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Diversity and richness of small mammals at a well-conserved site of The Yungas in Jujuy Province, Argentina

Abstract: We present the results obtained from 12 small-mammal surveys conducted between 1996 and 2013 in "Finca Las Capillas", province of Jujuy, Argentina. This region has been formally recognized as an "Area of Importance for the Conservation of Bats" (AICOM) based on the diversity of species detected in our previous studies. This site in the Yungas forests of northwestern Argentina still maintains an excellent conservation status due to restrictions to human activities involving deforestation and limitations to cattle-raising imposed 50 years ago. A total of 39 species belonging to three orders, namely, Didelphimorphia, Chiroptera and Rodentia, were recorded. The species accumulation curve revealed that our records represent 83–95% of the community, and with high diversity indexes. Several of the genera and species that we recorded from our collection trips have been included in the fauna of Argentina. Our previous studies and the present findings provide new records for the province or significant extensions to previously known distributions of several taxa of small mammals. These results show that the site represents an icon for conservation in such a fragmented and exploited area as the Yungas in Argentina today.

Keywords: Chiroptera; conservation; Didelphimorphia; Rodentia; Yungas forest.

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Introduction

Over the decades, the fragmentation and degradation of habitats as a result of land-use changes have reached critical levels, with particular intensity in the tropics (Wade et al. 2003, Hansen et al. 2010). Globally, tropical forests are rapidly disappearing because of deforestation, and there is a persistent and strong pressure to replace natural forests with agricultural lands and pastures for livestock (Noss et al. 2006). This action generates a strong retraction of habitats, thereby transforming these areas in isolated patches and consequently decreasing species diversity and abundance. These patches play a key role in the conservation of areas under human influence and at the same time constitute shelters for endangered species (Turner and Corlett 1996, Dotta and Verdade 2011).

The Yungas belong to the Amazonic Domain of the Neotropical Region (Cabrera 1976), and are distributed from the borderline with Bolivia to the north of the province of Catamarca, including three neighboring provinces, namely, Jujuy, Salta and Tucuman (Brown et al. 2001). These forests represent a biodiversity hotspot for being one of the richest and most diverse areas on Earth (Mittermeier et al. 1999, Ceballos and Ehrlich 2006). However, over the

last decades, large areas of the Yungas have been affected and altered by human activities through deforestation, cattle-raising, and fire in the piedmont areas (Brown et al. 2001); as well as energy and mining projects; and through the exploitation of forest resources in the montane areas (Pacheco and Cristóbal 2009). These activities have a negative effect on mammals, which are a diverse group with more than 120 species in the Argentine Yungas (Ojeda et al. 2003, Barquez et al. 2006b, Jayat and Ortiz 2010). Many of these species have suffered significant retractions in their distribution (e.g., *Panthera onca* (*Linnaeus 1758*) *and Tapirus terrestris* (*Linnaeus 1758*)), particularly due to the loss of their natural habitat, which is reflected through the fact that the conservation status of many of these species is at risk (Chalukian et al. 2012, Aprile et al. 2012).

The study area, known as "Las Capillas", is located in the province of Jujuy, and basically corresponds to the mountain forest vegetation in very good condition as it has remained largely isolated from human impact for over the last 50 years. Recently, it has been recognized as an "Area of Importance for the Conservation of Bats" (AICOM; in Spanish, it stands for "Area de Importancia para la Conservación de los Murciélagos") by the Latin American Bat Conservation Network (RELCOM, or "Red Latinoamericana para la Conservación de los Murciélagos") (see www.relcomlatinoamerica.net).

The aims of the present study were (1) to estimate the diversity and species richness of small mammals in the AICOM, and (2) to compare this information with the results obtained in similar studies conducted in other countries and in the Argentine Yungas. Moreover, the factors that probably contributed to such diversity in the area were analyzed and compared with data from surrounding areas. We also propose future actions to ensure the conservation of the site in its current condition.

Materials and methods

Study area

The fieldwork was conducted at four selected sites (see Appendix I) within "Finca Las Capillas", an area of 3500 ha located approximately 2 km north of "Las Escaleras", Manuel Belgrano Department, Jujuy Province, Argentina. The area corresponds to the montane forest district, a part of the Yungas eco-region, which is extended approximately between 700 and 1500 m (Burkart et al. 1999, Brown et al. 2001). The observed vegetation is typical of the district, which is dominated by tall trees such as *Cedrela angustifolia Sessé and Moc. ex DC* (cedar), *Enterolobium contortisiliquum* (*Vell.*) *Morong* (earpod tree), *Anadenanthera colubrina* (*Vell.*) *Brenan* (cebil), *Cinnamomum porphyrium* (*Griseb.*) *Kosterm.* (laurel) and *Myrcianthes pungens (O.Berg*) *D.Legrand* (mato). There are also smaller trees, such as *Allophyllus edulis* (*A. St.-Hil., A. Juss. and Cambess.*) *Hieron. ex Niederl.* (chalchal) and *Celtis brasiliensis* (*Gardner*) *Planch.* (tala), among others, that do not exceed 20 m. Bushes such as *Urera baccifera* (*L.*) *Gaudich. Piper tucumanum C. DC.* and *Solanum* spp., as well as herbs ranging from smaller forms to taller than 2 m (Cabrera 1976), are present. Epiphytes are abundant, and lichens, ferns, bromeliads and mosses are dominant, which are present in more than 70% of the trees (Brown et al. 2001).

