## REFERENCES


ATKINSON, I. A. E., 1964. Feeding stations and food of North Island saddleback in August. *Notornis* 11: 93–97.

ATKINSON, I. A. E., 1966. Feeding stations and food of North Island saddleback in May. *Notornis* 13: 7–11.

BLACKBURN, A., 1964. Some observations on behaviour of the North Island saddleback in August. *Notornis* 11: 87–92.

BULLER, W. L., 1888. *A history of the birds of New Zealand* Vol. 1. Second edition. London.

GIBB, J. A., 1961. Ecology of the birds of Kaingaroa forest. *Proc. N.Z. Ecol. Soc.* 8: 29–38.

HINDWOOD, K. A., 1940. Birds of Lord Howe Island. *Emu* 40: 1–86.

LACK, D., 1942. Ecological features of the bird faunas of British small islands. *J. Anim. Ecol.* 11: 9–36.

LINDSAY, C. J., and ORDISH, R. G., 1964. The food of the morepork. *Notornis* 11: 154–158.

MAYR, E., 1942. *Systematics and the origin of species.* Columbia University Press. New York.

MERTON, D. V., 1966a. Transfer of saddlebacks from Hen Island to Middle Chicken Island January, 1964. *Notornis* 12: 213–222.

MERTON, D. V., 1966b. Some observations of feeding stations, food and behaviour of the North Island saddleback on Hen Island in January. *Notornis* 13: 3–6.

OLIVER, W. R. B., 1955. *New Zealand birds.* Second edition. A.H. and A.W. Reed, Wellington.

REISCHEK, A., 1887. Ornithological notes. *Trans. N.Z. Inst.* 19: 188–193.

SKEGG, P. D. G., 1964. Birds of the Hen and Chicken Islands. *Notornis* 11: 159–176.

STEAD, E. F., 1937. The Maori rat. *Trans. N.Z. Inst.* 66: 178–181.

TURBOTT, E. G., 1947. Birds of Little Barrier Island. *N.Z. Bird Notes* 2: 92–108.

WODZICKI, K. A., 1950. Introduced Mammals of New Zealand. *Dep. Sci. Industr. Res. Bull.* 98.


# A FIELD TRIAL OF A NEW RAT POISON, COMPOUND S-6999, ON BROWN RATS


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## INTRODUCTION

The problem of introduced rats endangering the survival of rare birds is a very real one. This is shown by a recent depressingly long list of birds known to have become extinct since 1600, prepared by Vincent (1965) of the International Union for the Conservation of Nature and Natural Resources. Vincent shows that rats and other introduced predators have been directly responsible for the extinction of at least 30 species and subspecies of birds in that time, and probably of twice or three times that number. Several rare species and subspecies of birds surviving on New Zealand's off-shore islands are likewise in danger of extermination by rats.

A recent survey of Big South Cape Island off Southwest Cape, Stewart Island (Blackburn 1965) revealed that six species and subspecies of birds have either been exterminated or driven close to extermination on this island by rats during the past two years. Merton (1965) noted that the black rat *(Rattus rattus)* was responsible.

Following an ecological study of the brown rat *(Rattus norvegicus)* on Mokoia Island, Lake Rotorua (Beveridge and Daniel 1965), the opportunity arose, through the courtesy of the Australian manufacturers, to conduct acceptance trials of a unique new rat poison called "Raticate" which contains 1% of the organic compound S-6999† w./w. in maize. Trials with compound S-6999 (also called norbormide) to control brown rats in the United States have been described by Crabtree *et al* (1964). The present paper describes two acceptance trials with brown rats carried out on Mokoia Island from November 1965 to January 1966.

