

# Actions Speak Louder than Words: A Call for Preventing Further Mongoose Invasions in Fiji

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**ABSTRACT:** The small Indian mongoose was deliberately released into Fiji to control rats. Unfortunately, since their arrival many bird and reptile species have disappeared from the two largest islands, Viti Levu and Vanua Levu, and mongoose are the likely culprits. Fortunately, mongoose have not been introduced to every island in Fiji. Thus, it is imperative that we prevent mongoose from ever reaching these offshore havens. However, this is unlikely because the public is not aware of the problems created by mongoose and there are few biosecurity controls in place. To prevent further mongoose invasions, we need an active "first-strike" response team that will rapidly deal with any reported incursions. The various "first-strike" methods that should be employed to prevent mongoose from invading these mongoose-free Fijian islands are discussed.

**KEY WORDS:** biosecurity, extinction, Fiji, *Herpestes javanicus*, incursions, invasive species, island, management strategies, mongoose

Proc. 21<sup>st</sup> Vertebr. Pest Conf. (R. M. Timm and W. P. Gorenzel, Eds.)  
Published at Univ. of Calif., Davis. 2004. Pp. 37-41.

## INTRODUCTION

More terrestrial species have gone extinct in the Pacific over the last 1,000 years than in any other region (Atkinson 1989, Case et al. 1992, Honegger 1981, Steadman 1995). More than 2,000 bird species in the Pacific alone are estimated to have gone extinct (Steadman 1995). These were mostly flightless rails, megapodes, pigeons and parrots, and countless other species have been eliminated by humans and their commensal animals from island nations such as Fiji (Worthy 1999a, 2000, 2001), New Zealand (Atkinson 1985, Worthy 1999b), Hawaii (Olson and James 1991), Samoa, Tonga, and the Cook Islands (Steadman 1989, Steadman 1995). Habitat destruction and fragmentation played a large part in their extinction, but it is now the effect of invasive species on islands that is pushing many island organisms to the brink of extinction (Flannery 1994, Quammen 1996).

Many island species are endemics that often have small populations; consequently, they are particularly vulnerable to biological invasions (Simberloff 1995). When exotic mammals are introduced onto islands, they can quickly become pests simply by outcompeting and preying on culturally naïve species (McLean 1997). Efforts to control these pests for conservation purposes have met with varying levels of success (Cote and Sutherland 1997, Towns and Broome 2003). Moreover, alien species already present (e.g., *Rattus* spp.) may increase their destructiveness if other invasives such as cats (*Felis catus*) are eradicated. Eradication after a pest has arrived is difficult, costly, and complex (Courchamp et al. 2003). Ideally, preventing incursions by invasives is the best form of protection for an island's flora and fauna (Simberloff 2003).

Fiji is located between 16-20° S and 177° W-175° E and has more than 320 islands with a total land area of 18,270 km<sup>2</sup>, making it the largest landmass in the Central Pacific (Pernetta and Watling 1978). When humans arrived some 3000 years ago, Fiji had 57 native breeding

landbirds (46% endemic) and 20 breeding seabirds, 26 species of reptile (40% endemic), and 6 species of bats (Pernetta and Watling 1978, Zug 1991). However, after the arrival of people, many species went extinct: two megapodes, a giant flightless pigeon, a large fruit pigeon, at least one rail, a *Coenocorypha* snipe, a terrestrial crocodile, a giant iguana, a giant frog, and possibly a tortoise (Worthy 1999a).