The climate in this altitudinal belt is warm and humid, and the temperature and humidity vary in relation to altitude, latitude, topography and slope exposure. Annual precipitation varies between 900 and 1000 mm. Rainfalls are concentrated mainly in summer, and last for about 5–6 months. During the cooler months, the condensed water mist that characterizes these "cloud forests" is captured and cooperates to partially compensate for the lack of rains in that season (Burkart et al. 1999). The area includes a hydrographic system that is part of the Basin of the Mojotoro-San Francisco-Lavayen Rivers and the sub-basin of the Negro-Upper San Francisco Rivers. The main river at the study area is Las Capillas, which changes its name to Negro River before it flows into the San Francisco River (Paoli et al. 2011).

Sampling

The specimens were collected through 12 field surveys (a total of 63 nights) conducted between 1996 and 2013. The bats were captured using 6–10 mistnets 6, 9 and 12 m long, placed inside the forests and over streams or rivers, and kept open for 6–10 h after sunset every night. The total sampling effort was estimated using the method described by Medellín (1993), which is calculated as the total number of mistnets in meters by the total hours (m×h). For the non-volant small mammals, trap lines were set in different places (e.g., inside and at the margin of vegetation and near water). The lines could contain from 35 up to 140 stations (10 m spacing), and each station included a live trap (Sherman or Tomahawk) or snap trap (Victor or Museum Special) active overnight. Traps were baited with peanut butter and oats. The sampling effort was estimated as nights trap (n.t.). Bat species were identified following Barquez et al. (1993) and Barquez and Díaz (2009), and classified into trophic guilds according to Aguirre (2002). Marsupials and rodents were identified

following Díaz (2000), Díaz and Barquez (2002), and Jayat et al. (2010). The taxonomic arrangement follows Díaz and Barquez (2007), except in *Marmosa* (*Micoureus*) *constantiae* Marmosa (Micoureus) constatiae Thomas for which we considered *Micoureus* a subgenus of *Marmosa*, following Voss and Jansa (2009).

Data collection

External and cranial measurements were recorded from all collected specimens following Díaz et al. (1998). Voucher specimens were prepared as skin, skull and skeleton or preserved in alcohol, and deposited at the Colección Mamíferos Lillo (CML), Universidad Nacional de Tucumán, and Fundación Miguel Lillo, Argentina. The specimens we examined that are yet to be accessioned into an institutional collection or museum were labeled with the initials of the collectors as follows: ARG (Catalogue of specimens from Argentina of the Sam Noble Oklahoma Museum of Natural History and PIDBA), MFL (María Fernanda López), MMD (María Mónica Díaz), MS (Mariano Sánchez), PIDBA (Programa de Investigaciones de Biodiversidad Argentina) and SGA (Santiago Gamboa Alurralde).

Community analysis

To determine whether the survey was representative of the small-mammal community, we calculated and plotted the species accumulation curve using the software EstimateS (Colwell 2005) (EstimateS version 7.5.2, University of Connecticutt, Connecticutt, USA), and the surveyed years were considered as a sampling unit. The curve was calculated using the non-parametric estimators Chao 1 and Jackknife 1 to estimate the number of species present in the area. Chao 1 is based on the number of rare species in a sample as a way to calculate the percentage of completeness of an inventory (Colwell 2005). This estimator is especially suitable for data obtained in rapid inventories in studies of mammalian diversity (Simmons and Voss 1998, Gallo et al. 2010, Jayat and Ortiz 2010, Rodriquez Macedo et al. 2014). Jackknife 1 is based on the number of species that occur only in a sample and is one of the most effective estimators because it is the least susceptible to sampling bias (Moreno 2001). This estimator, along with Chao 1, is one of the most reliable according to Walther and Moore (2005). Using the EstimateS program, the Shannon-Wiener index and Simpson index were calculated to analyze and describe the diversity in the area and to compare the results with those of similar studies conducted in other areas.

