

Short Communication

Has the invasive mongoose *Herpestes javanicus* yet reached the island of Taveuni, Fiji?

Craig G. Morley

Abstract The Fijian island of Taveuni is being proposed as a potential World Heritage Site because much of its flora and fauna, including many endemic species, remains intact. The greatest threat facing Taveuni's wildlife is a potential incursion by the invasive small Indian mongoose *Herpestes javanicus* from nearby islands, and anecdotal reports have suggested that the mongoose may already be present. To determine if mongooses were present on Taveuni 40 traps were set in two locations close to the main ports of entry, in typical mongoose habitat. Normally mongooses are easily

caught if they are present, but in 204 trap nights none were captured, although eight feral cats and 11 rats were caught. None of the 31 people questioned from around the island had seen the mongoose. A list of seven recommendations is provided for a management strategy to prevent any possible incursion by mongooses and to eradicate any arrivals at the earliest opportunity.

Keywords Extinction, Fiji, *Herpestes javanicus*, invasive species, island, mongoose, Taveuni.

At least 75% of all known extinctions since 1600 AD have occurred on oceanic islands, including 93% of 176 species or subspecies of birds now extinct and >90% of the 30 species of now extinct reptiles and amphibians (Honegger, 1981; Ceballos & Brown, 1995). Foremost among the cause of these extinctions is the introduction of invasive species (Atkinson, 1989; Mooney & Hobbs, 2000). Because island biotas are more sensitive to damage from invaders than those of many mainland areas, the introduction of invasive species in the Pacific is generally regarded as a more serious threat to biodiversity than habitat destruction or fragmentation (Simberloff, 1995; Vitousek *et al.*, 1997; Courchamp *et al.*, 2003).

The islands of Fiji originally had 59 species of breeding land birds (46% endemic), 20 breeding seabird species, 26 species of reptiles (40% endemic), and six species of bats (Pernetta & Watling, 1978). The first Fijians introduced Polynesian rats *Rattus exulans* and pigs *Sus scrofa*, and Europeans introduced cats *Felis catus*, dogs *Canis familiaris*, cattle *Bos taurus*, sheep *Ovis aries*, goats *Capra hircus*, mice *Mus musculus* and two further rat species (*R. rattus* and *R. norvegicus*). Some introductions were accidental (e.g. cats and rats) whereas others (e.g. cattle and goats) were deliberate (Pernetta & Watling,

1978). The small Indian mongoose *Herpestes javanicus* was deliberately introduced in 1883 to control rats on the main sugar-growing islands of Fiji (Gorman, 1975). This biological control experiment failed because the mongooses preferred to eat species other than rats.

Mongoose are voracious and opportunistic predators (Lowe *et al.*, 2000) and in Fiji they consume lizards, frogs, toads, birds, invertebrates and plants, as well as rats (Gorman, 1975). The Fijian ground frog *Platymantis vitianus* and two of Fiji's largest skinks, *Emoia nigra* and *E. trossula*, are now found only in mongoose-free areas (Zug, 1991; Watling & Zug, 1998). The low numbers of banded iguana *Brachylophus fasciatus* on Fiji's two largest islands, Viti Levu and Vanua Levu, may also be due to mongoose predation (Gorman, 1975).

Other than the two largest islands where the species was first introduced, mongooses are now also present on the Fijian islands of Kioa, Rabi, Macuata-i-wai, Beqa, Yanuca, Malake, Nananu-i-ra and Nananu-i-cake (C. Morley, pers. obs.). These islands range in distance from 0.8 to 9.6 km from the nearest larger island on which mongooses occur. There have recently been unsubstantiated reports, by visitors, of mongooses on the relatively species-rich island of Taveuni. The aim of this study was to investigate whether these anecdotal reports were correct and, if not, to propose preventative measures to ensure that mongoose do not colonize the island.

Taveuni is Fiji's third largest island (435 km², maximum altitude 1,241 m) and, although it already has other invasive species, including cats and rats, it is the second

Craig G. Morley Department of Biology, School of Pure and Applied Science, P.O. Box 1168, The University of the South Pacific, Suva, Fiji Islands.
E-mail: morley_c@usp.ac.fj

Received 18 September 2003. Revision requested 16 January 2004.
Accepted 1 June 2004.

