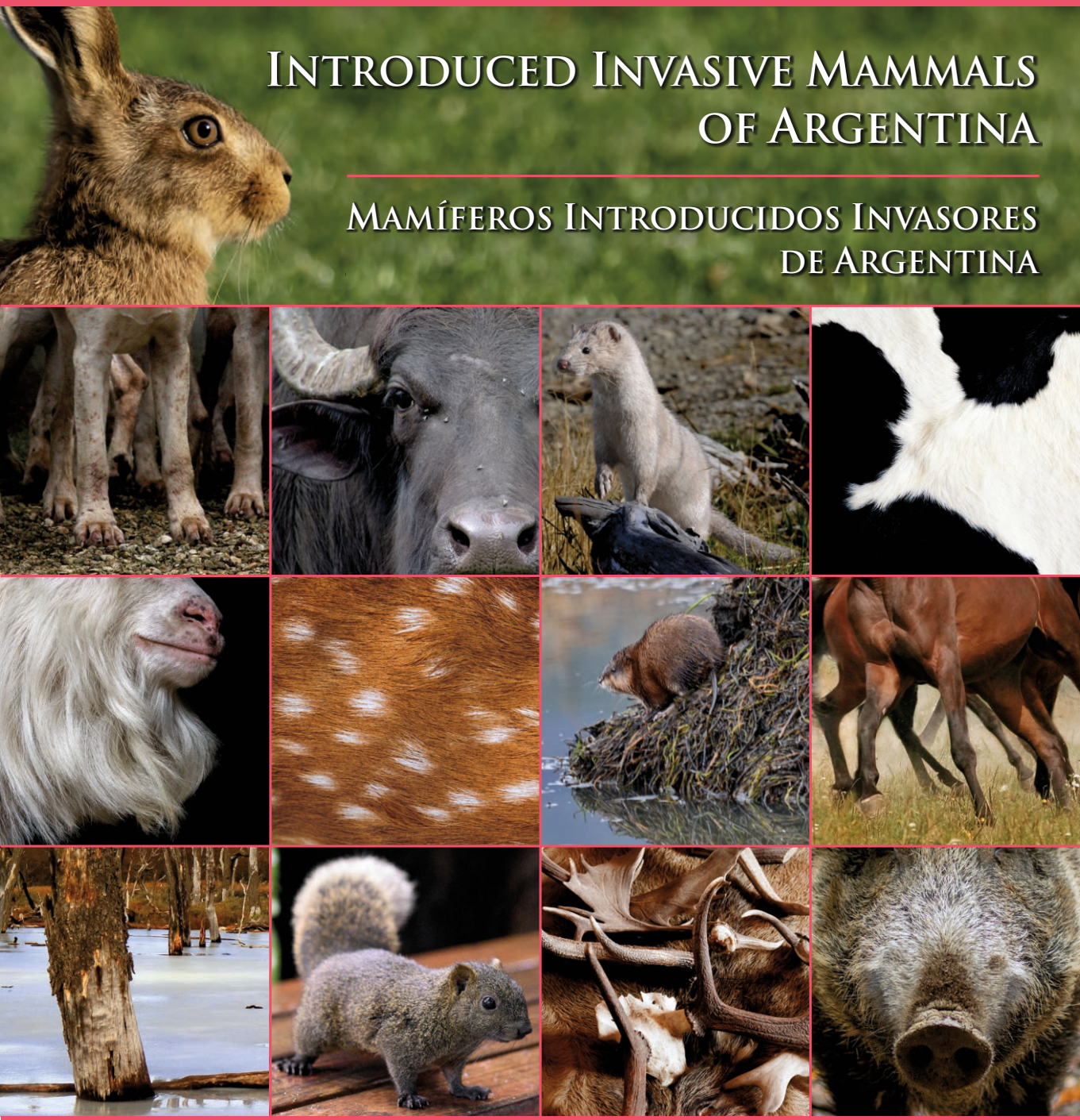
SAREM Series A
Mammalogical Research
Investigaciones Mastozoológicas

Volume 3

Introduced Invasive Mammals of Argentina

Mamíferos Introducidos Invasores de Argentina



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The Argentine Society for the Study of Mammals (Sociedad Argentina para el Estudio de los Mamíferos – SAREM) was created in 1983, and currently has about 300 members from several countries. SAREM is an interdisciplinary society of natural sciences professionals whose main goals are the promotion of scientific and technical research, the consolidation of national collections and research centers, and the publication and diffusion of research on living and/or extinct mammals. SAREM has organized scientific meetings for mammal researchers since 1994, publishes the journals *Mastozoología Neotropical* and *Notas sobre Mamíferos Sudamericanos*, and has edited books on the systematics, distribution and conservation of the mammals of southern South America, including *Libro Rojo de los mamíferos amenazados de la Argentina* (first ed. 2000, second ed. 2012) and *Mamíferos de Argentina. Sistemática y distribución* (2006), as well as contributing to the *Libro Rojo de los mamíferos y aves amenazados de la Argentina* (currently out of print).

