Review of impacts of the introduced house mouse on islands in the Southern Ocean: are mice equivalent to rats?

Andrea Angel[1], Ross M. Wanless[1,2,*] and John Cooper[1,3]

*[1]CORE Initiatives, 9 Weltevreden Avenue, Rondebosch 7700, South Africa; [2]DST/NRF Centre of Excellence at the Percy FitzPatrick Institute, University of Cape Town, Rondebosch, 7701, South Africa; [3]Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch, 7701, South Africa; *Author for correspondence (e-mail: ross.wanless@uct.ac.za, tel: +27 21 650 3290, fax: +27 21 650 3295)*

Abstract

Research on the impacts of house mice *Mus musculus* introduced to islands is patchy across most of the species' global range. However, the islands of the Southern Ocean have been unusually well studied. Here we review mouse impacts on Southern Ocean islands' plants, invertebrates, land birds and seabirds, and describe the kinds of effects that can be expected in other island systems where similar studies are few or lacking. A key finding is that where mice occur as part of a complex of invasive mammals, especially other rodents, their densities appear to be suppressed and rat-like impacts have not been reported. Where mice are the only introduced mammal, a greater range of native biota is impacted and the impacts are most severe, and include the only examples of predation on seabird eggs and chicks. Thus mice can have devastating, irreversible and ecosystem-changing effects on islands, impacts typically associated with introduced rats *Rattus* spp. Island restoration projects should routinely include mouse eradication or manage mouse impacts.

Key words: House mouse *Mus musculus*, introduced mammals, islands, Southern Ocean, invasive alien species

Rattus exulans and the Catastrophic Disappearance of Hawai‘i’s Native Lowland Forest

by
J. Stephen Athens
International Archaeological Research Institute, Inc.
2081 Young St.
Honolulu, Hawai‘i 96826
tel.: (808) 946 2548 ext. 104
e-mail: <JSAthens@iarii.org>
manuscript prepared for:
Biological Invasions
December 2, 2007

ABSTRACT
Paleoenvironmental and archaeological investigations from the ‘Ewa Plain of O‘ahu provide insight into the problem of understanding lowland native forest loss in Hawai‘i. The data, from pollen analysis of a pond core record, avian paleontology, and archaeology, document a precipitous decline of the native forest starting *before* Polynesian settlement on the ‘Ewa Plain but after Polynesian colonization of O‘ahu. It is hypothesized that rats, introduced by Polynesian colonizers, increased exponentially in the absence of significant predators or competitors, feeding on a largely endemic vegetation that had evolved in the absence of mammalian predators. The rats radiated ahead of human colonizers on O‘ahu, eating their way through the vegetation probably before the colonizers had encountered much of the pristine lowland forest into which the rats had radiated. This hypothesis is supported by several observations, including the almost complete absence of extinct or extirpated avian faunal remains in archaeological deposits, the present distribution of endemic vegetation in Hawai‘i, rat ecology, population biology, and other evidence.

Key Words: Hawai‘i, prehistoric rats, paleoenvironment, endemic vegetation, forest loss, avian extinctions

The rat and the octopus: initial human colonization and the prehistoric introduction of domestic animals to Remote Oceania

Atholl Anderson

Department of Archaeology and Natural History, Research School of Pacific and Asian Studies, Australian National University, Canberra ACT 0200, Australia (email: atholl.anderson@anu.edu.au)

Key words: prehistoric colonization, Pacific islands, faunal introduction, invasion biology, seafaring, pig, dog, rat, chicken

Abstract

Remote Oceania was colonized initially in three migratory phases: **the western archipelagos of Micronesia plus eastern Melanesia** out to west Polynesia in the period 3500-2800 cal BP (all dates hereafter are cal BP), central and eastern Micronesia 2200-2000 BP and east and south Polynesia 1100-700 BP. The early and late migration phases are best-known archaeologically. During these phases a number of plants and animals were introduced. Of the latter, the pig (*Sus scrofa*), dog (*Canis familiaris*), fowl or chicken (*Gallus gallus*) and rats (*Rattus* spp., especially *R. exulans*) were most deliberately associated with human settlement. The pattern of introductions appears to be only partly in agreement with an implication of widespread early distribution derived from the orthodox colonisation model of 'transported landscape' coupled with sophisticated seafaring. Within the two main migrations the pattern of introductions is similar. Excepting in the movement to West Micronesia, all four taxa were transported into the islands nearest their proximate sources at, or soon after, the beginning of migration, but their introduction to more remote islands was partial and patchy. Evaluation of invasibility, invasiveness and transportability characteristics amongst the four taxa suggest that island size and complexity, propagule pressure and seafaring capability were important factors in differential distribution and survival. Seafaring capability was especially important because it determined the extent of accessibility to islands near and far and the degree of propagule or introduction pressure that was exerted. Framing the archaeological data within a model of invasion biology offers a richer and more systematic approach to the complexities of introduction than adopting a culture-historical perspective.

