



RESEARCH ARTICLE

Predation by *Rattus norvegicus* on a native small mammal in an *Araucaria araucana* forest of Neuquén, Argentina

La depredación en pequeños mamíferos nativos por *Rattus norvegicus* en un bosque de *Araucaria araucana* en Neuquén, Argentina

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ABSTRACT

Few previous studies document *Rattus* predation as a mechanism of impact on native small mammals. In a mixed *Araucaria araucana* (Molina) Koch -*Nothofagus* forest in Parque Nacional Lanín in southwestern Neuquén Province, Argentina, we discovered the remains of long-clawed mice, *Chelemys macronyx* Thomas, cached in a burrow of *Rattus norvegicus* Berkenhout. We discuss this evidence of predation in light of *Rattus* biology and invasion ecology. Predation on native small mammals by invasive rats is easily underestimated or overlooked and deserves more careful attention.

Key words: Argentina, *Chelemys macronyx*, invasive species.

RESUMEN

Pocos estudios anteriores documentan depredación por *Rattus* como mecanismo de impacto sobre los mamíferos pequeños nativos. En un bosque mixto de *Araucaria araucana* (Molina) Koch -*Nothofagus* de Parque Nacional Lanín al suroeste de la provincia del Neuquén, Argentina, encontramos los cadáveres del ratón topo grande, *Chelemys macronyx* Thomas, almacenados en una cueva de la rata noruega, *Rattus norvegicus* Berkenhout. Discutimos esta evidencia de la depredación a la luz de la biología de *Rattus* y la ecología de invasión. La depredación en pequeños mamíferos nativos por las ratas invasoras está fácilmente subestimada o pasada por alto. Este tema merece una atención más cuidadosa.

Palabras clave: Argentina, *Chelemys macronyx*, especies invasoras.

INTRODUCTION

Managing worldwide impacts of rats (*Rattus* spp.) requires knowledge of the nature and range of their interactions in host ecosystems (Drake & Hunt 2009, Caut et al. 2009). Such interactions with native biota are fairly well known for organisms like seabirds (Townsend et al. 2006, Jones et al. 2008) and some plants (Meyer & Butaud 2009, Auld et al. 2010), but are not well documented for small mammals (Harris 2009, Traveset et al. 2009).

Rats are known to introduce disease and to displace native small mammals through competition (Harris 2009). In a review of invasive vertebrates in Chile, Jaksic (1998) listed crop losses and predation on birds as the only *Rattus* impacts. Novillo & Ojeda (2008)

added disease transmission and competition with native small mammals as additional effects in a study of exotic mammals in Argentina. Evidence for predation as a mechanism by which rats impact native small mammals is limited to the few studies that report predation on bats and rodents (Harris 2009). The scarcity of direct observations is not surprising given that most rat-small mammal predation would occur hidden from human view. In some cases, for example in rat removal studies, we might also presume only competitive interactions when predation may have contributed to a decline in numbers of native animals (Goodman 1995, Stokes et al. 2009). In spite of the dramatic impact on seabirds and some other animals, the effects of rat predation on small mammals may be overlooked because it is

poorly known, difficult to document, and has not been the focus of research.

Black and Norway rats (*R. rattus* L. and *R. norvegicus* Berkenhout) have cosmopolitan distributions because of their commensal relationship with people (Musser & Carleton 2005). In many environments, ranging from subpolar and temperate to Mediterranean and tropical, they move out from peridomestic habitats and establish feral, naturalized, populations (eg., Key et al. 1994, Goodman 1995, Lobos et al. 2005, Traveset et al. 2009, Auld et al. 2010, Stolzenburg 2011). *R. rattus* appears to be more successful in warmer and drier habitats and climates and *R. norvegicus* more successful in colder and wetter ones (Russell & Clout 2004, Harper et al. 2005, Musser & Carleton 2005). Differences in climbing ability, habitat structural complexity, spatial distribution of foods, and the presence of native or naturalized competitors can all affect the success and distribution of these species (Harper 2006, King et al. 2011).

In Argentina and Chile, the ecological literature is ambiguous about exotic rat ecology and distribution. Vázquez (2002) hypothesized that *Rattus* spp. would have little impact on forests because they are limited to peridomestic habitats in Chile. Simonetti (1983) suggested that *R. norvegicus* was a peridomestic species, but that *R. rattus* established naturalized populations. Feral populations of Norway rats exert predation pressure in the intertidal zone of central Chile (Navarette & Castilla 1993). Pearson (1995) found only *R. norvegicus* naturalized in Argentine Patagonian forests, without any evidence of *R. rattus*. A more recent study including the same author found only *R. rattus* in the same area after a massive flowering of *Chusquea culeou* Desvaux. bamboo (Sage et al. 2007). Lobos et al. (2005) found both species had invaded natural areas of Mediterranean Chile but were limited by desert, high altitude and high latitude. This literature and the global ecology of these species suggest that either one can be found naturalized in southern South America.

