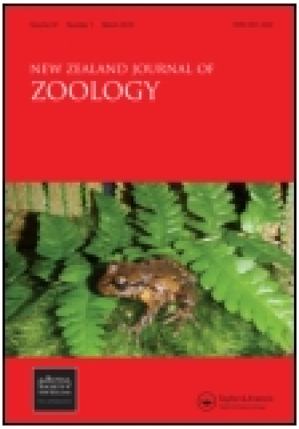

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A new location record for kiore (Rattus exulans) on New Zealand's South Island

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A new location record for kiore (*Rattus exulans*) on New Zealand's South Island

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Abstract Thirteen kiore (*Rattus exulans*), also known as the Pacific or Polynesian rat, were trapped in Waitutu Forest, Southland, New Zealand in November 2002 and February 2003. This is a new mainland location for kiore, approximately 75 km south of the closest recorded extant population in the Borland Valley. Kiore remained undetected at Waitutu Forest during the first 18 months of trapping, until the population responded to tree seeding. Morphological characters of the trapped animals are compared with those of previously reported kiore and ship rats (*R. rattus*), to aid in the correct identification of future captures. Kiore may be more widespread in mainland New Zealand than presently known for reasons of misidentification or trapping when numbers are very low.

Keywords *Rattus exulans*; kiore; Polynesian rat; misidentification; seeding; Waitutu Forest

INTRODUCTION

Kiore (*Rattus exulans*) were introduced to New Zealand by Polynesians at least 700–750 years ago and perhaps as long as 2000 years ago (see Holdaway et al. 2002). New Zealand forests were previously devoid of rodents and, in fact, all terrestrial mammals (apart from bats). Kiore were able to exploit abundant plant seeds, small vertebrates and invertebrates, and they invaded the intact forests of New Zealand's main islands and many offshore islands. Records from as late as 1890 report plagues of kiore in beech forests (*Nothofagus* sp.) during high seedfall years (see Atkinson & Moller 1990).

House mice (*Mus musculus*), ship rats (*R. rattus*), Norway rats (*R. norvegicus*) and stoats (*Mustela erminea*) were introduced by Europeans during the period 1792–1860. These animals also invaded forest areas and have been held responsible for the demise of kiore on the mainland. Taylor (1975) suggested that these four rodent species could not coexist in New Zealand environments.

Today kiore are present on some offshore islands but are known to survive in only a handful of isolated locations in the south-west of the South Island (Fig. 1): (A) Jackson Bay (Choate 1965; Robertson & Meads 1979, cited in Atkinson & Moller 1990); (B) Hollyford Valley (Taylor 1975; King & Moller 1997; W. A. Ruscoe pers. obs. 1999–2003); (C) coastal and inland valleys of Milford Sound (Taylor 1975); (D) Takahe Valley in the Murchison Mountains (cited in Atkinson & Moller 1990); (E) Doubtful Sound and Lake Manapouri (Watson 1956); and (F) Borland Valley (King 1983). Because kiore and ship rats are morphologically similar, it is possible that kiore have been misidentified as ship rats in the past, and may in fact be more widespread on the New Zealand mainland. See Atkinson & Moller (1990) and Atkinson & Towns (2001) for a full review of kiore in New Zealand.

STUDY SITES AND METHODS

As part of a detailed forest ecosystem study, nine rodent trapping grids were established in Waitutu Forest (46°14.4′S, 167°3.9′E; 46°15.7′S, 167°12.9′E, Fig. 1). Live-trapping of rodents using Elliott Scientific rat traps ($300 \times 100 \times 100$ mm), was undertaken at 6-monthly intervals between May 2001 and November 2002 and then in February 2003, totalling 13 440 trap nights. All animals were ear-tagged and released.

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All trapped rats were identified, weighed, measured, and the sex recorded. The measurements of kiore are reported in Table 1. The characters that were used to distinguish kiore from ship rats, the most similar rat species present in Waitutu Forest, include: (1) ear morphology (kiore ears barely cover the eyes when pulled forward, whereas ship rat ears are larger and cover the eye completely when pulled forward); (2) tail length to head-body length ratio (kiore adults usually have a shorter tail than head-body length, whereas adult ship rats usually have a longer tail than head-body); and (3) foot coloration (kiore hind feet are dark near the ankle, have a white stripe along the outside of the foot and white toes

Table 1 Body measurements and sex of the trapped kiore (*Rattus exulans*) from Waitutu Forest, November 2002 and February 2003.

