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The least known with the smallest ranges: analyzing the patterns of occurrence and conservation of South American rodents known only from their type localities

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The identification of taxa with small range sizes is important both from an ecological and conservational perspective. As other small mammals, several species of rodents have restricted geographical distributions, a situation that could increase their immediate risk of extinction. Species having restricted ranges and/or low population sizes have usually lower genetic variation than wide-ranging relatives, being highly susceptive to disruptive treats, such as new or introduced competitors, pathogens, and predators, severe climatic events, cataclysms, and/or population-level phenomena. We reviewed the most recent compilations on South American rodents to identify those only known from their type locality (*i. e.*, an area with a maximum latitudinal and longitudinal range of < 10 km). This restriction is in accordance with an extent of occurrence < 100 km^2, which fits partially with the criterion B1 of the IUCN for an extent of occurrence of a critically endangered species. For each species, we recorded the year of description, country of origin, main habitat use, use of substrate, and conservation status. We identified 58 species of South American rodents that are known only from their type localities or their vicinities. These species belong to two suborders, seven families, and 29 genera. The family with more species in this list is Cricetidae, which accounted for a half of the included species. Most species in our list were described during the decades of 1890-1930 and 1990 to recent. The habitat type with more species in the list was tropical forest. Almost a third of the species are considered under the highest categories of threat, such as CR, EN o VU. Two species within the list are considered to become extinct in historical times, including the akodont *Juscelinomys candango* and the vizcacha *Lagostomus crassus*. Almost half of the species in our list are referred as DD. Fifty eigth rodent species from South American are only known from their type localities and their surroundings; *i. e.*, *ca.* 9 % of the currently approximately 650 recorded species of the subcontinent. The species list provided here need to be depurated trough additional field and collection based work. Even when some species could be removed from this list (due taxonomical changes or additional records from other localities), it is also possible than others could be included. Most species in our list are found at or close to highland areas, such as the Andes or the Serra do Mar, suggesting that at least partially the rarity of some of them could be related to the relative inaccessibility of these places. As in previous contributions focused on geographically restricted taxa, most species in our list are considered as DD in the IUCN Red List. This is unfortunate, since species listed as DD usually do not gain much attention (*i. e.*, conservation programs, founds) as those considered as CR, EN or VU. Previous authors discussed this point, suggesting the need to designate as CR all species geographically restricted to their type localities, at least when no recent records (*i. e.*, in the last 25 years) exists.

La identificación de especies con áreas de distribución pequeña es importante tanto desde una perspectiva ecológica como de conservación. Como es frecuente en mamíferos pequeños, varias especies de roedores tienen distribuciones geográficas restringidas. Las especies que ocupan áreas restringidas y/o tienen tamaños poblacionales pequeños suelen tener una variación genética menor que aquellas de distribución más amplia y son más susceptibles a situaciones disruptivas, como la introducción de competidores, patógenos y depredadores, eventos climáticos severos, cataclismos y/o fenómenos a nivel poblacional. Revisamos las compilaciones más recientes sobre roedores de América del Sur para identificar aquellas especies que únicamente se conocen de su localidad tipo (es decir, un área con un intervalo máximo, latitudinal y longitudinal, de < 10 km). Esta restricción está de acuerdo con una extensión de la ocurrencia < 100 km^2, que se ajusta parcialmente al criterio B1 de la UICN para una extensión de ocurrencia de una especie en peligro crítico. Para cada especie, registramos el año de descripción, país de origen, uso principal del hábitat, uso del sustrato y estado de conservación. Identificamos 58 especies de roedores sudamericanos que se conocen sólo de sus localidades tipo y/o cercanías. Estas especies pertenecen a dos subórdenes, siete familias y 29 géneros. La familia con más especies en esta lista es Cricetidae, que representó la mitad de las especies incluidas. La mayoría de las especies en nuestra lista fueron descritas durante las décadas de 1890-1930 y 1990-2019. El tipo de hábitat con más especies en la lista fue el bosque tropical. Casi un tercio de las especies se consideran en las categorías más altas de amenaza, como CR, EN o VU. Dos especies dentro de la lista están consideradas como extintas en tiempos históricos, incluyendo el ratón *Juscelinomys candango* y la vizcacha *Lagostomus crassus*. Casi la mitad de las especies en nuestra lista son referidas como DD. Hay 59 especies de roedores sudamericanos que se conocen sólo de su localidad tipo; es decir, *ca.* del 9 % de las aproximadamente 650 especies registradas actualmente en el subcontinente. La lista de especies que proporcionamos debe depurarse a través de trabajo adicional, tanto en el campo como en colecciones biológicas. Incluso cuando algunas especies podrían eliminarse de esta lista (debido a cambios taxonómicos o registros adicionales de otras localidades), también es posible que otras puedan incluirse. La mayoría de las especies en nuestra lista se encuentran en o cerca de áreas de tierras altas, como los Andes o la Serra do Mar, lo que sugiere que al menos parcialmente la rareza de algunas de ellas podría ser un artefacto relacionado a la relativa inaccesibilidad a estos lugares. Como en contribuciones anteriores centradas en taxones restringidos geográficamente, la mayoría de las especies en nuestra lista se consideran DD en la Lista Roja de la UICN. Esto es desafortunado, ya que las especies listadas como DD generalmente no reciben tanta atención (es decir, fondos para establecer programas de investigación o conservación) como aquellas consideradas como CR, EN o VU. Autores anteriores discutieron este punto, sugiriendo la necesidad de designar como CR a todas las especies restringidas geográficamente a sus localidades tipo, al menos cuando éstas no tengan registros recientes (es decir, en los últimos 25 años).

