

The Indian brown mongoose, yet another invader in Fiji

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Abstract A thriving population of the Indian brown mongoose (*Herpestes fuscus*), native to southwest India and Sri Lanka, has been discovered on the island of Viti Levu in Fiji. This is the first known introduction of this species and may derive from a pair brought from an unknown source to a private zoo in the late 1970s. They co-occur on Viti Levu with the much smaller small Indian mongoose (*H. auro-punctatus*), and they are probably nocturnally active.

No research has been conducted on their activity, diet, or impact on Fiji.

Keywords Fiji · *Herpestes fuscus* · Mongoose

The Fiji islands comprise over 320 islands covering 1,290,000 km² (Watling 2001); the two largest islands are Viti Levu and Vanua Levu. The native terrestrial wildlife of the archipelago includes 6 mammals, 57 breeding landbirds, 150 recorded birds, 30 reptiles, and 3 amphibians, most of which are endemic. The mammals are all bats with one endemic species, the monkey-faced bat, *Pteralopex acrodonta* (Watling 2001). Humans introduced all other terrestrial mammals including rats *Rattus sp.*, cats *Felis catus*, dogs *Canis familiaris* and the small Indian mongoose *Herpestes auro-punctatus*, and these have had a major impact on the native fauna (Pernetta and Watling 1978).

Mongoose are small carnivores in the family *Herpestidae*. They are adapted to running along the ground, as they have long, slender bodies and short legs, perfect for scurrying and tunnelling. They can be found in a range of habitats from desert to forest. Most have a very high reproductive rate and breed 2–3 times a year, producing litter sizes of ca. 2–4 (Gilchrist et al. 2009). Mongooses are agile predators, feeding on a variety of small mammals, birds, reptiles, insects, crabs and bird eggs, but some also incorporate plant material into their diet.

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The small Indian mongoose has been introduced to many islands worldwide to control rats and snakes (Baldwin et al. 1952; Husson 1960; Hoagland et al. 1989; Morley 2004a, and see review in Simberloff et al. 2000). This species has been considered conspecific with *Herpestes javanicus* (Corbet and Hill 1992; Wozencraft 1993, 2005), so the latter name is often used in the literature for this introduced mongoose (e.g. Simberloff et al. 2000). A recent study has determined that the small Indian mongoose *H. auro punctatus* (distributed from India to Myanmar) is a separate species from the Javan mongoose *H. javanicus* (South-east Asia) (Veron et al. 2007, agreeing with Honacki et al. 1982). The identification of this species on Fiji has never been debated; authors have agreed that it is *H. auro punctatus*, and this has been confirmed by molecular data (Veron et al. 2007). Other introduced mongoose populations (such as those of the Caribbean Islands, the Hawaiian Islands, Croatia, Japan, Mauritius, and Guyana) also belong to this species (Veron et al. 2007).

A pair of small Indian mongooses was introduced to Fiji in 1883, on Ovalau (see Simberloff et al. 2000; Morley et al. 2007), but a genetic study has suggested multiple introductions into Fiji (Thulin et al. 2006). Ovalau nowadays lacks mongooses, but the small Indian mongoose is common on Viti Levu, Vanua Levu, and 11 other outer islands (Morley et al. 2007; Fig. 1). In Fiji, this species is believed to have extirpated the skinks *Emoia nigra* and *E. trossula* and possibly the banded rail (*Rallus philippensis*), sooty rail (*Porzana tabuensis*), white-browed rail (*Polio limnas cinereus*), purple swamphen (*Porophyrio porphyrio*) and bar-winged rail (*Nesoclopeus poecilopterus*) (Gorman 1975; Zug 1991; Hays and Conant 2007). It has also been implicated in the decline of native frogs (Kuruyawa et al. 2004), and the impact on some native birds seems demonstrated (Gorman 1975). Predation on some species of bats has been suggested (Palmeirim et al. 2007).

