*Russian J. Theriol. 24 (1):* 37–48 

# Status and distribution of Paraguayan Sciuridae (Rodentia) and Leporidae (Lagomorpha)

**Paul Smith**

ABSTRACT. Two species of Sciuridae (*Hadrosciurus ignitus* and *H. spadiceus*) and two species of Leporidae (one native *Sylvilagus* cf. *brasiliensis* and one exotic *Lepus europaeus*) are known to occur in Paraguay. However, their distribution is poorly understood, and no compilation of the knowledge of these families in Paraguay exists. This paper reviews the available specimens and literature, provides distribution maps and corrects existing errors of misunderstanding with a view towards promoting their future study in the country.

How to cite this article: Smith P. 2025. Status and distribution of Paraguayan Sciuridae (Rodentia) and Leporidae (Lagomorpha) // Russian J. Theriol. Vol.24. No.1. P.37–48. doi: 10.15298/rusjtheriol.24.1.07

KEY WORDS: *Guerlinguetus brasiliensis*, *Hadrosciurus ignitus*, *Hadrosciurus spadiceus*, *Lepus europaeus, Sylvilagus* cf. *brasiliensis*.

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# Статус и распространение парагвайских беличьих (Rodentia: Sciuridae) и заячьих (Lagomorpha: Leporidae)

**П. Смит**

РЕЗЮМЕ. Для Парагвая известно обитание двух видов беличьих (*Hadrosciurus ignitus* и *H. spadiceus*) и двух видов заячьих (нативного *Sylvilagus* cf. *brasiliensis* и акклиматизированного *Lepus europaeus*). Однако их распространение плохо изучено, и не существует обобщения информации об этих семействах в Парагвае. В данной статье рассмотрены имеющиеся коллекционные и литературные данные, приведены карты распространения и исправлены существующие ошибки недопонимания с целью содействия их будущему изучению в стране.

КЛЮЧЕВЫЕ СЛОВА: *Guerlinguetus brasiliensis*, *Hadrosciurus ignitus*, *Hadrosciurus spadiceus*, *Lepus europaeus, Sylvilagus* cf. *brasiliensis*.

## Introduction

The presence of the family Sciuridae in Paraguay had been speculated on since as early as Bertoni (1914), but there was no confirmation that the family occurs in the country until D'Elía *et al.* (2008) documented the presence of *Hadrosciurus spadiceus* (Olfers, 1818) (as *Sciurus urucumus* Allen, 1914). Timm *et al.* (2015) then documented a second species *Hadrosciurus ignitus* (Gray, 1867) in Paraguay and provided a review of previous squirrel records in the country that contained some errors of understanding. De la Sancha *et al.* (2017) later suggested the presence of three species in the country, without identifying one of them to species level, but this was also in error. These errors are corrected herein.

Two species of Leporidae (Lagomorpha) are known to occur in Paraguay. One, a widespread native species (*Sylvilagus* cf. *brasiliensis*) is the subject of ongoing, continent wide taxonomic studies to determine its specific identity. It has long been known to occur in Paraguay, being reported by the earliest students of the country fauna (Azara, 1801, 1802; Rengger, 1830). The other, an introduced species (*Lepus europaeus*), is apparently expanding its range in the Oriental region despite only being confirmed to occur in Paraguay less than 15 years ago (de la Sancha *et al.*, 2009).

None of the species covered in this paper have ever been the subject of ecological studies focused specifically on them in Paraguay. The most recent conservation assessment found both species of Sciurid to be Data Deficient, but inexplicably failed to evaluate *Sylvilagus* cf. *brasiliensis* (Saldívar *et al.*, 2017). As an exotic species *Lepus europaeus* was also Not Evaluated.

In this paper I provide for the first time a review of the Paraguayan distribution and literature of these two

families, pulling together the known data for the country, mapping the species distribution for the first time, correcting errors and highlighting unresolved issues.

## Material and methods

Specimens of Sciuridae and Leporidae from the major zoological collections in Paraguay were reviewed during 2022–2024, identifications were confirmed by inspection of the specimens and locality data were collated from museum databases and specimen labels. The location of specimens in non-Paraguayan museums was gleaned from the literature and from Vert Net (which returned 2 results for Sciuridae and 44 for Leporidae). Where possible specimens considered to represent significant geographical range extensions were reviewed with the assistance of museum curators. Those that did not present noteworthy distributions were assumed to be correct and not examined.

Taxonomy of the squirrels follows Abreu-Junior *et al.* (2020) and taxonomy of the leporids follows Ruedas *et al.* (2017). Collection codes for museums housing Paraguayan specimens are as follows: AMNH — American Museum of Natural History, New York, USA; CBMI — Colección


**Fig. 1.** Map showing the political departments of Paraguay. Departments as follows: Chaco region — Alto Paraguay (APY), Boquerón (BOQ), Presidente Hayes (PHA); Oriental region — Amambay (AMA), Alto Paraná (APA), Caaguazú (CAA), Canindeyú (CAN), Caazapá (CAZ), Central (CEN), Concepción (CON), Cordillera (COR), Guairá (GUA), Itapúa (ITA), Misiones (MIS), Ñeembucú (ÑEE), Paraguarí (PAR), San Pedro (SPE).