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Introduced Invasive Mammals of Argentina

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Introduced invasive species are a major driver of local to global environmental change, including important negative impacts on biodiversity, ecosystem processes, economies, health and other social values. At the same time, however, different social actors can hold diverse representations of these species, particularly of introduced invasive mammals (IIMs). Such divergent values and perceptions can lead to conflicts regarding the management of IIMs, but also invite researchers and managers to be reflexive regarding their own work at a more fundamental level. Therefore, it is key that we advance towards a holistic understanding of IIMs and develop strategies to manage them based on solid technical information and plural perspectives regarding their multiple values. Despite a rich history of initiatives in Argentina to study and manage IIMs, until now there has not been an opportunity to assess the state-of-the-art knowledge in our country. This book seeks to provide rigorous, relevant and legitimate information to support research, policymaking and management decisions regarding IIMs in Argentina. With this objective in mind, the book presents a series of chapters selected to highlight priority topics concerning the conceptualization and implementation of IIM research and management. Then, fact sheets are provided for the different IIMs found in Argentina. Finally, beyond the realm of academic inquiry, the timing of this publication is ideal to re-enforce policy and decision-making, such as the recently approved National Invasive Exotic Species Strategy, which seeks to implement actions and enhance institutional capacities related to invasive species management in Argentina, and the Convention on Biological Diversity's new Global Biodiversity Framework, which also addresses biological invasions as part of broader efforts to attain the 2050 Vision for Living in Harmony with Nature.

Dr. Alejandro E.J. Valenzuela
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Editors, Vol. III SAREM Series A

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Foreword

Biological invasions by introduced species are one of the great changes rapidly transforming the globe today, with innumerable impacts on economics, human health, ecosystem services, and biodiversity. Mammals are among the most impactful of invasive species, transmitting diseases to humans, livestock, and native animals, trampling native grasslands, voraciously devouring vegetation from groundcover to saplings of forest trees, fouling water, causing erosion, and preying on and outcompeting native animals. They were among the first species humans introduced worldwide and in Argentina, both deliberately (*e.g.*, livestock) and inadvertently (*e.g.*, rats and mice). They have been introduced for sport (*e.g.*, deer, boar) and companionship (*e.g.*, cats, dogs), or simply as attractive ornamentals (*e.g.*, squirrels). Some that are meant to be kept in captivity, such as cats, dogs, and squirrels, escape and establish feral populations.

Argentina looms large in the history of biological invasions by introduced mammals. The earliest permanent European settlers of Buenos Aires in 1580 discovered huge herds of feral horses already on the pampas, and soon after, Vázquez de Espinoza described feral horses in Tucumán that were "in such numbers that they cover the face of the earth…". Many sheep were in Tucumán as well at that time, and of course later sheep were enormously numerous in Patagonia, effecting huge changes in the vegetation and driving land degradation and desertification to this day. When Charles Darwin visited the La Plata region in 1832 during the voyage of the Beagle, he reported that "…countless herds of horses, cattle, and sheep, not only have altered the whole aspect of the vegetation, but they have almost banished the guanaco, deer and ostrich. Numberless other changes must likewise have taken place; the wild pig in some parts probably replaces the peccari; packs of wild dogs may be heard howling on the wooded banks of the less-frequented streams; and the common cat, altered into a large and fierce animal, inhabits rocky hills."

Approximately 40 mammals have been introduced to South America, of which 25–30 have established populations; most of these are in the Southern Cone. In Argentina, I count 23 successfully introduced mammal species, including feral cats, dogs, and cows. Many, such as rats, rabbits, boar, and goats, are widely distributed around the world. By contrast, the hairy armadillo has been introduced nowhere else but from the mainland of Patagonia to Tierra del Fuego Island. Strikingly, except for the rats and house mouse, all these mammals were brought to Argentina deliberately; this is very different from, say, introduced insects. A few of these invasive mammals, like the squirrel, were not intended to be released, but I hesitate to term such invaders truly "accidental," because the people who brought them should have realized that escapes or later releases were almost inevitable. Of course, almost all of these mammals were introduced before the late twentieth century, which was when most scientists and the public began to recognize the extent and importance of impacts of introduced species. However, the squirrel and armadillo introductions were recent enough that potential impacts should have been foreseen. Things could be worse, of course—mammals deliberately brought to Argentina that either were released, but did not establish persistent populations or have not yet escaped from hunting preserves include reindeer, silver fox, mule deer, African buffalo, white-tailed deer, Père David's deer, thar, barbary sheep, wisent, mouflon, chamois, and ibex.