Key words: distribution; endemism; extinction; rare species; Rodentia; small mammals.

Introduction

With *ca*. 2600 species, rodents compose the most diverse order within Mammalia, including about 42 % of the living mammal species (D'Elía *et al.* 2019a). Native rodents inhabit almost every habitat on Earth, except Antarctica, New Zealand, and some oceanic islands. They occupy a large variety of terrestrial and freshwater niches, including even gliding species (D'Elía *et al.* 2019a). As other small mammals, rodents play a fundamental role in trophic chains, acting as preys of other vertebrates, and contributing to energy and nutrient flow, providing key functions to the ecosystems, such as seed dispersal or soil removal (Lacher *et al.* 2017). Despite these characteristics, rodents are among the least known mammals, both in terms of their taxonomy and natural history, with many species that are known only from the holotype or type series and frequently from collections made more than a century ago (Amori *et al.* 2016).

From a conservational perspective, even when laudable efforts exists (notable the IUCN Small Mammal Specialist Group, which also covers tree shrews and eulipotyphlans), rodents are not charismatic species as other medium and large mammals (*e. g.*, canids, cetaceans, felids or ungulates), attracting little attention from media and financial founds (Fleming and Bateman 2016). This is an unfortunate situation, since the historical record indicates that rodents are among the most vulnerable mammals to extinction owing to direct or indirect human activities, accounting *ca.* 53 % of the total number of mammal losses during the last 500 years (Turvey 2009).

As other small mammals, several species of rodents have restricted geographical ranges, a fact that could increase their immediate risk of extinction (*e. g.*, Gaston 1994). It is widely accepted that species having restricted distributions and/or low population sizes have usually lower genetic variation than wide-ranging relatives (*e. g.*, Caughley 1994; MacArthur and Wilson 1967), being highly susceptive to disruptive treats, such as new or introduced competitors, pathogens, and predators, severe climatic events (*e. g.*, droughts), cataclysms (*e. g.*, volcanic eruptions), and/or population-level phenomena (*e. g.*, inbreeding depression). An eloquent example of the vulnerability of rodents with restricted distributional ranges is the biological extinctions of *ca.* 21 endemic species from the Caribbean islands since 1500 AD after the European colonization (Turvey 2009).

At the time of description, new species are known at least from one locality (*i. e.*, the type locality) and a single individual (*i. e.*, the holotype), on which the species description is based. The known distribution of most species is normally enlarged as new specimens are recorded in other localities. However, some species remaining being known from only the vicinities of their type localities; sometimes, this fact reflects the existence of microendemisms (*e. g.*, *Phyllotis bonariensis*, which is apparently restricted to the hilly system of Ventania in central-eastern Argentina; see Steppan and Ramírez 2015), but in most cases is only because of the limited field work or to already collected specimens have not been identified as representative of those species.

In this contribution, we reviewed the distribution patterns, main habitats, use of substrate, and conservation implications of South American rodents that are only known from their type locality or its immediate surroundings. We also discussed if these species are geographically distributed in poorly surveyed areas or if they share some life traits that may make them easy to overlook (*e. g.*, fossoriality).

Materials and methods

To identify those species only known from their type localities and/or its immediate surroundings, we reviewed the most recent compilations on Neotropical rodents, using Patton *et al.* (2015) as starting point. For those species described since 2015, we consulted the review of D'Elía *et al.* (2019a) plus the literature published after December 2017, which is the date that ends the period included in this review. We also reviewed the primary literature. In each case, we individually reviewed the distributional range of each taxon, searching in published (*e. g.*, Patton *et al.* 2015) and online data sources (*e. g.*, GBIF, www.gbif.org). Taxonomy follows Patton *et al.* (2015), with minor modifications according to the posterior literature.