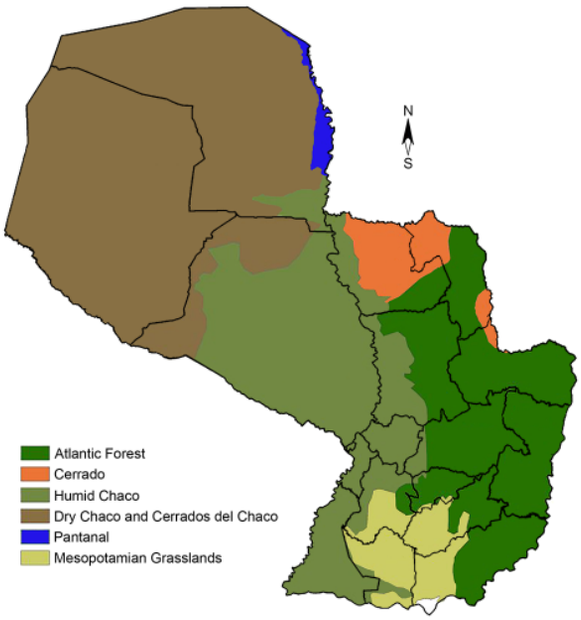


**Fig. 2.** Map showing Paraguayan ecoregions.

Biológica del Museo Itaipú, Hernandarias, Paraguay; CZPLT — Colección Zoológica Para La Tierra, Pilar, Paraguay; EBD — Estación Biológica Doñana, Sevilla, Spain; FMNH — Field Museum of Natural History, Chicago, USA; KU — Kansas University Natural History Museum, Lawrence, USA; MACN — Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina; MHNG — Museum d'Histoire Naturelle Genève, Geneva, Switzerland; MJUF — Museo Jakob Unger, Filadelfia, Paraguay; MNHNP — Museo Nacional de Historia Natural del Paraguay, San Lorenzo, Paraguay; MSB — Museum of Southwestern Biology, University of New Mexico, Albuquerque, USA; MVZ — Museum of Vertebrate Zoology, University of California, Berkeley, USA; NHM — Natural History Museum, London, UK; TTU — Museum of Texas Tech University, Lubbock, USA; UMMZ — University of Michigan Museum of Zoology, Ann Arbor, USA; USNM — United States National Museum, Smithsonian Institution, Washington, USA.

Species accounts begin with the current common name, scientific name and author is presented for each species in bold type following Patton *et al.* (2015). The original described name, author and type locality follow. There then follows a referenced list of the synonyms used in the Paraguayan literature with a (hopefully self-explanatory) single word descriptor of the subject of the publication, as follows: biogeography, checklist, conservation, distribution, ethnography, etymology, guide, history, mention, mortality, nomenclature, parasitology, predation, specimen/s, taxonomy, tracks and uses.

The synonymy deals only with Paraguayan literature or literature citing Paraguayan specimens and is not intended to be a complete list of synonymy for the species.

*Local names*: All local common names published in the Paraguayan literature known to me are provided. An attempt to reference the earliest published usage for each name is made.

*Comments:* Addressing noteworthy or confusing themes in the Paraguayan literature.

There then follows a "hierarchical reliability" approach to the Paraguayan distribution of each species. This approach is taken so as to not unduly bias understanding by depending solely on the limited specimen record. The hierarchies are, in order of documented reliability: 1) examined specimen, 2) specimen not examined, 3) published literature record, 4) published or author examined photographic record, 5) reliable field observation by one of the authors or knowledgeable local observer. Records are presented with the political department in bold capitals, followed by the details of the record (in alphabetical order). For specimen records this involves the specimen number (for museum codes see above) followed by the locality. These records are also mapped distinguishing the hierarchical categories so that readers may interpret their reliability for themselves (Figs 3–6). Records corresponding to categories 4) published photographic record, 5) reliable field observation; include only localities that are not covered by any one of the previous three categories.

The criteria for inclusion of literature were that it was published in Paraguay or specifically deals with Paraguay, or in the case of international publications that it makes specific reference to Paraguayan specimens. The maps included in Neris *et al.* (2002) were omitted from this compilation. These maps were based on interviews with local people and contain numerous, obvious errors that I am keen not to perpetuate here. Also excluded are the results of Rapid Ecological Evaluations produced and published locally, due to the tendency amongst authors to extrapolate distributions without the necessary evidence in an effort to enhance the results produced after limited field time. Every effort was made to be thorough in this regard, though undoubtedly some obscure references will have been missed.

A statement on the ecological affinities of each species in Paraguay is provided based on the ecoregions defined in Guyra Paraguay (2005) and Mereles (2013) (Fig. 2). These can be broadly defined as follows: Atlantic Forest (subtropical humid forests of eastern Paraguay); Cerrado (central South American bushy savanna of northern eastern Paraguay); Dry Chaco (low, arid thorn forest and scrub of the western Occidental region); Humid Chaco (palm savanna and marshlands of the Paraguay River Basin; Pantanal (gallery forests and swamps of the north-eastern Chaco); Cerrados del Chaco (an area of Cerrado in the northern Chaco contiguous with the Chiquitania of Bolivia) and Mesopotamian Grasslands (flooded grasslands of the southern Oriental region).

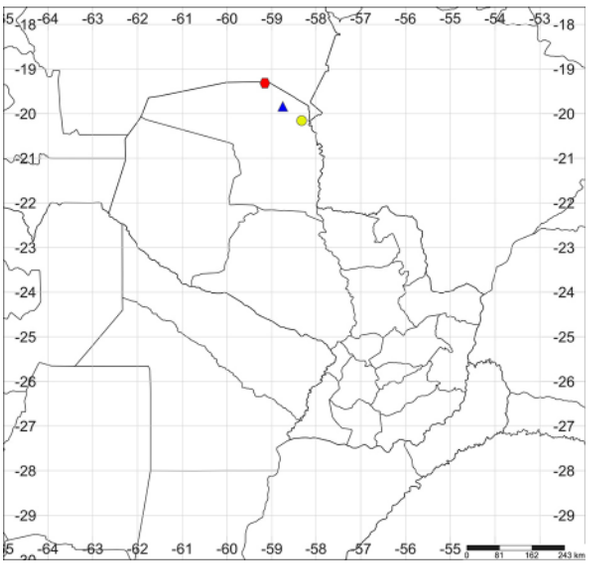

**Fig. 3.** Distribution of *Hadrosciurus spadiceus* in Paraguay. Circle: Specimen examined; Triangle: Specimen not examined; Hexagon: Photographic record.