Avoiding surprise effects on Surprise Island: alien species control in a multi-trophic level perspective

Stéphane Caut*, Elena Angulo & Franck Courchamp

Laboratoire d'Ecologie, Systématique & Evolution, UMR CNRS 8079, Bât. 362, Univ Paris Sud, 91405 Orsay Cedex, France. Tel : (33) 169155688, Fax : (33) 169155696.

*Corresponding authors : stephane.caut@u-psud.fr, franck.courchamp@u-psud.fr

Abstract

Successful eradications of invasive alien species have generally benefited biological diversity. However, there is also evidence that, without sufficient planning, successful eradications can have unexpected and unwanted consequences on native species and ecosystems. In particular, the "surprise effect" is the rapid increase of hitherto unnoticed species following the sudden removal of an invasive alien that was exerting an ecological force on those species (predation, competition or herbivory for example). The only way to prevent these undesired outcomes is to adapt the control programme following the characterisation of the trophic relationships between the invasive alien species and the invaded communities, that is, to view the control with a global perspective.

Here, we conducted a study of the role of an invading species, the ship rat (*Rattus rattus*), within the invaded communities, and assessed the risk of surprise effects during a pre-eradication phase of several years, assessing the potential link between rats and other inconspicuous alien species, using an array of approaches. Consequently, we adapted our control methodology in order to avoid any surprise effects. Post-eradication monitoring showed that, at least in the short term, the eradication was successful both in removing introduced rodents and in avoiding surprise effects.

Key words: alien invasive species, *Rattus rattus*, eradication strategy, trophic relationships

The end of an 80-million year experiment: a review of evidence describing the impact of introduced rodents on New Zealand's 'mammal-free' invertebrate fauna.

George W. Gibbs

School of Biological Sciences, Victoria University, P.O. Box 600, Wellington, New Zealand. (george.gibbs@vuw.ac.nz; Tel +64 4 463 6089; Fax +64 4 463 5331)

Key words: beetles, extinction, Holocene fossils, kiore, islands, mammal-free evolution, rats

Abstract

Since separating from its super-continental origin 80 million years ago, New Zealand has effectively been isolated from the impacts of terrestrial mammals. The arrival of Polynesians in 13th C heralded the end of this era, with the introduction of kiore, (*Rattus exulans*, or Pacific rat), which had far-reaching effects on plant regeneration, survival of small ground vertebrates, larger invertebrates, and seabird breeding colonies. This paper reviews the evidence available from raptor nest sites and Quaternary beetle fossils to summarise extinctions thought to be caused by kiore in New Zealand. It also utilises invertebrate comparisons between islands with and without rats, or where rats have been eradicated, in order to document the impacts of rats (*R.. exulans, R.. norvegicus*) on invertebrate abundance, body mass, and the behavioural responses of some large New Zealand insects to the presence of rats. The role of a 'mammal-free' evolutionary history is discussed.

The demographics of destruction: isolated populations of arboreal snails and sustained predation by rats on the island of Molokaʻi 1982 - 2006.

Michael G. Hadfield
and
Jennifer E. Saufler

Pacific Biosciences Research Center and Department of Zoology
University of Hawaiʻi at Manoa
Edmondson Hall
Honolulu, Hawaii 96822
Telephone: 808-539-7319
FAX; 808-599-4817
E-mail: Hadfield@hawaii.edu

Abstract
A mark-recapture investigation of *Partulina redfieldi*, an achatinelline tree snail endemic to the Hawaiian island of Molokaʻi, recorded significant population growth in four trees isolated in a grassy meadow at 1150 m elevation. From 1983 to 1995, populations increased 100 – 900%. In 1995 - 1996, 85% of the snails disappeared and dead shells beneath the trees accumulated, many of them crushed by feeding rats. While rat-killed shells were always present in the study area, the numbers increased significantly in 1995-96. A baiting program to eradicate rats, initiated in 1995, appears to have only reduced the rat population. We consider reasons for the sudden destruction of the populations by rats and conclude that it was likely due to continued rat migration from surrounding areas into the study area and a switch in rat-food preference toward the snails in the densely populated trees. In the surrounding forest, where tree canopies are more continuous, snail density is lower and there is little evidence of rat predation. The high density of snails in the study trees may have been responsible, at least in part, for their destruction. An experiment to introduce captive-bred snails to a small unoccupied tree in 1989 was successful, although this population suffered the same fate as the natural snail populations nearby in 1995. Since 2000, the populations of *P. redfieldi* have remained low and rat predation continues. Whether the species will persist in the Molokaʻi meadow is questionable, as is the survival of nearly all of Hawaiʻi's once abundant tree snails.