Unfortunately, this was not the end of the extinction story in Fiji. When Europeans arrived, they introduced another two species of rat (*R. rattus* and *R. norvegicus*), cats, dogs (*Canis familiaris*), goats (*Capra hircus*), and perhaps the worst offender, the small Indian mongoose (*Herpestes javanicus*). These invasive mammals, in combination with humans, have continued the extinction events that started over a thousand years earlier. Fiji has now lost all four rail species (barred-wing rail, *Nesoclopeus poecilopterus*; white-browed rail, *P. cinereus*; sooty rail, *P. tabuensis*; and banded rail, *Gallirallus philippensis*), the purple swamphen (*Porphyrio porphyrio*), at least two nesting seabirds (collared petrel, *Pterodroma brevipes*; and Audubon's shearwater, *Puffinus lherminieri*), two species of skinks (*Emoia nigra* and *E. trossula*), and the Fijian ground frog (*Platymantis vitiensis*) from Fiji's main island, Viti Levu. Except for the barred-wing rail, the only places where these species still exist are on mongoose-free islands.

Although the mongoose is not the only pest species in Fiji, it has been identified by the IUCN (The World Conservation Union) as one of the worst mammals that could ever be introduced to an island ecosystem (Lowe et al. 2000). However, the only known bird extinction directly attributed to mongoose is the barred-winged rail in Fiji (Hays and Conant 2003, Watling 2001). Nevertheless, there is more than enough circumstantial evidence that points toward the mongoose as the agent of decline, as many birds once common on Viti Levu are now only found on islands without mongoose. Furthermore, the destructive capabilities of mongoose are also well-

Table 1. Islands in Fiji where mongoose have established.

Island Name	Area of Island (km <sup>2</sup> )	Distance (km) to nearest mainland island	Type of Introduction
Viti Levu*	10,387	Main Island	Deliberate
Vanua Levu*	5,535	Main Island	Deliberate
Beqa*	36.2	9.6 (1)	Accidental/Deliberate
Yanuca (Serua)*	1.54	9.8 (1)	Deliberate
Nasoata**	0.74	0.8 (1)	Uncertain
Malake*	4.53	2.0 (1)	Deliberate
Nanau-i-cake*	3.0	0.6 (1)	Deliberate
Nanau-i-ra*	2.7	1.4 (1)	Deliberate
Yanuca (Ra)*	0.88	1.3 (1)	Uncertain
Rabi*	68.78	5.4 (2)	Deliberate
Kioa*	18.6	0.8 (2)	Deliberate
Drudrua**	3.9	1.9 (2)	Deliberate
Macuata-i-wai*	3.06	1.5 (2)	Deliberate

\* = Islands where mongoose were trapped by the author \*\* = Islands where mongoose were observed by the author.  
No other records exist of mongoose on any other islands in Fiji.

Distance from the two main islands are indicated as:  
(1) = From Viti Levu or (2) = From Vanua Levu.

Type of Introduction: Information records from anecdotal conversations with the island elders during 2002-3.  
Deliberate: the year and reason for introduction are known  
Accidental: the year is known but no reason given for their introduction  
Uncertain: no local knowledge of when mongoose arrived

documented in the Caribbean (Coblentz and Coblentz 1985, Seaman and Randall 1962, Vilella 1998), and Hawaii (Kami 1964, Keith et al. 1987, van Riper and Scott 2001).

Mongoose have spread to several outer islands in Fiji (Table 1), and this is a cause for much concern. On Viti Levu, mongoose are known predators of geckoes, skinks, frogs, toads, birds, invertebrates, and plant matter as well as rats (Gorman 1975). The fact that there are no crested iguanas (*Brachylophus vitiensis*) and only a few banded iguanas (*B. fasciatus*) on Fiji's two main islands is also probably due to mongoose predation, as both iguana species survive quite well on islands without mongoose (Harlow and Biciloa 2001).

Mongoose were introduced deliberately to most of the outer islands (Table 1), often in attempts to control rats and the harmless Pacific boa (*Candoia bibroni*). However, on two islands, Beqa and Yanuca, the mongoose may have rafted over on material floating down the Navua River after the large cyclone event in 1964. All these islands are relatively close to the two main islands of Viti Levu and Vanua Levu, where mongoose are abundant and common.