The technology of eradicating introduced invasive mammals has made enormous strides in the last thirty years—at least 31 mammal species have been eradicated from islands worldwide, including relatively large islands like South Georgia. Both Norway and ship rats have been eradicated hundreds of times, and house mice about 100 times. Most large mammals, such as deer and horses, are technologically easier eradication targets—many can simply be tracked and shot, for instance. However, mammals more than any other introduced species pose the complication that many people—especially hunters—simply do not want to eradicate them, and many animal welfare advocates, even those recognizing the damage some invaders cause, object to eradicating them by the only currently feasible means—killing them, humanely if possible. Even rat eradication has been impeded on animal rights/animal welfare grounds, and free-ranging dog and cat populations frequently are seen more as animal welfare issues than as conservation problems to broad sectors of some societies. In Argentina, the problem of implementing feasible eradication programs for invasive mammals is epitomized by the rather schizophrenic attitude taken by the National Parks Administration (Administración de Parques Nacionales – APN) towards red deer. The APN's conservation imperative is supported by the section of Law #22,351 that forbids propagating introduced animals, yet red deer, known to damage native species and ecosystems, are managed in Lanín National Park to foster ongoing hunting, and even to improve the size and quality of the deer for better hunting trophies. Additionally, there is often inconsistent and inadequate funding for managing and eradicating invasive mammals in protected areas, almost always constituting a supervening impediment even when a rational and effective goal is stated.

Argentine scientists have participated heavily in the rapid growth of modern invasion science since its inception in the 1980s, and they and overseas colleagues have conducted substantial research on the biology and impacts of many of the introduced invasive mammals in Argentina, as well as other invasive species. Some of the threats posed by these mammals have even become widely known to the general public in Argentina and beyond—the spread of the beaver from Tierra del Fuego to the mainland has been an international news story. *Introduced Invasive Mammals of Argentina* is therefore an exciting and timely addition to the literature on invasions in southern South America for both the Argentine public (and its political representatives and environmental managers) and scientists worldwide. The many authors assembled for this book explore how these biological invasions happened in the first place, how they spread, what they do to biodiversity, ecosystems, and human enterprises, what has been done about them so far, what can be done about them now, and what might be done with them in the future. The editors and authors are to be congratulated for an excellent exposition of the Argentine part of a growing global phenomenon.

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Rodentia: Muridae
commensal rodents, roedores comensales

Mus musculus
house mouse, ratón doméstico

Rattus norvegicus
Norway rat, rata parda o noruega

Rattus rattus
black rat, rata negra o de los tejados

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Resumen. *Mus musculus*, *Rattus norvegicus* y *R. rattus* son roedores invasores de la familia Muridae y se encuentran entre las especies invasoras más importantes del mundo. Estas especies son originarias de Asia y Europa y se han expandido siguiendo al hombre, teniendo actualmente una distribución cosmopolita. Su introducción en nuestro país fue accidental y ocurrió en sucesivos momentos desde la colonización europea como polizón en los barcos, aunque se cree que *R. rattus* habitaba el Nuevo Mundo antes de la llegada de los españoles, posiblemente acompañando las distintas corrientes de asiáticos que llegaron a América. Su alimentación es omnívora y tienen hábitos principalmente nocturnos. Habitan una gran variedad de ambientes, especialmente en estrecha relación con el hombre (comensal), prefiriendo sus viviendas, comercios, industrias y granjas de cría de animales a los ambientes naturales o cultivos. *R. norvegicus* y *R. rattus* también forman colonias en ambientes naturales como en el archipiélago fueguino e Islas Malvinas, donde afectan la fauna nativa. Su actividad reproductiva depende de las condiciones ambientales; en climas templados pueden reproducirse durante todo el año y en climas rigurosos son marcadamente estacionales, con un máximo reproductivo en los meses estivales. Estos roedores producen daños estructurales, consumen y contaminan el alimento, provocando pérdidas productivas, y hospedan y dispersan agentes patógenos. En Argentina se los ha encontrado portando los agentes de la triquinosis, teniasis, rodentolepiasis, criptosporidiosis, toxoplasmosis, leptospirosis, salmonelosis, coriomeningitis linfocitaria y síndrome renal por hantavirus, entre otros. Debido a los daños que producen estos roedores es muy común en la actividad privada la aplicación de medidas de control, principalmente químicas y mecánicas. A nivel programático, es evidente la falta de continuidad de programas y de formación de recursos humanos capacitados, transformándose esto en parte del problema.

Mus musculus, Schwarz and Schwarz, 1953

Familia Muridae Illiger, 1815
Subfamilia Murinae Illiger, 1815
Género *Mus* Linnaeus, 1766

General description of the species

This species has a small, thin body; a small, slightly pointed snout; small black protruding eyes; moderately large, round ears; relatively short legs; and a dark, almost hairless tail with scales distributed like rings (Fig. 1). The tail length is about the same as the body and head length together. The hair is short, soft, and glossy. The back is light brown with ocher dyes to dark grey-brown. The belly fur is lighter. It has five pairs of teats (one pectoral, two postaxillary and two inguinal). The total adult length ranges from 148 to 205 mm; the body-head is 65 to 90 mm; the body is 69 to 85 mm; and the hind foot is 16 to 20 mm. The mouse's weight is 11 to 30 g. This rodent has a dental formula of 1/1 0/0 0/0 3/3. It is omnivorous, but prefers grains and seeds.