Animal tag no.	Date trapped	Sex	Reproductive condition*	Head-body length (mm)	Tail length (mm)	Weight (g)
162	20 Nov 2002	Female	Perforate	115	110	37
089	20 Nov 2002	Female	Pregnant	130	–	61
159	21 Nov 2002	Male	Scrotal	100	92	25
041	22 Nov 2002	Male	Scrotal	135	125	57
033	22 Nov 2002	Male	Scrotal	128	120	52
039	22 Nov 2002	Male	Scrotal	125	118	51
038	24 Nov 2002	Male	Scrotal	120	110	53
215	24 Feb 2003	Female	Imperforate	100	95	24
009	24 Feb 2003	Male	Abdominal	121	110	37
637	26 Feb 2003	Male	Abdominal	110	110	33
447	26 Feb 2003	Male	Abdominal	100	90	22.5
691	27 Feb 2003	Female	Perforate	116	110	37
611†	27 Feb 2003	Male	Scrotal	122	106	33

*Females: vagina imperforate or perforate, visibly pregnant, or lactating. Males: testes scrotal or abdominal.
†Animal removed for independent identification.
–, Not recorded.

Table 2 Body measurements (mean and range) of adult male kiore in New Zealand.

Location	Head-body length (mm)	Tail length (mm)	Weight (g)	Sample size
Stewart Island* (47°S)	126 (109–144)	140 (125–163)	76.9 (55–97)	28
Waitutu Forest† (46°15′S)	120 (100–135)	111 (92–125)	43.5 (23–57)	6
Borland Valley§ (45°45′S)	140	124	46.3	1
Hollyford Valley§ (44°45′S)	142 (121–150)	124 (118–127)	42.3 (29.5–69)	5
Kapiti Island* (40°52′S)	149 (128–177)	154 (129–171)	91.1 (55–130)	35
Marotiri Island* Chickens group (35°53′S)	158 (123–175)	165 (141–180)	134.5 (80–187)	76
Macauley Island* Kermadec group (30°S)	133 (122–144)	158 (148–164)	84.0 (74–104)	15

*Taken from Atkinson & Moller (1990).
†Only scrotal males from Waitutu Forest were identified as "adults".
§For comparison with other mainland populations (King & Moller 1997). Males only, reproductive status not reported.

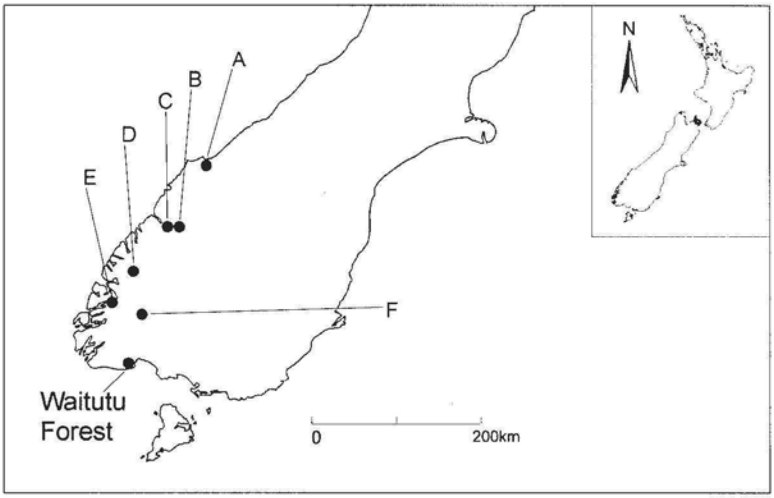

Fig. 1 Current known distribution of kiore in the southern South Island. Waitutu Forest is shown in relation to previously known populations (Locations A–F listed in text, taken from Atkinson & Moller 1990).

compared with those of ship rats which are a single, usually dark colour). There is considerable variation in the above characteristics, but although the kiore pelage is similar in colour to that of the "alexandrinus" morph of the ship rat, kiore can be reliably distinguished from ship rats from the belly fur colour (kiore have grey fur that is white-tipped whereas ship rat belly fur is uniform in colour). Atkinson & Moller (1990) give a full comparison of distinguishing marks of all rodent species in New Zealand.