Fortunately, mongoose are not on Fiji's third and fourth largest islands, Taveuni and Kadavu. Taveuni (435 km<sup>2</sup>) is the second-largest island in the Pacific without mongoose after Kauai, Hawaii. However, as it is only 7.85 km away from Vanua Levu and also very close to Kioa and Rabi (approximately 8 km from both islands), there is concern about how long Taveuni will remain mongoose-free. Taveuni is being promoted by the Fijian Government as a potential World Heritage Site because it has 24 endemic bird, frog, and lizard species, and has intact watersheds from the 1,200-m ridge-top to the reef, which is rare in the Pacific. There are also another three biologically important islands close to

Taveuni that remain mongoose-free: Qamea (2.5 km east of Taveuni), Matagi (1.2 km north of Qamea), and Laucala (0.5 km east of Qamea). If these islands can be kept mongoose-free, then many of the region's endemics will be preserved.

Kadavu (408.4 km<sup>2</sup>), on the other hand, is a considerable distance from any mongoose population (67 km south of Beqa), and none of the islands near Kadavu have mongoose. The other main mongoose-free islands around Fiji are Vatulele, the Lomaiviti Group (including Koro, Gau, Ovalau, Moturiki, Wakaya, Makogai, Bataki, and Nairai), the Lau Group (including Vanua Balavu, Lakeba, Nayau, Cicia, Mago, and Kabara), and the Mamanucas and Yasawas (including Malolo, Kuata, Waya, Naviti, Yaqeta, Matacawa Levu, Nacula, and Yasawa). Most of these islands are too far away for a naturally-dispersing mongoose to ever reach. Unfortunately, one of the negative by-products of improved transportation is the increased risk of accidental introductions of organisms (McNeely 2001, Vitousek et al. 1997). Therefore, to prevent any accidental (or deliberate) movement of mongoose between islands, strict internal biosecurity measures need to be put in place.

Currently, Fiji has no internal biosecurity policies for non-agricultural animals, and people can freely transport non-livestock animals between the islands (Anon. 2002). Thus, the risk of introducing exotic organisms is relatively high. Furthermore, people often do not know which organisms are native and which are introduced. Virtually all mammals except for 6 species of bats are introductions (Ingleby and Flannery 1990, Pernetta and Watling 1978), but many Fijians think animals such as mongoose, cats, and rats are a natural part of their environment. This is because they have lived with these animals for several generations and few people know they

were introduced. This problem is not unique to Fiji, but if we are to stop exotic species from spreading throughout Fiji, then the people should be informed which species are harmful and why.

To improve public awareness about the impact of invasive species, there needs to be a willingness by government officials to recognise them as unwanted pests. This can be done through legislation and tighter internal biosecurity controls, and through widespread education campaigns. However, these controls and campaigns must be realistic and financially sound, and not just passive words on paper. Some recent reports have clearly highlighted the problems caused by invasive species in Fiji and the Pacific (e.g., Sherley 2000, FBSAP 1998), but little action has resulted from these documents. It is no use having well-thought-out policies and reports if they just end up sitting on a shelf. Further, it is no use having laws if the people do not understand their purpose, benefit, or objectives.

In Fiji, it is the local landowners rather than the government that decide on what action should be taken within a community, so if we are to prevent incursions by invasive species, we need to work closely with the communities. Once they understand (and see) the impacts and costs of invasives, most communities wish to rid themselves of these pests. But the problem for the communities is not an issue of preventing further incursions, but more to do with people's day-to-day priorities. Gathering food and looking after the family are considered much more important than stopping invasive species. Moreover, these communities simply do not have the time or resources to continually monitor the spread of invasive organisms, even when they recognize their potential impacts.

Nevertheless, prevention of further invasions and management of existing pests requires urgent attention. Already mongoose have established on several Fijian islands, and if they are to be stopped from spreading any further, there needs to be decisive action and not just a reliance on the words written in a biosecurity document or in an education campaign. The best method to prevent further mongoose incursions is to eradicate them (Simberloff 2003), but this is impossible with our current technology, as Viti Levu and Vanua Levu have a large number of mongoose. Therefore, eradicating mongoose from the main islands is not an option at this stage. Eradication from the smaller islands is possible, given a concerted effort and a lot of money, something Fiji simply does not have. Therefore, we are left with containment.