Results

The present study involved 63 survey nights and a total sampling effort of 37.868 m×h and 2.729 n.t. A total of 1001 specimens of 39 species of small mammals belonging to the orders Didelphimorphia, Chiroptera and Rodentia were recorded (Table 1). The species accumulation curve (Figure 1A) shows that the number of species continued to increase with increased sampling effort. The number of species in the area based on Chao 1 and Jackknife 1 was 40.88±2.26 and 47±4 species (Mean±SD), respectively. Accordingly, about 83% and 95% of the species were recorded in the area, respectively, indicating that, in general, we achieved a good representation of species diversity in the area.

Order Didelphimorphia

Family Didelphidae was represented in our study by 19 individuals of two species (Table 1): *Thylamys sponsorius* (Thomas 1921) was represented by 15 specimens, and *Marmosa (Micoureus) constantiae* was less abundant and represented by only four specimens.

Although an individual of *Didelphis albiventris* (Lund 1841) was also collected, it was not included in the analysis because it could not be considered as a small-mammal owing to its medium body size.

Order Chiroptera

We captured 882 specimens of bats belonging to 18 genera and 24 species, representing the four families known from Argentina (Table 1). The family Phyllostomidae was the best represented, comprising 88.3% of the captured specimens, followed by Vespertilionidae (6.3%), Molossidae (5.3%) and Noctilionidae (0.1%). The most abundant species was *Sturnira lilium* (E. Geoffroy Saint-Hilaire 1810) (39% of the total captures), followed by *S. erythromos* (Tschudi 1844) (22%) and *Artibeus planirostris* (Spix 1823) (20%).

Seven trophic guilds were recorded in the area (see Aguirre 2002), including 15 species of insectivorous bats (six fast-flying and nine slow-flying), followed by frugivorous bats with five species, but the latter could be considered as the most abundant considering the number of individuals. The others guilds (nectarivorous, carnivorous, piscivorous and sanguivorous) were represented by only one species each (Table 1).

The species accumulation curve (Figure 1B) reached values close to the asymptote, and Chao 1 and Jackknife 1

Table 1: List of species of small mammals captured between 1996 and 2013 in Las Capillas (Jujuy Province, Argentina).

Species	Loc 1	Loc 2	Loc 3	Loc 4	Trophic guilds
DIDELPHIMORPHIA					
Didelphidae					
Marmosa (*Micoureus*) *constantiae*	0	4	0	0	
Thylamys sponsorius	3	12	0	0	
CHIROPTERA					
Noctilionidae					
Noctilio leporinus	1	0	0	0	Ps
Phyllostomidae					
Anoura caudifer	3	1	0	0	Nec
Artibeus planirostris	72	93	10	0	Fru
Chrotopterus auritus	1	4	0	0	Car
Desmodus rotundus	18	29	0	0	San
Pygoderma bilabiatum	1	0	0	0	Fru
Sturnira erythromos	74	117	0	0	Fru
Sturnira lilium	120	219	1	1	Fru
Sturnira oporaphilum	5	7	0	0	Fru
Molossidae					
Cynomops planirostris	5	0	0	0	Ff-Ins
Eumops glaucinus	18	0	0	0	Ff-Ins
Molossops temminckii	2	0	0	1	Ff-Ins
Molossus molossus	1	0	0	1	Ff-Ins
Nyctinomops macrotis	1	0	0	0	Ff-Ins
Tadarida brasiliensis	18	1	0	1	Ff-Ins
Vespertilionidae					
Dasypterus ega	4	0	0	1	Sf-Ins
Eptesicus chiriquinus	1	1	0	0	Sf-Ins
Eptesicus furinalis	11	0	1	2	Sf-Ins
Histiotus laephotis	1	0	0	0	Sf-Ins
Histiotus velatus	2	0	0	0	Sf-Ins
Lasiurus blossevillii	6	8	1	0	Sf-Ins
Lasiurus cinereus	2	0	0	0	Sf-Ins
Myotis albescens	12	0	0	0	Sf-Ins
Myotis dinellii	3	0	0	0	Sf-Ins
RODENTIA					
Cricetidae					
Akodon budini	17	26	0	0	
Akodon caenosus	1	0	0	0	
Akodon simulator	3	1	0	0	
Calomys venustus	3	1	0	1	
Euryoryzomys legatus	7	1	0	0	
Oligoryzomys brendae	15	1	0	1	
Oligoryzomys chacoensis	1	0	0	0	
Oligoryzomys flavescens	0	2	0	0	
Oligoryzomys sp.	1	3	0	0	
Oxymycterus paramensis	2	6	0	0	
Rhipidomys austrinus	0	2	0	0	
Tapecomys primus	1	2	0	0	
Ctenomyidae					
Ctenomys frater	2	0	0	0	
TOTAL	**438**	**541**	**13**	**9**	**1001**

The number of individuals for each species is indicated for each locality (Loc 1–4). See the list of acronyms for the localities in Appendix I. Trophic guilds for bats are indicated as follows: Fru, frugivorous; Nec, nectarivorous; Car, carnivorous; Ff-Ins, fast-flying insectivorous; Ps, piscivorous; San, sanguivorous; Sf-Ins, slow-flying insectivorous.