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† The chemical formula for this compound is:— [5–(alpha–Hydroxy– –phenyl–alpha [2–pyridyl] methyl) –7–(phenyl–2–pyridylmethylene)–5–norbornene–2, 3–dicarboximide]

The $LD_{50}$ of compound S-6999 for *Rattus norvegicus* is 15 mg./kg., and at a concentration of 1% it is a highly specific poison for rats. The manufacturers claim that Raticate baits are harmless to other mammals, including mice and humans, and to birds.

Raticate baits are normally distributed merely by placing on the ground the sealed Glassine envelopes, each containing 2 g. of bait (Fig. 1); this quantity is said to be a lethal dose for four average-sized rats. The average-sized brown rat on Mokoia Island weighs 200 g., and the $LD_{50}$ of Raticate bait for such specimens would thus be 0.3 g. Death is said to occur 15 minutes to 4 hours after a lethal dose has been eaten.

## METHODS

Acceptance of Raticate bait was tested on two lines, each consisting of 100 bait stations spaced at intervals of approximately 20 ft. The "hill line" followed a track leading to the summit of the island and was situated entirely in second-growth forest. The "shore line" was 1-5 chains from the lake edge, partly in a grassed area at the forest margin and partly within the forest.

The main trial was carried out from 22 November to 6 December 1965. Non-poisonous baits were placed at the 200 stations for four nights before and three nights after the laying of Raticate baits. On two nights preceding the Raticate test, non-poisonous baits were placed in Raticate envelopes. Empty Raticate envelopes were also put out for one night before they were associated with food. The laying of non-poisonous baits served several purposes:

1. To accustom the rats to the presence of food and Raticate envelopes at the bait stations before laying poison.
2. To determine the number of stations visited by rats before and after poisoning.
3. To find out whether the envelopes had anything to do with acceptance of bait contained in them.

The non-poisonous baits consisted of either *Pinus radiata* seed coated with a white bird repellent containing thiram, or peanut butter. Both these baits were known to be palatable to wild brown rats on Mokoia Island. *Pinus radiata* seeds are opened in a typical manner by brown rats.

Packeted Raticate baits were first put out on 28 November at the rate of one packet per station, and the packets were replaced daily for five consecutive days. Each morning an inspection was made of the packets placed overnight, and acceptance of bait was recorded. Raticate packets were pegged to the ground with a wire bearing the station number. At each bait station a small patch of leaf litter or grass was cleared away to expose the topsoil.

One female brown rat of average size (200 g.) trapped on the island was kept in captivity for five days and then given Raticate bait to observe its effect.

On 21 December, 50 "break-back" traps were set on each line and trapping success was recorded the following day.

On 26 January 1966 packets of Raticate bait were placed at stations without pegging, to determine whether or not rats would remove the packets and how much bait had been taken from opened packets. After two nights each opened packet was removed in a separate plastic bag and the bait remaining in it was oven-dried and weighed.

## RESULTS AND DISCUSSION

*Pinus radiata* seed was eaten by rats at a minimum of 50% of the stations before Raticate bait was placed. Seed was eaten when either enclosed in packets or unenclosed. Most seed was eaten on the spot, the opened seed coats remaining as evidence.

During the trial with Raticate, increasing interference by wekas *(Gallirallus australis)* to some extent confused the observations on acceptance of the bait by rats. Some packets damaged by wekas appeared to have been crumpled by beak or claw, with or without perforations; some had been torn across, or away from the attaching wire peg and it was difficult to determine whether rats had been present.

However, sufficient packets were typically damaged by rats to enable some conclusions to be made on acceptance of the bait (see Table 1).

Packets opened by rats had ragged holes; wekas made even-edged tears and punctures (Fig. 1). Mouse damage is similar to that done by rats, but in 620 rat-trap nights only four mice had been caught on Mokoia Island, all near huts.

Ant damage to packets was not observed during the main trial, although ants were occasionally recorded as present and, as the

later trial showed (26-28 January 1966), they could have removed some bait. In the main trial, however, many of the opened packets were in the rat-chewed condition shown in Figure 1, the amount of bait removed being roughly proportional to the shredded area of the packet.