Figure 1. *Mus musculus*. (Photo: Gerardo Cueto).

The average life expectancy is about one year. Reproductive strategies change according to environmental characteristics. In temperate rural environments, it reproduces throughout the year with peaks in spring and summer (Gómez *et al.*, 2008; Vadell *et al.*, 2010; León *et al.*, 2013; Vadell *et al.*, 2014). It is reproductively active at 6-to-10-weeks of age. Five to six young are born after 19–21 days of gestation (Timm, 1994a; Vadell *et al.*, 2014). They have postpartum estrous. The population can grow rapidly when the climatic conditions are favorable, but survival and reproduction of young individuals declines when abundance is high.

This species is nocturnal, but it can have diurnal activity, not necessarily associated to a high abundance. It climbs, jumps and swims well, and it enters buildings by gnawing through materials.

It builds burrows in the soil or under wood floors when other places are not available (Timm, 1994a).

The nests are sloppy, and they look like a ball of 10 to 15 cm in diameter. Mice inhabit a great variety of environments. This species is closely associated with humans (*i.e.*, is commensal), preferring houses and other dwellings, commercial buildings, and farms over natural environments and croplands (León *et al.*, 2013; Lovera *et. al.*, 2019). Mice are also common in shanty towns and urban vacant lots where there is a lack of public sanitation services (Cavia *et al.*, 2009; Gomez *et al.*, 2009; Cavia *et al.*, 2015).

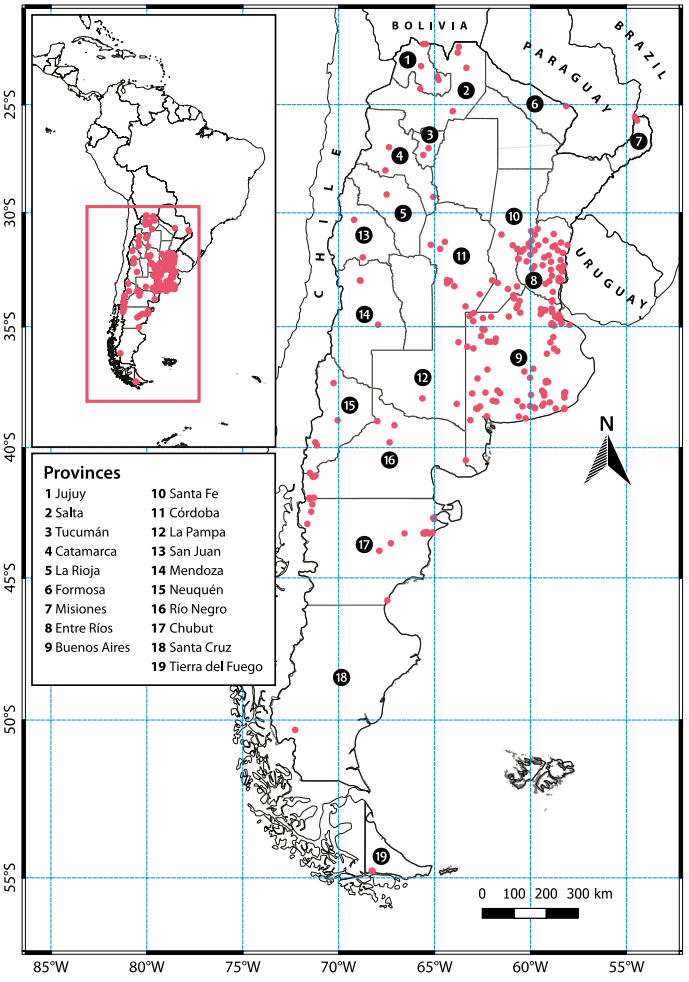

Figure 2. Distribution of *Mus musculus* in Argentina. Modified from Cavia *et al.* (2019a). (Mapping: Ian Barbe and Alfredo Claverie).

History of the invasion

Original from Central Asia, the house mouse introduction in Argentina was accidental and probably occurred multiple times since European colonization. It is among the most detrimental invasive species in the world together with *Rattus norvegicus* and *R. rattus* (Lizarralde, 2016).

Patterns of expansion and current distribution

Mus musculus has been accidentally spread by humans, having today a worldwide distribution (Fig. 2).

Impacts

House mice damage structural, components and equipment buildings, and they consume and contaminate animal and human food, promoting production loss and spread of diseases and ectoparasites (Timm, 1987; Timm, 1994a; Pratt, 1991; Villa and Velasco, 1994).