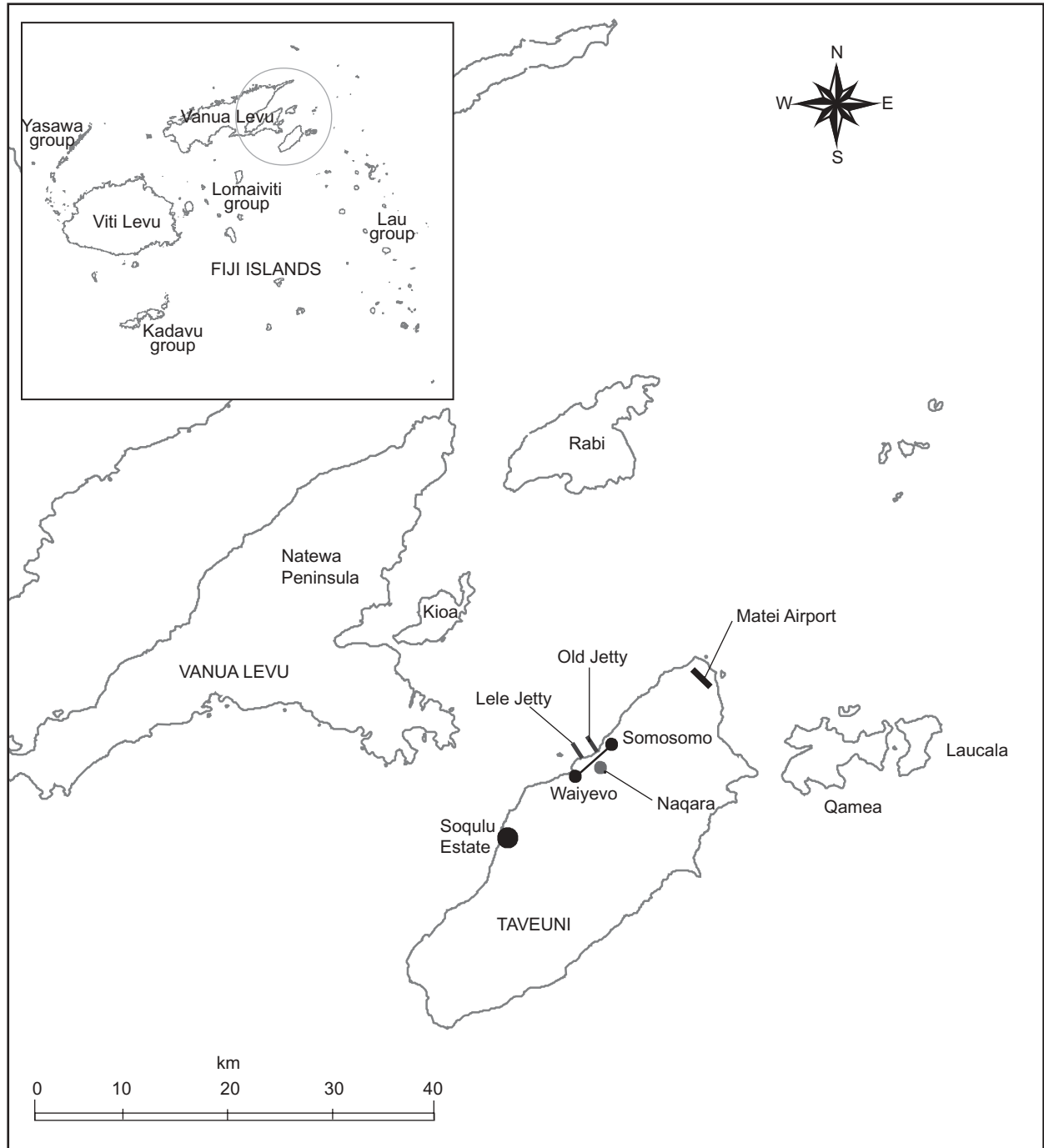


Fig. 1 Map of Taveuni with the survey locations, jetties and main towns (see text for details). The circle on the inset map indicates the location of the main map.

largest apparently mongoose-free island in the Pacific after the Hawaiian island of Kauai. Of particular concern is the fact that Taveuni is only 7.9 km east of Vatudamu Point, Vanua Levu (Fig. 1), where mongooses are already present. This distance is less than that of some of the other smaller islands from islands that already harbour

the mongoose. The Department of Environment in Fiji is promoting Taveuni as a potential World Heritage Site because it has large tracts of undisturbed tropical rainforest, mostly in the east. Taveuni is an internationally important island for bird biodiversity, with 22 regional endemic species, including the orange dove

Chrysoenas victor and silktail *Lamprolia victoriae* (Watling, 2001). On the western side of the island the climate is drier and the habitat has been heavily modified, with many settlements, roads and plantations.

One of the reports of mongoose was by Zafir Kizilkaya, a National Geographic photographer. He reported to the Wildlife Conservation Society, Fiji, that he had seen a mongoose on western Taveuni in July 2002. Following this report, in the first week of September 2002, I set 40 cage traps, suitable for catching mongoose, for six nights in two areas on the western side of Taveuni: near human settlements and along the edge of a highly modified forest. These are the type of habitats in which mongooses are most readily caught (Coblentz & Coblentz, 1985; Courchamp *et al.*, 2003).

