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# Patagonian bats: new size limits, southernmost localities and updated distribution for *Lasiurus villosissimus* and *Myotis dinellii* (Chiroptera: Vespertilionidae)

https://doi.org/10.1515/mammalia-2019-0024
Received March 10, 2019; accepted June 7, 2019

**Abstract:** Vespertilionid species are widely distributed in South America. They are highly diverse, with physiological and behavioral adaptations which allow them to extend their distributions into temperate areas. In Patagonia, this family is represented by seven species in three genera (*Histiotus*, *Lasiurus* and *Myotis*). In this study, we analyzed the distribution of two vespertilionid species, *Lasiurus villosissimus* and *Myotis dinellii*, including new southernmost records, and their relationship with environmental variables. Two different spatial scales were analyzed: a continental approach for species distribution analyses (South America), and local trapping of bats in northwestern Chubut province, Argentina. We present new southern limits for *L. villosissimus* and *M. dinellii*, and included new records for Patagonian bats. The big hoary bat *L. villosissimus* was recorded as the largest bat inhabiting Patagonia, relating it as a bat mainly inhabiting low, humid and temperate/warm areas. The little yellow bat *M. dinellii*, instead, is the smallest mammal and the smallest bat recorded in Patagonia to date, related mainly with dry, mid-altitude and temperate/warm areas.

**Keywords:** big hoary bat; geographic limits; little yellow bat; Patagonia.

## Introduction

Understanding species' geographic distributions is one of the main goals in ecology (Humpries et al. 2002). The distribution of a species is related to a number of biotic (i.e. intra and interspecific interactions) and abiotic factors (i.e. temperature, altitude, precipitation and productivity), together with dispersal ability capacities and the evolutionary history of each lineage (Gaston 2003, Cox and Moore 2005, Soberón and Peterson 2005). As abiotic factors are not evenly distributed in space or time, they shape the borders of species' distributions trough extreme values (e.g. minimum or maximum temperatures, dry or humid areas), which in turn influence resource availability and impose limits to reproduction and survival (Mackey and Lindenmayer 2001, Gaston 2003). In this way, those areas with more favorable abiotic (and biotic) conditions will show the highest relative abundance, while records will become more scarce and more far away from each other toward the borders of a species' distribution (Brown 2003 and references therein).

South American insectivorous bats are faced in their southern limits of distribution (i.e. Patagonia) with a series of environmental restrictions due mainly to minimum temperatures (Pearson and Pearson 1989), which are directly related to the availability of food resources. This resource availability is, in turn, one of the main determinants of bat communities (McNab 1982, Findley 1993, Aguirre et al. 2003), because it is considered as highly variable between seasons in temperate climates like those of Patagonia. Patagonian bats show a number of physiological traits (i.e. hibernation, daily torpor, migration and delayed fertilization; McNab 1982, Pearson and Pearson 1989, Stevens 2004) that allow their survival and reproduction. The analysis of localities in the borders of species' distributions is of great importance because it provides information on extreme climatic values affecting species distributional limits.

Only the families Molossidae and Vespertilionidae are recorded amongst Patagonian bats (Koopman 1982, Giménez 2014). Only two species of the Molossidae family are currently recorded: *Tadarida brasiliensis* (Geoffroy St.-Hilaire 1824) as the most commonly found, and *Eumops patagonicus* Thomas 1924, with only one record (Monjeau et al. 1994). Species of Vespertilionidae are widely distributed in South America, and they are highly diverse with physiological and behavioral adaptations which allow them to extend their distributions into temperate areas (Stevens 2004). Vespertilionids in Patagonia are represented by

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seven species in three genera: *Histiotus* Gervais 1856, *Lasiurus* Gray 1831 and *Myotis* Kaup 1829. However, new records (Giménez 2010, Giménez et al. 2012, Barquez et al. 2013, Díaz et al. 2017) and taxonomic revisions (Novaes et al. 2018a,b) are constantly modifying the number of recorded species, and changing the austral limits of their distribution.

The taxonomy of the tribe Lasiurini within Vespertilionidae is being reviewed, and molecular studies suggest a split in three different genera: *Lasiurus* [red bats, e.g. *Lasiurus blossevillii* (Lesson 1826), *Lasiurus varius* Poeppig 1835], *Aeorestes* Fitzinger 1870 [hoary bats, e.g. *Aeorestes cinereus* (Palisot de Beauvois 1796)] and *Dasypterus* W. Peters 1870 [yellow bats, e.g. *Dasypterus ega* (Gervais 1856); Baird et al. 2015, 2017]. In the present work, however, we follow Ziegler et al. (2016) and Novaes et al. (2018b) and consider *Aeorestes* as a subgenus of *Lasiurus*. Molecular evidence also provided support to treat the subspecies *Lasiurus cinereus villosissimus* as a full species (Baird et al. 2015, 2017). So according to these studies, we considered *Lasiurus villosissimus* (É. Geoffroy St.-Hilaire 1806) as the hoary bat widely distributed in South America, in accordance with Teta et al. (2018). The big hoary bat *L. villosissimus* has its type locality in Paraguay (restricted to Asuncion by Cabrera 1958), and is widely distributed in South America, including records in different environments of Colombia, Venezuela, Ecuador, Paraguay, Peru, Chile, Bolivia, Uruguay, Argentina and southern Brazil (Baird et al. 2015, Díaz et al. 2016). The southernmost records to date are in 39° S in Argentina (Chimpay, Río Negro; Peracci and Perez 1999) and 41° S in Chile (Puerto Montt, Región de Los Lagos; Mann Fischer 1978).