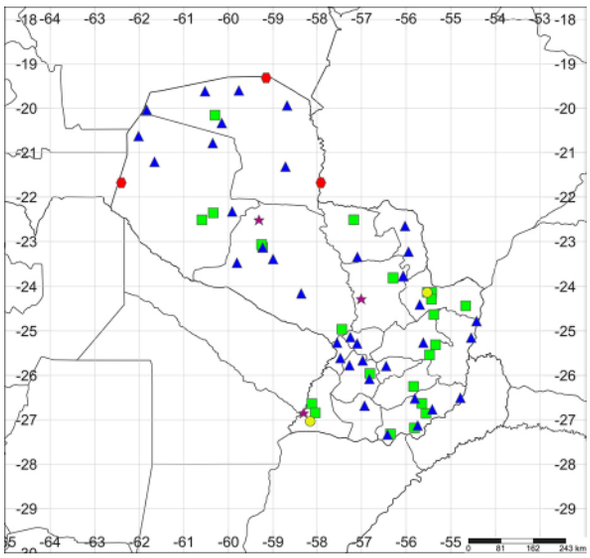

**Fig. 5.** Distribution of *Sylvilagus* cf. *brasiliensis* in Paraguay. Circle: Specimen examined; Triangle: Specimen not examined; Square: Literature reference; Hexagon: Photographic record; Star: Reliable observation.

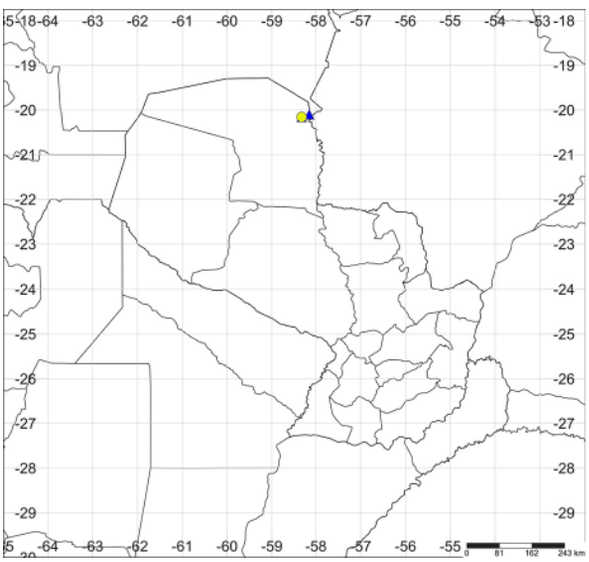

**Fig. 4.** Distribution of *Hadrosciurus ignitus* in Paraguay. Circle: Specimen examined; Triangle: Specimen not examined.

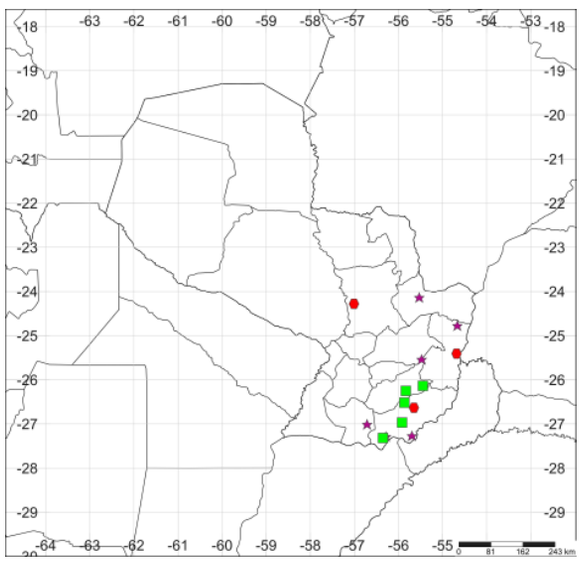

**Fig. 6.** Distribution of *Lepus europaeus* in Paraguay. Square: Literature reference; Hexagon: Photographic record; Star: Reliable observation.

## Results

**Family Sciuridae**

**Southern Amazon red squirrel *Hadrosciurus spadiceus* (Olfers, 1818)**

*Sc.[iurus] spadiceus* Olfers, 1818: 208. Type locality "Brasilia". Restricted to "Cuyabá, Mato Grosso" by Hershkovitz (1959: 346)

*Sciurus* sp. Morales (2007: conservation)

*Sciurus spadiceus* Morales (2007: mention); Guyra Paraguay (2008: distribution)

*Sciurus urucumus* D'Elía *et al.* (2008: first record)

*Hadrosciurus spadiceus* de la Sancha *et al.* (2017: checklist); Saldívar *et al.* (2017: conservation)

*Local names*: SPANISH: Ardilla (Morales 2007); Ardilla roja del Amazonas sur (González *et al.* 2019).

*Comments: Sciurus langsdorffii urucumus* J. A. Allen, 1914:595 was described with type locality: "Uru-

cum (altitude 400 feet), Rio Paraguay (at mouth of Rio Tacuari), Brazil" and D'Elía *et al.* (2008) used the name *Sciurus urucumus* Allen, 1914 when documenting the species in Paraguay. This name is now considered a synonym of *Sciurus langsdorffii steinbachi* J. A. Allen, 1914: 596 (Type locality "Santa Cruz de la Sierra, Bolivia"). *Sciurus langsdorfii* Brandt, 1835: 425 itself is now considered a synonym of *Sc.[iurus] spadiceus* Olfers, 1818. Thus the correct subspecific name for the Paraguayan populations is *Sciurus spadiceus steinbachi* J. A. Allen, 1914.

The species was first mentioned in the Paraguayan fauna by Morales (2007), and it was included in an appendix on threatened mammals without a specific assignation, and declared to be "Endangered" (En Peligro, according to the 2006 SEAM Resolución 524/06). However, the first details of the presence of the species were published by D'Elía *et al.* (2008) under a different scientific name. The published report of this species for Estación Los Tres Gigantes (González *et al.*, 2019) is omitted here as it is considered to refer to *H. ignitus* (which see).