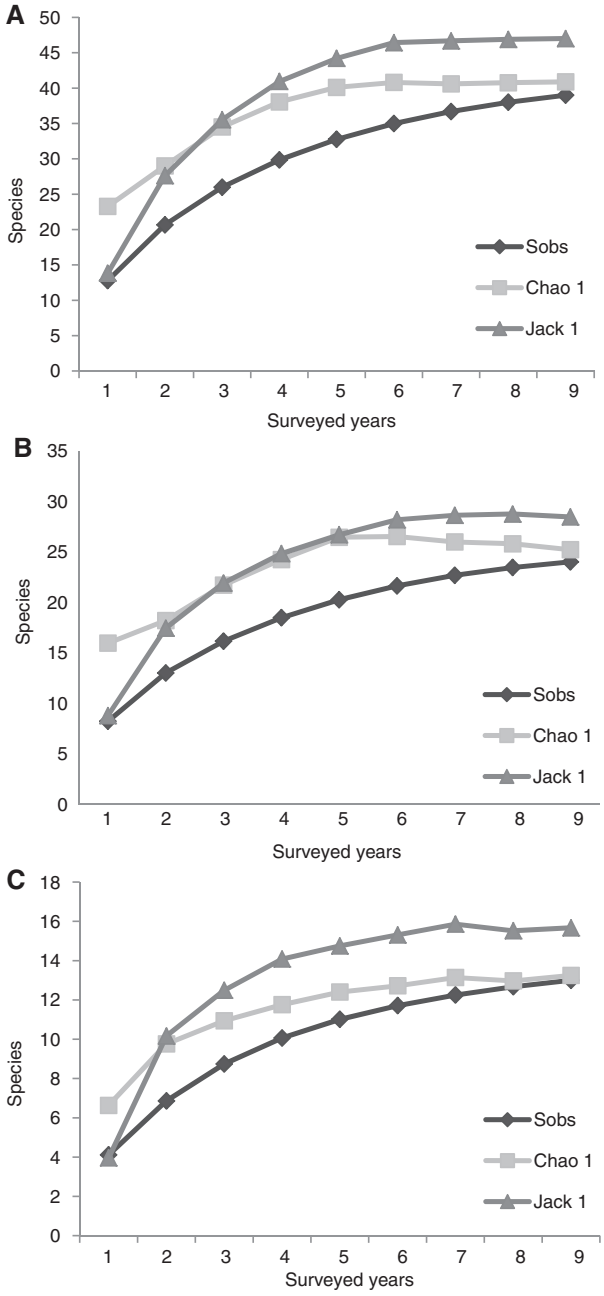

Figure 1: Species accumulation curve and estimated richness in Las Capillas: (A) small mammals, (B) bats, and (C) rodents.

estimated a total of 25.2±1.84 and 28.44±2.7 species, respectively. Based on these estimators, the community was represented between 84% (Jack 1) and 95% (Chao 1), indicating that the number of recorded species was optimal.

Order Rodentia

The small rodents were represented by 100 individuals belonging to two families, eight genera, and 13 species. Additionally, other rodents [*Dasyprocta punctata* (Gray 1842) (Dasyproctidae); and *Sciurus ignitus* (Gray 1867) (Sciuridae)] were also recorded, but these were not included in the analysis because they are not small mammals. The best-represented species were *Akodon budini* (Thomas 1918) with 43 individuals and *Oligoryzomys brendae* Massoia 1998 with 17 (Table 1).

The species accumulation curve for rodents increased (Figure 1C) with sampling years, but it still did not approach an asymptote. Jackknife 1 estimated a total number of 15.67±1.89 species, representing 83% of the community. Based on Chao 1, the species accumulation curve reached a curve with an asymptote and estimated the total number of species to be 13.25 ± 0.74, representing 98% of the recorded species in the study area and indicating that the sampling process was efficient.

Community diversity

Based on the Shannon index, the diversity of the small-mammal community at Las Capillas was 2.23. For each group of mammals, the value for the same index was 0.51 for marsupials, 1.83 for bats and 1.91 for rodents. Based on the Simpson index, the diversity of small-mammal community was 0.19, whereas that for bats was 0.24 and 0.18 for non-volant small mammals. For marsupials and rodents, we calculated a single value for the Simpson index to be able to compare this figure with that from other studies.