Key words: Hawaiian tree snails, Achatinellidae, mark-recapture, *Partulina redfieldi*, rat predation, rat eradication, species reintroduction, population decline, Molokaʻi

Review of negative effects of introduced rodents on small mammals on islands

Donna B. Harris

Ecologie, Systématique et Evolution, Université Paris-Sud XI,
Bâtiment 362, 91405 Orsay Cedex, France.
Tel: +33 (0) 1 69 15 57 01
Fax: +33 (0) 1 69 15 56 96

E-mail: donna.harris@u-psud.fr

Abstract
It is now widely accepted that introduced rodent species pose a major threat to unique island species and ecosystems. Yet, there has been no comprehensive review of their effects on insular small mammals. I address this deficiency with a review of the evidence, from circumstantial inference to replicated field experiment, for negative effects of *Rattus rattus*, *R. norvegicus*, *R. exulans* and *Mus musculus*. The evidence implicates these introduced rodents in at least three historical extinctions and eight modern-era (since AD 1500) extinctions of insular small mammals. Furthermore, while some are equivocal, other circumstantial and correlative data suggests that extant species are currently being impacted across the globe. Reliable confirmation of rodent impact at the population level is, however, best obtained from the study of manipulated systems. Of the species removal experiments, eradications and control programmes reviewed, all provided evidence for a negative effect of introduced rodents on insular small mammals. While data are currently insufficient for meaningful generalisation with regard to the most threatening rodents, the most threatened small mammals, and the true extent of the problem, it is interesting that *R. rattus* was implicated in the majority of impacts. This may be explained by its extensive distribution and ecological plasticity or by interspecific dominance. I conclude with methodological recommendations to guide data collection for impact quantification and the study of impact mechanism. This information should facilitate project prioritisation, justification and fund-raising while ensuring that much-needed attention is paid to the conservation of the less charismatic members of island ecosystems.

Keywords
Competition, disease transmission, impact, introduced species, island, *Mus musculus*, predation, *Rattus exulans*, *Rattus norvegicus*, *Rattus rattus*, rodent, small mammal.

Mitochondrial DNA evidence for the spread of Pacific rats through Oceania

Elizabeth Matisoo-Smith and Judith Robins
Dept of Anthropology and Allan Wilson Centre for Molecular Ecology and Evolution, University of Auckland, Private Bag 92019, Auckland, New Zealand

Abstract
In the ten years since we published our first full analysis of mitochondrial DNA (mtDNA) variation in *Rattus exulans* as a means for tracking human migration in Polynesia, we have extended the commensal approach through time and space with the use of ancient DNA (aDNA) and by analysing samples from across the Pacific. Not only can mtDNA phylogenies provide information regarding population origins and paths of migration, they have also provided information regarding degrees of contact and interaction between islands. An important extension of the *R. exulans* project is the creation and on-going development of a genetic database for the identification of *Rattus* species based on mtDNA sequences. The phylogenetic analysis of sequences from 18 species and 1 subspecies of *Rattus* thus far has raised some questions regarding species identification and species distributions in the Pacific.

The impacts of rats on the endangered native flora of French Polynesia (Pacific Islands): drivers of plant extinction or "coup de grâce species"?

Jean-Yves MEYER[1] & Jean-François BUTAUD[2]

[1]Délégation à la Recherche, Government of French Polynesia, B.P. 20981 Papeete, Tahiti, French Polynesia
[2]Laboratoire de Chimie des Substances Naturelles, University of French Polynesia, B.P. 6570 Faaa, Tahiti, French Polynesia

