C.T. EASON, G.R. WRIGHT, AND H. FITZGERALD

Manaaki Whenua Landcare Research New Zealand Ltd., P.O. Box 31-011, Christchurch, New Zealand.

SHORT COMMUNICATION

SODIUM MONOFLUOROACETATE (1080) WATER-RESIDUE ANALYSIS AFTER LARGE-SCALE POSSUM CONTROL

Summary: Successful possum control operations were conducted in 1990, using aerially-sown sodium monofluoroacetate (1080) possum baits, at Waipoua (85% kill) and on Rangitoto Island (93% kill). In Waipoua Forest Sanctuary, streams and rivers were monitored for 4 months after 100 tonnes of 1080 possum baits were sown over 17 000 ha of forest. At Rangitoto Island, adjacent to Auckland, surface and ground water samples were analysed for 6 months after 20 tonnes of 1080 possum baits were sown over the 2300 ha island. No 1080 was detected in the streams and rivers of the Waipoua forest or in the surface or ground water of Rangitoto Island.

Keywords: Sodium monofluoroacetate; poisoning of animal pests; contamination, water quality.

Introduction

In 1990 two major control operations using aerially-sown baits containing the poison 1080 were mounted against brushtail possums *(Trichosurus vulpecula* (Kerr)) in the kauri *(Agathis australis* Salisb.) mixed hardwood forests of Waipoua Forest Sanctuary (Northland) in September and against brushtail possums and rock wallabies *(Petrogale penicillata* (Griffith)) in the pohutukawa *(Metrosideros excelsa* Sol. ex Gaertn.) forests on the volcanic cone of Rangitoto Island (Hauraki Gulf) during November. Both these operations were successful, killing 85% of the possums at Waipoua and over 93% on Rangitoto. Within 6 months there was clear visual evidence of significant regeneration of browsed vegetation (Anne Stewart, Don McKenzie (D.O.C.), *pers. comm.)*

Despite the success of such operations, the use of 1080 still provokes controversy. The fate of 1080 in the soil has been well-established by research defining the degradation of this naturally-occurring fluoroacetate, which has evolved in plants apparently as a deterrent to browsing herbivores (Oliver, 1977). Sodium monofluoroacetate is water soluble and residues from uneaten baits leach into the soil where they are degraded to non-toxic metabolites by soil micro-organisms, including bacteria *(Pseudomonas)* and the common soil fungus *(Fusarium solani)* (David and Gardiner, 1966; Bong, Cole and Walker, 1979; Walker and Bong, 1981). An overseas study has shown that 1080 could not be detected in streams over a 5-month period after a large-scale rodent control operation (Saito, Kitayama and Misawa, 1966). However, public concern over possible contamination of waterways is less easy to allay in New Zealand where the little work done has not yet been published.

Because of continuing anxiety over the fate of 1080, the likely continued use of 1080 in the 1990s as an essential tool in possum and tuberculosis control in New Zealand, and the lack of formally published data in New Zealand on 1080 residues in water, we undertook water-residue analysis for the Department of Conservation after both the Waipoua and the Rangitoto operations. The Rangitoto operation was of particular interest because of the scarcity of soil on the island, the concomitant lack of soil micro-organisms, and the possibility that 1080 could percolate through the lava to the water table - it could be considered a potential 'worst-case'.

This research note reports the water-residue analysis undertaken using analytical techniques that have the ability to detect 1080 at extremely low concentrations in water (Ozawa and Tsukioka, 1987).

Methods

Cereal-based possum baits for both control operations were obtained from the Animal Control Products factory, Wanganui. Baits containing 0.08% w/w 1080 were aerially sown (by fixed-wing plane or helicopter) over Waipoua forest at 5-6 kg per hectare. On Rangitoto Island baits were sown at the higher rate of approximately 14 kg per hectare because it was perceived that baits might fracture or be lost in cracks on the broken lava surface of the island. The possum-poisoning campaign in 17000 ha of Northland's Waipoua forest used 100 tonnes of cereal-bait pellets (equivalent to 80 kg of 1080 powder). At Rangitoto Island, 20 tonnes of cereal-bait pellets (equivalent to 16 kg of 1080 powder) were sown over 2300 ha.

Single water samples (250 cm^3) were taken from six streams in Waipoua Forest immediately after the application of bait, after the first major rainfall, and on two further occasions during the first 6 weeks after the

operation. Samples were then collected monthly (September 1990 to December 1990) from the same six sites. Single water samples (250 cm^3) were taken from each of four sites on Rangitoto Island twice during the first month after the bait drop. Further samples were collected monthly from November 1990 to April 1991. The sampling points selected on Rangitoto Island were the causeway adjacent to Motutapu Island, the raupo swamp area on the north-west coast of the island, a drinking fountain, and the wharf bore. Water samples from the causeway and the raupo swamp were representative of surface water. Samples from the drinking fountain and the wharf bore were ground water from the water table beneath Rangitoto Island. A total of 24 samples were analysed from Rangitoto Island and 36 samples from Waipoua Forest.