Discussion

Ecological studies on small mammals, especially in areas with little human influence in the Argentine Yungas, are scarce. Consequently, little is known about the species composition, population abundance and other ecological aspects of the region. According to Ojeda et al. (2003), efforts towards biodiversity conservation at smaller spatial scales need a comprehensive understanding of these ecological features.

Among the main threats to the population of mammals in Argentina, fragmentation and habitat degradation are the most significant, but sport hunting, conflicts with livestock, and illegal trafficking of wildlife for commercial purposes also pose serious threats (Ojeda et al. 2012). In recent years, these issues have become increasingly important, and further conservation efforts are badly needed in the Yungas (Ojeda et al. 2003). Moreover, other

authors (Gallo et al. 2010, Amori et al. 2012) have suggested the need to focus conservation efforts on forested environments because these areas contain a large number of endangered species, arguing that doing so might counteract the negative consequences already caused by the destruction and modification of natural environments.

The habitats in the Yungas of Argentina might act as a barrier against threats to extinction or extirpation or provide refuge for vulnerable tropical faunal species, but in recent years these areas have been severely fragmented. However, the absence of certain keystone food resources (e.g., nectar and fruits) constrains the occurrence of such species (Terborgh and Winter 1980). Nevertheless, some well-conserved areas still exist in the region, represented by some National Parks, such as the Calilegua and Baritú, and sites such as Las Capillas, where the observed species richness showcases the interesting diversity and uniqueness of small mammals in the region, thereby reinforcing the need to preserve these forests.

With regard to the diversity of small-mammal community in Las Capillas, the value of Shannon index could not be compared with that for other sites in the Yungas because of the lack of studies in Argentina using the same index. However, if we consider the values for each group of mammals separately, they could be compared with those from several similar studies in highly preserved habitats in other countries. The value of Shannon index for the bat community obtained in the present study was higher than that reported by Bianconi et al. (2004) in a study on bats conducted in a similar latitude at the Atlantic Forest in southern Brazil (1.83 vs. 1.38). However, compared with those reported by other studies in the Yungas, the value of Shannon index for bat community herein is relatively lower. Flores-Saldaña (2008) reported that the diversity of bats in a transitional region in the Amazonia was 2.14 and 2.24 in the lower and higher parts, respectively, of a gradient in the Yungas in Bolivia.

With regard to rodents, a study of a community in the montane forests of Mexico by Vázquez et al. (2000) revealed that in the better preserved areas the value of diversity was 1.13, which is similar to that we obtained in Las Capillas.

Moreover, the values of Simpson index obtained in the present study can be compared with those reported by other similar local studies in the Argentine Yungas. For example, Jayat and Ortiz (2010) reported an index of 0.47 for bats and 0.24 for non-volant small mammals. With respect to bats, our study revealed a more diverse community compared with those found by the aforementioned study because we obtained a higher diversity due to lower values of dominance. In Las Capillas, *Sturnira lilium* was the most dominant species with 39% of total captures. This species was also the most dominant as found by Jayat and Ortiz (2010), but it comprised almost 70% of total captures in their study. In contrast, the community of non-volant small mammals in Las Capillas was slightly more diverse, with lower Simpson's value than that reported by Jayat and Ortiz (2010) (0.18 vs. 0.24).

With regard to marsupials, *Marmosa (Micoureus) constantiae* is very rare in collections, and only a few localities and specimens are known throughout its distribution (Flores and Díaz 2002, Flores 2006, Jayat and Ortiz 2010). The total number of species of Didelphimorphia in the Yungas that has been listed to date is 11, eight of which are considered small mammals (Flores et al. 2000, 2007, Flores 2006). The two species recorded herein represent 25% of the total number of small marsupial species occurring in the Yungas of Argentina, and are endemic to this phytogeographic unit (Flores 2006).

In the present study, the structure of bat community matched the pattern observed in other studies of local bat communities (Bracamonte 2010, Jayat and Ortiz 2010): the structure is characterized by a few common species that occur in abundance, and many rare species were captured infrequently. Moya et al. (2008) obtained similar results in a forest in the Yungas of Bolivia, where they reported that frugivorous species were the most abundant. With regard to trophic guilds, the best-represented guild with a higher number of species was the slow-flying insectivorous bats, a finding consistent with that reported in several studies conducted in the Neotropics (Aguirre 2002, Flores-Saldaña 2008).

Interestingly, earlier studies by Barquez and Díaz (2001, 2009) recorded 37 species of bats in the province of Jujuy, with 34 of them found in the Yungas eco-region. This finding entails that 71% of all bat species from that region are found in Las Capillas, a single locality.