Disruption of small mammal communities may have wide-reaching ecosystem effects given the position of these animals in food chains, their importance in soil tillage, and their roles as both seed predators and dispersers. This may be especially important in continental

and insular forest ecosystems where large-seeded tree species are dispersed by rodents. Invasion by an exotic rodent predator has potentially important consequences that include species extinctions and changes in forest regeneration. In this note we describe evidence of predation by Norway rats (*R. norvegicus*) on a native small mammal in an *Araucaria araucana* (Molina) Koch forest in the southern Andes. What we already know about the ecology of rats suggests that this phenomenon is much more widespread than previously thought.

METHODS

From 2002 to 2008, we conducted studies of the small mammal community in a mixed forest in Parque Nacional Lanín in southwestern Neuquén Province, Argentina. In Parque Nacional Lanín exotic species constitute 15.4 % of the Park's mammals, within a Patagonian Forest Ecosystem where 23.5 % of mammals are exotics (Merino et al. 2009). The study forest is located between Chilean and Argentine immigration/customs checkpoints (1.0 and 0.5 km away respectively), on the north side of Volcán Lanín at 1200 masl (39.58088° S and 71.46461° W). *A. araucana* dominated the canopy, mixed with *Nothofagus pumilio* (Poepp. & Endl.) Krasser, *N. alpina* (Poepp. & Endl.) Oerst., and *N. antartica* (Forster) Oerst. Forest understory included shrubs, bunch grasses, trunks of fallen trees and dense patches of bamboo (*C. culeou*). No domestic livestock had access to the forest but populations of feral exotic species (Norway rats, *R. norvegicus*, wild boar, *Sus scrofa* L., red deer, *Cervus elaphus* L., and rabbits, *Oryctolagus cuniculus* L.), impact the forest and compete with native species (Shepherd & Ditgen 2005, Sanguinetti & Kitzberger 2010). *Araucaria* seed predators include the Austral Parakeet, *Enicognathus ferrugineus* Müller, exotic Norway rats, *R. norvegicus*, and three native rodent species (Shepherd et al. 2008, Shepherd & Ditgen, in press). The long-haired mouse, *Abrothrix longipilis* Waterhouse, may be an important seed dispersal agent (Shepherd & Ditgen, in press). The forest is 2 km from a peridomestic rat population in the stables and storehouses of Argentine border and park personnel.

In April 2008, we studied secondary dispersal of *A. araucana* seeds by small mammals (Shepherd & Ditgen, in press). Seeds containing small rare earth magnets were placed in front of automatic camera traps (Trailmaster TM550 PIR Monitor with TM 35-1 Canon Powershot A1 camera) in order to identify seed visitors in the photos. Dispersed seeds were located with a magnetic field locator (Schonstedt Magnetic Locator GA-52B).

In addition, between 2002 and 2008 we used camera traps and Sherman live traps in a variety of sampling and monitoring efforts that, in aggregate, provide information about the presence of rats in the forest. In 2003, 2004 and 2007, we used camera traps to monitor visitors to the *A. araucana* seed fall. In April 2007, we placed 'mixed' bait (chicken, oats, peanut butter, jelly) in front of four camera traps (six trap nights) in order to identify small mammals present, but not attracted to seed baits. We used Sherman live traps in trap lines (2002 & 2003, 120

traps and 720 trap nights each year, Shepherd & Ditgen, 2005) and 100-trap grids (2004, 1 grid, 500 trap nights; 2005-2007, 2 grids, 1000 trap nights each year) to identify and monitor small mammals in the forest during the autumn seed fall. Live traps were baited with rolled oats and ground peanuts.

RESULTS

Between 11 and 15 April 2008, a camera trap placed next to a partially decomposed *A. araucana* log (90 cm diameter) collected 34 photographs of *R. norvegicus* taking a total of 45 *A. araucana* seeds containing magnet labels. The first group of 15 seeds was removed in 17 minutes and two subsequent groups of 15 seeds were each removed in six minutes, with repeated visits one or two minutes apart. Photographs showed that a rat may take more than one seed at a time. On the morning of 16 April, we used the magnetic field locator to find a burrow system inside the adjacent log. The large burrow diameter (6-10 cm) and fresh rat feces identified it as the work of *R. norvegicus*, rather than one of the smaller native mice in our study.