RESULTS

Although trapping began in May 2001, it was not until November 2002 that any rats (either kiore or ship rats) were trapped. They appeared after a very heavy rimu (*Dacrydium cupressinum*) seedfall in winter and spring 2002. Both miro and Hall's totara produced some seed, but there was very little beech seed produced in 2002. In November 2002, 7 kiore and 1 ship rat were trapped. In February 2003, 6 new kiore and 1 new ship rat were trapped.

Twelve of the kiore were trapped on grids in relatively open forest dominated by rimu, silver beech (*Nothofagus menziesii*), mountain beech (*N. solandri* var. *cliffortioides*), miro (*Prumnopitys ferruginea*), Hall's totara (*Podocarpus hallii*), kamahi (*Weinmannia racemosa*), and rata (*Metrosideros umbellata*) in the canopy and subcanopy, and the fern *Blechnum* "capense" and moss on the ground. The 13th kiore was trapped on an alluvial river terrace dominated by dense cover of crown fern (*B. discolor*) and tree ferns (*Dicksonia squarrosa* and *Cyathea smithii*) with rimu, kamahi, and silver beech in the canopy. House mice were trapped in large numbers in November 2002 and February 2003, both in the open forest and the alluvial river terrace grids (Ruscoe et al. unpubl. data).

The body measurements of the six adult male kiore trapped in Waitutu Forest (Table 1) can be compared with those of adult male kiore caught in other locations (Table 2).

One kiore (Tag no. 611) was removed from Waitutu Forest for independent identification. It was a male with testes classed on the borderline between abdominal and scrotal. In addition to measurements reported in Table 1, it had an ear length of 17 mm and a hind foot length (without claw) of 24 mm. This hind foot measurement was at the lower end of the range for kiore foot length (cf. Watson 1956).

The ship rat trapped in November 2002 was a large scrotal male (head-body = 170 mm, tail = 190 mm, weight = 128 g) trapped on an alluvial river terrace grid. A juvenile male ship rat was trapped in February 2003 (head-body = 104 mm, tail = 104 mm, weight = 28 g) on an open-forest grid.

DISCUSSION

The 13 kiore trapped in Waitutu Forest were generally smaller than those reported from elsewhere in New Zealand. There appears to be a geographic cline in the average size of adult kiore in New Zealand, with those from southern locations (Stewart Island, Waitutu Forest, and Hollyford Valley) being smaller in both weight and head-body length than kiore trapped from further north (Kapiti Island, and the Chickens and Kermadec groups), contradicting Bergmann's Rule. By contrast, Yom-Tov et al. (1999) showed that skull length of kiore is negatively correlated with the presence of the other three species of rodents in New Zealand. This may explain why kiore are smaller on Stewart Island and in Fiordland, including Waitutu Forest where other rodent species are found, than on Kapiti, Marotiri, and Macauley Islands where the other rodent species are absent. The kiore in southern locations are more similar in body size to *Rattus exulans* in the Pacific Islands, many of which also have ship rats and mice.

We compared the measurements of adult kiore captured in Waitutu Forest (Table 1) with adult ship rats caught in the Eglinton Valley, another Fiordland location, between 1999 and 2002 (W. A. Ruscoe pers. obs.). Male rodents are easily identified as adult rather than juvenile by the presence of scrotal testes. For scrotal-male ship rats, the smallest head-body lengths and weights were: 135 mm, 127 g; 140 mm, 105 g; 145 mm, 106 g; and 150 mm and 97 g. The smallest scrotal-male ship rats reported by King & Moller from the Hollyford Valley, Fiordland (in Innes 1990), were 183 mm in head-body length and 104 g in weight. This may represent the minimum size male ship rats need to attain to become reproductively active. These weights all exceed the largest kiore measurements from Waitutu Forest (Table 1). The scrotal-male ship rat trapped in Waitutu was similar in weight to adult male ship rats trapped in Eglinton Valley. This suggests that there is a size difference between adult kiore and adult ship rats in Fiordland. On the other hand, the juvenile ship rat trapped in Waitutu was similar in size to kiore trapped in Waitutu Forest and indeed other parts of Fiordland. The overlap in size and coloration between kiore and the "alexandrinus" morph of ship rats emphasises the potential for confusion between the two species. In this particular case, the juvenile ship rat trapped in Waitutu Forest was of the "rattus" morph (black back and slate-grey belly) and therefore easily distinguished from kiore.