This species is involved in the transmission of the pathogen agents of teniasis, trichinosis, babesiosis, rodentolepiasis, capillariasis, brachylatmiasis, cryptosporidiosis, chagas, leptospirosis, salmonellosis, campylobacteriosis, rat-bite fever, hemolytic uremic syndrome, cholera, hepatitis, typhoid fever, toxoplasma, cowpox and lymphocytic choriomeningitis to human and livestock (Meerburg *et al.*, 2009; Gürtler and Cardinal, 2015; Cavia *et al.*, 2019a). It is also involved in the transmission of bubonic plague, murine typhus, scrub typhus and vesicular rickettsiosis, transmitted by their ectoparasites (mites, fleas and lice; Meerburg *et al.*, 2009; Bitam *et al.*, 2010; Eisen and Gager, 2012; Lareschi *et al.*, 2016). In Argentina, mice have been found that were infected by various pathogenic agents, including taeniasis, trichinosis, rodentolepiasis, toxoplasma, cryptosporidiosis, leptospirosis and the virus of lymphocytic choriomeningitis (Castillo *et al.*, 2003; Lovera *et al.*, 2017; Hancke and Suárez, 2017, 2018a, 2018b; Fitte *et al.*, 2021).

Management

Due the magnitude of damage *Mus musculus* and other rat species (*Rattus norvegicus* and *R. rattus*) cause to in farming activities (*i.e.*, in cereal storage silos, livestock production, meat industry, food industry, fruit and vegetable markets), extensive management actions have been implemented. Nevertheless, potential contamination of livestock with pathogens of rodents is not yet seen as a problem by farmers (Meerburg, 2010). Mechanical and chemical control measures are the most common methods, which are implemented in various ways. At the institutional level, a lack of program continuity, technical skills and training have been linked to problems in effectively managing rodent problems (Coto, 2015). Some areas have or have had rodent prevention and control programs, such as the Ciudad Autónoma de Buenos Aires and Río Cuarto. Also, in Argentina, rodents are prohibited in pig farms since they are involved in the transmission of *Trichinella spiralis* (see SENASA resolutions #834-2002, #555-2006, #819/2011 in http://www.senasa.gob.ar/normativas).

Figure 3. *Rattus norvegicus*. (Photo: Gustavo Ramos).

Rattus norvegicus, Berkenhout, 1758

Familia	Muridae Illiger, 1815
Subfamilia	Murinae Illiger, 1815
Género	*Rattus* Fischer, 1803

General description of the species

Norway rats have a thick, flat and heavy body (more robust than that of *R. rattus*) and strong legs. Their head is flat and has an obtuse snout. Their eyes are small, and it has small, rounded, almost bare ears. The tail is shorter than the body and head length together. The rings of scales are less marked than in *R. rattus.* Short and stiff fur, but not as rigid as *R. rattus*. The color of the dorsal fur is grey–brown to brown interspersed with black hairs (Fig. 3). Belly fur is pale gray or pale brown. Six pairs of teats (one pectoral, two postaxillary and three inguinal).

The total adult length can range from 320 to 480 mm; the body-head is 150 to 225 mm; the body is 130 to 215 mm; and the hind foot is 37 to 44 mm. The Norway rat weighs from 300 to 500 g. This rodent has a dental formula of 1/1 0/0 0/0 3/3. It is omnivorous, preferring cereals, meat, fish meat and garbage. It especially seeks high fat foods. It needs daily between 20 to 30 g of food and about 30 ml of water.

The average life expectancy is one year. Reproductive strategies change according to environmental conditions (Vadell *et al.*, 2014). In sylvan areas, where animals are more exposed to seasonal changes in weather conditions, changes in reproductive investment are more evident than in rural or urban areas. In temperate climates, it reproduces throughout

the year with peaks in spring and summer. Six to twelve young are born after 21 to 23 days of gestation. It can be sexually mature at the age of three to five months.

This species is nocturnal, but high abundances can lead it to also present diurnal activity. Rats typically construct nests in below-ground burrows, but also at ground level or with different materials.

It has poor eyesight, but their senses of smell, taste and touch are well-developed.

It is not a good climber, moving principally at ground level (being more terrestrial than *R. rattus*). It is good at swimming, jumping and gaining entry to structures by gnawing (Timm, 1994b). Its home range is about 36 m in diameter (range from 4 to 45 m in diameter; Timm, 1994b; Gómez Villafañe *et al.*, 2008a; Montes de Oca *et al.*, 2017). It can travel farther than 100 m to obtain food or water.