We use the definition of type locality given by Meiri *et al.* (2017), which considered a maximum latitudinal and longitudinal range of < 10 km (= 0.1°). This restriction is in accordance with an extent of occurrence < 100 km^2, which fits partially with the criterion B1 of the IUCN for an extent of occurrence of a critically endangered species (IUCN, 2017).

For each species, we distinguished between those known only from old records and those recently described or known by repeated records in the type locality. The cut-off between old and recent records was arbitrarily placed at 50 years ago (1969; see Meiri *et al.* 2017 for a similar procedure).

Use of substrate for each species was taken from the literature (e.g., Patton *et al.* 2015). Six main habitat categories were considered in the analysis, following the proposal of Amori *et al.* (2016): *i*) deserts, *ii*) grasslands, *iii*) scrublands, *iv*) temperate forests, *v*) tropical forest, *vi*) unknown.

Results

We identified 58 species of South American rodents that are known only from their type localities or their vicinities (Figure 1, Table 1). These species belong to seven families, of which six belong to Hystricomopha (Table 1). However, the family with more species (n = 28; 48.3 % of the total) in this list is Cricetidae, all belonging to the subfamily Sigmodontinae. The 58 identified species are part of 29 genera; the genus with most species in the list is the ctenomyid *Ctenomys* with 11, followed by the cricetid *Thomasomys* with five. Remarkably, some of the South American rodent species known only from the surroundings of their type localities are relatively large animals as the mountain vizcacha *Lagidium ahuacaense* (2,000 g), recorded at a single rocky outcrop point in the coastal Desert of Ecuador and the

chinchilla rat *Cuscomys ashaninka* (910 g) only know from its holotype collected at a Peruvian humid cloud forest (Emmons 1999; Spotorno and Patton 2015).

Most species included in our list were described during the decades of 1890 to 1930 (*n* = 18; 31 %) and 1990 to recent (*n* = 33; 56.9%), with a peak between 1990-2000 (*n* = 14; 24.1 %); Table 1; Figure 2). More than the half of the surveyed species (*n* = 36; 61.1 %) were described since 1969. At least four species of those described prior to 1969 (*i. e.*, *Ctenomys bicolor*, *Phyllomys thomasi*, *Phyllotis bonariensis*, and *Santamartamys rufodorsalis*) were recorded again from their type localities during the last 50 years (cf. Patton *et al.* 2015).

The majority of the selected species were collected at open to brushy and arid-semiarid to temperate habitats, including deserts (*n* = 6; 10.3 %), grasslands (*n* = 14; 24.1 %), and scrublands (*n* = 14; 24.1 %). However, the habitat type with more species in the list was tropical forest (*n* = 21; 36.2 %; Table 1; Figure 3). Looking at the country of origin, we observed that a high number of the species in our list occurs in Argentina (*n* = 21; 36.2 %), Brazil (*n* = 12; 20.7 %), and Peru (*n* = 9; 15.5 %). Other seven countries are represented by 1 (Colombia, Paraguay, Uruguay, Venezuela) to 3 (Bolivia) or 6 (Ecuador) species (Table 1). No species comes from Guyana, Suriname or French Guiana.

