank, elev. 150 m [one male, three females, KU 140263, 140267–69]; Departamento Madre de Dios, 14 km NE of Puerto Maldonado, Reserva Cuzco Amazónico, elev. 200 m [$12^{\circ}33'S$, $69^{\circ}03'W$] [one male, three females, KU 144562–65].