The water samples were analysed by a gas chromatography method with a level of detection of 0.001 ppm (Ozawa and Tsukioka, 1987). Any 1080 in the water sample is acidified with hydrochloric acid and converted to the dichloroanilide derivative by using dicyclohexylcarbodiimide (DCC) and 2,4-dichloroaniline (DCA). The derivative is extracted with ethyl acetate and cleaned up on a silica cartridge. The derivative in toluene is quantified by gas chromatography with electron capture detection.

Results

There was no 1080 detected in any of the water samples examined. Therefore, there was no evidence of short or long-term contamination of streams in Waipoua forest or of the surface water or ground water beneath Rangitoto after the sowing of 1080 possum baits. Even on Rangitoto measurable quantities of 1080 did not percolate through to the water table, despite consistent rainfall over the sampling period.

The amounts of 1080 per hectare used in these two operations would have been equivalent to 4-11.0 g ha^{-1} (0.4-0.11 mg m^{-2}) - a small amount. There was heavy rainfall each month at both sites during the sample collection period (see Table 1). On Rangitoto Island, a worst-case scenario can be hypothesised in which the heavy rainfall during the first month succeeded in washing all the 1080 through the surface of the island to the water table. This simplistically assumes no evaporation, no microbial action, and no consumption of baits by possums or wallabies. The potential concentration in the November rainfall is derived from total amount of 1080 (16 kg) divided by volume of rainfall on the island (110 mm x 2.294 x 107 m^2)

$$= \frac{16 \times 10^6 \text{ mg}}{2.52 \times 10^6 \text{ m}^3}$$

$$= 0.0064 \ \mu\text{g cm}^{-3} \text{ (ppm)}$$

This 'worst-case' model was shown to be invalid since no 1080 was detected during the first month, at a level of detection of 0.001 ppm. Even at a concentration of 0.001 ppm, a dog would have to drink 700 litres of water within 4 hours to receive a lethal dose.

Table 1. *Rainfall figures at the two control sites during the sample collection period. * = Poisoning initiated.*

Waipoua Forest	Rain (mm)	Rangitoto Island	Rain (mm)
September*	92.2	November*	110.0
October	128.9	December	35.0
November	88.1	January	22.9
December	39.1	February	44.2
		March	73.4
		April	173.7

Discussion

The lack of 1080 in the water samples should reassure the public and those professionally involved in habitat protection that water contamination is extremely unlikely after aerial distribution of 1080 possum baits.

During the 1970s the likelihood of 1080 contaminating ecosystems, including rivers and streams, was modelled by Peters (1975), who concluded that the levels of 1080 used in possum control operations imposed an exceedingly small toxic burden on the environment and that the chances of significant contamination of either rural or suburban water supplies were remote. Our extrapolations (see Results section) for Rangitoto Island, and our analytical results from both sites, generated 15 years later using analytical techniques with a precision and level of detection unavailable in the 1970s, validate Peters' conclusion.

The aerial sowing rates for toxic baits used on Rangitoto Island of 14 kg of bait per hectare were slightly higher than the 10 kg per hectare commonly used in standard operations. The sowing rates used in Waipoua Forest (5-6 kg of bait per hectare) were approximately half those routinely used, and represent a major advance in large-scale possum control, since an 85% kill was achieved with a substantial cost-saving (D. Morgan, *pers. comm.).*

Acknowledgements

This residue analysis was funded by the Department of Conservation (D.O.C.), and the support of D.O.C. staff, in particular Don McKenzie and Nick Hancox at Whangarei, and Dr Anne Stewart and Jim Henry at Auckland was much appreciated. Steve Hough and Case Pekelharing are thanked for help with water sampling. Joanna Orwin and Jim Coleman are thanked for reviewing the paper.

References

Bong, C.L.; Cole, A.L.J.; Walker, J.R.L. 1979. Effect of sodium monofluoroacetate (compound 1080) on soil microflora. *Soil Biology and Biochemistry 11* : 13-18.

David, W.A.; Gardiner, B.O. 1966. Persistence of fluoroacetate and fluoroacetamide in soil. *Nature 209:* 1367-1368.

Oliver, AY. 1977. The evaluation of resistance to fluoroacetate intoxication in mammals. *Search 8*: 130-132.

Ozawa, H.; Tsukioka, T. 1987. Gas chromatographic determination of sodium monofluoroacetate in water by derivatization with dicycIohexyl-carbodiimide. *Analytical Chemistry 59*: 2914-17.

Peters, J.A 1975. Contamination of forest ecosystems by sodium fluoroacetate (compound 1080). *Proceedings of the New Zealand Ecological Society 22*: 34-41.

Saito, M.; Kitayama, M.; Misawa, T. 1966. Studies on the prevention of poisoning by agricultural chemicals. IX. Influence of a rodenticide (sodium fluoroacetate) spread on forest regions upon rivers. *Hokkai-dorisu Eisei Kenkyusko Ho 16*: 101-102.

Walker, J.R.L. and Bong, C.L. 1981. Metabolism of fluoroacetate by a soil *Pseudomonas* and *Fusarium solani*. *Soil Biology and Biochemistry 13*: 231-235.