*Geographical distribution:* Confined to a small area of Chiquitano forest and neighbouring Pantanal in the extreme north of Alto Paraguay department where it is locally common. The core of the Paraguayan range seems to be the Cerrados del Chaco ecoregion as defined by Mereles (2013). Though the two species of squirrel have not yet been recorded at the exact same Paraguayan locality, the ranges of the two approach each other very closely (to within a few kilometers) and partial sympatry seems likely, as in other areas of the species range.

*Examined specimens:* **ALTO PARAGUAY:** Linea 1 km17, Bahia Negra at 20.1566º S, 58.3194º W (CZPLT 644).

*Specimens not examined:* **ALTO PARAGUAY:** Parque Nacional Rio Negro, Estancia Kamba Aka at 19.8390° S, 58.7550° W (TK 67300; Guyra Paraguay, 2008; D'Elía *et al.*, 2008).

*Photographic records:* **ALTO PARAGUAY:** Chovoreca (Diario Ultima Hora 23 November 2022; Luis Recalde).

**Bolivian squirrel *Hadrosciurus ignitus* (Gray, 1867)**

*Macroxus ignitus* Gray, 1867: 429. Type locality "Bolivia (Brydges)". Restricted to "probably near Yungas, upper Rio Beni" by Allen (1915: 204)

*Sciurus* sp. D'Elía *et al.* (2008: mention)

*Sciurus ignitus* Timm *et al.* (2015: first record); de la Sancha *et al.* (2017: checklist); Saldívar *et al.* (2017: conservation)

*S.[ciurus] i.[gnitus] boliviensis* Timm *et al.* (2015: first record)

*Hadrosciurus* sp. de la Sancha *et al.* (2017: checklist)

*Hadrosciurus spadiceus* González *et al.* (2019: distribution)

*Local names*: None.

*Comments:* Timm *et al.* (2015) assigned Paraguayan specimens to *S. i. boliviensis* Osgood, 1921: 39 with type locality "Sarayacu on the Ucayali River" restricted by Sanborn (1951: 18).

De la Sancha *et al.* (2017) listed three species of squirrel for Paraguay, including *Hadrosciurus* sp., an unidentified juvenile specimen (KU 165551; collected by Kristof Zyskowski, 3 October 1999) referred to in passing in D'Elía *et al.* (2008) as *Sciurus* sp. They appear to have overlooked that this was one of the specimens examined by Timm *et al.* (2015) and identified as *Sciurus ignitus*, thus resulting in the duplication of a species in their list.

González *et al.* (2019) listed *Hadrosciurus spadiceus* for Estación Tres Gigantes, citing the Guyra Paraguay Biodiversity Database as the source. The only reference to a squirrel in the GPBD was indeed to *Hadrosciurus spadiceus*, but this was in error as the source specimen cited was KU 165551, one of the specimens included by Timm *et al.* (2015) in their publication documenting *H. ignitus* in Paraguay (H. del Castillo pers. comm.). Thus that reference properly refers to this species.

*Geographical distribution:* Known distribution is highly localized in the Pantanal in the extreme northeast of Alto Paraguay department.

*Specimens not examined:* **ALTO PARAGUAY:** 17 km NW of Bahia Negra (20.1567º S, 58.3195º W) (JL Cartes collection; Timm *et al.*, 2015); west bank of the Río Negro, 8 km (via river) above mouth (20.1000º S, 58.1500º W) (=Estación Tres Gigantes) (KU 165551; D'Elía *et al.*, 2008; Timm *et al.*, 2015; González *et al.*, 2019).

***Hypothetical species***

**Brazilian squirrel *Guerlinguetus brasiliensis* (J.F. Gmelin, 1788)**

[*Sciurus*] *brasiliensis* J.F. Gmelin, 1788: 151. Type locality "Brasilia et Guiana". Restricted to "Pernambuco, Brazil" by de Vivo & Carmignotto (2015)

*Sciurus aestuans* Bertoni (1914: checklist, hypothetical); Timm *et al.* (2015: taxonomy)

*Sciurus ingrami* Bertoni (1939: checklist, hypothetical); Timm *et al.* (2015: taxonomy)

*Local names:* AVÁ: Wareruâ (Bertoni, 1914).

*Comments:* Bertoni (1914, 1939) used two names for a species of squirrel purported to be of potential occurrence in the Oriental region a) 1914 *Sciurus aestuans* Linnaeus, 1766; and b) 1939 *Sciurus ingrami* Thomas, 1901a, which as currently understood, refers to a similar species confined to coastal southeast Brazil (Alvarenga & Talamoni, 2005). The current valid name for the species that occurs on the coasts of the Paraná and intended by Bertoni (1914, 1939) is *Guerlinguetus brasiliensis* (Gmelin, 1788). However, the taxonomy of South American squirrels is far from resolved (Abreu-Junior *et al.,* 2020).

In their discussion of the history of sciurid reports in Paraguay Timm *et al.* (2015) substantially confuse the text of Bertoni (1939), unnecessarily introducing

doubt as to whether or not the author recorded zero, one or two species in Paraguay. In fact, the first discussion of a squirrel in the context of Paraguay was earlier (Bertoni, 1914), which uses different nomenclature for the species but otherwise includes the same text verbatim as Bertoni (1939). Both are quite categorically clear in that the author had no personal knowledge of any species in Paraguay beyond second hand accounts from the Avá-chiripá indigenous people of Alto Monday (who claimed to be aware of two species). Furthermore, the use of italicized text for the scientific name in Bertoni (1914) and non-italicised text in Bertoni (1939) is standard format in both works referring to species for which no documentation yet exists (i.e. indicating species of hypothetical or possible occurrence in Paraguay) (Smith, 2024). Bertoni (1914, 1939) does indeed speculate on the possible identity of a second species should there in fact be one, but he goes to pains to again stress that neither record should be accepted until there is proper scientific documentation. Thus, Bertoni categorically did not have any evidence of squirrels occurring in Paraguay (Smith, 2024).