The genus *Myotis* has a high diversity of over 110 extant species, with numerous and recent taxonomic reviews (see Wilson 2007, Moratelli and Wilson 2011, Moratelli et al. 2013, 2016, 2017, Novaes et al. 2018b). The little yellow bat *Myotis dinellii* Thomas 1902 has been treated as a subspecies of both *Myotis chiloensis* (Waterhouse 1840) and *Myotis levis* (I. Geoffroy St.-Hilaire 1824) (see Cabrera 1958, LaVal 1973, Barquez et al. 1999, Simmons 2005). We follow Miranda et al. (2013) who, using morphometric techniques and comparative analysis with *M. levis*, proposed to treat *M. dinellii* as a full species (see also Teta et al. 2018). The type locality of the little yellow bat is Tucumán (Tucumán province, Argentina) and its distribution encompasses Bolivia, Brazil and Argentina (Barquez 2006, Passos et al. 2010, Moratelli and Wilson 2011, Miranda et al. 2013). The southernmost locality recorded to date is in Neuquén province, and does not reach 39° S (Confluencia, Neuquén, Argentina; Barquez et al. 1999).

The aim of this work is to present an updated distribution analysis for these two vespertilionid species (*Lasiurus villosissimus* and *Myotis dinellii*), including new southernmost records, and analyze their relationship with environmental variables. New general information for several species of Patagonian bats is presented too.

# Materials and methods

## Study area

Following the objectives, two different spatial scales were analyzed: a continental approach for species distribution analyses (i.e. South America), and local trapping of bats in northwestern Chubut province, Argentina (i.e. Central Patagonia).

The climate of South America presents tropical, subtropical and extratropical areas due to the great latitudinal extension and orography (Garreaud et al. 2009). Two anticyclones affect precipitation patterns, with the South Pacific Anticyclone and the Andes mountains influencing the west-east rain gradient, while the Atlantic South Anticyclone carries humid winds to the center of the continent (Mancini et al. 2005). The temperature decreases from the Equator to the Poles, although anomalies can cause different temperatures at equivalent latitudes (Garreaud et al. 2009). Following the biogeographic scheme of Olson et al. (2001), South America is included within the Neotropical realm, with tropical and temperate forests, mangroves, grasslands and shrublands, and xeric formations (Dinerstein et al. 1995).

Bats were surveyed in two protected areas of northwestern Chubut (Argentina): Área Natural Protegida (ANP) Nant y Fall (43° 11′ 25″ S, 71° 28′ 19″ W), and ANP Piedra Parada (42° 38′ 30″ S, 70° 05′ 59″ W, Figure 1).

Nant y Fall occurs within the Valdivian Temperate Forests (*sensu* Olson et al. 2001, Figure 1), an ecoregion characterized by temperate/cold and humid climate, with winter rains and snow, frost extending almost all year and strong westerlies (Burkart et al. 1999). The dominant trees are species of the genus *Nothofagus* (*Nothofagus antarctica*, *Nothofagus dombeyi*, *Nothofagus pumilio*; Nothofagacea), *Austrocedrus chilensis* (Cupressaceae), *Fitzroya cupressoides* (Cupressaceae), *Embothrium coccineum* (Proteaceae) and *Lomatia hirsuta* (Proteaceae). Among shrubs, *Chusquea culeou* (Poaceae), *Fuchsia magellanica* (Onagraceae) and *Berberis microphylla* (Berberidaceae) are usually found (Veblen and Lorenz 1988, León et al. 1998, Burkart et al. 1999).

Piedra Parada, instead, is found within the Patagonian steppe (*sensu* Olson et al. 2001; Figure 1), is an

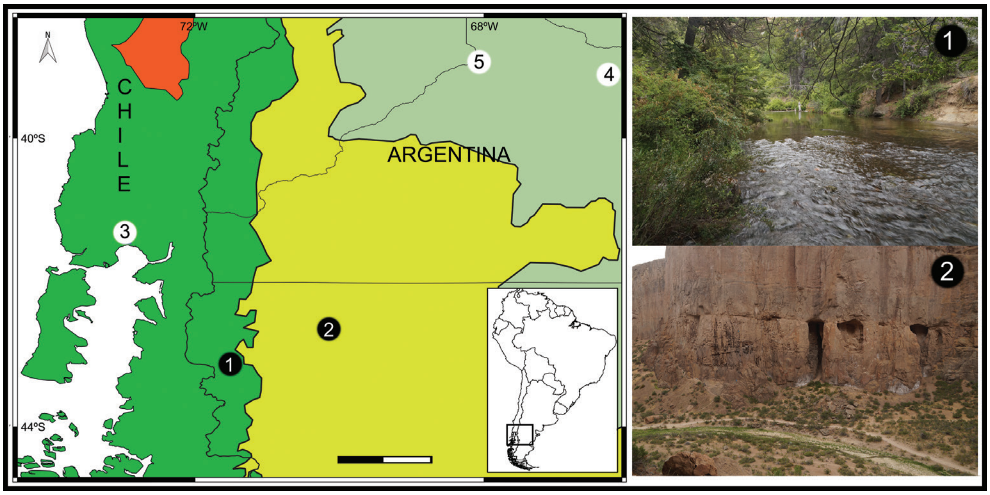


**Figure 1:** Map and images of protected areas sampled in NW Chubut province: (1) ANP Nant y Fall, (2) ANP Piedra Parada, (3) and (4) previous southernmost localities in Argentina and Chile for *L. villosissimus*; (5) previous southernmost locality for *M. dinellii*. Ecoregions *sensu* Olson et al. (2001): Valdivian Temperate Forests (green); Patagonian Steppe (yellow); Low Monte (gray); Chilean Matorral (red). Scale (black and white bar) = 100 km.