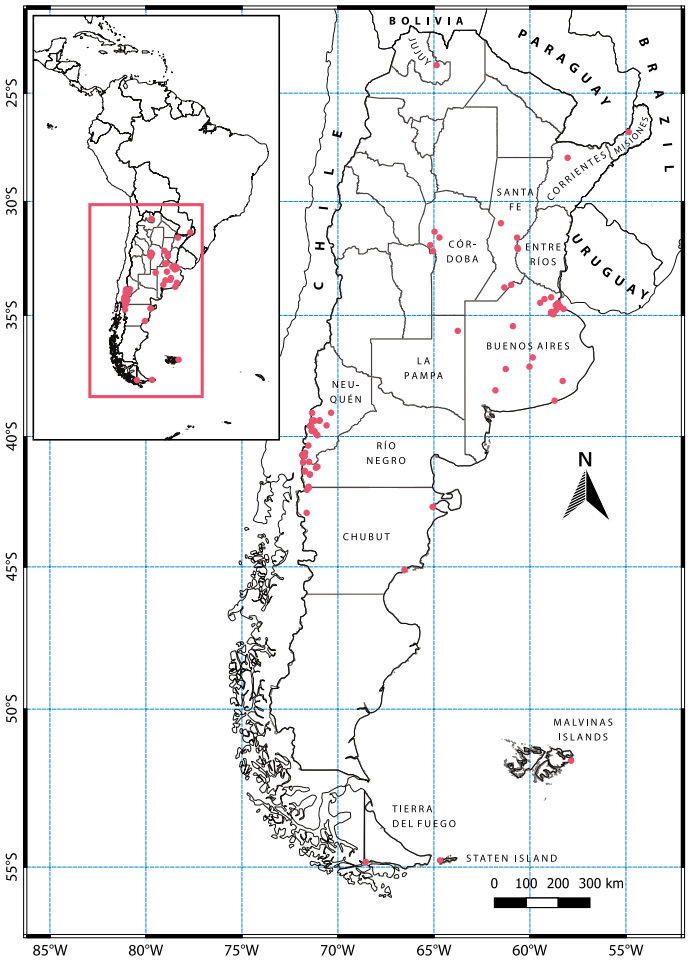

Figure 4. Distribution of *Rattus norvegicus* in Argentina. It also occurs in the South Georgia Islands. Modified from Cavia *et al.* (2019b). (Mapping: Ian Barbe and Alfredo Claverie).

It inhabits a great variety of environments. This species reaches the highest abundances in urban, periurban and rural ecosystems. In this last area, it is associated with livestock production (Coto, 2015; Gómez Villafañe and Busch, 2007; Lovera *et al.*, 2015; Montes de Oca *et al.*, 2020). In urban areas, it prefers sites like garbage dumps, sewer systems and river and channel banks; usually related to socioeconomic conditions differences within the urban areas (Castillo *et al.*, 2003; Traweger *et al.*, 2006; Cavia *et al.*, 2009; Masi *et al.*, 2010; Feng and Himsworth, 2014). These sites provide food and water resources and would provide suitable conditions for the construction of ground burrows. In the Ciudad Autónoma de Buenos Aires, captures occurred in different environments and the highest abundances were registered in shanty towns (Cavia *et al.*, 2009; Cavia *et al.*, 2015), and in Río Cuarto it was only captured along stream and railway banks (Castillo *et al.*, 2003). However, it also can live in natural environments, such as in the Fuegian Archipelago and the Malvinas Islands (Hilton and Cuthbert, 2010; Coto, 2015).

History of the invasion

The Norway rat had its origin in the East, probably in Mongolian China or Russia. In the 18th century it arrived to Europe and by 1775 was in the United States, being brought aboard merchant ships (Coto, 1997). Its introduction in Argentina was accidental and occurred probably in successive times since European colonization. Between 1899 and 1913 bubonic plague, associated to the presence of rats (although species was not specified), was reported in many Argentine cities, such as Tucumán in 1900, Córdoba in 1907, and Bahía Blanca in 1913.

Patterns of expansion and current distribution

Today, this species has a worldwide distribution, principally associated to human activities. But also, it has dispersed to natural environments of the Fuegian Archipelago, Malvinas Islands and South Georgia Islands, living in sylvan colonies. In Argentina, there are many provinces without published data or collected specimens (Fig. 4). The lack of interest by museums to collect this common pest species and differential characters in the jaws with *R. rattus* may contribute to this lack of data. Records from raptor pellets are mostly published as *Rattus* spp.

Impacts

R. norvegicus produces damage to crops; preys upon poultry and other animals; consumes and contaminates stored food and animal feed (Timm 1994b; Brown *et al.*, 2020); causes damage to leather and packaging materials, among others; and causes structural damage to buildings, ships, and furniture (Timm 1994b).

Its accidental introduction on many islands around the world has had significantly negative impacts on native species (Hilton and Cuthbert, 2010). It preys on nests causing the extinction of endemic island bird species. On isolated environments like Staten Island, and

South Georgias and Malvinas Islands, several bird species are under its hunting pressure (Massoia and Chebez, 1993; Catry *et al.*, 2007; Hilton and Cuthbert, 2010).