The text from Bertoni (1914, 1939) is produced here below with a translation:

"Wareruâ (Avá-chiripá del Monday). *Existe en Santa Ana e Iguazú — Misiones argentina, pero nunca lo hallé en la costa paraguaya. Sin embargo los guaraní del Alto Monday lo reconocieron y dicen existir dos especies en el Paraguay. Si esto es exacto, la segunda debe ser el S. variabilis Is. Geoff. del Brasil y Bolivia; más la exactitud exige que esto sea comprobado antes de enumerarla entre las especies paraguayas. Los Guayaná le llaman kuatí-serelepé. Mi ejemplar es gris*".

[Our translation] "Wareruâ (according to the Avá-chiripá tribe of Monday). It occurs in Santa Ana and Iguazú — Misiones, Argentina, though I have never found it on the Paraguayan side of the Paraná. Notwithstanding, the Guaraní of Alto Monday recognize it and claim that two species exist in Paraguay. If this is correct, the second must be *S. variabilis* Is. Geoff. of Brazil and Bolivia; but scientific rigour demands that this be proven before it is included in the Paraguayan fauna. The Guayaná call it kuatí-serelepé. My specimen is grey."

A specimen (MHNG 1704.095; male; skull and alcohol examined) collected by Carlo Dlouhy with locality "Puerto Iguazú, Alto Paraná, Paraguay" is actually from Argentina (Alan de Chambrier, Manuel Ruedi in litt.). I am aware of a credible sight record of an unidentified squirrel at Estancia Nueva Gambach, Itapúa department (Rebecca Smith) that may pertain to this species. Timm *et al.* (2015) also mentioned local hunters from Alto Paraná referring to "small, dark squirrels" at Estancia Muxfeldt, Parque Nacional Ñacunday and Puerto Barra Aché Indigenous Community, but all of these records are unconfirmed. Furthermore, I consider that proposed occurrence at Puerto Bertoni has no sound basis (for reasons discussed earlier) and concur with Timm *et al.* (2015) that an undiscovered population within the well-sampled complex of Itaipú reserves would seem unlikely. If the species is indeed present in the Oriental region of Paraguay it is extremely rare and elusive.

**Family Leporidae**

**Tapeti *Sylvilagus* cf. *brasiliensis* (Linnaeus, 1758)**

[*Lepus*] *brasiliensis* Linnaeus, 1758: 58. Type locality "America Meridionali". Restricted to "coastal Pernambuco State, near Recife" by Ruedas *et al.* (2017)

*Lepus brasiliensis* Rengger (1830: ecology); Bertoni (1914: checklist); Bertoni (1939: checklist)

*Sylvilagus brasilensis* Hill & Hawkes (1983: ethnography, uses); Hill *et al.* (2003: ethnography, uses)

*Sylvilagus brasiliensis paraguayensis* Roguin (1986: specimens)

*Sylvilagus brasiliensis* Schmidt & Martin (1978: parasitology); Masi Pallares (1990: parasitology); Brooks *et al.* (1993: distribution); van Humbeck & Silvera Avalos (1995: distribution); Gamarra de Fox & Martin (1996: distribution, specimens); Lowen *et al.* (1996: distribution); Taber *et al.* (1997: predation); Gamarra de Fox *et al.* (1998: conservation); Yahnke *et al.* (1998: biogeography, distribution); Hill *et al.* (1999: ethnography); Hill & Padwe (2000: ethnography, uses); Villalba & Yanosky (2000: tracks); Areskoug (2001: distribution, ecology); Esquivel (2001: guide); Myers *et al.* (2002: biogeography); Ziegler *et al.* (2002: specimen); Fariña & Hostettler (2003: distribution); Neris & Franco Rivarola (2005: guide); Nava *et al.* (2007: parasitology); Cartes *et al.* (2010: mortality); Cartes *et al.* (2011: mortality); Rumbo (2010: biogeography); Masi Pallares (2011: ecology, guide); Centrón *et al.* (2013: distribution); Cartes (2014: etymology); Velázquez & Ramírez Pinto (2014: guide); de la Sancha *et al.* (2017: checklist); Epp (2018: guide); Gengler (2018: distribution); Ortega & Weiler (2018: mortality); Villalba *et al.* (2018: guide); Owen & Smith (2019: distribution, specimen); Weiler *et al.* (2019: guide); Weiler *et al.* (2020: ecology); Salinas *et al.* (2022: distribution, ecology); Zuercher *et al.* (2022: predation)

*Sylvilagus paraguensis* Myers *et al.* (2002: nomenclature)

*Sylvilagus brasiliensis paraguensis* Wetzel & Lovett (1974: specimen); Myers *et al.* (2002: nomenclature)

*Sylvilagus brasiianus* Smith (2005a: distribution); Smith (2005b: distribution)

*Sylvilagus minensis* Ruedas *et al.* (2017: nomenclature, taxonomy); Weiler *et al.* (2023: guide)

*Local names*: ACHE: Ata (Hill & Hawkes, 1983); ENGLISH: Brazilian Cottontail (Gamarra de Fox & Martin, 1996); Brazilian Rabbit (Brooks *et al.,* 1993); Cottontail Rabbit (Weiler *et al.*, 2019); Forest Rabbit (Hill & Hawkes, 1983); Rabbit (Hill & Padwe, 2000); Tapiti Cottontail (Smith, 2024); GUARANÍ: Tapiti (Azara, 1802); Tapiti mburicá (Azara, 1802) MENNO: Südamerikanisches Kaninchen (Epp, 2018); SPANISH: Conejito de monte (Esquivel, 2001); Conejo (Azara, 1802); Conejo de bosque (Villalba *et al.*, 2018);

Conejo de monte (Neris & Franco Rivarola, 2005); Liebre (Masi Pallares & Benítez Usher, 1982); Tapétí (Velázquez & Ramírez Pinto, 2014).