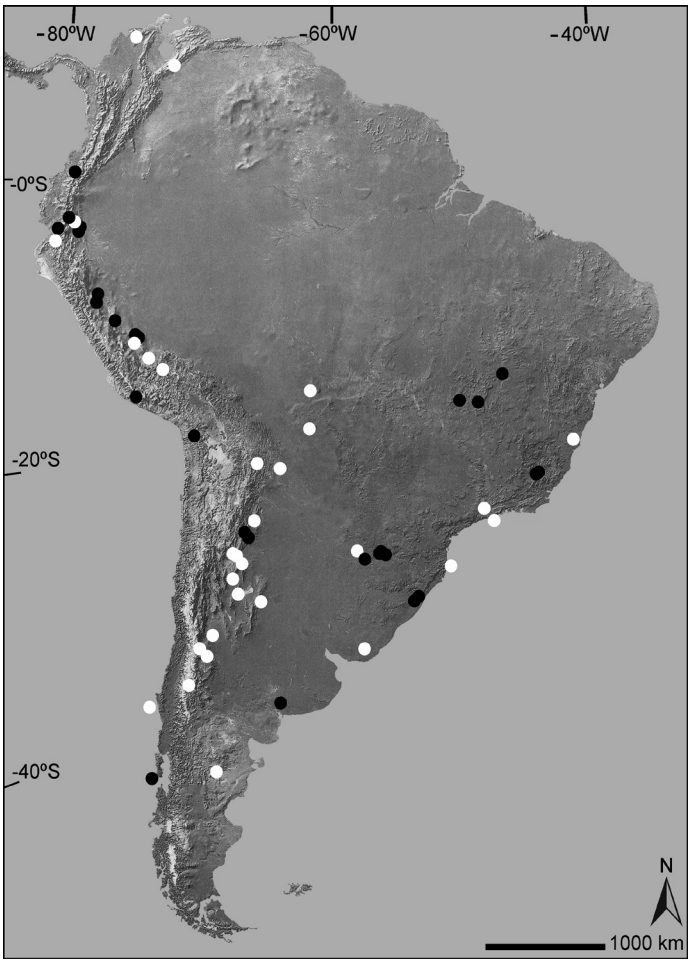

Figure 1. Map of South America depicting the geographical distribution of those rodent species only known from their type localities (black circles = sigmodontine; white circles = caviomorph).

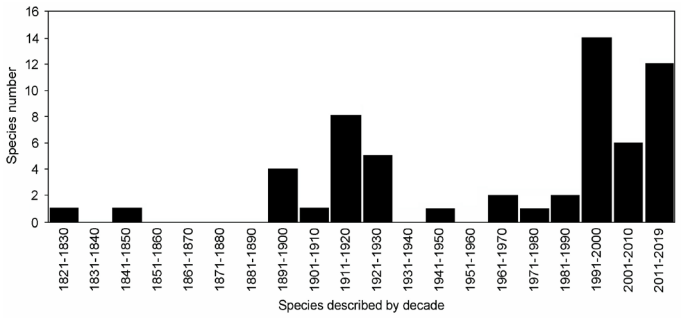

Figure 2. Number of South American rodent species described by decade between 1820 and the present that are only known from their type localities.

Regarding the use of substrate, four major groups can be recognized: cursorial (*n* = 32; 55.2 %), fossorial (*n* = 16; 27.6 %), climber (*n* = 9; 15.5 %), and semiaquatic (*n* = 2; 3.4 %; Table 1).

In terms of conservation status as considered by the IUCN Red List , two species (3.4 %) are considered as extinct (EX), including the akodont *Juscelinomys candango* and the vizcacha *Lagostomus crassus* (Table 1; Figure 4). Almost a third of the remaining species are considered under the highest categories of threat, such as critically endangered (CR; *n* = 8; 13.8 %), endangered (EN; *n* = 3; 5.2 %), vulnerable (VU; *n* = 3; 5.2 %) or near threatened (NT; *n* = 1; 1.7 %). Only one species is considered as of least concern (LC; *n* = 1; 1.7 %); while almost half of the species in our list are referred as data deficient (DD; *n* = 26; 44.8 %). Finally, the IUCN has not yet evaluated most of the species described or removed from the synonymy of other taxa since 2014; consequently these species are listed as not evaluated (NE; *n* = 14; 24.1 %; Table 1; Figure 3).

Discussion

Our study document that 58 rodent species from South American are only known from their type localities and their surroundings; *i. e.*, ~9 % of the currently ~650 recorded species of the subcontinent (Patton *et al.* 2015). The number

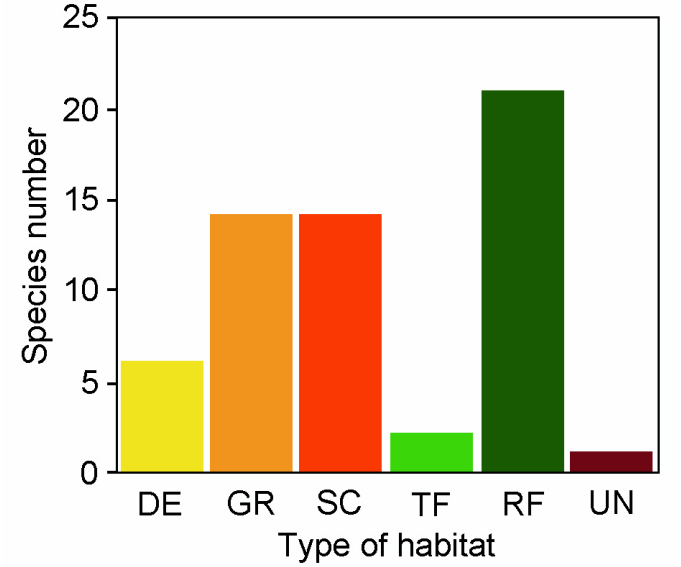

Figure 3. Number of South American rodent species by habitat type that are only known from their type localities. Abbreviations are as follow: deserts (DE); grasslands (GR); scrublands (SC); temperate forests (TF); tropical forest (RF); unknown (UN).