ABSTRACT

Although the role of rats (mainly *Rattus rattus*, *R. exulans* and *R. norvegicus*) is clearly demonstrated in extirpations or extinctions of native and endemic seabirds and land-birds in island ecosystems where they have been introduced by humans, their role in plant extinctions is not clear. Recent paleo-environmental studies conducted in Rapa Nui and Hawai'i (Pacific Islands) suggest that the Pacific rat *Rattus exulans* were responsible of the past demise of several palm species. The ca. 120 small tropical oceanic islands of French Polynesia (South Pacific) provide an excellent opportunity to test the "modern" impacts of rats on the native and endemic flora as they comprise a high number of threatened plants (between 47 to 165 species), and as rats have invaded almost all the islands and habitat types. Our study shows that at least 14 endangered taxa belonging to 8 different botanical families have their fruits, seeds, stems, barks or leaves damaged by rats in French Polynesia. All the 11 species whose seeds are eaten by rats are woody plants, ranging from subshrubs to large trees, bearing drupes with relatively large seeds (> 1 cm in length). Predation intensity is severe for three of them, with an important recruitment depression observed in the wild (*Santalum insulare*, Santalaceae, *Ochrosia tahitensis*, Apocynaceae and *Nesoluma nadeaudii*, Sapotaceae). A three-years monitoring two Polynesian sandalwood (*Santalum insulare*) populations in Tahiti during a rat control experiment indicated that more than 99% of the fruits were eaten by rats before ripening. Seed predation in the ten islands where Polynesian sandalwood currently occurs appeared to be lower on islands where black rats *Rattus rattus* are absent. A comparison with other tropical Indo-Pacific Islands reveals comparable trends. At least 56 native and endemic taxa belonging to 27 botanical families are impacted by rats, most of them are woody species bearing drupes. Taxa of the families Arecaceae (Palmae), Elaeocarpaceae, Rubiaceae, Santalaceae, Sapotaceae seem to be the most vulnerable to seed predation. Soft-barked trees such as Araliaceae, Euphorbiaceae and Malvaceae suffer from rat damages, especially during dry seasons. However, despite the fact that rats can severely depress seedling recruitment and thus alter the vegetation dynamics, we didn't find any evidence in the field for French Polynesia or in the literature for other Indo-Pacific islands that rats are the sole responsible for current plant extirpations or extinctions. A great majority of the endangered woody species impacted by rats in French Polynesia are found in low or mid elevation littoral, dry, or mesic forests. These natural habitats have been severely transformed and disturbed by humans in the past and in present times (by deforestation and land development, fire, feral ungulate grazing, invasion by alien plants, plant species overexploitation). In the light of these newly collected data, we suggest that rats can be viewed more as "coup de grâce species" (i.e. that give the final stroke to death), rather than the main drivers of plant extinctions in tropical islands. More research is needed to enlighten the impacts of each rat species and their relative importance in plant population decline or demise.

Humans or introduced rats – Which is to blame for the deforestation of Easter Island (Rapa Nui)?

Andreas Mieth and Hans-Rudolf Bork
University of Kiel, Ecology Centre
Olshausenstrasse 40, D 24098 Kiel, Germany
Phone: ..49 (0) 431 880 4168 / 4030
Fax: .. 49 (0) 431 880 1626
e-mail: amieth@ecology.uni-kiel.de

Abstract
When the Polynesian settlers arrived on Rapa Nui, about 70% of the island was covered with dense woodland in which *Jubaea* palms dominated. Our investigations of soil-profile transects suggest that > 16 million palm trees grew on the island. Nearly all these palms were gone by the 16th century. Teeth marks on nutshells of the *Jubaea* palms from the 13th or 14th centuries attest to the activity of Pacific rats (*Rattus exulans*) on Rapa Nui, which were probably brought there by the first Polynesians settlers. Did the rats prevent the germination of palm seeds and thus the regeneration of the dense palm forest of Rapa Nui? Our investigations suggest that rats might have prevented the regeneration of palms on a small scale. Only few carbonized palm nuts carry teeth marks from rats. Palm trees that were alive when Polynesians first arrived on Rapa Nui could not have been eliminated by rats. Indeed, the remains of palm stumps verify their felling of the palms by man. The stumps were burned and, in some cases, the stumps were used *in situ* as fire material for the cooking of meals. Root formations and stump structures document that young palm individuals existed until the forest was destroyed by humans. In one area on Rapa Nui, the palm forest regenerated after being cleared. In *Jubaea chilensis* forests in Central Chile, small rodents and *Jubaea* palms co-exist. We conclude that humans, not rats were the main destroyers of the palm forest on Rapa Nui.

Key words
Ecosystem collapse; Easter Island; environmental history; islands; *Jubaea chilensis*; land use; palm forest; Rapa Nui; rats; rodents

Direct and Indirect Effects of Rats: Does Rat Eradication Restore Ecosystem Functioning of New Zealand Seabird Islands?