One of our most significant captures that is highly relevant for faunal record was that of *Eptesicus chiriquinus* Thomas 1920 a species considered rare and with little information available about its distribution in the southern part of South America (Barquez et al. 2009). Moreover, the capture of *Histiotus velatus* (I. Geoffroy Saint-Hilaire 1824) in the study area significantly extended the distributional range of the species from the Misiones Province to northwestern Argentina (Díaz and Barquez 2007). For the Jujuy Province, two other species of bats with very few records, namely, *Anoura caudifer* (E. Geoffroy Saint-Hilaire 1818) and *Noctilio leporinus* (Linnaeus 1758), have been reported. The capture of *Noctilio leporinus* represents the first record in Jujuy Province (Díaz and Barquez 2007), after 40 years without information about this species,

since the last known record dates back to 1959 as reported by Davis (1973).

[Correction added after online publication 24 June 2015: The originally published text of the last sentence of the previous paragraph was: "The capture of *Noctilio leporinus* represents the first record of this species in the Jujuy Province (Díaz and Barquez 2007). The last known record of the Greater bulldog bat in the area dates back to 1959 (Davis 1973), and for over 40 years there has been no information about the species."]

According to Medellín et al. (2000), high diversity (as indicated by the number of total and rare species) and Shannon-Wiener values, as well as the low relative abundance of the most common species, are indicators of undisturbed habitats. On one hand, bats are sensitive to changes in land-use practices, such as landscape changes, agricultural intensification and development, and habitat fragmentation. These changes are also relevant to many other wildlife species, making these species excellent indicators. On the other hand, bats are abundant, diverse and easy to capture, especially in Neotropical forests – another factor that makes them good bioindicators. Because of the great diversity of bat species recorded in the study area, which includes vulnerable and rare species such as *Chrotopterus auritus* (Peters 1856), *Anoura caudifer* and *Pygoderma bilabiatum* (Wagner 1843) (Díaz 2012), Las Capillas has been named as an AICOM as part of a system of protected areas promoted by the RELCOM.

For the order Rodentia, Díaz (2000) reported 28 species of small rodents for the Yungas in Jujuy Province, whereas at Las Capillas we recorded 13 species, indicating that 46% of the total number of species documented for the whole phytogeographic unit in the province are present in that single yet faunistically diverse site.

One of the most significant captures during our field collections was that of three specimens of *Tapecomys primus* Anderson and Yates 2000. The first capture constituted the first record of this new and rare genus and species of the tribe Phyllotini in Argentina. This species, which is known only from three localities – the type locality is in Bolivia, and from two other localities in Argentina – is probably an exclusive species for the Yungas region (Barquez et al. 2006a, Díaz et al. 2009). We also recorded *Rhipidomys austrinus* Thomas 1921, the only genus and species of the tribe Thomasomyini that has been recorded in Argentina to date, with few records from Salta and Jujuy (Díaz et al. 2006, Jayat et al. 2009, Jayat and Ortiz 2010). Other species cited in the Yungas of Jujuy by Díaz and Barquez (2007) as *Calomys boliviae* (Thomas 1901), *Holochilus chacarius* (Thomas 1906) and *Graomys domorum* (Thomas 1902) are highly probable in the area.

Some previous studies conducted in the Argentine Yungas mention more than 40 species of small mammals for the region. Nuñez Montellano et al. (2010) cited 42 species in Parque Biológico Sierra de San Javier, in Tucumán Province, whereas Jayat and Ortiz (2010) reported 41 species for the Yungas piedmonts in Jujuy and Salta provinces. These findings and our results allow us to reaffirm that the Yungas are an important center of species diversity. Finally, the results presented herein also provide quantitative information regarding the diversity of small mammals in this highly preserved area and, to a large extent, can be used to generate conservation management plans for its protection.

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Appendix I

List of specimens, the number of collected and released individuals by species in brackets, collection locality, the sex of captured individuals and collection number are indicated (see Materials and methods). The collection localities are:

- Locality 1 (Loc 1): Laja Morada, 15 km al N de Las Capillas por ruta provincial 20; 24° 02′ S, 65° 07′ W, 1061 m.
- Locality 2 (Loc 2): Los Matos, 7 km al N de Las Capillas por ruta provincial 20; 24° 04′46″ S, 65° 08′36 W, 1198 m.
- Locality 3 (Loc 3): Río Las Capillas, cruce con ruta provincial número 20; 24° 05′ S, 65° 10′ W, 1168 m.
- Locality (Loc 4): Las Capillas; 24° 05′29″ S, 65° 10′33″ W, 1175 m.

DIDELPHIMORPHIA

Didelphidae

Didelphis albiventris (n=1): Loc 1, 1 male (CML 7353).