Kiore were thought to be extinct on the Chatham Islands (Atkinson & Moller 1990), but were rediscovered during recent monitoring programmes (Atkinson & Towns 2001). It is thought that their "extinct" status on the Chatham Islands was due to infrequent monitoring and misidentification (P. J. Dilks unpubl. data). If we had been trapping in Waitutu Forest for the first 12 months of this study only, we would have failed to find kiore (and ship rats, and the large numbers of mice that appeared in November 2002). These records emphasise the sporadic nature of rodent population eruptions in New Zealand forests (King & Moller 1997). During this "low phase" in population numbers, rodents of all species were present somewhere, perhaps confined to small isolated refugia where we were not trapping. It took a widespread heavy rimu seedfall to either directly or indirectly (via a consequent increase in invertebrate abundance) allow the population increase in numbers and distribution, sufficient for us to detect them. Whereas house mouse and kiore population eruptions are well known from beech forests, their dramatic response to a heavy rimu seedfall has not previously been documented (Ruscoe et al. unpubl. data).

CONCLUSIONS

This study extends the known current distribution of kiore in the south-west of New Zealand's South Island. It is possible that kiore are actually more widespread on the mainland than previously thought. The lack of distribution records of kiore may be due to misidentification, because their pelage colour and body measurements overlap with ship rats, or to the inability of short-term monitoring programmes to detect patchy, scarce kiore populations.

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REFERENCES

Atkinson, I. A. E.; Moller, H. 1990: Kiore. *In*: King, C. M. *ed*. The handbook of New Zealand mammals. Auckland, Oxford University Press. Pp. 175–192.

Atkinson, I. A. E.; Towns, D. R. 2001: Advances in New Zealand mammalogy 1990–2000: Pacific rat. *Journal of the Royal Society of New Zealand 31*: 99–109.

Choate, T. 1965: Mammal and bird studies at Jackson's Bay. *Science Record 15*: 59–61.

Holdaway, R. N.; Roberts, R. R.; Beavan-Athfield, N. R.; Olley, J. M.; Worthy, T. H. 2002: Optical dating of quartz sediments and accelerator mass spectrometry ^{14}C dating of bone gelatin and moa eggshell: a comparison of age estimates from non-archaeological deposits in New Zealand. *Journal of the Royal Society of New Zealand 32*: 463–505.

Innes, J. G. 1990: Ship rat. *In*: King, C. M. *ed*. The handbook of New Zealand mammals. Auckland, Oxford University Press. Pp. 206–225.

King, C. M. 1983: The relationships between beech (*Nothofagus* sp.) seedfall and populations of mice (*Mus nusculus*), and the demographic and dietary responses of the stoat (*Mustela erminea*), in three New Zealand forests. *Journal of Animal Ecology 52*: 141–166.

King, C. M.; Moller, H. 1997: Distribution and response of rats *Rattus rattus*, *R. exulans* to seedfall in New Zealand beech forests. *Pacific Conservation Biology 3*: 143–155.

Taylor, R. H. 1975: What limits kiore (*Rattus exulans*) distribution in New Zealand? *New Zealand Journal of Zoology* 2: 473–477.

Watson, J. S. 1956: The present distribution of *Rattus exulans* (Peale) in New Zealand. *New Zealand Journal of Science and Technology 37*: 560–570.

Yom-Tov, Y.; Yom-Tov, S.; Moller, H. 1999: Competition, co-existence, and adaptation amongst rodent invaders to Pacific and New Zealand islands. *Journal of Biogeography 26*: 947–958.