Christa P.H. Mulder[1], M. Nicole Grant-Hoffman[1], David R. Towns[2], Peter J. Bellingham[3], David A. Wardle[3,4], Melody S. Durrett[1], Tadashi Fukami[3,5], and Karen I. Bonner[3]

[1]Institute of Arctic Biology and Department of Biology and Wildlife, University of Alaska Fairbanks, Fairbanks, AK 99775, USA, ffcpm2@uaf.edu.
[2]Terrestrial Conservation Unit, Department of Conservation, Private Bag 68-908, Auckland, New Zealand
[3]Manaaki Whenua- Landcare Research, PO Box 40, Lincoln 7640, New Zealand
[4]Department of Forest Vegetation Ecology, Faculty of Forestry, Swedish University of Agricultural Sciences, S 901 83 Umeå, Sweden
[5]Department of Zoology, University of Hawaii at Manoa, Honolulu, HI 96822, USA

ABSTRACT

Introduced rats (*Rattus* spp.) can affect island vegetation structure and ecosystem functioning, both directly through the consumption of seeds and seedlings, and indirectly through the reduction of seabird populations. Rat eradication programs, sometimes followed by the (re)introduction of native animals, have been conducted on many islands across the globe. However, the extent to which functioning of these islands may converge to that of uninvaded islands remains unclear. We examined potential direct and indirect impacts of introduced rats on several community- and ecosystem-level variables by comparing three groups of islands in New Zealand: islands never invaded by rats, islands currently populated with rats, and islands on which rats have been controlled. Differences between island groups in soil chemistry were explained entirely by seabird burrow densities. Similarly, differences in leaf nutrient concentrations and leaf production of trees were largely explained by burrow densities, but leaf morphology differences were not. The community structure of woody seedlings differed according to rat history, with some, but not all, differences explained by burrow density . Plots on islands with high seabird densities had the greatest number of non-native plant species. We conclude that for most variables related to ecosystem processes, impacts of rats were mediated through seabird density; the removal of rats without recolonization by seabirds is unlikely to result in a reversal of these processes. Furthermore, even if seabirds return, islands on which rats have been eradicated may diverge in plant community structure from both rat-invaded and uninvaded islands, potentially resulting in a novel community type.

Key words: invasive plants, rat eradication, restoration, seabird density, soil characteristics, woody seedlings.

Prospects for the eradication of rats from a large inhabited island: community based ecosystem studies on Great Barrier Island, New Zealand.

John Ogden [(1)] and Judy Gilbert [(2)]

[(1)] School of Geography, Geology and Environmental Science, University of Auckland, Auckland, New Zealand. J.ogden@auckland.ac.nz. [(2)] Little Windy Hill, Great Barrier Island. Lovebirds@xtra.co.nz

Abstract

Great Barrier Island (c. 27400 ha) is the largest off-shore Island in New Zealand. Some of the most serious introduced mammalian pests of New Zealand are absent, but feral cats and rodents are present. Community based trusts are spear-heading ecological studies to support conservation and a pest eradication program. Rodent numbers are greatest in late summer/autumn and lowest in winter/early spring. Maximum abundances were recorded in riparian and coastal vegetation, and in mature forest. Monitoring shows that trapping alone is not able to reduce rat numbers sufficiently for safety in avian re-introductions. A combination of trapping and strategically pulsed toxin baits however achieved low levels of rats. Ecosystem recovery is demonstrated by increases in key tree seedlings, large invertebrates and lizards in managed compared to unmanaged areas, and by the survivorship of translocated robins (*Petroica longipes*). The Great Barrier Island Charitable Trust is communicating these benefits, and associated risks, to the Island community, with a view to promoting pest eradication as a key component in an ecology-based economy, centred on eco-tourism.

Detecting the initial impact of humans and introduced species on island environments in Remote Oceania using palaeoecology

Matiu Prebble[a, b] and Janet M. Wilmshurst[c]

[a]Department of Archaeology and Natural History, Research School of Asia Pacific Studies, The Australian National University, Canberra,
ACT 0200, Australia
[b]Nga Pae o te Maramatanga Fellow, University of Auckland, New Zealand
[c]Landcare Research, PO Box 40, Lincoln 7640, New Zealand.