ecoregion characterized by a cold and dry climate (i.e. semi desert), with annual precipitation with an average of less than 250 mm and strong westerlies (Burkart et al. 1999). The most common vegetation are low shrubs such as *Mulinum spinosum* (Apiaceae), *Senecio bracteolatus* (Asteraceae), *Berberis microphylla* and *Adesmia volckmannii* (Fabaceae), and grasses such as *Pappostipa humilis* (Poaceae) and *Festuca pallescens* (Poaceae), among others (Veblen and Lorenz 1988, León et al. 1998, Paruelo et al. 1998, Burkart et al. 1999, Velasco and Siffredi 2009).

## Bat survey

Bats were surveyed from December 2017 to February 2018, including five survey nights in each protected area. Five mist nets of 6 m long, 2 m wide and 38.1 mm of mesh were used each night, which were opened at dusk and kept open for ca. 5 h. Captured specimens were measured, weighted and identified following Barquez et al. (1993, 1999) and Barquez and Díaz (2009). Collected specimens were deposited in the Mammal Collection of Laboratorio de Investigaciones en Evolución y Biodiversidad (LIEB, Facultad de Ciencias Naturales y Ciencias de la Salud, Universidad Nacional de la Patagonia San Juan Bosco, Sede Esquel, Argentina). Dirección de Fauna y Flora Silvestre and Subsecretaría de Conservación y Áreas Protegidas of Chubut province granted the capture permits (Disp. N° 25/2017 DFyFS-SSG; Disp. N° 69/17-SsCyAP). We followed the guideline proposed by Sikes et al. (2016) for the fieldwork with mammals.

The following external measures were taken: weight (g), total length (TL), head-body length (HB), tail length (T), ear length (E), tragus length (Tr), forearm length (FA) and tibial length (Tb). Weight was taken using a Pesola scale, while all other measures were taken with digital caliper of precision 0.01 mm. Only weight, E, FA and Tb were taken for individuals which were released (i.e. not kept as voucher specimens). Weight and FA of captured specimens were compared to published references with box-plots.

## Distribution analyses

All known localities of *Lasiurus villosissimus* and *Myotis dinellii* were recorded from scientific references and museum specimens. Each locality was georeferenced using gazetteers (www.fallingrain.com) and reference maps. Point maps were generated for both species, and the following climatic values for each locality were obtained from www.worldclim.org at a resolution of 1 $km^2$: altitude, annual mean temperature, minimum and maximum monthly temperatures, and annual precipitation (Hijmans et al. 2005a). Also, the presence of each locality within a particular ecoregion was assigned following the scheme of Olson et al. (2001). All these analyses were done using DIVA GIS v. 7.5 (University of California, CA, USA) (Hijmans et al. 2005b) and gvSIG Desktop v 2.4.0-2850 (Valencia, Spain) (www.gvsig.org 2018).

# Results

## Bat survey

Eleven specimens from six different vespertilionid species were captured in the two protected areas. Specimens of *Histiotus macrotus* (Poeppig 1835), *Histiotus magellanicus* Philippi 1866, *Lasiurus varius* Poeppig 1835 and *Myotis chiloensis* were recorded, while new southern limits were found for *Lasiurus villosissimus* and *Myotis dinellii*. Measurements for each captured species are presented in Table 1. Below we present a detailed review of these records and their biological implications.

## Vespertilionidae

### *Lasiurus villosissimus*

**Specimens examined (n=1)**
One adult female (LIEB-M 1570) captured in ANP Nant y Fall, NW Chubut, Argentina (43° 11′ 25″ S, 71° 28′ 19″ W).

**Comments**
The specimen of *Lasiurus villosissimus* showed a frosty yellowish coloration, with white-tipped hairs both ventrally and dorsally. The neck and upper part of the head were markedly yellow. The rostra and outer edge of the ears were clearly dark, almost black (Figure 2A). The weight of the captured specimen was 25 g, much larger than any other extant bat recorded in Patagonia (Figure 3). This bat was captured in a mist net at Nant y Fall stream (Figure 1), ca. 1.5 m above the ground. Two specimens of *Histiotus macrotus* (two males, LIEB-M 1617 and one released), one of *Histiotus magellanicus* (female, LIEB-M 1618), three of *Lasiurus varius* (one female, LIEB-M 1620 and two males, LIEB-M 1619 and one released) and one of *Myotis chiloensis* (female, LIEB-M 1621) were also captured in the same locality (see Table 1).