Marmosa (*Micoureus*) *constantiae* (n=4): Loc 2, 1 male (PIDBA 1281), 3 released (undetermined sex).

Thylamys sponsorius (n=15): Loc 1, 1 female (CML 4276), 2 males (PIDBA 1552, 1553). Loc 2, 7 females (PIDBA 1256, 1257, 1260, 1272, 1275, 1285, 1556), 2 males (PIDBA 1481, 1557), 1 undetermined sex (PIDBA 1270), 2 released (undetermined sex).

CHIROPTERA

Noctilionidae

Noctilio leporinus (n=1): Loc 1, 1 male (ARG 4246).

Phyllostomidae

Anoura caudifer (n=4): Loc 1, 1 female (CML 4278), 1 male (CML 7727), 1 released (undetermined sex). Loc 2, 1 female (CML 7726).

Artibeus planirostris (n=175): Loc 1, 6 females (2 ARG 4243, 4248; 4 CML 4158, 4159, 4280, 7609), 7 males (1 ARG 4215; 5 CML 4160, 4279, 4417, 5125, 5129; 1 released), 59 released (undetermined sex). Loc 2, 2 females (CML 7331, 8928), 1 male (CML 8415), 90 released (undetermined sex). Loc 3, 1 female (CML 8417), 1 male (PIDBA 1296), 8 released (undetermined sex).

Chrotopterus auritus (n=5): Loc 1, 1 male (CML 4277). Loc 2, 1 male (CML 8945), 3 released (undetermined sex).

Desmodus rotundus (É. Geoffroy Saint-Hilaire 1810) (n=47): Loc 1, 2 females (CML 6512; 1 released), 5 males (2 CML 4286, 5131; 1 MS 8; 2 released), 11 released (undetermined sex). Loc 2, 1 female (PIDBA 1252), 28 released (undetermined sex).

Pygoderma bilabiatum (n=1): Loc 1, 1 male (CML 7730).

Sturnira erythromos (n=191): Loc 1, 4 females (1 ARG 4251; 2 CML 6510, 6511; 1 MS 15), 2 males (CML 4281, 4282), 1 undetermined sex (ARG 4227), 67 released (undetermined sex). Loc 2, 4 females (3 CML 7397, 7705, 7706; 1 MS 5), 2 males (CML 7333, 7704), 111 released (undetermined sex).

Sturnira lilium (n=341): Loc 1, 4 females (1 ARG 4217; 2 CML 4283, 4284; 1 PIDBA 1541), 5 males (CML 5123, 5124, 6508, 6509, 7849), 111 released (undetermined sex). Loc 2, 4 females (3 CML 7329, 7330, 7332; 1 PIDBA 1248), 215 released (undetermined sex). Loc 3, 1 male (PIDBA 1298). Loc 4, 1 male (ARG 6939).

Sturnira oporaphilum (Tschudi 1844) (n=12): Loc 1, 1 female (CML 4285), 1 male (MS 12), 3 released (undetermined sex). Loc 2, 1 female (PIDBA 1288); 6 released (undetermined sex).

Molossidae

Cynomops planirostris (Peters 1865) (n=5): Loc 1, 2 females (1 CML 4177; 1 PIDBA 1551), 1 male (PIDBA 1543); 2 released (undetermined sex).

Eumops glaucinus (Wagner 1843) (n=18): Loc 1, 11 females (4 CML 4319, 7616, 7918, 8418; 1 SGA 16; 6 released), 3 males (1 CML 4318; 1 SGA 10; 1 released), 4 released (undetermined sex).

Molossops temminckii (Burmeister 1854) (n=3): Loc 1, 1 male (PIDBA 1538), 1 released (undetermined sex). Loc 4, 1 male (PIDBA 1485).

Molossus molossus (Pallas 1766) (n=2): Loc 1, 1 female (released). Loc 4, 1 female (PIDBA 1487).

Nyctinomops macrotis (Gray 1839) (n=1): Loc 1, 1 female (CML 7737).

Tadarida brasiliensis (I. Geoffroy Saint-Hilaire 1824) (n=20): Loc 1, 2 females (1 CML 4321; 1 MS 11), 9 males (2 CML 4320, 7921; 1 PIDBA 1535; 1 SGA 11; 5 released), 7 released (undetermined sex). Loc 2, 1 released (undetermined sex). Loc 4, 1 male (PIDBA 1488).

Vespertilionidae

Dasypterus ega (Gervais 1856) (n=5): Loc 1, 3 females (1 CML 4163; 1 PIDBA 1547; 1 SGA 13), 1 released (undetermined sex). Loc 4, 1 male (PIDBA 1484).

Eptesicus chiriquinus (n=2): Loc 1, 1 female (released). Loc 2, 1 female (CML 7541).