The first transect, of 25 traps, was from Somosomo Village along the coastal road to Waiyevo (Fig. 1). This is one of the busiest areas on the island. It has two jetties and includes the town rubbish dump and the main shopping centre at Naqara. The Lele Jetty is the arrival point for the ferry from Vanua Levu. The older jetty, 800 m to the north, is used by people arriving in smaller boats from the islands of Vanua Levu, Kioa and Rabi, all of which already harbour the mongoose. There are no bio-security controls between the islands for non-agricultural animals and plants. The second transect, of 15 traps, was from sea level to an altitude of 500 m within Soqulu Estate (Fig. 1). The traps were placed at the forest edge.

All traps were spaced 200 m apart and checked daily. They were baited with tinned fish and burnt coconut (Gorman, 1975). The sex, weight, and morphological measurements of all mammals caught were recorded. All animals captured were killed humanely, as the local community considered them unwanted pests.

No mongooses were captured in 204 corrected trap nights (which take into account sprung traps; Nelson & Clark, 1973). Five traps were interfered with on various days and it is not known whether these traps caught any animals. Eight cats and 11 *R. rattus* were caught.

Mongoose are frequently seen during the day (Buskirk *et al.*, 1990; Palomares & Delibes, 1992), especially around human settlements (Gorman, 1979). Eighteen people, including the local District Officer, the Turaga ni Koro (village headmen) of four villages, and several drivers who frequently use the main road were asked if they had ever seen a mongoose on Taveuni. A further 13 people that worked on Soqulu Estate, including the estate manager and several grounds people, were also questioned. All 31 people questioned stated they have never seen a mongoose on Taveuni.

I have been back to Taveuni twice since this trapping survey, in May and July 2003, and again I asked 18 local people, 10 of whom I questioned in 2002, if they had seen

any mongoose, and they all indicated they had not. A group of five postgraduate students from the University of the South Pacific, Suva, searching for the Fijian ground frog on Taveuni for three consecutive weeks in January 2004 did not see any mongoose (J. Kuruyawa, pers. obs.).

Although further trapping surveys in other areas of potentially suitable mongoose habitat are required, together the trapping results and personal communications suggest that, despite reports, the mongoose is not present on Taveuni. This is important for two reasons. Firstly, we now have a date on which the mongoose was apparently absent and, secondly, this information can now be used to instigate measures to prevent any incursions by the mongoose. It is easier to eradicate a few mongooses than a well-established population (Simberloff, 2003).

Of some concern are reports of mongoose being deliberately released onto mongoose-free islands. Village elders on the islands of Beqa and Kioa both claim that fishermen from neighbouring islands deliberately released mongooses onto the islands in retaliation for losing fishing rights (Beckon, 1988). An alternative possibility is that during a major cyclone in 1964 mongooses could have travelled on rafts of debris down the Navua River of Viti Levu and across to Beqa Island. There is a record of a cow from Viti Levu being swept down this river and out into the Beqa Lagoon, which separates Viti Levu from Beqa, during this cyclone (P. Saville, pers. comm.). Vanua Levu, Kioa and Rabi are even closer to Taveuni than Beqa is to Viti Levu, and it is conceivable that mongooses could be carried in this manner across the Somosomo Strait to Taveuni.

With a large amount of boat and aircraft traffic between the islands it is doubtful whether Taveuni will remain mongoose-free unless a management strategy is put in place to prevent incursions. The first five recommendations below are preventative measures that need to be instigated, and the last two must be implemented if mongooses ever arrive.

1. Bait stations or tracking tunnels (for recording animal footprints) should be placed near all ports of entry. A simple wire stake baited with burnt coconut would be suitable to determine if mongooses are present.
2. Large, permanent, weatherproof posters, in the three languages of the islands (Fijian, Hindi and English), with a photograph and general description of the mongoose should be placed at all ports of entry, in local villages and in schools. The posters should have information on who to contact if any mongooses are seen (see recommendation 6).
3. Drivers of carriers, taxis, and resort vehicles should be taught how to identify the mongoose.

4. There should be random bio-security searches on vessels travelling from Vanua Levu, Kioa and Rabi to Taveuni.
5. Trapping surveys should be carried out on Taveuni at least once per year.
6. The Roko Tui (chief provincial administrator of Cakaudrove, which includes the island of Taveuni) and the District Officer of Waiveyo should be the first people contacted if any mongoose are seen. A toll-free phone number should be available for the public to report any sightings.
7. A task force should be formed to trap any mongoose, possibly using a trained dog handler, whenever a possible sighting is reported.