Table 1. List of species of South American rodent that are only known from their type localities.

	Suborder	Family	Year of description	Habitat	Country	Habits	UICN
Akodon kotosh	Supramyomorpha	Cricetidae	2016	tropical forest	Peru	cursorial	NE
Akodon mystax	Supramyomorpha	Cricetidae	1998	grassland	Brazil	cursorial	DD
Akodon philipmyersi	Supramyomorpha	Cricetidae	2005	grassland	Argentina	cursorial	DD
Brucepattersonius guarani	Supramyomorpha	Cricetidae	2000	tropical forest	Argentina	cursorial	DD
Brucepattersonius misionalis	Supramyomorpha	Cricetidae	2000	tropical forest	Argentina	cursorial	DD
Brucepattersonius paradisus	Supramyomorpha	Cricetidae	2000	tropical forest	Argentina	cursorial	DD
Calomys chinchilico	Supramyomorpha	Cricetidae	2007	desert	Peru	cursorial	NE
Cerradomys akroai	Supramyomorpha	Cricetidae	2014	scrubland	Brazil	cursorial	NE
Deltamys araucaria	Supramyomorpha	Cricetidae	2017	tropical forest	Brazil	cursorial	NE
Euneomys fossor	Supramyomorpha	Cricetidae	1899	uncknown	Argentina	uncknown	DD
Geoxus lafkenche	Supramyomorpha	Cricetidae	2016	temperate forest	Chile	fossorial	NE
Hylaeamys tatei	Supramyomorpha	Cricetidae	1998	tropical forest	Ecuador	cursorial	DD
Juliomys ximenezi	Supramyomorpha	Cricetidae	2016	tropical forest	Brazil	climber	NE
Juscelinomys candango	Supramyomorpha	Cricetidae	1965	scrubland	Brazil	cursorial	EX
Microakodontomys transitorius	Supramyomorpha	Cricetidae	1993	scrubland	Brazil	cursorial	EN
Neacomys macedoruizi	Supramyomorpha	Cricetidae	2018	tropical forest	Peru	cursorial	NE
Necromys lilloi	Supramyomorpha	Cricetidae	2016	grassland	Argentina	cursorial	NE
Nectomys saturatus	Supramyomorpha	Cricetidae	1897	tropical forest	Ecuador	semiaquatic	NE
Oxymycterus caparaoe	Supramyomorpha	Cricetidae	1998	grassland	Brazil	cursorial	LC
Phyllotis anitae	Supramyomorpha	Cricetidae	2007	grassland	Argentina	cursorial	DD
Phyllotis bonariensis	Supramyomorpha	Cricetidae	1964	grassland	Argentina	cursorial	NT
Phyllotis osgoodi	Supramyomorpha	Cricetidae	1950	desert	Chile	cursorial	DD
Rhipidomys albujai	Supramyomorpha	Cricetidae	2017	tropical forest	Ecuador	climber	DD
Thomasomys apeco	Supramyomorpha	Cricetidae	1993	tropical forest	Peru	cursorial	VU
Thomasomys fumeus	Supramyomorpha	Cricetidae	1924	tropical forest	Ecuador	cursorial	DD
Thomasomys hudsoni	Supramyomorpha	Cricetidae	1923	scrubland	Ecuador	cursorial	VU
Thomasomys onkiro	Supramyomorpha	Cricetidae	2002	tropical forest	Peru	cursorial	VU
Thomasomys rosalinda	Supramyomorpha	Cricetidae	1926	tropical forest	Peru	cursorial	EN
Abrocoma budini	Hystricomorpha	Abrocomidae	1920	scrubland	Argentina	cursorial	DD
Abrocoma famatina	Hystricomorpha	Abrocomidae	1920	scrubland	Argentina	cursorial	DD
Abrocoma vaccarum	Hystricomorpha	Abrocomidae	1921	scrubland	Argentina	cursorial	DD
Cuscomys ashaninka	Hystricomorpha	Abrocomidae	1999	tropical forest	Peru	cursorial	DD
Cuscomys oblativus	Hystricomorpha	Abrocomidae	1916	tropical forest	Peru	cursorial	DD
Cavia intermedia	Hystricomorpha	Caviidae	1998	grassland	Brazil	climber	CR
Cavia patzeli	Hystricomorpha	Caviidae	1981	grassland	Ecuador	climber	DD
Lagidium ahuacaense	Hystricomorpha	Chinchillidae	2009	desert	Ecuador	cursorial	DD
Lagostomus crassus	Hystricomorpha	Chinchillidae	1910	grassland	Peru	cursorial	EX
Ctenomys andersoni	Hystricomorpha	Ctenomyidae	2014	scrubland	Bolivia	fossorial	NE
Ctenomys bicolor	Hystricomorpha	Ctenomyidae	1914	scrubland	Bolivia	fossorial	NE
Ctenomys brasiliensis	Hystricomorpha	Ctenomyidae	1826	grassland	Uruguay	fossorial	DD
Ctenomys fochi	Hystricomorpha	Ctenomyidae	1919	grassland	Argentina	fossorial	DD
Ctenomys johanis	Hystricomorpha	Ctenomyidae	1921	scrubland	Argentina	fossorial	DD
Ctenomys juris	Hystricomorpha	Ctenomyidae	1920	scrubland	Argentina	fossorial	DD
Ctenomys lessai	Hystricomorpha	Ctenomyidae	2014	grassland	Bolivia	fossorial	NE
Ctenomys osvaldoreigi	Hystricomorpha	Ctenomyidae	1995	grassland	Argentina	fossorial	CR
Ctenomys paraguayensis	Hystricomorpha	Ctenomyidae	2000	grassland	Paraguay	fossorial	NE
Ctenomys pontifex	Hystricomorpha	Ctenomyidae	1918	scrubland	Argentina	fossorial	DD
Ctenomys validus	Hystricomorpha	Ctenomyidae	1977	scrubland	Argentina	fossorial	DD
Ctenomys yatesi	Hystricomorpha	Ctenomyidae	2014	scrubland	Bolivia	fossorial	NE
Ollalamys edax	Hystricomorpha	Echimyidae	1916	tropical forest	Venezuela	climber	DD