From August to September 2004, around the upper campus of the University of South Pacific Suva (on

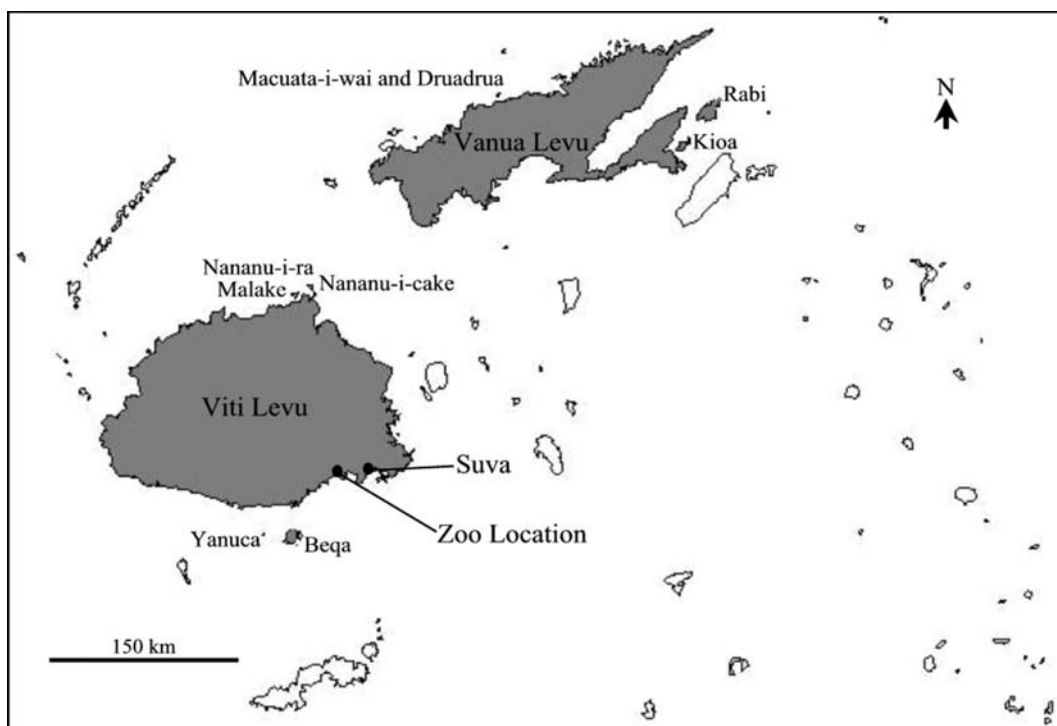


Fig. 1 Distribution of the small Indian mongoose (*Herpestes auro punctatus*) in Fiji (in grey, with the names of the islands where the species occurs), zoo location (see text), and location

of Suva, trapping site of the brown mongoose (*Herpestes fuscus*) (Morley 2004a; Morley et al. 2007; C. Morley, personal observation)



Fig. 2 Picture of individuals of the small Indian mongoose (*top*) and of the brown mongoose (*bottom*) trapped in Suva, Fiji (C. Morley)

Viti Levu; Fig. 1), 67 small Indian mongooses and six large, red-coloured mongooses were caught in traps (Morley et al. 2007; Fig. 2). These red mongooses were weighed, sexed and measured (Morley et al. 2007): the head and body length was 369 ± 4 mm for the females ($N = 3$), and 368 ± 6 mm for the males ($N = 3$), and the mean weight was 787 ± 93 g for the females ($N = 3$) and 910 ± 46 g for males ($N = 3$). Not only were the six red mongooses significantly larger than the *H. auropunctatus* specimens captured, but their coat colour was red instead of grey (see Morley et al. 2007).

A recent molecular study based on two mitochondrial (*Cytb* and *ND2*) and one nuclear (Beta Fibrinogen intron 7) genes, including most of the mongoose species, clearly identified the second red species from Fiji as the Indian brown mongoose *Herpestes fuscus* (Patou et al. 2009). It clustered with two specimens of *H. fuscus*, both from Sri Lanka (American Museum of Natural History specimen AMNH 217678, Field Museum Natural History specimen FMNH 95035; Patou et al. 2009). This identification fits with the morphological identification key provided by Corbet and Hill (1992) and with examination of museum specimens (GV, personal observation). This species may have been overlooked previously in the field because it appears to be nocturnal (see Gilchrist et al. 2009).