*Comments:* This is the *Tapití* of Azara (1802, 2: 32) and *le Tapiti* of Azara (1801, 2: 57). It has been proposed that the origin of the name *Tapiti* is the Tupí language and means "white belly" (Cartes, 2014). This was the name used by Marcgraf, the description upon which [*Lepus*] *brasiliensis* Linnaeus, 1758 is based and is likely why Rengger (1830) made reference to the word as being the "Guyanese name" for the species. However, there are even earlier references of usage of the word in Brazil (de Léry, 1575). Given this I consider that the alternative explanation provided by González (2009) that the derivation is from the Guaraní *"Tapi"* groin and *"Ti"* nose (in allusion to a supposed crouched position with the nose between the legs) to be fanciful.

Rengger (1830) provided detailed ecological data on the species, including potential seasonal changes in pelage and reproductive data, as well as observations based on captive individuals. However, this account seems to be at least in part derived from Azara (1802). Masi Pallares & Benítez Usher (1982) provided information on ticks on Paraguayan vertebrates, but referred to this species only by the common names "conejo" and "liebre".

Following a taxonomic revision, Ruedas *et al.* (2017) determined that *Sylvilagus brasiliensis sensu lato* was a cryptic species complex and restricted the type locality of [*Lepus*] *brasiliensis* Linnaeus, 1758 to "coastal Pernambuco State, near Recife". In the process they concluded that populations south of the Amazon belong to different taxa, but the number of species taxa has not yet been elucidated. However, two names are available for unnamed populations south of the Amazon: *S. minensis* Thomas, 1901b: 535 (Type locality: "Rio Jordão and Lagoa Santa") and *S. paraguensis* Thomas, 1901c: 549 (Type locality: "Sapucay, E of Asunción, Paraguay", adult female collected by William Foster 30 May 1901). Ruedas *et al.,* (2017: 53) speculate that these are unlikely to represent the same biological species, in which case *S. paraguensis* Thomas, 1901b would refer to Paraguayan populations. However, the authors recommended the usage of *S. minensis "pro tempore*, while further studies are being undertaken". I choose not to assign a species name for Paraguayan populations, pending the results of these studies.

*Geographical distribution:* Widespread in both dry and humid forested areas in all departments of the country (Rumbo, 2010). The species is probably most common in dry and subhumid forest of the Chaco and Cerrado, but is present albeit at lower density in the humid Atlantic Forests. Though it may be encountered in adjacent open habitats, it requires the presence of some forest cover for occupancy (Rengger, 1830).

No explanation is provided as to why the species was Not Evaluated in the latest conservation assessment of Paraguayan mammals (Saldívar *et al.*, 2017), but the wide distribution, generalist habitat requirements and apparent abundance of the species provide no reason to consider the species anything other than Least Concern in Paraguay in agreement with earlier assessments (Gamarra de Fox *et al.*, 1998).

*Examined specimens:* **"Chaco" (**MJUF; Ziegler *et al.*, 2002; Cartes *et al.*, 2011; Weiler *et al.*, 2020); **CANINDEYÚ:** Reserva Bosque Mbaracayú (CZPLT 709; Hill & Hawkes, 1983; Lowen *et al.*, 1996; Hill *et al.*, 1999; Hill & Padwe, 2000; Esquivel, 2001; Fariña & Hostettler, 2003; Hill *et al.*, 2003; Velázquez & Ramírez Pinto, 2014; Owen & Smith, 2019; Zuercher *et al.*, 2022); **ÑEEMBUCÚ:** Ruta Isla Umbu–Desmochados at 27.0345º S, 58.1527º W (CZPLT 1070).

*Specimens not examined:* **ALTO PARAGUAY:** 3 km E of Fortín Gabino Mendoza (TTU 79706; Ruedas *et al.*, 2017); 4 km E of Fortín Gabino Mendoza (MNHNP 2499); Estancia Punto Alto (TTU 117584); Fortín Gabino Mendoza (TTU 79720); Fortín Teniente Picco (EBD 4092, 4173, 4857, 6766); Palmar de las Islas (TTU 79882); Parque Nacional Defensores del Chaco 11km W of AG at 20.3330º S, 60.1500º W (MSB 54076); Puerto Casado, 7 km SW Laguna General Diaz (FMNH 54335; Gamarra de Fox & Martin, 1996); **ALTO PARANÁ:** Puerto Dorila (CMBI 0003); Puerto Sauce (CMBI 0004); **AMAMBAY:** Estancia Paicuará, 45 km W of Capitán Bado (MNHNP 1873; Gamarra de Fox & Martin, 1996); Parque Nacional Cerro Corá (MNHNP 546, 2501, TTU 79950; Gamarra de Fox & Martin, 1996; Yahnke *et al.*, 1998; Ruedas *et al.*, 2017); **BOQUERÓN:** 50 km WSW Fortín Madrejón (AMNH 248395); 310 km NW of Villa Hayes at 23.1333º S, 59.2333º W (MVZ 145356); Orloff (FMNH 54336, 63866; Gamarra de Fox & Martin, 1996); Destacamento Policial at 20.6263º S, 62.0170º W (TTU 117585); Parque Nacional Teniente Enciso (MNHNP 544, 545, TTU 118162; Gamarra de Fox & Martin, 1996; Yahnke *et al.*, 1998); **CAAGUAZÚ:** Caaguazú (MACN 23464); **CANINDEYÚ:** 6.3 km by road NE of Curuguaty (UMMZ 124453); 3.3 km by road NE of Curuguaty (UMMZ 126115, 126116, 126117, 134015); **CENTRAL:** near Asunción (FMNH 26726); Nueva Italia, Colonia Villeta (FMNH 53938, MACN 188; Gamarra de Fox & Martin, 1996); **CONCEPCIÓN:** Horqueta (UMMZ 65523, 65908, 68129, 68130, 68131); **CORDILLERA:** 1.6 km S of Tobatí (MVZ 145358, UMMZ 147937); 20 km N by road from Altos (MVZ 145357); **GUAIRÁ:** Villarrica (AMNH 66781); **ITAPÚA:** 3.5 km E of San Rafael at 27.3333º S, 56.41867º W (UMMZ 126114); Capitán Meza (MACN 334); CYTASA, Puerto San Lorenzo (EBD 4096); San Pedro Mi, Área para Parque Nacional San Rafael (KU 158978, 158979, MNHNP 2944); Trinidad (AMNH 36512); **MISIONES:** 2.7 km N by road from San Antonio (UMMZ 124454); **PARAGUARÍ:** 3 km N of Carapeguá (MHNG 1683.066; Roguin, 1986; Gamarra de Fox & Martin, 1996); Parque Nacional Ybycuí (MNHNP 547; Gamarra de Fox & Martin, 1996; Yahnke *et al.*, 1998); Sapucay (NHM 1902.4.7.43 [Type of *S. paraguensis*], USNM 115125, 115126, 115127,