Awareness campaigns and tighter internal biosecurity measures will assist with preventing mongoose incursions but these will take a long time and a lot of money to implement. Unfortunately, the question remains what happens in the meantime? It would be unethical to allow further incursions while we wait for new eradication methods and technology to arrive. If, as in the case of Fiji, there are no containment measures in place, and we are left only with post-border responses (i.e., dealing with incursions after they happen), then we must respond with several strategic actions. The first is to train people from each island group to investigate all possible sightings.

This will involve making sure that the people who report these sightings have positively identified a mongoose. A large rat can look like a mongoose when running quickly. In addition, people in the immediate vicinity should also be canvassed to check if they had seen any mongoose.

If no further sightings are reported, then the next step will be to send a quick response (or "first-strike") team into the area where the mongoose was reported. This response need not initially be an expensive trapping programme, but may consist of experienced wildlife personnel who can detect mongoose sign, e.g., scats, pathways, or dens, and experienced dog-handlers able to track mongoose. If these methods fail, then the next step should be to set out bait stations to attract the mongoose. Mongoose eat virtually anything (Gorman 1975), and the best lures in Fiji are burnt coconut or tinned fish. Only if a mongoose is discovered at a bait station should a trapping or poisoning program be implemented to prevent the mongoose from dispersing (Courchamp et al. 2003, Pascoe 2002).

However, if after all this effort no mongoose have been found, then the biosecurity experts must make a judgement call on their next move. False alarms can cost a lot of money and dissuade people from reporting any sightings. Bait stations to track the movement of animals are relatively cheap to maintain, and these should be placed near all ports of entry, along with posters in the local dialects informing the people about the impacts of mongoose, for several months after any reported incursions. A key process in this whole strategy is continual consultation and communication with the landowners, community, wildlife experts, and biosecurity people (Pascoe 2002). Everyone must be involved or the strategy will fail. Once landowners realise the problems created by mongoose, they are more than willing to help remove them, but this action often only happens after the mongoose have arrived.

The strategy outlined above needs to be coordinated at the government level, possibly by the Department of Environment. This department needs a national telephone hotline so people can report any mongoose activity. They also need people trained in observing mongoose sign, and a dog-handler that can track mongoose. These last two people would be more than useful if Fiji were to start eradicating mongoose on their outer islands (A. Saunders, Invasive Species Specialist Group, pers. commun.). Currently, there are no efforts under way to prevent mongoose incursions in Fiji or to strengthen the internal biosecurity regulations. However, the suggestions above should mean we could stop mongoose from establishing on any new islands. This strategy would not require a huge investment in capital and could be place within months of initiation. Compared to the cost of losing our threatened species, this amount would seem paltry.

## SUMMARY

We have enough knowledge at present to stop further mongoose incursions, but what we really need now is an adequate base of public understanding as well as support from the politicians. Continuing ecological research and refinement of biosecurity strategies for mongoose is also

important, especially if we want to develop new tools to eradicate mongoose from the outer islands. Once we have perfected the eradication techniques on the outer islands, then we could look at the two main islands of Viti Levu and Vanua Levu. Eradicating mongoose off these two source islands is the best method of preventing any future mongoose invasions.

#### ACKNOWLEDGEMENTS

I express my sincerest thanks to the Fijian communities I visited whilst trapping, and to the University of the South Pacific for funding this research. M. Heads provided useful comments on the draft manuscript.