**Distribution**
A total of 140 records from 134 localities were obtained for *Lasiurus villosissimus*, distributed in several countries of South America (Supplementary Table 1). From the total, 62.4% records were from Argentina, 7.5% from Bolivia, 6.8% from Paraguay, 5.3% from Chile, 4.5% from Brazil and Ecuador, 3% from Venezuela, 2.25% from Peru and Uruguay, and 1.5% from Colombia. The northernmost locality was Bonda (Magdalena, Colombia, 11°14′ N), while the eastern and westernmost localities were Sao Paulo (Sao Paulo, Brazil, 46°37′ W) and Santa Isabel island (Galapagos, Ecuador, 91°8′ W), respectively. The new record of ANP Nant y Fall (Chubut, Argentina, 43°12′ S) is the most austral record known to date (Figure 4A), extending the species distribution to at least 600 km southwest from previously known records in Argentina, and more than 225 km from previously known locality in Chile.

Records indicate that *Lasiurus villosissimus* occurs at a mean altitude of 623 m (above sea level), although the altitude range of the localities varied from 0 to 3373 m. However, most localities for this species (48%) were located below 300 m (Figure 5A), notoriously decreasing above 1000 m. As to temperatures, the annual mean temperature of the localities for *L. villosissimus* was 17.8°C, ranging from –1°C to 36°C of minimum and maximum monthly temperatures, respectively. Most records (76%) were concentrated between 15°C and 22°C, decreasing in

**Table 1:** External measures from captured specimens in ANP Nant y Fall and ANP Piedra Parada.

| Species | *L. villosissimus* (n=1) | *H. macrotus* (n=4) | *H. magellanicus* (n=1) | *L. varius* (n=4) | *M. chiloensis* (n=1) | *M. dinellii* (n=1) |
|---|---|---|---|---|---|---|
| Weight (g) | 25 | 13.5 (12.5–15.2) | 14 | 10.8 (9–12) | 5.25 | 4.5 |
| TL | 123 | 115 (112.5–117.5)[a] | 121 | 90 (89–91)[a] | 82 | 80 |
| HB | 68 | 60.7 (57.5–64)[a] | 61 | 49 (47–51)[a] | 48 | 46 |
| T | 55 | 54.2 (53.5–55)[a] | 60 | 41 (38–44)[a] | 34 | 34 |
| FA | 51.8 | 49.6 (48.3–50.2) | 49.3 | 41.3 (39.6–42.5) | 39.4 | 35.6 |
| E | 11 | 31.5 (31–31.8) | 24 | 11.8 (11.5–12) | 13 | 13.5 |
| Tr | 8 | 14.9 (14.3–14.5)[a] | 13 | 7.5 (7–8)[a] | 8 | 6.45 |
| Tb | 21.6 | 21.9 (20.5–22.8) | 21.4 | 19.5 (19.2–20) | 16.7 | 16.1 |

In species were n>1, the average, minimum and maximum values were included. [a]Indicates measures without released specimens.
E, ear length; FA, forearm length; HB, head-body length; T, tail length; Tb, tibial length; TL, total length; Tr, tragus length.

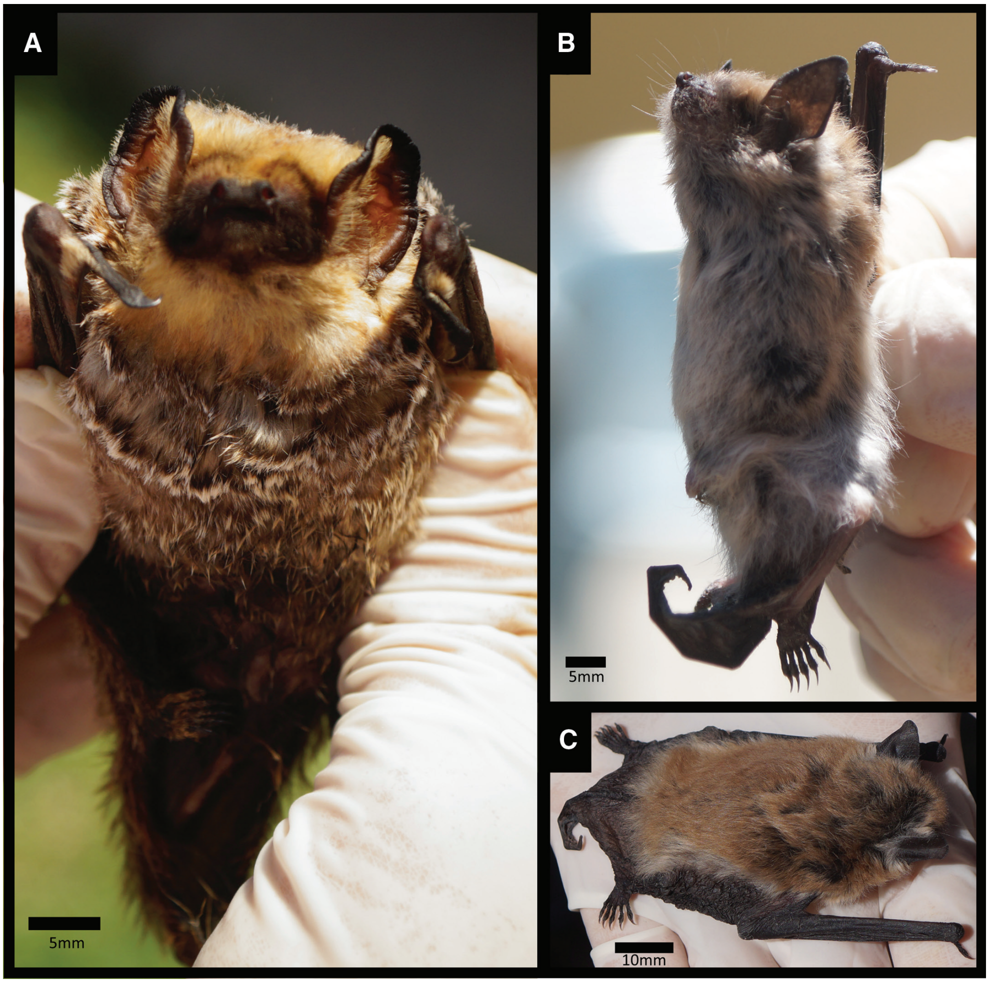


**Figure 2:** Photographs taken to captured specimens of *L. villosissimus* LIEB-M 1570 (A) and *M. dinellii* LIEB-M 1571 (B and C).