Phyllomys mantiqueirensis	Hystricomorpha	Echimyidae	2003	tropical forest	Brazil	climber	CR
Phyllomys thomasi	Hystricomorpha	Echimyidae	1897	tropical forest	Brazil	climber	EN
Phyllomys unicolor	Hystricomorpha	Echimyidae	1842	tropical forest	Brazil	climber	CR
Octodon pacificus	Hystricomorpha	Octodontidae	1994	temperate forest	Chile	cursorial	CR
Tympanoctomys aureus	Hystricomorpha	Octodontidae	2000	desert	Argentina	fossorial	CR
Tympanoctomys kirchnerorum	Hystricomorpha	Octodontidae	2014	desert	Argentina	fossorial	DD
Tympanoctomys loschalchalerosorum	Hystricomorpha	Octodontidae	2000	desert	Argentina	fossorial	CR
Santamartamys rufodorsalis	Hystricomorpha	Octodontidae	1899	tropical forest	Colombia	climber	CR

and identity of species listed may change owing to distinct reasons, in particular as result of both field and taxonomic work. As such, the list provided here is provisory and prone to change in the near future. Having said that, we expect that the general trends discussed here would remain for several years.

The species of our list are not evenly distributed among rodent families. Most belong to the family Cricetidae, a fact that it is not surprising since, in South America, this is the richest species rodent family (Patton *et al.* 2015) and by far the family were more new species are discovered (D'Elía *et al.* 2019a). Moreover, of the three cricetid subfamilies found in South America, none of the listed species belong to Neotominae nor Tylomyinae, but all to Sigmodontinae. The second family with more representatives is Ctenomyidae. No species from our list belongs to the hystricomorph families Erethizontidae, Dinomyidae, Dasyproctidae and Cuniculidae, nor the sciuriomorph Sciuridae and the supramyomorph Heteromyidae.

Amori *et al.* (2016) listed 30 South American rodent species only known from their type localities. Our list includes several restricted species described after Amori *et al.* (2016) closed their data compilation (*i. e.*, 2005), but also several geographically restricted species, such as *Akodon mystax* and *Oxymycterus caparoae*, omitted by Amori *et al.* (2016). In addition, some species listed by Amori (2016) were not included in our list. This fact is consequence of changes