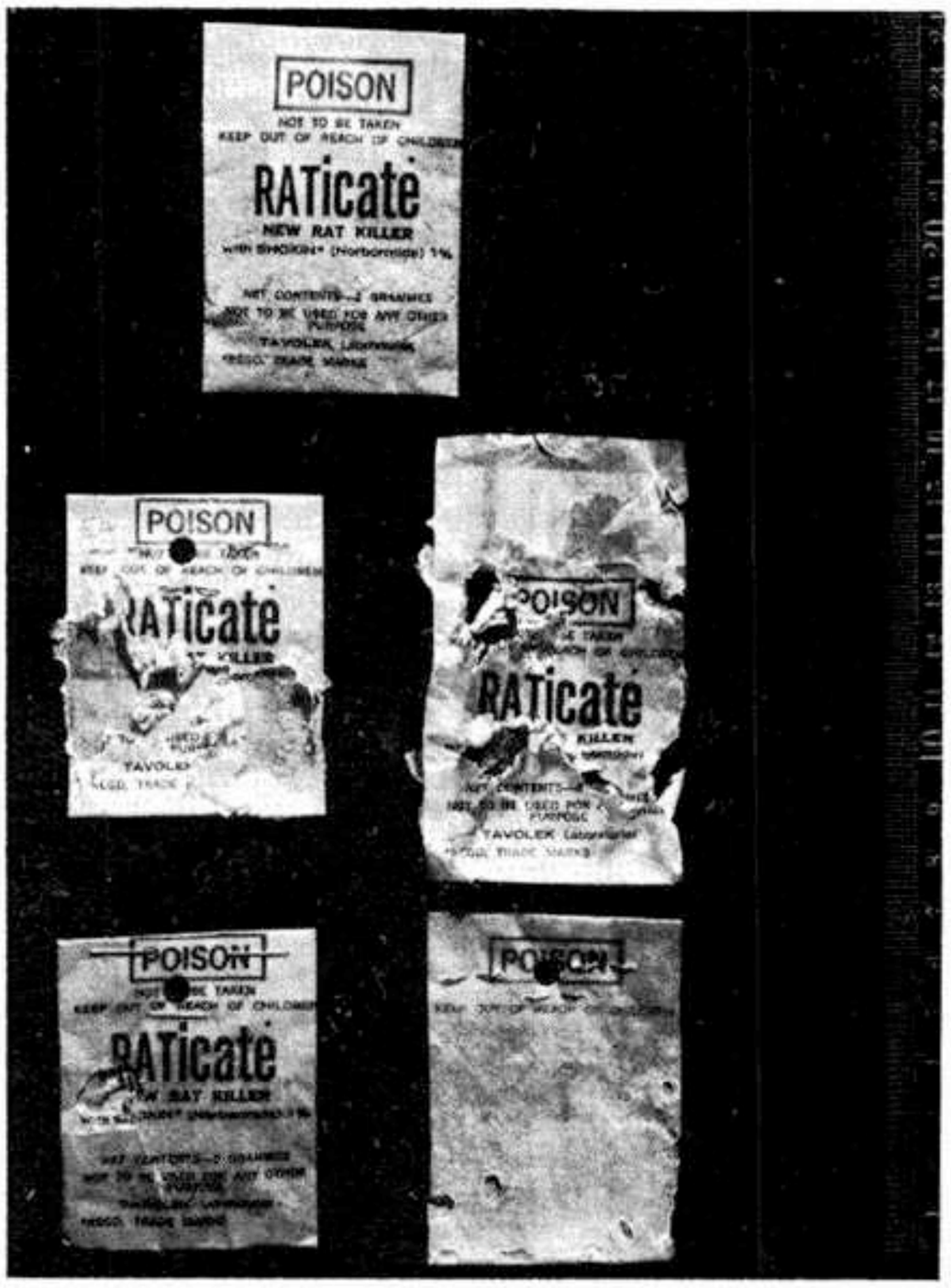


FIGURE 1. *Damage to Raticate bait packets. Middle left: opened by Mokoia Island brown rat. Middle right: opened by caged wild mouse. Lower left: damaged by weka. Lower right: opened by ants (lettering possibly bleached by sulphur fumes at Whakarewarewa).*