number toward colder and warmer areas (Figure 5B). The mean annual precipitation of the recorded localities for *L. villosissimus* was 931 mm, ranging from 1 to 4536 mm. Most localities (59%) were located between 600 and 1200 mm, notoriously decreasing toward more humid and arid areas (Figure 5C). In an ecoregional context (Olson et al. 2001), most records of *L. villosissimus* came from Humid Pampas (21%), Southern Andean Yungas (15%), Dry Chaco (13%) and Espinal (7%). The Valdivian temperate forests was the only Patagonian ecoregion with the presence of this species (4%).

### *Myotis dinellii*

#### Specimens examined (n = 1)

One adult male (LIEB-M 1571) captured on ANP Piedra Parada, Chubut, Argentina (42° 38′ 30″ S, 70° 05′ 59″ W).

#### Comments

The specimen of *Myotis dinellii* showed a pale yellow dorsal pelage, with brown hairs at the base, and yellow tips. The ventral pelage was whitish, with dark hairs at the base, and lighter tips. Wing membranes and ears were darker, highly contrasting with the pelage (Figure 2B–C). This captured specimen weighed 4.5 g, being the smallest extant Patagonian bat recorded to date (Figure 3). This bat was captured on a mist net, ca. 2 m above the ground outside a large cave which was presumably used as a roost (Figure 1). Two specimens of *Histiotus macrotus* (two males, LIEB-M 1616 and one released) were also captured in the same place (see Table 1).

#### Distribution

A total of 167 records from 142 different localities were recorded for *Myotis dinellii* distributed in Argentina, Bolivia and Brazil (Supplementary Table 2). Of the total,

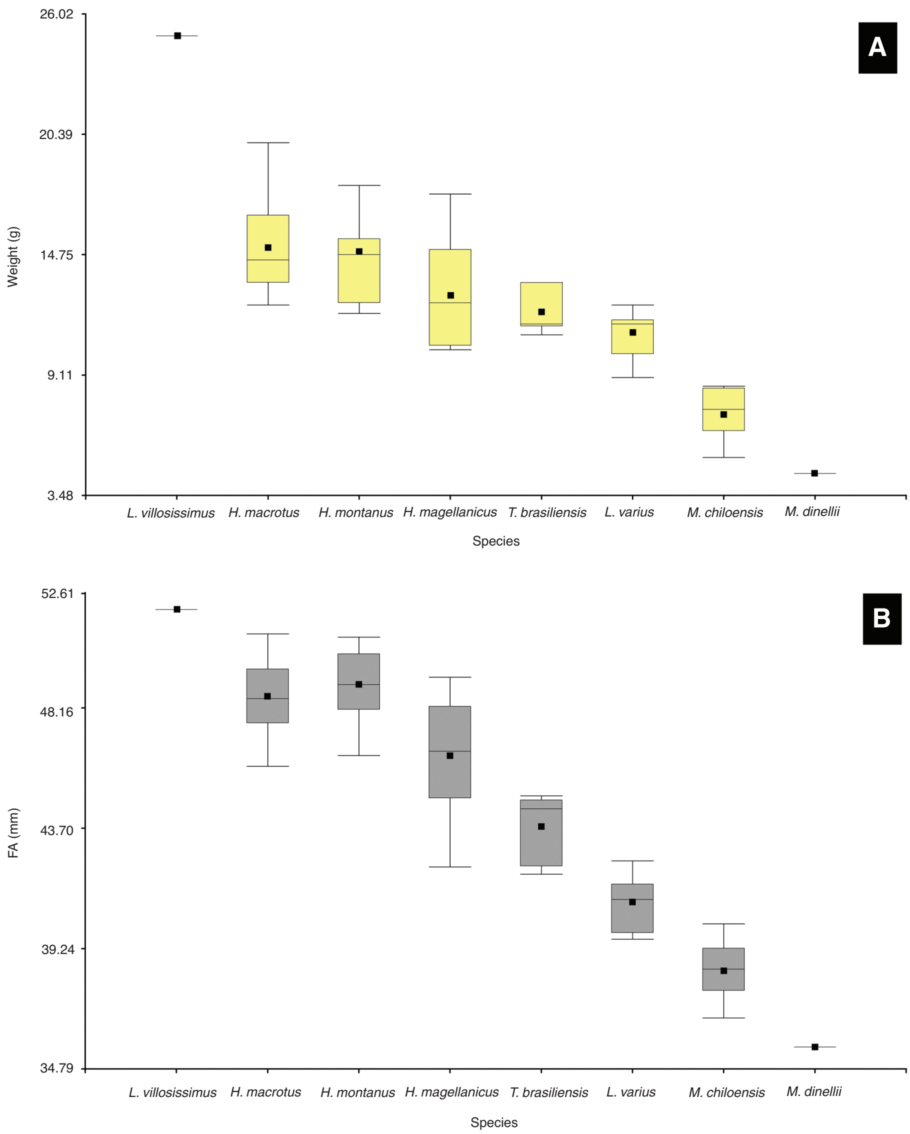


**Figure 3:** Box-plots of weight (A) and forearm length (B) indicating size limits of Patagonian bat species. References taken from Giménez (2010, 2014), Giménez et al. (2012).