The burrow entered the log at the upturned end 1.5 m from the camera trap and ran more than a meter and a half into the log on two levels. Inside the burrow, we found 47 magnets: 13 bare magnets, 13 magnets in partially-eaten seeds, 21 intact seeds containing magnets. The number of recovered magnets indicated that some of the labeled seeds had been brought from another camera trap, 70 m away, where a rat was also photographed.

A single chamber located 1.2 m into the log contained a cache of 33 seeds among dried bamboo leaves. In addition, the cache contained the partially-eaten remains of three adult long-clawed mice, *Chelemys macronyx* Thomas. Two of the carcasses were stiff with rigor mortis, but their flesh had not dried out, nor lost all of its color. In one of these, the head, forelimbs, and viscera were gone; the other had the viscera and cranium eaten. The third carcass was the freshest. It was still limp and its muscles had not lost their pink color. This body lacked only the viscera. These specimens could be identified to species from size, pelage, claws, and the remaining skull. The specimens were collected and deposited in the Museo Argentino de Ciencia Natural "Bernardino Rivadavia" in Buenos Aires.

The long-term presence of rats in the forest was confirmed with both cameras and live traps. Rats were photographed on *A. araucana* seeds the four years camera traps were used (2003, 2004, 2007, 2008). In 2007 we photographed adult rats examining, but not entering, Sherman traps baited only with oats, peanuts, and *A. araucana* seeds. In April 2007 at camera traps with mixed bait, 60 out of 64 pictures with identifiable animals were juvenile and adult rats. *R. norvegicus* was caught 3 out of 6 years in Sherman live traps with oat and peanut bait (Fall 2002: 1 juvenile, 1 adult; Fall 2004: 1 adult; Fall 2005: 1 juvenile, 1 adult).

DISCUSSION

Searching for dispersed seeds resulted in the fortuitous discovery of small mammal remains cached in a *R. norvegicus* burrow. The condition of the long-clawed mouse bodies indicated that they were prey rather than scavenged carcasses: they were fresh and in good condition except for the parts already consumed; one animal appeared to have been killed only a short time before we discovered it.

Rattus species are successful invaders partly because of a notoriously opportunistic diet, preying on native vertebrates when they are available (e.g., Major et al. 2006, Caut et al. 2008, Harris 2009). There is no reason to expect them not to eat suitable small mammals. This instance of *R. norvegicus* predation on *C. macronyx* documents their predatory role in this community.

We hypothesize that even such an opportunistic predator will have disproportionate impact on more susceptible prey species. *C. macronyx* is a heavy-bodied burrowing species that also caches *A. araucana* seeds collected from the forest floor (Shepherd & Ditgen, in press). It is likely to be more vulnerable to rat predators than more agile species in this community (e.g., *Oligoryzomys longicaudatus* Bennett, *Abrothrix* spp.). Similarly vulnerable small mammal species in this forest might include the tuco-tuco, *Ctenomys maulinus* Philippi, and the microbiotherian marsupial monito del monte, *Dromiciops gliroides* Thomas. We predict that *R. norvegicus* predation has greatest impacts on those terrestrial species that are less agile, those it encounters on shared resources,

and those with similar foraging and activity patterns. Such predictions await testing with new field studies.

R. norvegicus also competes with native species that are potential seed dispersers (Shepherd & Ditgen, in press). During an intermast year, *R. norvegicus* removed 19 % of marked seeds from the forest floor. More than two thirds of these seeds were eaten within a week. Seeds cached whole were deposited in microsites deep within burrows that would have prevented seedling establishment. *R. norvegicus* functions as a seed predator. By changing seed availability and the risk of predation for native seed handlers, these exotic rats have the potential to alter secondary seed dispersal, and patterns of regeneration of the dominant tree.

Our repeated observations of juveniles and adults suggest that Norway rats are established as a persistent feral population in our study area. In adjacent Chilean Parque Nacional Villarica, *R. norvegicus* is also known 14 km from peridomestic settings (Lobos et al. 2005). Through predation on and competition with native seed predators, Norway rats may have a pervasive negative impact in the natural communities of this area.

Previous work in Chile and Argentina (Jaksic 1998, Novillo & Ojeda 2008) reports invasive rats only as disease vectors, as predators of avian ground nesting birds, and as competitors of native small rodents. Our observation of predation on a native small mammal suggests another means of direct impact. Because it is difficult to document, the potentially great effect of rat-small mammal predation can easily be underestimated or overlooked entirely. As invasive rat populations encounter native small mammal communities throughout the world, we think it probable there are cases of selective predation to be discovered. This deserves more careful study.

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