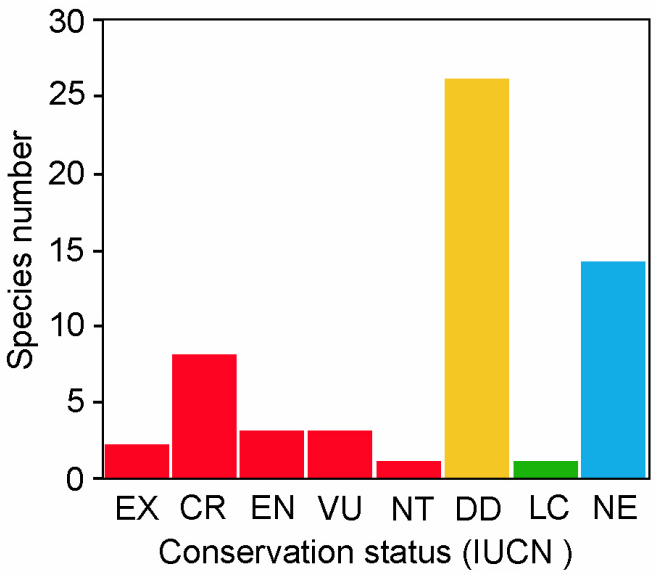

Figure 4. Number of South American rodent species according to their category in the IUCN's Red List that are only known from their type localities. Abbreviations are as follow: EX, extinct; CR, critically endangered; EN, endangered; VU, vulnerable; NT, near treathened; LC, least concern; DD, data deficient, NE, not evaluated

prompted by recent taxonomic work (*e. g.*, *Akodon aliquantulus* is now considered a synonymy of *A. caenosus*; *Juscelinomys guaporensis* is now considered a synonym for *J. huancachae*) and because known distributions have been redefined (*e. g.*, *Oecomys cleberi* is now recognized as a widely distribute species in the southern portion of the Brazilian Cerrado; Patton *et al.* 2015).

Even when our criterion for inclusion species in the list is clear, some uncertainties persist regarding some species. One of these is *Ctenomys brasiliensis*, the type species of the genus *Ctenomys*. We include it in our list indicating it comes from the Uruguayan grasslands; however, the specific collection locality of the single specimen is unknown (Bidau 2015). Traditionally, *C. brasiliensis* whose collection locality data is consigned as "des parties intérieures du Brésil, de la Province de Las Minas" has been considered as collected in Minas Gerais, Brazil. However, not specimen of *Ctenomys* is known from that Brazilian state, while the holotype of *C. brasiliensis* falls in the morphospace of *C. pearsoni*, an Uruguayan species that inhabits a general area close to the Uruguayan city of Minas (Fernandes *et al.* 2012). In addition, at the time of collection, what is now Uruguay was part of the Brazilian Empire. As such, tentatively *C. brasiliensis* is considered as an Uruguayan form whose distinction of *C. pearsoni* should be further evaluated (Bidau 2015).

The taxonomic distinction of some of the species included in the list is doubtful and, as such, their presence in our list depends on the results of future taxonomic assessments. One of such case is the leaf eared mouse *Phyllotis bonariensis*, a form geographically restricted to the hilly system of Ventania in central-eastern Argentina (Steppan and Ramírez 2015). While some authors maintained this nominal form as a distinct species (being the reason why it is included in our list), others had suggested its conspecificity with *P. xanthopygus*, a species widely distributed in western South America, from Peru to Argentina and Chile (*e. g.*, Teta *et al.* 2018). Another example is that of the vizcacha *Lagostomus crassus*, that may represent an extinct Peruvian population of *L. maximus* (Spotorno and Patton 2015). As an extreme case, it is possibly that the three supposedly endemic species of *Brucepattersonius* from Argentina (*B. guarani*, *B. misionensis*, and *B. paradisus*) could be considered as synonym of *B. iheringi*, a taxon currently distributed in forested areas of southern Brazil (Lanzone *et al.* 2018).

Several reasons could interplay to cause the rarity and/or the absence of recent records for some rodent species;

some of them would be ultimately because of the lack of enough work and others are derived from biological attributes of the species (Amori *et al.* 2016; Meiri *et al.* 2017). For those recently described taxa, rarity could be an artifact of the lack of knowledge, as perhaps not enough time has elapsed for researchers to study them, including their distributional ranges (Meiri *et al.* 2017). If additional fieldwork is conducted, is likely that the known distribution of some species would be enlarged. For example, the fish-eating rat *Neusticomys mussoi* was only known from its type locality in western Venezuela since its description in 1991, being subsequently found at two additional localities in Venezuela and Colombia in 2008 and 2014, respectively (Rodríguez-Posadas 2014). A more eloquent example is that of the Kerr's Atlantic forest rat, *Phyllomys kerri*, that being described in 1950, it was not rediscovered until 68 years later (Abreu-Junior *et al.* 2018). This could be certainly the case of other species in our list, since most of them were described in the last 50 years.