90% came from Argentina, 6.4% from Bolivia and 3.6% from Brazil. The northernmost locality recorded to date was Cochabamba (Cochabamba, Bolivia, 17°12′ S), while the easternmost locality was Pedras Grandes (Santa Catarina, Brazil, 49°15′ W). The new record presented here from ANP Piedra Parada (Chubut, Argentina, 42° 38′ 30″ S, 70° 05′ W) is the western and southernmost recorded locality to date, extending the species distribution in 445 km (Figure 4B).

The mean altitude of the recorded localities of *Myotis dinellii* was 938 m, ranging from 0 to 4469 m, notoriously decreasing above 1500 m (Figure 5D). However, most localities (26%) were found between 300 and 600 m, and 82% were recorded between 0 and 1300 m. The mean annual temperature for the species localities had an average of 17.1°C, ranging from −9°C to 35°C of minimum and maximum monthly temperatures. Most records (85%) were found between 14°C and 20°C of the annual mean temperature, decreasing toward colder areas (Figure 5E). The mean annual precipitation for records of *M. dinellii* was 625 mm, ranging from 147 to 2999 mm, with the majority of localities (92%) found between 147 and 1000 mm, decreasing toward more humid areas (Figure 5F). In an ecoregional context (Olson et al. 2001), most records for this species were located in Dry Chaco (35%), followed by Southern Andean Yungas (18%), Espinal, and High Monte (11% each) and Low Monte (6%).

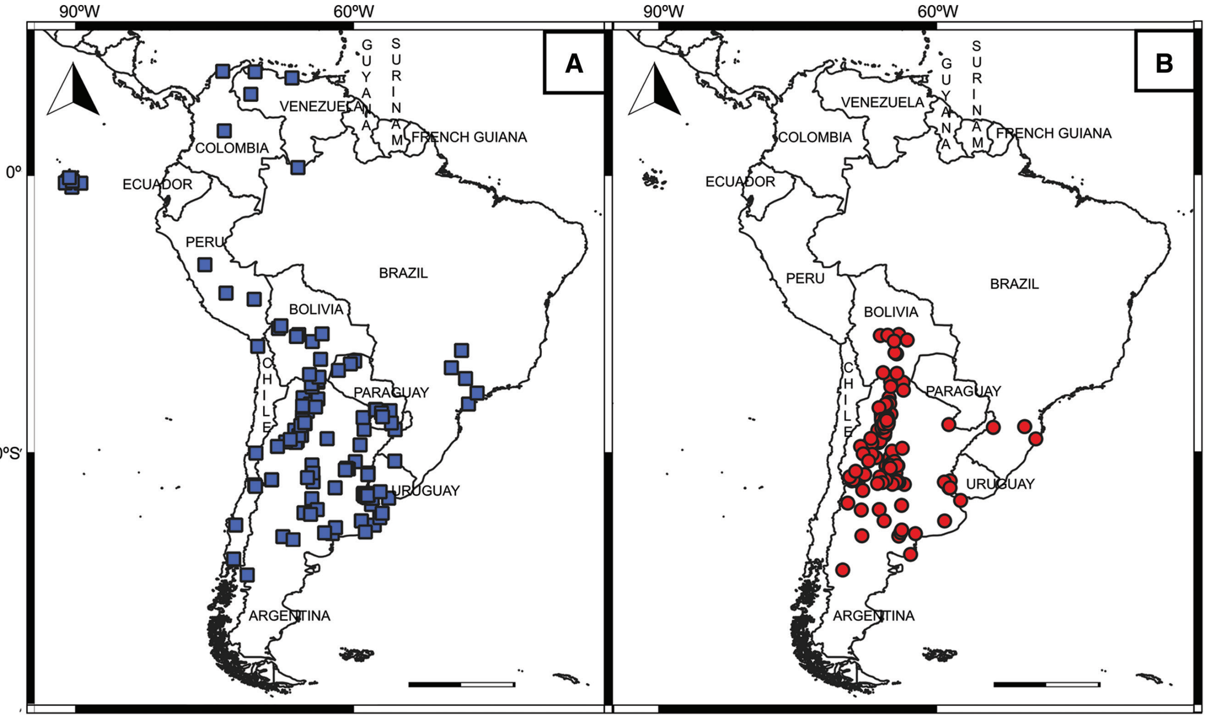


**Figure 4:** Recorded localities analyzed in distribution analysis for *L. villosissimus* (A, blue squares) and *M. dinellii* (B, red dots). (1) ANP Nant y Fall and (2) ANP Piedra Parada. Scale (black and white bar) = 1000 km.