Worldwide, *R. norvegicus* is involved in the transmission to human and livestock of the pathogen agents of teniasis, trichinosis, babesiosis, rodentolepiasis, schistosomiasis, capillariasis, brachylatmiasis, cryptosporidiosis, chagas, leptospirosis, salmonellosis, campylobacteriosis, rat-bite fever, hemolytic uremic syndrome, Q-fever, cholera, hepatitis, typhoid fever, toxoplasma, cowpox, hepatitis E, swine fever, and hemorrhagic fever with renal syndrome (Meerburg *et al.*, 2009; Himsworth *et al.*, 2013; Gürtler and Cardinal, 2015; Cavia *et al.*, 2019b). It is also involved in the transmission of bubonic plague, murine tifus, Lyme disease, scrub typhus and vesicular rickettsiosis, transmitted by their ectoparasites (mites, fleas and lice; Meerburg *et al.*, 2009; Bitam *et al.*, 2010; Eisen and Gager, 2012; Lareschi *et al.*, 2016). Particularly in Argentina, it was found infected by the pathogen agents of the taeniasis, trichinosis, rodentolepiasis, capillariasis, toxoplasma, cryptosporidiosis, leptospirosis and haemorrhagic fever with renal syndrome (Arango *et al.*, 2001; Seijo *et al.*, 2003; Cueto *et al.*, 2008; Gómez Villafañe *et al.*, 2008b; Hancke *et al.*, 2011; Lovera *et al.*, 2017; Hancke and Suárez, 2018a, 2018b, 2020, 2022; Fitte *et al.*, 2021).

Management

See management programs in *M. musculus*.

Rattus rattus, Linnaeus, 1758

Familia Muridae Illiger, 1815
Subfamilia Murinae Illiger, 1815
Género *Rattus* Fischer, 1803

General description of the species

Smaller than the Norway rat, the black rat is slim and has a light body. It has big eyes, an extended head and pointed snout. Its conspicuous, big ears are almost hairless. Ears can be pulled to the eyes covering them completely. Its incisors have orange enamel. Its legs are agile and have slim thighs. The tail has conspicuous rings and is longer than the head and body length together (larger proportions compared to the Norway rat). The tail is almost hairless. Overall, it has rough and hard fur. Its dorsal fur is moderately spiny, while long, black guard hairs along the back are characteristics of this species (Fig. 5). Highly variable in color, the dorsal zone is usually grey-brown to greyish or black. The belly fur is more pale than the dorsal, but also variable in color. The species has a variable mammary formula with five or six pairs of teats (one pectoral, one or two postaxillary and three inguinal). The total adult length ranges 327 to 430 mm, the body-head is 166 to 205 mm, the body is 190 to 215 mm and the hind foot is 35.5 mm. The weight is 120 to 350 g. This rodent has a dental formula of 1/1 0/0 0/0 3/3. It is omnivorous, preferring vegetables, fruits, and cereals. It is more herbivorous than the Norway rat. It is resistant to the lack of water.

Reproductive activity depends on environmental conditions. In temperate climates, it may reproduce year-round, but with activity peaking in the spring and fall and declining in the winter. In rigorous climate conditions, reproduction is markedly seasonal with peaks in spring and fall, declining in summer and with a reproduction break in winter (Coto, 1997). Six to twelve young are born after 21 to 23 days of gestation. It can be sexually mature at the age of three to five months.

Figure 5. *Rattus rattus*. (Photo: Isabel Gómez Villafañe).

This species is nocturnal, but with high abundances it can present diurnal activity. It often makes nests in high and inaccessible places like in tree crowns and trunks, inside walls, attics, and ceilings, or on climber and creeper plants (Marsh, 1994). It builds its nests with different materials like plastic bags, paper, fabrics, threads, straws, and sawdust. It is less aggressive than the Norway rat. It is an agile climber. It is also good at jumping, swimming (but not as good as Norway rat) and it gains entry into buildings by gnawing. Its home range is about 30 to 45 m in diameter. If necessary, it can travel distances of 90 m for food (Marsh, 1994).

It inhabits mainly the residential or industrial areas of cites like the Ciudad Autónoma de Buenos Aires (Cavia *et al.*, 2009), and in a variety of environments of Río Cuarto, including in riverbanks and streams (Castillo *et al.*, 2003). In rural areas, black rats often occupied sugarcane fields and citrus groves and are less frequent in rice fields or livestock farms (Gómez Villafañe *et al.*, 2005; Lovera *et al.*, 2015; Montes de Oca *et al.*, 2020).

History of the invasion

The specific origin of the black rat is uncertain. This pest arrived to the Americas at the middle of the 18th century, but rats inhabited this continent before European colonization, dispersed by successive Asian migrant populations (Coto, 1997).