The Indian brown mongoose *H. fuscus* occurs naturally in southwest India and on Sri Lanka. This

species was previously considered conspecific with the short-tailed mongoose (*Herpestes brachyurus*) (Bechthold 1939; Wenzel and Haltenorth 1972), but this assignment is not supported by morphology (Corbet and Hill 1992; and GV, personal observation.) or molecular data (Patou et al. 2009). The Indian brown mongoose is a quite large, heavily built mongoose, with blackish-brown fur, speckled with yellow or tan, and the feet are darker than the body. The tail is bushy and conical, and about 60–70% the length of the head and body; the head and body length is 330–480 mm, the tail, 198–336 mm, the hind feet, 65–87 mm (Corbet and Hill 1992); weight is greater in India (2.7 kg in Prater 1971; 3.5 to 6 lbs [1.5–2.7 kg] in Pocock 1937, and NHM London specimens, G. Veron, personal observation) than in Sri Lanka (1.75–4 lbs [0.8–1.8 kg] in Pocock 1937). The body colour is variable: it is dark greyish brown with light creamy subterminal bands on their hair in India, while its colour varies from yellowish to reddish brown on Sri Lanka (Corbet and Hill 1992). However, owing to the paucity of museum specimens and observations in the wild, variation within this species should be studied further. The species is terrestrial and seems to live mainly in dense forests, but further information on its habitat is needed. Nothing is known about its diet (Gilchrist et al. 2009). It is believed to be solitary, and it appears to be nocturnal, based on a few camera-trap photographs (Mudappa 2001; Fieldtripearth 2008). It is said to breed in burrows beneath rocks and tree roots and to have three to four young (Mudappa 1998, 2001; Gilchrist et al. 2009). The species was recently moved from Data Deficient to Vulnerable (IUCN Red List 2008). Specific threats to this species are not known, but habitat loss, fragmentation, and degradation could have major impacts on populations.

This is the first record of the Indian brown mongoose out of its natural range, raising the question of when and how it reached Fiji. During intensive field work and trapping in Fiji in the early 1970s by Gorman (1979), no red mongoose were ever caught or observed. However, Ryan (1988) reported that both the small Indian mongoose and the Indian gray mongoose (*Herpestes edwardsii*) may occur sympatrically within Fiji. He observed “a large reddish coloured mongoose at Orchid Island Zoo” (i.e. on Viti Levu), which he suggested was *H. edwardsii* and that it may have been introduced

at the same time as the small Indian mongoose. The owner of Orchid Island Zoo remembered two red mongooses brought to the zoo in the late 1970s but did not know where these originated (Keith Watkins, personal communication). There are no official records regarding the introduction of *H. fuscus* into Fiji. Activity of this species in Fiji has not been studied, but it has been observed in the morning and evening. Its diet on Fiji is unknown. Whether there is an interaction or competition between the two species of mongooses on Fiji is unknown. As their activity periods may differ, there may be little interaction between the two species.

To date, we have no estimate of the size of population of *H. fuscus* in Fiji and of its impact on Fiji's native fauna. Research and funding are urgently needed to determine the current abundance, distribution and diet of this species, especially if it is nocturnal and may target a different suite of prey than that of *H. auropunctatus*. *H. fuscus* has so far been found only on Viti Levu, but with no inter-island biosecurity protocols or restrictions, it would be relatively easy for this mongoose to travel to Vanua Levu and even worse to Taveuni (Morley 2004a, b). Therefore, preventing any further incursions must be considered a priority.