Eptesicus furinalis (d'Orbigny y Gervais 1847) (n=14): Loc 1, 5 females (1 ARG 4222; 3 CML 4312, 4313, 7878; 1 PIDBA 1539), 6 released (undetermined sex). Loc 3, 1 female (PIDBA 1299). Loc 4, 2 females (PIDBA 1486, 1489).

Histiotus laephotis (Thomas 1916) (n=1): Loc 1, 1 female (MS 68).

Histiotus velatus (n=2): Loc 1, 2 females (1 CML 7059; 1 SGA 17).

Lasiurus blossevillii (Lesson y Garnot 1826) (n=15): Loc 1, 2 females (1 CML 7060; 1 PIDBA 1542), 1 male (MS 9), 3 released (undetermined sex). Loc 2, 1 female (PIDBA 1555); 7 released (undetermined sex). Loc 3, 1 undetermined sex (PIDBA 1292).

Lasiurus cinereus (Beauvois 1796) (n=2): Loc 1, 2 males (1 CML 4314; 1 SGA 12).

Myotis albescens (É. Geoffroy Saint-Hilaire 1806) (n=12): Loc 1, 3 females (1 CML 7068; 1 MS 10; 1 PIDBA 1540), 7 males (1 ARG 4238; 4 CML 4315, 4316, 7067, 8936; 2 released), 2 released (undetermined sex).

Myotis dinellii (Thomas 1902) (n=3): Loc 1, 2 females (1 CML 4317; 1 SGA 15), 1 male (SGA 14).

RODENTIA

Cricetidae

Akodon budini (n=43): Loc 1, 6 females (CML 4323, 5035, 5036, 5038, 5041, 5042), 9 males (3 ARG 4220, 4240, 4247; 6 CML 4322, 5034, 5037, 5039, 5040, 6448), 2 released (undetermined sex). Loc 2, 3 females (PIDBA 1277, 1278, 1286), 6 males (PIDBA 1268, 1273, 1276, 1283, 1284, 1291), 1 undetermined sex (PIDBA 1293), 16 released (undetermined sex).

Akodon caenosus (Thomas 1918) (n=1): Loc 1, 1 female (PIDBA 1546).

Akodon simulator (Thomas 1916) (n=4): Loc 1, 1 female (ARG 4225), 1 male (PIDBA 1554), 1 undetermined sex (PIDBA 1537). Loc 2, 1 male (PIDBA 1267).

Calomys venustus (Thomas 1894) (n=5): Loc 1, 1 female (MFL 30), 2 males (CML 4324, 4325). Loc 2, 1 male (PIDBA 1274). Loc 4, 1 male (PIDBA 1483).

Euryoryzomys legatus (Thomas 1925) (n=8): Loc 1, 1 female (ARG 4237), 6 males (4 ARG 4226, 4239, 4241, 4253; 2 CML 4327, 8330). Loc 2, 1 male (PIDBA 1289).

Oligoryzomys brendae (n=17): Loc 1, 3 females (1 CML 4326; 2 MMD 344, 345), 12 males (3 ARG 4236, 4244, 4245; 1 CML 4500; 1 MFL 54; 5 MMD 346, 347, 348, 356, 357; 2 PIDBA 1544, 1545). Loc 2, 1 male (CML 8332). Loc 4, 1 male (ARG 6941).

Oligoryzomys chacoensis (Myers y Carleton 1981) (n=1): Loc 1, 1 male (ARG 4242).

Oligoryzomys flavescens (Waterhouse 1837) (n=2): Loc 2, 2 males (1 MS 52; 1 PIDBA 1279).

Oligoryzomys sp. (n=4): Loc 1, 1 female (MFL 29). Loc 2, 1 female (PIDBA 1282), 2 males (1 CML 8331; 1 PIDBA 1259).

Oxymycterus paramensis (Thomas 1902) (n=8): Loc 1, 2 males (1 ARG 4219; 1 CML 6397). Loc 2, 4 males (PIDBA 1271, 1280, 1294, 1295), 2 released (undetermined sex).

Rhipidomys austrinus (n=2): Loc 2, 1 female (PIDBA 1482), 1 male (CML 7750).

Tapecomys primus (n=3): Loc 1, 1 male (MFL 55). Loc 2, 1 female (CML 7080), 1 male (PIDBA 1480).

Ctenomyidae

Ctenomys frater (Thomas 1902) (n=2): Loc 1, 2 females (1 ARG 4252; 1 CML 7235).

Dasyproctidae

Dasyprocta punctata (n=1): Loc 2, 1 undetermined sex (CML 7676).

Sciuridae

Sciurus ignitus (n=1): Loc 2, 1 male (PIDBA 1253).

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