Abstract
The isolated archipelagos of Remote Oceania provide useful microcosms for understanding the impacts of initial human colonisation on highly sensitive island ecosystems, because colonisation was relatively recent (<3500 years ago) resulting in multiple sources of evidence relating to this process usually being well-preserved in archaeological and sedimentary records. Palaeoecological data from most islands reveal rapid and catastrophic transformations, with losses of many species through over-hunting, deforestation and the introduction of novel mammalian predators, the most ubiquitous and devastating being commensal rats. Two case studies are presented from two very different contexts which demonstrate the potential of palaeoecological methods, one from Rimatara, Austral Islands, French Polynesia and the other from North Taranaki, North Island, New Zealand. Palaeoecological proxy data, in this case plant cultigen pollen and rat gnawed seeds, can be used in an integrated and iterative way to show how multiple layers of information can build up detailed and robust models of initial human impacts including forest clearance, the effects of introduced rats and the expansion of agricultural systems on previously uninhabited pristine island ecosystems. The research emphasis in palaeoecology, as it pertains to archaeological research in the Remote Oceania, is moving from developing corroborative chronologies of human settlement with the archaeological record, by mapping the timing of initial environmental degradation, towards understanding the downstream cultural and environmental consequences of the interactions of people and introduced species with indigenous island biotas.

Key words: human colonization, islands, introduced plant cultigens, rat gnawed seeds, palynology, deforestation

Title: Invasive rats and seabirds after 2,000 years of an unwanted coexistence on Mediterranean islands

Ruffino L., Bourgeois K., Vidal E., Duhem C., Paracuellos M., Escribano F., Sposimo P., Baccetti N., Pascal M. and Oro D.

Corresponding author: RUFFINO Lise, IMEP-CNRS, Paul Cézanne University, Bâtiment Villemin, Domaine du Petit Arbois, Avenue Philibert, B.P. 80, F-13545 Aix-en-Provence Cédex 04, FRANCE.
Ph.: +33 (0)4 42 90 84 69; Fax: +33 (0)4 42 90 84 48
e-mail: ruffino_lise@yahoo.fr
BOURGEOIS Karen, IMEP-CNRS, Paul Cézanne University, Bâtiment Villemin, Domaine du Petit Arbois, Avenue Philibert, B.P. 80, F-13545 Aix-en-Provence Cédex 04, FRANCE.
Ph.: +33 (0)4 42 90 84 70; Fax: +33 (0)4 42 90 84 48
e-mail: karen.bourgeois@univ-cezanne.fr
VIDAL Eric, IMEP-CNRS, Paul Cézanne University, Bâtiment Villemin, Domaine du Petit Arbois, Avenue Philibert, B.P. 80, F-13545 Aix-en-Provence Cédex 04, FRANCE.
Ph.: +33 (0)4 42 90 84 72; Fax: +33 (0)4 42 90 84 48
e-mail: eric.vidal@univ-cezanne.fr
DUHEM Céline, IMEP-CNRS, Paul Cézanne University, Bâtiment Villemin, Domaine du Petit Arbois, Avenue Philibert, B.P. 80, F-13545 Aix-en-Provence Cédex 04, FRANCE.
e-mail: duhem.celine@neuf.fr

PARACUELLOS Mariano, Grupo de Investigacion Ecologia Acuatica y Acuicultura, Universidad de Almeria, Apdo. 110, E-04770, Adra, Almería, SPAIN.
Ph: +34 670941287
e-mail: mparacuellos@cajamar.es
ESCRIBANO Fernando, Dirección General del Medio Natural, Consejería de Desarrollo Sostenible y Ordenación del Territorio, C/ Catedrático Eugenio Úbeda, 3 3ª planta. Despacho 302, E-30008, Murcia, SPAIN.
Ph: +34 968228449; Fax: +34 968228922
e-mail: fernando.escribano@carm.es
SPOSIMO Paolo, NEMO, Nature and Environment Management Operators S.r.l., Piazza D'Azeglio 11, I-50121 Firenze, ITALY.
Ph.: +39 0552466002; Fax: +39 055243718
BACCETTI Nicola, Istituto Nazionale per la Fauna Selvatica, via ca' Fornacetta, 9
I-40064 Ozzano Emilia BO, ITALY.
Ph.: +39 0516512219; Fax: +39 051796628
e-mail: nicola.baccetti@infs.it
PASCAL Michel, INRA SCRIBE, Équipe Écologie des Invasions Biologiques, UMR Écologie et Santé des Écosystèmes, Campus de Beaulieu, F-35000 Rennes, FRANCE
Ph.: +33 223485379; Fax : +33 223485020
e-mail: michel.pascal@rennes.inra.fr
ORO Daniel, Institut Mediterrani d'Estudis Avancats IMEDEA (CSIC-UIB), Miquel Marques 21, E-07190 Esporles, Mallorca, SPAIN
fax: +34 971611761