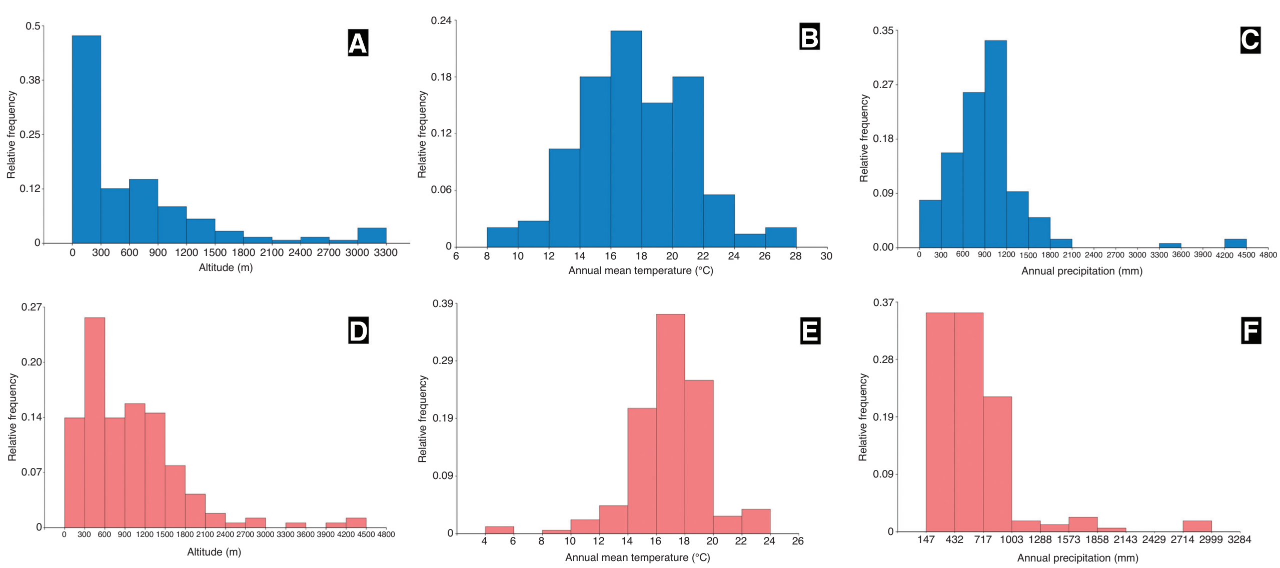


**Figure 5:** Climatic histograms on the basis of climatic variables for *L. villosissimus* and *M. dinellii* of altitude (A, D), annual mean temperature (B, E) and annual precipitation (C, F), respectively.

## Discussion

Latitudinal differences between tropical and extratropical zones have long been acknowledged as the main cause for the difference in bat species richness and density in America (Willig and Selcer 1989, Stevens 2004). Different bats respond to latitude in different ways: Phyllostomidae increase their diversity toward the Equator, while Vespertilionidae are thought to achieve their highest species richness at mid-latitudes, decreasing toward both lower and higher latitudes, and Molossidae show a slower increase in species richness with decreasing latitude (Willig and Selcer 1989). In consequence, Patagonian bats are mostly represented by vespertilionid species (Giménez 2014). The main factors that condition their occurrence in temperate zones like Patagonia are the availability of resources and roosts. Among bats living in the same latitudinal bands, resource partitioning has been proposed as the main factor allowing their coexistence: feeding on different food items (i.e. fruit, nectar, insects), at different hours and/or at different flight altitudes (McNab 1982). Food habits are related to the basal metabolic rate, in a way that insectivorous bats living at high latitudes of South America are expected to show low metabolic rates and a poor thermoregulatory capacity (McNab 1969). To cope with this poor thermoregulatory capacity and the lack of food resources (i.e. flying insects) during much of the year, bats at their distribution extremes (e.g. cold zones as Patagonia) may enter into torpor, display clustering behavior and/or have heavy insulation (McNab 1969), or simply migrate to other areas (McNab 1982, Pearson and Pearson 1989, Stevens 2004). Likewise, the availability of suitable roosts may limit their geographic occurrence as well, because they are fundamental for mating, hibernating and rearing the young (Kunz and Lumsden 2003). In turn, roost selection can be determined by the physiological demands of the adults or young (Findley 1993).

Some studies in Patagonia presented new limits of distribution for bats (Koopman 1982, Dabbene 1902, Barquez et al. 2013, Udrizar Sauthier et al. 2013, Díaz et al. 2017), but lacking the focus of the importance of austral limits of distribution. Here, we extend the latitudinal range of *Lasiurus villosissimus*. Its presence in such a southern locality might be explained by a migratory behavior, as in other lasiurines such as *Lasiurus cinereus* and *Lasiurus borealis* in North America (Shump and Shump 1982a,b, Cryan 2003). As larger animals lose more heat than smaller ones in absolute terms (McNab 2010), we propose that it is unlikely that Patagonian ecoregions host such a large bat (25 g) all year round, depending exclusively on flying insects, a resource that exhibits great fluctuations between seasons (Mazía et al. 2006, Ruggiero et al. 2009). The new record for Nant y Fall is not only the southernmost locality to date, but is also the upper size limit of any recorded bat in Patagonia, weighting 25 g and with an FA of 51.8 mm. Prior to this work, the largest ones were *Histiotus macrotus*, weighing 14.35 g (12.5–18 g) with an FA of 48.1 mm, and *Histiotus montanus* weighing 14.87 g (12–18 g) with an FA of 49.01 mm (taken from Giménez 2010, 2014). Concomitant with its large size, *L. villosissimus* displays a cranial morphology often associated with a durophagous diet (see Giménez and Giannini 2011, 2016), representing a morphotype not likely to overlap with any other extant Patagonian bat.