As mentioned above, even when field work is conducted, some biological attributes of the species may hamper the registry of new recording localities, including the fact that some species *i*) could be difficult to observe and collect due to their size, habits (*e. g*., climber, fossorial), or for being microhabitat specialists; *ii*) could be difficult to distinguish from other species and even when specimens are collected they are misidentified; *iii*) could have low populational densities; or *iv*) could be extinct (Amori *et al.* 2016; Meiri *et al.* 2017). Most species in our list are fossorial (*e. g*., *Ctenomys*) and some of them are climber (*e. g*., *Phyllomys*), which make them more difficult to catch trough traditional trapping procedures (Patterson 2002). Two species within our list, *Juscelinomys candango* and *Lagostomus crassus*, are considered extinct by the IUCN Red List; unfortunately, this number could increase in the next years. This could be the case of the water rat *Nectomys saturatus*, which is not observed since 1897 and that has lost most of its habitat owing to growing urbanization and desiccation of the meadows at its type locality (Chiquito and Percequillo 2019).

Most species in our list are found at or close to the Andes, including both forested and desert regions. Thus at least partially, the rarity of some of them could be related to the relative inaccessibility of medium to high altitude Andean areas. This could be the case of the mice of the genus *Thomasomys*, which in addition includes several species that easily confound among them (Pacheco 2015). Montane areas are usually complex geographical systems, in which speciation and microendemism are promoted by physical barriers and vertical succession of habitats (Maestri and Patterson 2016). This could be also the case of the Serra do Mar, in southeastern Brazil, which is included, together with the western Andean ranges, within the high richness areas for rodents in South America (Maestri and Patterson 2016).

At least four species in our list are island endemics; these are *Cavia intermedia* from Moleques do Sul Islands (Santa Catarina, Brazil; Cherem *et al.* 1999), *Geoxus lafkenche* from Guafo Island (Los Lagos, Chile; Teta and D'Elía 2017), *Octodon pacificus* from Mocha Island (Bio Bio, Chile; Hutterer 1994), and *Phyllomys thomasi* from Ilha de São Sebastião (Sao Paulo, Brazil; Emmons *et al.* 2002). Frequently, island endemics are more threatened than their continental counterparts owing to their usually smaller distributions, as well as facing habitat loss and introduction of alien species (Amori and Clout 2003). The four island endemics identified here fall in this trend; the tree of them that have been categorized by the IUCN are listed as CR (*Cavia intermedia* and *Octodon pacificus*) and EN (*Phyllomys thomasi*). We note that none of the endemic oryzomyine species from Galapagos Islands have distributional ranges restricted to their type localities, at least as is here defined; however, all of them occupies small geographical ranges, and are considered as VU (*Aegialomys galapagoensis*, *Nesoryzomys fernandinae*, *N. narboroughi*, *N. swarthi*) or even EX (*N. darwini*, *N. indefessus*).

As in previous contributions focused on geographically restricted taxa, most species in our list are considered as DD in the IUCN Red List (Figure 4), even when the use of this category is explicitly discouraged by the IUCN (IUCN 2017). Amori *et al.* (2016) suggested that this situation reflects a bias produced by the heterogeneity of assessors of the IUCN and the generalized assumption among researchers that extremely rare species are the consequence of suboptimal research efforts rather other causes. This situation is not exempt of consequences; species listed as DD usually do not gain much attention (*i. e*., conservation programs, founds) as those considered as CR, EN or VU (Amori *et al.* 2016). Almost one fourth of the species in our survey are included under one of the highest three categories of threat defined by the Red List (*e. g*., CR, EN, VU). Remarkably, there are more caviomorph than sigmodontine rodents on that list, perhaps because vizachas, chinchilla rats, and their relatives are more charismatic than mice and rats. Amori *et al.* (2016) draw attention to the points discussed here, suggesting the need to designate as CR all species geographically restricted to their type localities, at least when there are no recent records (*i. e*., in the last 25 years).

The identification of those species with the smallest ranges is important both from an ecological and conservational perspective (Meiri *et al.* 2017). On the one hand, most of the geographically restricted species may be functionally analogous to "singletons" in ecological communities, being mostly unknown in their basic aspects of their natural history (*e. g*., diet, movements, reproduction). True narrow endemic species are also pivotal to understood biogeographical processes (Meiri *et al.* 2017). On the other hand, considering these species is crucial to develop adequate conservation strategies and to decide how to allocate finite resources (Amori *et al.* 2016). As such, the species list provided here needs to be depurated trough additional field and collection based work. Even when some species could be removed from this list, it is also possible that others could be included. We close this contribution by stating that we expect that our list and the consider-

ations expressed will help draw attention to those poorly known South American rodent species, triggering the desire to conduct research on them. Also, we expect that authorities and agencies granting funds and authorizations to conduct field work understand the importance of this activity towards a better knowledge on these species and ultimately towards their conservation (see Thomson *et al.* 2018 and D'Elía *et al.* 2019b).

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