e-mail: d.oro@uib.es

Abstract
Burrowing seabirds are considered to be one of the groups negatively affected by the introduction of alien predators on islands worldwide. In the Mediterranean, the survival of four endemic Procellariiformes despite 2,000 years of ship rat (*Rattus rattus*) presence constitutes an amazing conservation paradox. A database gathering information about *ca.* 300 Western Mediterranean islands was analyzed through Generalized Linear Models to identify factors likely to influence ship rat presence and to account for how ship rat presence and island characteristics may have driven the presence and abundance of seabirds. Our review showed that few Mediterranean islands remained rat-free and that neither distance to continent nor human activities influenced rat presence on islands. At the regional scale, rat presence is only a limiting factor in the abundance of the smallest seabird, the storm petrel, (*Hydrobates pelagicus*), while the distribution and abundance of the three shearwater species were more influenced by island characteristics. Here we hypothesized that the long-term persistence of these seabirds at the scale of the Western Mediterranean Basin may have been facilitated by the various biogeographical contexts of Mediterranean islands, providing intra-island refuges where interactions with introduced rats may be limited. Unfortunately, the literature contains little on rat impact on Mediterranean seabirds and on the causal mechanisms of seabird population decline. The Mediterranean Basin encompasses more than 5,000 islands and islets, yet few rat eradications have been carried out. Given the high level of biodiversity on Mediterranean islands and the great variety of biogeographical contexts, the Mediterranean Basin should be a key island restoration site.

Keywords : coexistence; eradications; impact; introduced predators; islands; Mediterranean; Procellariiformes; *Rattus rattus*; ship rat

Title: Population structure of invading Norway rats (*Rattus norvegicus*)

Authors: James C. Russell[1], Jawad Abdelkrim[2,3], and Rachel M. Fewster[1]
[1] University of Auckland, Private Bag 92019, Auckland, NEW ZEALAND
[2] Muséum National d'Histoire Naturelle, 43 rue Cuvier, F-75003 Paris, FRANCE
[3] University of Canterbury, Private Bag 4800, Christchurch, NEW ZEALAND

Keywords: bottleneck, catch-effort, founder effect, inbreeding, invasion, island, mating system, microsatellite, parentage, removal

Corresponding Author:
James Russell
University of Auckland
Private Bag 92019
Auckland, NEW ZEALAND
j.russell@auckland.ac.nz

Abstract

Studying invasive species immediately following arrival can provide useful insights into early colonisation population dynamics. Colonising populations undergo non-equilibrium processes affecting establishment such as founder effects, inbreeding and changing population size. These in turn will influence the mating system and demography of a population. Such processes may differ substantially between colonising and established populations, and understanding them in colonising populations can inform management and be used to prevent further invasions. We sampled most individuals of a two year old reinvading population of Norway rats (*Rattus norvegicus*) on Moturemu island (5 ha) in New Zealand, and described genetic structure using eight microsatellite loci. Population size was estimated from trapping data to be between 27-44 rats. Multiple genetic methods all detected a clear bottleneck signal for the founder effect. Parentage assignment revealed a promiscuous mating system dominated by a few individuals and increasing inbreeding was detected, both putatively a result of the small island size. Combining ecological and genetic information from a single sample allowed inferences on the structure and functioning of the invading population. We demonstrate that Norway rats invading islands can rapidly achieve population structure similar to well-established island populations despite a small number of colonists and associated inbreeding. Overcoming these initial obstacles to population establishment contributes to the global success of introduced rats as an invasive species.

Rats aren't the only introduced rodents producing ecosystem impacts on islands

Daniel Simberloff
Department of Ecology and Evolutionary Biology
University of Tennessee
Knoxville, TN 37996

Abstract

In addition to rats, nutria (*Myocastor coypus*) and the North American beaver (*Castor canadensis*) have certainly caused damage at an ecosystem level when introduced to islands, in both cases primarily by ecosystem engineering. Of other introduced rodents successfully established on islands, the gray squirrel (*Sciurus carolinensis*) may be in the process of damaging entire forest ecosystems, particularly by bark-stripping. Though introduced muskrats (*Ondatra zibethicus*) have had ecosystem-level impacts in continental Europe, their impact on islands worldwide to which they have been introduced has been very limited. The North American red squirrel (*Tamiasciurus hudsonicus*) and Barbary ground squirrel (*Atlantoxerus getulus*) have each had substantial impacts when introduced to particular islands, but for neither species have these impacts yet been demonstrated to spread through an entire ecosystem. Introduced house mice (*Mus musculus*) may well generate ecosystem impacts on remote islands lacking rats, and it is possible that explosions of house mice on islands after rat eradication, a common occurrence, will lead to in some instances to ecosystem impacts.