#### LITERATURE CITED

- ANON. 2002. Endangered and Protected Species Bill 2002. Ministry of Environment, Suva, Fiji Islands.
- ATKINSON, I. A. E. 1985. The spread of commensal species of *Rattus* to oceanic islands, and their effect on island avifaunas. Pp. 35-81 in: P. J. Moors (Ed.), Conservation of island birds. International Council for Bird Preservation, Technical Publication No. 3.
- ATKINSON, I. A. E. 1989. Introduced animals and extinctions. Pp. 54-75 in: D. Western and M. C. Pearl (Eds.), Conservation in the Twenty-first Century. Oxford University Press, Oxford, U.K.
- CASE, T. J., D. T. BOLGER, AND A. D. RICHMAN. 1992. Reptilian extinctions: the last ten thousand years. Pp. 91-125 in: P. L. Fiedler and S. K. Jain (Eds.), Conservation Biology. Chapman and Hall, New York.
- COBLENTZ, B. E., AND B. A. COBLENTZ. 1985. Control of the Indian mongoose *Herpestes auropunctatus* on St. John, US Virgin Islands. *Biol. Conserv.* 33:281-288.
- COTE, I. M., AND W. J. SUTHERLAND. 1997. The effectiveness of removing predators to protect bird populations. *Conserv. Biol.* 11:395-405.
- COURCHAMP, F., J.-L. CHAPUIS, AND M. PACSAL. 2003. Mammal invaders on islands: impacts, control and control impact. *Biological Rev.* 78:347-383.
- FBSAP. 1999. Terrestrial vertebrates and invertebrates. Report for Fiji Biodiversity Strategy and Action Plan, Technical Group 2, Suva, Government of Fiji. 107 pp.
- FLANNERY, T. F. 1994. The Future Eaters: An Ecological History of the Australasian Lands and People. Reed, New Holland, Adelaide. 423 pp.
- GORMAN, M. L. 1975. The diet of feral *Herpestes auropunctatus* (Carnivora: Viverridae) in the Fijian Islands. *J. Zool.* 175:273-278.
- HARLOW, P. S., AND P. N. BICILOA. 2001. Abundance of the Fijian crested iguana (*Brachylophus vitiensis*) on two islands. *Biol. Conserv.* 98:223-231.
- HAYS, W. S. T., AND S. CONANT. 2003. Impact of the small Indian mongoose (*Herpestes javanicus*) (Carnivora: Herpestidae) on native vertebrate populations in areas of introduction. Unpublished report, Honolulu, HI. 20 pp.
- HONEGGER, R. E. 1981. List of amphibians and reptiles either known or thought to have become extinct since 1600. *Biol. Conserv.* 19:141-158.
- INGLEBY, S., AND T. FLANNERY. 1990. A survey of the mammals of Fiji. Australian Museum in collaboration with the National Trust of Fiji and Ministry of Primary Industries. Unpublished report. 14 pp.
- KAMI, H. T. 1964. Foods of the mongoose in the Hamakua District, Hawai'i. *Zool. Record* 3:165-170.
- KEITH, J. O., D. N. HIRATA, AND D. L. ESPY. 1987. Control of mongoose predation on endangered Hawaiian birds. USDA APHIS, and Hawaii Division of Forestry and Wildlife, Department of Land and Natural Resources. Unpublished progress report. 21 pp.
- LOWE, S., M. BROWNE, AND S. BOUDJELAS. 2000. 100 of the world's worst invasive alien species: a selection from the global invasive species database. Aliens 12. Invasive Species Specialist Group, University of Auckland, Auckland, New Zealand. 10 pp.
- MCLEAN, I. G. 1997. Conservation and ontogeny. Pp. 132-156 in: J. R. Clevings and R. Buchholz (Eds.), Behavioral Approaches to Conservation in the Wild. Cambridge University Press, Cambridge, U.K.
- MCNEELY, J. A. 2001. The great reshuffling: how alien species help feed the global economy. IUCN - The World Conservation Union. Cited in <http://www.iucn.org/biodiversityday/mcneelyreshuffling.html>, accessed 8/1/04.
- OLSON, S. L., AND H. F. JAMES. 1991. Descriptions of thirty-two new species of birds from the Hawaiian Islands, Part 1. Non-Passeriformes. *Ornithol. Monogr.* 45:1-88.
- PASCOE, A. 2002. Strategies for managing incursions of exotic animals to New Zealand. Pp. 129-135 in: R. Muniappan, and R. Campbell (Eds.), Invasive species and their management, Supplement 6, Proceedings of the Pacific Science InterCongress Session on Invasive Species. Micronesica: University of Guam journal of natural sciences of Micronesia and related regions. August 2002.
- PERNETTA, J. C., AND D. WATLING. 1978. The introduced and native terrestrial vertebrates of Fiji. *Pacific Sci.* 32:223-244.
- QUAMMEN, D. 1996. The Song of the Dodo: Island Biogeography in an Age of Extinctions. Pimlico, London. 702 pp.
- SEAMAN, G. A., AND J. E. RANDALL. 1962. The mongoose as a predator in the Virgin Islands. *J. Mammal.* 43:544-546.
- SHERLEY, G. 2000. Invasive species in the Pacific. South Pacific Regional Environment Programme. Unpublished Report, Apia, Samoa. 190 pp.
- SIMBERLOFF, D. 1995. Why do introduced species appear to devastate islands more than mainland areas? *Pacific Sci.* 49:87-97.
- SIMBERLOFF, D. 2003. How much information on population biology is needed to manage introduced species? *Conserv. Biol.* 17:83-92.
- STEADMAN, D. W. 1989. Extinction of birds in Eastern Polynesia: a review of the record, and comparisons with other Pacific Islands groups. *J. Archaeol. Sci.* 16:177-205.
- STEADMAN, D. W. 1995. Prehistoric extinctions of Pacific Island birds: biodiversity meets zooarchaeology. *Science* 267:1123-1131.
- TOWNS, D. R., AND K. G. BROOME. 2003. From small Maria to massive Campbell: forty years of rat eradications from New Zealand islands. *New Zealand J. Zool.* 30:377-398.
- VAN RIPER III, C., AND J. M. SCOTT. 2001. Limiting factors affecting Hawaiian native birds. Pp. 221-233 in: J. M. Scott, S. Conant, and C. van Riper III (Eds.), Ecology, conservation and management of endemic Hawaiian birds: a vanishing avifauna. *Studies in Avian Biol.* No. 22.