121423, 121424, 121425, 121426); **PRESIDENTE HAYES:** Estancia Appendice km 293 Transchaco (MHNG 1690.040; Roguin, 1986; Gamarra de Fox & Martin, 1996); Estancia Samaklay (MNHNP 2500); Río Negro (AMNH 36511); **SAN PEDRO:** Yaguarete Forest (MNHNP 2498, TTU 80579).

*Literature references:* **ALTO PARANÁ:** Estancia San Antonio (Brooks *et al.*, 1993; Lowen *et al.*, 1996); "Área de Itaipú" (van Humbeck & Silvera Avalos, 1995); **BOQUERÓN:** Estancia Gran Siete (Areskoug, 2001); Fortín Toledo (Masi Pallares & Benítez Usher, 1982); **BOQUERÓN/PRESIDENTE HAYES:** Transchaco between km173 and access road to Filadelfia (Cartes *et al.*, 2010); **CAAZAPÁ:** Reserva Natural Privada Tapytá (Velázquez & Ramírez Pinto, 2014); Reserva Privada Ypeti (=Reserva Privada Golondrina I) (Brooks *et al.*, 1993); **CANINDEYÚ:** Estancia Itabó (Brooks *et al.*, 1993); Jejuí-Mi, Reserva Bosque Mbaracayú (Brooks *et al.*, 1993); Lagunita, Reserva Bosque Mbaracayú (Brooks *et al.*, 1993); Reserva de Patrimonio Aché de Kuetuvy (Centrón *et al.*, 2013); **CANINDEYÚ/CAAGUAZÚ:** Reserva Natural Privada Morombi (=Reserva Privada Golondrina II) (Brooks *et al.*, 1993); **CENTRAL/CORDILLERA/SAN PEDRO:** Ruta III (Ortega & Weiler, 2018); **CONCEPCIÓN:** Parque Nacional Serranía San Luis (Gamarra de Fox & Martin, 1996); **ITAPÚA:** Hotel El Tirol (Smith *et al.*, 2005a); "Río Pirapó area" (Nava *et al.*, 2007); San Cosme y Damían (Salinas *et al.*, 2022); **ÑEEMBUCÚ:** Estancia Yacare (Masi Pallares & Benítez Usher, 1982); **PARAGUARÍ:** Isla Alta (Gengler, 2018); **PRESIDENTE HAYES:** 1–2 km E of km 310 (Transchaco) (Wetzel & Lovett, 1974); Estancia Playada (Caballero-Gini *et al.*, 2020); Fortín Juan de Zalazar (Wetzel & Lovett 1974; Nava *et al.*, 2007); Transchaco between km 50 and km 173 (Cartes *et al.*, 2010); **SAN PEDRO:** Rancho Laguna Blanca (Smith *et al.*, 2005b; FPMAM834-835PH).

*Photographic records:* **ALTO PARAGUAY:** Carmelo Peralta (https://uk.inaturalist.org/observations/123207981); Parque Nacional Defensores del Chaco (FPMAMM833PH); **BOQUERÓN:** Infante Rivarola (https://uk.inaturalist.org/observations/129075338); **ITAPÚA:** Estancia Nueva Gambach (FPMAM894VI); **ÑEEMBUCÚ:** Estancia Santa Ana (Para La Tierra).

*Reliable observations:* **ÑEEMBUCÚ:** Pilar Military Base (PS); **PRESIDENTE HAYES:** Chaco Lodge (PS); **SAN PEDRO:** Colonia Volendam (Dominic Oviedo-Löwen);

**Eurasian brown hare *Lepus europaeus* Pallas, 1778**

*Lepus (Eulagos) europaeus europaeus* Pallas, 1778: 30. Type locality not given. Restricted to "Pologne Sud et de Pannonie" (= "southern Poland and Pannonia") by Trouessart (1910: 219) and again to southwestern Poland by Ognev (1940: 140)

*Lepus capensis* Velázquez & Ramírez Pinto (2014: guide, mention)

*Lepus europaeus* de la Sancha *et al.* (2009: distribution); Velázquez & Ramírez Pinto (2014: guide); Timm *et al.* (2015: mention); de la Sancha *et al.* (2017: checklist); Salinas *et al.* (2022: distribution)

*Local names*: GUARANÍ: Tapiti guasu (Velázquez & Ramírez Pinto, 2014); SPANISH: Liebre europea (Velázquez & Ramírez Pinto, 2014).

*Comments:* An introduced species. The first documented report of the species in Paraguay was by de la Sancha *et al.* (2009) who illustrated a roadkill individual from "outside of the town of Fram 26°58'3.608" S, 55°55'648"W (sic)". The corrected coordinates place this locality just outside of the town of La Paz, about 20 km or so north by road from Fram.