These recommendations will require less effort and be far cheaper than the cost of eradicating the mongoose. The recommendations are also equally applicable to the other apparently mongoose-free Fijian islands, especially Kadavu, Lau, Vatulele, and the Mamanuca and Yasawa island groups.

Acknowledgements

I thank the Wildlife Conservation Society (Fiji) for funding this research and the Roko Tui Cakaudrove, the District Officer at Waiveyo and Peter Stinson (Taveuni Estate Ltd) for granting me permission to work on their land. I also thank Joseph Brider and Maba Vakacegu, who provided assistance in the field, and Joape Kuruyawa and the BP Frog Team for their observations.

References

- Atkinson, I.A.E. (1989) Introduced animals and extinctions. In *Conservation in the Twenty-first Century* (eds D. Western & M.C. Pearl), pp. 54–75. Oxford University Press, Oxford, UK.
- Beckon, W. (1988) *Distribution of Land Birds in Fiji. A Provisional Annotated List, by Island*. Unpublished Report. University of California, Davis, USA.
- Buskirk, S.W., Delin, W.U. & Cleveland, A. (1990) Diel activity pattern of two female small Indian mongooses (*Herpestes auropunctatus*) in relation to weather. *Zoological Research*, **11**, 355–357.
- Ceballos, G. & Brown, J.H. (1995) Global patterns of mammalian diversity, endemism and endangerment. *Conservation Biology*, **9**, 559–568.
- Coblentz, B.E. & Coblentz, B.A. (1985) Control of the Indian mongoose *Herpestes auropunctatus* on St John, US Virgin Islands. *Biological Conservation*, **33**, 281–288.
- Courchamp, F., Chapuis, J.-L. & Pacsal, M. (2003) Mammal invaders on islands: impacts, control and control impact. *Biological Review*, **78**, 347–383.
- Gorman, M.L. (1975) The diet of feral *Herpestes auropunctatus* (Carnivora: Viverridae) in the Fijian Islands. *Journal of Zoology*, **175**, 273–278.
- Gorman, M.L. (1979) Dispersion and foraging of the small Indian mongoose, *Herpestes auropunctatus* (Carnivora: Viverridae) relative to the evolution of social viverrids. *Journal of Zoology*, **187**, 65–73.
- Honegger, R.E. (1981) List of amphibians and reptiles either known or thought to have become extinct since 1600. *Biological Conservation*, **19**, 141–158.
- Lowe, S., Browne, M. & Boudjelas, S. (2000) *100 of the World's Worst Invasive Alien Species*. The Invasive Species Specialist Group, The University of Auckland, Auckland, New Zealand.
- Mooney, H.A. & Hobbs, R.J. (eds) (2000) *Invasive Species in A Changing World*. Island Press, Washington, DC, USA.
- Nelson, L.J. & Clark, F.W. (1973) Correction for sprung traps in catch/effort calculations of trapping results. *Journal of Mammalogy*, **54**, 295–298.
- Palomares, F. & Delibes, M. (1992) Circadian activity patterns of free-ranging large gray mongooses, *Herpestes ichneumon*, in southwestern Spain. *Journal of Mammalogy*, **7**, 173–177.
- Pernetta, J.C. & Watling, D. (1978) The introduced and native terrestrial vertebrates of Fiji. *Pacific Science*, **32**, 223–244.
- Simberloff, D. (1995) Why do introduced species appear to devastate islands more than mainland areas? *Pacific Science*, **49**, 87–97.
- Simberloff, D. (2003) How much information on population biology is needed to manage introduced species? *Conservation Biology*, **17**, 83–92.
- Vitousek, P.M., D'Antonio, C.M., Loope, L.L., Rejmanek, M. & Westbrooks, R. (1997) Introduced species: a significant component of human-caused global change. *New Zealand Journal of Ecology*, **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 and Futuna*. Environmental Consultants (Fiji) Ltd., Suva, Fiji.
- Watling, D. & Zug, G.R. (1998) *Annotated List and Conservation Status of Fijian Terrestrial Reptiles and Amphibians*. Fiji Biodiversity Strategy and Action Plan. Unpublished Report. Environmental Consultants (Fiji) Ltd., Suva, Fiji.
- Zug, G.R. (1991) *Lizards of Fiji: Natural History and Systematics*. Unpublished Report. Bishop Museum, Honolulu, USA.

Biographical sketch

Craig Morley's main field of research is the impact of invasive species on island biota. Currently he is working in Fiji on the conservation status of *Platymantis* frogs and the crested iguana *Brachylophus vitiensis*.