*Photo by T. Ransfield, N.Z. Forest Service.*

The amount of bait eaten by rats could not be accurately assessed, as some was often spilled from the packet and mixed with soil. Also, recent tests have shown that a packet may be almost emptied overnight by ants, identified by Mr. W. Faulds of the Forest Research Institute as *Monomorium antarcticum* (White). Of three species of ants found near packeted baits, this was the only one found eating bait inside the packets.

TABLE 1. *Opening of packets containing Raticate bait.*

Categories used at bait inspections

| | | | |
|---|---|---|---|
| O | packet opened | R | packet opened by rats |
| M | packet missing | W | packet opened by wekas only |
| U | packet undisturbed | A | packet opened by ants only |

| | | Main Trial November-December 1965 | | | Supplementary Trial January 1966 | | | |
|---|---|---|---|---|---|---|---|---|
| Date of placing packets | | 28 Nov. | 29 Nov. | 30 Nov. | 1 Dec. | 2 Dec. | 26 Jan. | |
| Date of opening packets | | 29 Nov. | 30 Nov. | 1 Dec. | 2 Dec. | 3 Dec. | 27 Jan. | 28 Jan. |
| | | *Hill Line* (100 stations) | | | | | | |
| No. of stations in category | O | 69 | 78 | 81 | 70 | (80) | (36) | (58) |
| " " | M | 2 | 0 | 0 | 1 | 2 | 2 | 8 |
| " " | U | 29 | 22 | 19 | 29 | 18 | 62 | 34 |
| " " | R | . . | . . | . . | . . | 61* | 9 | 13 |
| " " | W | . . | . . | . . | . . | 19 | 7 | 28 |
| " " | A | † | † | † | † | † | 20 | 17 |
| | | *Shore Line* (100 stations) | | | | | | |
| " " | O | 82 | 63 | 51 | 49 | (47) | (40) | (46) |
| " " | M | 2 | 1 | 1 | 1 | 0 | 1 | 3 |
| " " | U | 16 | 36 | 48 | 50 | 53 | 59 | 51 |
| " " | R | . . | . . | . . | . . | 37‡ | 17 | 17 |
| " " | W | . . | . . | . . | . . | 10 | 2 | 4 |
| " " | A | † | † | † | † | † | 21 | 25 |

* 51 of these packets were damaged by both wekas and rats.
† Not recorded during main trial.
‡ Four packets were damaged by both wekas and rats.

When damage to packets by wekas was taken into account, the percentage of stations at which there was evidence of bait acceptance by rats in the main trial was approximately 60% for the hill line and from 40% to 80% for the shore line. The lethal rat dosage of 0.5 g. was removed from at least half of the packets opened by rats, but the amount taken from each packet ranged from a very small amount to almost the whole contents.

In the second small trial (26-28 January 1966) there was no prebaiting, and packets were opened by comparatively few rats in a rather tentative manner. The mean weight of oven-dried bait removed from 14 packets opened by rats was 0.891 g. (range 0.103–1.473 g.). The mean weight of bait removed from eight packets opened by ants was 1.076 g. (range 0.583–1.633).

There was no evidence that wekas or pheasants ate either Raticate bait or the coated *Pinus radiata* seed that was placed to indicate the presence of rats. Wekas, but not rats, appeared to be attracted by the packets themselves, and from the pattern of packet damage it appeared that wekas were responsible for removing the few packets that disappeared altogether. Only 4% of the empty Raticate packets were damaged. Rats normally opened packets at the bait stations and rarely moved them more than a few feet.