Eradications as reverse invasions: lessons from Pacific rat (*Rattus exulans*) removals on New Zealand islands

David R. Towns
Terrestrial Conservation Unit, Research Development & Improvement Division, Department of Conservation, Private Bag 68 908, Newton, Auckland 1145, New Zealand (e-mail: dtowns@doc.govt.nz; fax +64-9-377-2919)
This version: 20 December 2007 – For *Biological Invasions*: Rodents on islands special issue

Key words: invasion, ship rats (*Rattus rattus*), direct and indirect effects, fruit and seed predation, honey dew scale, tuatara (*Sphenodon punctatus*), burrowing seabirds

Abstract

The invasion of the Big South Cape islands by ship rats (*Rattus rattus*) in about 1962 devastated populations of invertebrates, birds and bats and led to the extinction of at least four endemic taxa. Anecdotal reports indicate that the invading rats also had indirect effects on invertebrate-plant interactions. More recently, the responses of resident species to eradications of rats from islands around New Zealand have enabled retrospective measures of the impacts of rats. The most comprehensive studies have been for kiore or Pacific rats (*Rattus exulans*), a south-east Asian species now widespread through the Pacific. Responses are reviewed here for selected examples of coastal plants, invertebrates, reptiles and seabirds. These data have limitations because the residual pool of native species may be restricted to those able to co-exist with rats. This limitation can be reduced by listing incompatible species, which are those with ranges confined to rat-free locations. The extended list includes at least 15 species of invertebrates, two species of frogs, tuatara (*Sphenodon punctatus*), 11 species of lizards, 10 species of seabirds and 8 species of forest birds. The analyses indicate direct and indirect effects of kiore similar to those reported after ship rat invasions. This is despite indications from the literature that kiore are the least damaging of the three commensal rat species.

A review on the effects of alien rodents in the Balearic (Western Mediterranean Sea) and Canary Islands (Eastern Atlantic Ocean)

A. Traveset[1*], M. Nogales[2], J. A. Alcover[1], J. D. Delgado[3], M. López-Darias[4-2], J. M. Igual[1], D. Godoy[5], and P. Bover[6]

[1]Institut Mediterrani d'Estudis Avançats (CSIC-UIB), Miquel Marqués nº 21, 07190 Esporles, Mallorca, Balearic Islands, Spain
[2]Island Ecology and Evolution Research Group (CSIC-IPNA), Astrofísico Francisco Sánchez nº 3, 38206 La Laguna, Tenerife, Canary Islands, Spain
[3]Departament of Ecology, University of La Laguna, Astrofísico Francisco Sánchez nº 1, 38206 La Laguna, Tenerife, Canary Islands, Spain
[4]Department of Applied Biology, Estación Biológica de Doñana (CSIC), Pabellón del Perú, Avda. Mª Luisa s/n, 41013 Sevilla, Spain
[5]Ayagaures Medioambiente, Perdomo 5, 35002 Las Palmas de Gran Canaria, Canary Islands, Spain
[6]Department of Mammalogy, American Museum of Natural History, Central Park West at 79th Street, New York, USA

*Contact author
Telephone number: +34 971 611718
Fax number: +34 971 611661
e-mail: atraveset@uib.es

Abstract Invasions of alien rodents can have devastating effects on insular ecosystems. Here we review their ecological impacts on the biodiversity of the Balearic and the Canary Islands. In contrast to most island ecosystems across the world, where usually two or three rodent species are found, a total of seven species (two rats, three mice, one dormouse and one squirrel) have been introduced in these archipelagos, six in the Balearics and four in the Canaries. Among them, rats appear to have the major impacts. They prey upon nesting seabirds, contributing to the decline of endangered populations in both archipelagos, upon terrestrial birds -such as the two endemic Canarian pigeons-, and upon other fauna including lizards and invertebrates, such as beetles and snails. Moreover, rats consume both vegetative and reproductive tissues of a high number of plants. In both archipelagos, rats and mice are seed predators of many endemic species and of plants with restricted distributions. The alien squirrel in the Canaries is another disruptor of seed dispersal systems of native plants. Although still little documented, they probably disrupt native seed dispersal mutualisms, reducing plant recruitment, and modifying the structure of plant communities. We suggest that alien rodents have played a key role in the transformation of Balearic and Canarian native ecosystems.