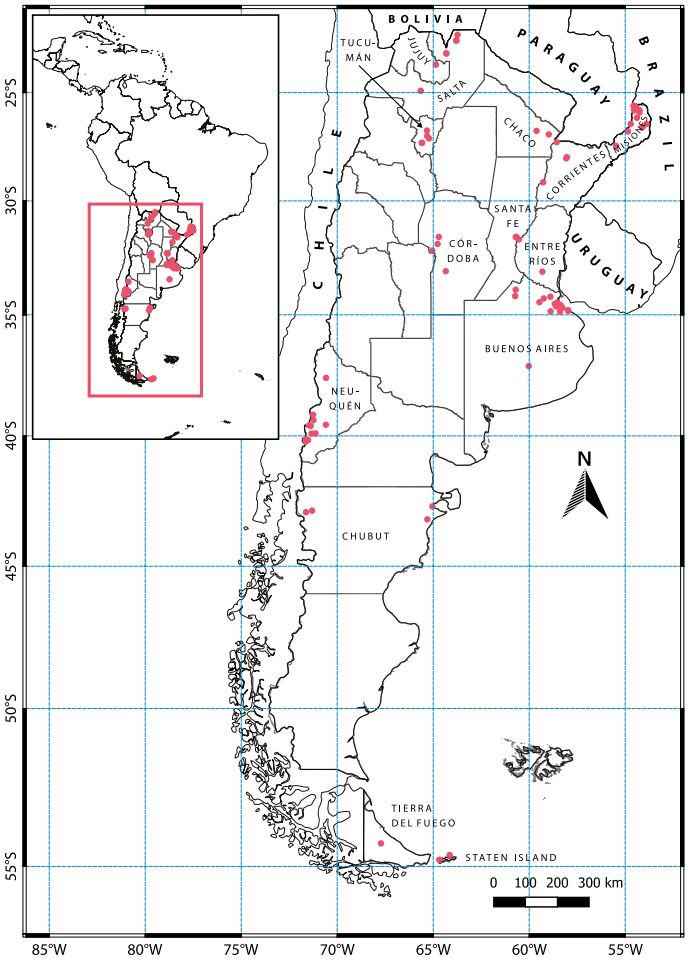

Figure 6. Distribution of *Rattus rattus* in Argentina. Modified from Cavia *et al.* (2019c). (Mapping: Ian Barbe and Alfredo Claverie).

Patterns of expansion and current distribution

This species has today a worldwide distribution, principally associated to human activities. It does not inhabit cold zones. This species apparently has not been spread on sylvan environments of the Fuegian Archipelago like Norway rats, being limited to human constructions (Coto, 2015), but it does also inhabit the Malvinas Islands (Catry *et al.*, 2007). Like *R. norvegicus*, there are many Argentine provinces without published data or collected specimens of this species (Fig. 6), probably due to the same reasons as *R. norvegicus*.

Impacts

Similar to *R. norvegicus*, the black rat can produce damage to crops; prey on poultry and other animals; consume and contaminate storage food and animal feed; cause damage to leathers and packaging materials among others; and cause structural damage to buildings, ships and furniture (Marsh, 1994; Brown et al., 2020).

Its introduction on islands also has negative impacts on native species and ecosystems, with greater negative impacts than *R. norvegicus* and *M. musculus* (Hall *et al.*, 2001; Harris, 2009; Mulder *et al.*, 2009).

Worldwide, *R. rattus* is involved in the transmission to humans of various pathogen agents (*e.g.*, taeniasis, trichinosis, babesiosis, rodentolepiasis, schistosomiasis, human fasciolosis, capillariasis, brachylatmiasis, cryptosporidiosis, chagas, leishmaniasis, leptospirosis, salmonellosis, rat-bite fever, Q-fever, cholera, typhoid fever, toxoplasma, hepatitis E, Kyasanur forest disease and haemorrhagic fever with renal syndrome) to both humans and livestock (Meerburg *et al.*, 2009; Himsworth *et al.*, 2013; Gürtler and Cardinal, 2015; Cavia *et al.*, 2019c). It is also involved in the transmission of bubonic plague, murine typhus, Lyme disease, scrub typhus and vesicular rickettsiosis, transmitted by their ectoparasites (mites, fleas and lice; Meerburg *et al.*, 2009; Bitam *et al.*, 2010; Eisen and Gager, 2012; Lareschi *et al.*, 2016). Specifically in Argentina, it was found to be infected by the following pathogenic agents: taeniasis, trichinosis, rodentolepiasis, capillariasis, toxoplasma, cryptosporidiosis, leptospirosis, and hemorrhagic fever with renal syndrome (Arango *et al.*, 2001; Cueto *et al.*, 2008; Hancke *et al.*, 2011; Lovera *et al.*, 2017; Hancke and Suárez, 2018a, 2018b, 2020, 2022; Fitte *et al.*, 2021).

Management

See management in *M. musculus*.

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