- VILELLA, F. J. 1998. Biology of the mongoose (*Herpestes javanicus*) in a rainforest of Puerto Rico. *Biotropica* 30:120-125.
- VITOUSEK, P. M., C. M. D'ANTONIO, L. L. LOOPE, M. REJMANEK, AND R. WESTBROOKS. 1997. Introduced species: a significant component of human-caused global change. *New Zealand J. Ecol.* 21:1-16.
- WATLING, D. 2001. A guide to the birds of Fiji and Western Polynesia: including American Samoa, Niue, Samoa, Tokelau, Tonga, Tuvalu and Wallis & Futuna. Environmental Consultants, Suva, Fiji.
- WORTHY, T. 1999a. Megafaunal expression in a land without mammals – the first fossil faunas from terrestrial deposits in Fiji (Vertebrata: Amphibia, Reptilia, Aves). *Senckenbergiana Biologica* 79:237-242.
- WORTHY, T. 1999b. What was on the menu? – avian extinction in New Zealand. *New Zealand J. Archaeol.* 19: 125-160.
- WORTHY, T. 2000. The fossil megapodes (Aves: Medapodiidae) of Fiji with descriptions of a new genus and two new species. *J. Royal Soc. New Zealand* 30:337-364.
- WORTHY, T. 2001. A giant flightless pigeon gen. et sp. nov. and a new species of *Ducula* (Aves: Columbidae) from Quaternary deposits in Fiji. *J. Royal Soc. New Zealand* 31: 763-794.
- ZUG, G. R. 1991. Lizards of Fiji: natural history and systematics. Bishop Museum Bulletin in Zoology 2, Honolulu, HI. 136 pp.