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References

- Baldwin PH, Schwartz CW, Schwartz ER (1952) Life history and economic status of the mongoose of Hawaii. *J Mammal* 33:335–356
- Bechthold G (1939) Die asiatischen formen der Gattung *Herpestes*, ihre systematik, ökologie, verbreitung und ihre zusammenhänge mit den afrikanischen arten. *Z Säugetierkunde* 14:113–219
- Corbet GB, Hill JE (1992) The mammals of the Indomalayan region: A systematic review. Oxford University Press, Oxford
- Fieldtripearth www.fieldtripearth.com [downloaded on 19 December 2008]
- Gilchrist JS, Jennings AP, Veron G, Cavallini P (2009) Family Herpestidae. In: Wilson D, Mittermeier RA (eds) Handbook of the mammals of the world, vol 1, Carnivores. Lynx edicions, Barcelona, pp 262–328
- Gorman ML (1975) The diet of feral *Herpestes auropunctatus* (Carnivora: Viverridae) in the Fijian Islands. *J Zool* 175:273–278
- Gorman ML (1979) Dispersion and foraging of the small Indian mongoose, *Herpestes auropunctatus* (Carnivora: Viverridae) relative to the evolution of social viverrids. *J Zool* 187:65–73
- Hays W, Conant S (2007) Biology and impacts of Pacific island invasive species. 1. A worldwide review of effects of the small Indian mongoose, *Herpestes javanicus* (Carnivora: Herpestidae). *Pac Sci* 61:3–16
- Hoagland DB, Horst GR, Kilpatrick CW (1989) Biogeography and population biology of the mongoose in the West Indies. *Biogeography of the West Indies* 1989:611–634
- Honacki JH, Kinman KE, Koepl JW (eds) (1982) Mammal species of the world. Allen Press Inc. and the Association of Systematics Collections, Lawrence, KS
- Husson AM (1960) Het voorkomen van de Mungo in Surinam. *Lutra* 2:12–13
- IUCN Red List 2008. <http://www.iucnredlist.org>. Downloaded on 17th March 2009
- Kuruyawa J, Osborne T, Thomas N, Rounds I, Morrison C, Morley CG (2004). Distribution, abundance and conservation status of the Fijian Ground Frog (*Platymanthis vitanus*). Unpublished Technical Report for the BP Conservation Programme, 16 pp
- Morley CG (2004a) Has the invasive mongoose *Herpestes javanicus* yet reached the island of Taveuni, Fiji? *Oryx* 38:457–460
- Morley CG (2004b). Actions speak louder than words: a call for preventing further mongoose invasions in Fiji. In: Proceedings of the 21st vertebrate pest conference, Visalia, 1–4 March 2004, pp 37–41
- Morley CG, McLenachan PA, Lockhart PJ (2007) Evidence for the presence of a second species of mongoose in the Fiji Islands. *Pac Conserv Biol* 13:29–34
- Mudappa D (1998) Use of camera-traps to survey small carnivores in the tropical rain forest of Kalakad-Mundanthurai Tiger Reserve, India. *Small Carnivore Conservation* 18:9–11
- Mudappa D (2001) Ecology of the Brown Palm Civet *Paradoxurus jerdoni* in the tropical forests of the Western Ghats, India. Dissertation, Bharathiar University Coimbatore
- Palmeirim JM, Champion A, Naikatini A, Niukula J, Tuiwawa M, Fisher M, Yabaki-Gounder M, Thorsteinsdottir S, Qalovaki S, Dunn T (2007) Distribution, status and conservation of the bats of the Fiji Islands. *Oryx* 41:509–519
- Patou ML, Mclenachan PA, Morley CG, Couloux A, Cruaud C, Jennings AP, Veron G (2009) Molecular phylogeny of the Herpestidae (Mammalia, Carnivora) with a special emphasis on the Asian *Herpestes*. *Mol Phylogenet Evol* 53:69–80
- Pernetta JC, Watling D (1978) The introduced and native terrestrial vertebrates of Fiji. *Pac Sci* 32:223–244
- Pocock RI (1937) The mongooses of British India, including Ceylon and Burma. *J Bombay Nat Hist Soc* 39:211–245
- Prater SH (1971) The book of Indian animals. Bombay Natural History Society, Oxford University Press, Bombay
- Ryan P (1988) Fiji's natural heritage. Southwestern, Auckland
- Simberloff D, Dayan T, Jones C, Ogura G (2000) Character displacement and release in the small Indian mongoose, *Herpestes javanicus*. *Ecology* 81:2086–2099
- Thulin CG, Simberloff D, Barun A, McCracken G, Pascal M, Islam MA (2006) Genetic divergence in the small Indian

- mongoose (*Herpestes auropunctatus*), a widely distributed invasive species. *Mol Ecol* 13:3947–3956
- Veron G, Patou M, Pothet G, Simberloff D, Jennings A (2007) Systematic status and biogeography of the Javan and small Indian mongooses (Herpestidae, Carnivora). *Zool Scr* 36:1–10
- 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 Consultant (Fiji) Ltd, Suva, Fiji
- Wenzel E, Haltenorth T (1972) System der Schleichkatzen (Viverridae). *Säugetierkunde Mitt* 20:110–127
- Wozencraft CW (1993) Order Carnivora. In: Wilson DE, Reeder DM (eds) *Mammal species of the world*, 2nd edn. Smithsonian Institution, Washington, DC, pp 279–348
- Wozencraft CW (2005) *Mammal species of the world*. In: Wilson DE, Reeder DM (eds) *A taxonomic and geographic reference*, 3rd edn. Smithsonian Institution Press, Washington & London
- Zug GR (1991) *The lizards of Fiji: Natural history and systematics*. Bishop Museum Press, Honolulu