As stated earlier, lower densities as those occurring at distributional extremes might also be the reason why this species was not recorded before, even after 10 years of continuous bat surveys using mist nets in northwestern Chubut province (see Giménez 2010, 2014, Giménez et al. 2012). However, we believe it is likely that the species might be found south of this location, given that the Valdivian temperate forests extend continuously to ca. 47° S (Olson et al. 2001). In comparison, other lasiurine species such as *Lasiurus cinereus* is widely distributed in North America, extending up to ca. 50° N, near the limit of trees in Canada (Shump and Shump 1982b). The widespread localities of *Lasiurus villosissimus* throughout many ecoregions suggests a generalist species, at least regarding its climatic tolerance. However, our results show that even with a wide range of extreme climatic values, the species is mostly found at low altitudes, warm and humid areas, consistent with the ecoregions where most records come from. Likewise, more favorable climatic areas might also be related to the larger abundance of specimens, increasing the amount of records in more suitable areas. It is well known that other *Lasiurus* species are mostly solitary and use trees as roosting sites (Mann Fischer 1978, Shump and Shump 1982b), which could explain its presence in forested ecosystems. This could be an indication that the polar limits to vespertilionid distribution could be directly related to the limits of forest areas in both Eurasia and North America, as a need for roosting sites (McNab 1982).

We also extended the limits for *Myotis dinellii*, representing the second record for the species in the Patagonian steppe ecoregion. Chubut province hosts two *Myotis* species again, given the recent proposal of *Myotis aelleni* Baud 1979 being a junior synonym of *Myotis chiloensis* (Novaes et al. 2018b). This new record represents the lower size limit known to date for any extant Patagonian mammal, weighing 4.5 g with an FA of 35.6 mm. Prior to this work, the smallest one recorded was *M. chiloensis* weighing 7.6 g (5.25–8.6 g) with an FA of 38.7 mm (see Table 1 and Giménez et al. 2012). As small insectivorous bats show poor thermoregulatory capacity and as food resources are highly seasonal, we believe it is likely that this species hibernates to survive the harsh winter Patagonian period, but this should be further tested. However, this behavior has been extensively documented in species of the genus *Myotis* such as *Myotis daubentonii*, *Myotis lucifugus*, *Myotis myotis* or *Myotis sodalis* (Clawson et al. 1980, Kokurewicz 2004, Wojciechowski et al. 2006, Boyles et al. 2007). Particularly in Patagonia, *M. chiloensis* has been recorded to be able to enter in torpor periods (Mann Fischer 1978, Bozinovic et al. 1985).

Most records of *Myotis dinellii* were concentrated in arid zones, which may be because the species prefers such environments, or because of a greater sampling effort in these particular areas. In Córdoba province (Argentina), this species was associated with areas where mountains prevail, because they have more environmental heterogeneity and available roosting sites (Castilla et al. 2013). In these areas, *M. dinellii* was related to caverns/caves or mines and anthropic buildings used as roosts (Tiranti Paz and Torres Martínez 1998, Castilla et al. 2013). Our specimen of *M. dinellii* agrees with this description, as we caught this specimen at the exit of a large cavern in the ANP Piedra Parada. Likewise, although the little yellow bat was found to spread from ca. 17° S to ca. 43° S in South America, records were not evenly distributed, but concentrated in dry and temperate/warm areas, with elevations lower than 1800 m. The Patagonian steppe ecoregion extends continuously to ca. 54° S (Olson et al. 2001). We believe it is likely that the species might be found south of this location. However, this must be confirmed with new studies.

As a conclusion, in this work we reported new records for Patagonian bats and extended the austral limit of distribution for two vespertilionid species, *Lasiurus villosissimus* and *Myotis dinellii*. The big hoary bat *L. villosissimus* was recorded as the largest bat inhabiting Patagonia, relating it as a bat mainly of low, humid and temperate/warm areas. The little yellow bat *M. dinellii*, instead, is the smallest bat recorded in Patagonia to date, also extending its known distribution to the Patagonian steppe mainly in dry, mid-altitude and temperate/warm areas. This information is important not only due to the gaps in knowledge about bats at the extreme of their distribution, but also for the conservation of the species, given the recent advances of wind farms (Oliva et al. 2007, Giralt 2011, Garrido et al. 2016) and its relation with bat fatalities (Barclay et al. 2007, Rydell et al. 2010, Rodriguez-Durán and Feliciano-Robles 2015), highlighting the importance of protected areas in Patagonia.

**Acknowledgments:** This work was possible thanks to a scholarship from provincia del Chubut granted to ALG (Beca Puente, Res. SCTeIP no. 11). Dirección de Fauna y Flora Silvestre and Subsecretaría de Conservación y Áreas Protegidas of Chubut province kindly granted the capture permits (Disp. no. 25/2017 DFyFS-SSG; Disp. no. 69/17-SsCyAP). We acknowledge the support from Agencia Nacional de Promoción Científica y Tecnológica (PICT 2016-0238 granted to MIS). We are grateful to the park rangers from ANPs Nant y Fall and Piedra Parada, particularly to Gabriela Tavella for the help during the fieldwork. Gabriel Martin helped with his valuable comments and English grammar. The manuscript was improved by the valuable comments of the editor and two anonymous reviewers.

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**Supplementary Material:** The online version of this article offers supplementary material (https://doi.org/10.1515/mammalia-2019-0024).