De la Sancha *et al.* (2017) hypothesized that the invasion of the species had been relatively recent as most of its current range was forested until the 1970s, a theory which implies a natural invasion, presumably from across the Paraná river in Argentina. A potentially significant date may thus be 14 October 1978 when the mighty Paraná river was re-routed allowing a section of the river bed to dry and allow the building of the immense Itaipú dam, as well as the possible passage of fauna. The earliest report I am aware of is an undocumented sight record by Hans Hostettler close to Edelira 28, Itapúa department in 1983.

Another theory worthy of consideration is deliberate introduction. European (Polish, Czech, Russian, Slovak and Ukrainian) farmers colonized the nearby area of Carmen del Paraná (approximately 21 km south of Fram) shortly after World War I and dedicated themselves extensively to agriculture from an early stage, thus suitable agricultural habitat was present in this region long before the time proposed by de la Sancha *et al.* (2017). It is also not inconceivable that the species was introduced by these settlers for sport and meat (as occurred in Argentina), it being a common and popular species with hunters in their countries of origin. However, I have been unable to find any documentation either to prove or disprove this theory.

I suspect that reports of hares "in the surroundings of Fortín General Díaz", Presidente Hayes department (Dr. B. Aranda Centurion, pers. comm. in Grigera & Rappoport, 1983) might be more likely to refer to Chaco Mara *Dolichotis salinicola* as there have been no additional records of the species from the Chaco region.

*Geographical distribution:* An exotic inhabitant of agricultural areas (especially soybean fields) that is confined to the Oriental region of Paraguay. There are reports from highly-disturbed habitats in Alto Paraná, Caazapá, Canindeyú, Itapúa, Misiones and San Pedro departments.

Inhabitants of Alto Vera (H. Hostettler) and Nueva Alborada (O. Ramírez) mention that the species is a common target for sport hunters, and that it has shown a significant decline in numbers over the last decade (for reasons that are unclear). This matches the authors` own experience with the species at Estancia Nueva Gambach, Itapúa department, where the species was formerly commonly observed but is now encountered

only rarely. The reasons for this decline (if indeed it is real) are not clear. Nonetheless the species appears to still be abundant in Alto Paraná department, and may be expanding north, though to date there are no records north of 24º S.

*Literature references:* **CAAZAPÁ:** Camino de Tavaí, Parque Nacional Caazapá at 26.1367° S, 55.4467° W (de la Sancha *et al.*, 2009); Reserva Natural Privada Tapytá (de la Sancha *et al.*, 2009; Velázquez & Ramírez Pinto, 2014); **ITAPÚA:** Área para Parque San Rafael at 26.5167º S, 55.8667º W (de la Sancha *et al.*, 2009); outside of the town of Fram 26.9677° S, 55.9185° W (=1 km northwest of La Paz by road) (de la Sancha *et al.*, 2009); San Cosme y Damián (Salinas *et al.*, 2022).

*Photographic records:* **ALTO PARANÁ:** Hernandarias (https://uk.inaturalist.org/observations/143935284); **ITAPÚA:** Pro Cosara, Parque Nacional San Rafael (=Estancia Nueva Gambach) (FPMAMM839-842PH); **SAN PEDRO:** Colonia Volendam (Dominic Oviedo-Löwen).

*Reliable observations:* **ALTO PARANÁ:** Road to Reserva Limoy (Oscar Rodríguez); **CAAZAPÁ:** Reserva Privada Ypeti (=Reserva Privada Golondrina I) (Oscar Rodríguez); **CANINDEYÚ:** Reserva Natural Bosque Mbaracayú (Sergio Ríos); **ITAPÚA:** Edelira 28 (Hans Hostettler); Nueva Alborada (Oscar Ramírez); Reserva Natural Arroyo Aguapey (Adolfo Vera); **MISIONES:** Ruta I near San Ramón (PS).

## Discussion

Much remains to be learned about the Paraguayan distribution of the species of Sciuridae and Leporidae. Whilst the Tapiti indeed seems to be widespread throughout the country, the distribution of *Lepus europaeus* is probably incompletely understood. There is however, much scope for tracing the historical distribution and expansion of this invasive species in the country, including the identification of the origin of the introduced stock, the speed at which the species is expanding and the ecological conditions required for it to do so.

The distribution of Sciuridae is also poorly known, with the northern region of Alto Paraguay one of the most remote and poorly explored in the country. Both species may prove to be more widespread in this area, and the extent of sympatry is also worthy of investigation. The possible existence and identity of squirrels in the Oriental region is also a tantalising line of inquiry for researchers, but despite an increase in local interest in Paraguayan fauna thanks to the popularity of online citizen science platforms, evidence of presence has still not been forthcoming.

The taxonomy of the South American members of these two families continues to be in a state of flux, with generic attributions and species limits changing regularly. It is hoped that new taxonomic techniques will shed light on the systematics of this group, clarifying the correct scientific names attributable to the Paraguayan taxa.

ACKNOWLEDGEMENTS. Manuel Ruedi (MHNG) and Nicole Steppan (CZPLT) assisted with access to the specimens in their collection. Hugo del Castillo assisted with confirmation of squirrel records attributed the Guyra Paraguay Biodiversity Database. Dominic Oviedo-Löwen, Oscar Ramírez, Oscar Rodríguez, Sergio Ríos and Adolfo Vera provided details of their field observations. Particular thanks are due to Hans Hostettler for sharing his valuable information about *Lepus europaeus*. Patricia Salinas confirmed the locality for *Lepus europaeus* omitted from her publication Salinas *et al.* (2022). The map for Figure 2 is from Wiki Commons produced by user Fernandolpd and made available on the page https://commons.wikimedia.org/wiki/File:Ecorregiones_PY.jpg.

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