Data summarised for the bait lines gave little indication of a decrease in rat activity during or immediately after the trial with Raticate baits, but such a decrease did, in fact, occur on sections of the line where prebaiting had shown that rats were initially most active; decrease in activity in these sections was masked by increased activity on other parts of the lines and by the interference of wekas.

Rats accepted both *Pinus radiata* seed and peanut butter when these baits were placed inside Raticate envelopes. Peanut butter was considerably more attractive to the rats than was Raticate bait; 90% of the packets containing it were opened in both prebaiting and post-baiting tests, and were often thoroughly shredded. The strong smell of peanut butter may have attracted rats and encouraged individuals to visit several bait stations.

During the poison trial only two dead rats were found, and both had sought cover. The single rat captured and fed with Raticate bait showed no ill effects from 0.25 g. of bait but died within 30 minutes of eating 0.5 g. The mean weight of bait from packets stored in a cardboard container was 2.83 g. and the mean oven-dry weight was 1.89 g., indicating a 50% moisture content for stored baits. The above points support statements by Crabtree *et al* (1964), that most rats poisoned with compound S-6999 seek cover before death, and that a sublethal dose does not affect subsequent acceptance of the bait.

On 21 December, 15 days after the last placement of poison bait, rats were caught in 36% of traps on the hill line and in 28% of traps on the shore line. No significant decrease in the rat population was expected from laying poison on two lines, and reinvasion could occur quickly from other parts of the 334 acre island.

The Raticate baits sometimes became sodden overnight with rain or dew even when packets were unperforated, and although some bait was eaten in such circumstances its palatability was probably affected. Rain fell on two of the five days of the main poison trial (0.8 in. on 28 November and 0.05 in. on 29 November); temperatures were mild, ranging from 39.9°F. to 71.8°F. (mean 58.1°).

## CONCLUSIONS

This trial indicated that brown rats in a forest habitat will accept packeted Raticate baits placed on the ground during summer. Data on acceptance were, however, confused by the opening of packets by wekas and the eating of bait by ants. Although a lethal dose was removed from a considerable proportion of the packets opened by rats, Raticate bait did not appear to be highly palatable to rats on Mokoia Island, especially when wet. Baiting in winter, when rats are bold and hungry, would probably be preferable to baiting in summer provided that baits were sheltered from rain and dew. If packeted baits are used, a period of prebaiting with farinaceous material is advisable. A concentrated Raticate bait is manufactured; this could be mixed with fresh bait suited to the locality (e.g. fish meal or peanut butter), and placed without envelopes. This would be particularly advisable if wekas were present. Acceptance of these poisoned baits in forested areas should be tested at various seasons.

The results of this single field trial should not be assumed to apply to urban areas. Further trials on islands are warranted, as several features of Raticate bait appear to make it promising for use in areas where bird life is threatened by rats.

## ACKNOWLEDGEMENTS

Assistance was given by staff of the Forest Research Institute. Raticate baits and envelopes were kindly supplied by Potter and Birks (N.Z.) Ltd.

## REFERENCES

BEVERIDGE, A. E., and DANIEL, M. J., 1965. Observations on a high population of brown rats (*Rattus norvegicus* Berkenhout (1767) on Mokoia Island, Lake Rotorua. *N.Z. J. Sci.* 8: 174–89.

BLACKBURN, A., 1965. Muttonbird Islands diary. *Notornis* 12: 191–208.

CRABTREE, D. GLEN, ROBISON, W. H., and PERRY, V. A., 1964. Compound S-6999 (McN-1025). New concept in rodent control. *Pest Control* 32 (5): 26–32.

MERTON, D. V., 1965. A brief history of the North Island saddleback. *Notornis* 12: 208–12.

VINCENT, J., 1965. List of birds either known or thought to have become extinct since 1600. *I.U.C.N. Bull.* 16 (special suppl.) 1–8.