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Andrew Radvanyi
Canadian Wildlife Service, Edmonton, Alberta, Canada

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Andrew Radvanyi
Research Scientist
Fisheries and Environment Canada
Canadian Wildlife Service
Edmonton, Alberta, Canada, T5J 1S6

In Canada the potential exists of over a million dollars girdling damage loss per year caused by small mammals to fruit trees in each of the four major orchard areas of British Columbia, Ontario, Quebec and Nova Scotia. Such annual losses continue to occur despite the existence of methods developed which could largely eliminate a large percentage of such losses at a fraction of the costs currently being spent on attempts to control small mammal populations (primarily meadow voles *(Microtus pennsylvanicus)* in orchard situations. In this paper I propose to outline briefly the developmental studies conducted by the Canadian Wildlife Service in research involving harmful small mammal populations on a hardwood plantation in southern Ontario and on a similar reclamation and afforestation program being conducted in the tar sands area of northeastern Alberta. I propose that the techniques developed in these studies hold considerable potential should they be applied to orchard damage situations such as those with which this symposium is concerned.

Ontario: In the mid 1950's the Ontario Department of Lands and Forests undertook a major expansion in their afforestation programs aimed at converting unproductive and abandoned farmlands into hardwood plantations. I propose to review the somewhat disastrous results encountered in the light of unanticipated problems with meadow voles on one of these plantations and the methods we developed to virtually eliminate the girdling problem.

The Coulson Tract is a piece of farmland property situated approximately 30 miles west of Toronto. The owner died and having no close relatives, the property was willed to the Ontario Department of Lands and Forests with the one stipulation - that the said property be planted to trees. The Department, receiving this 100 acres of choice land gratis, readily accepted the offer and proceeded in 1958 to turn it into a hardwood plantation. The initial plantings were primarily of white ash *(Fraxinus americana* L.) and basswood *(Tilia americana* L.) saplings. I might point out at this point that the local member of parliament lived on an adjacent property. The plantation was to be a showpiece. It, in subsequent years, in the light of the original intent, had become a disaster area.

Within a year a large majority of the planted young trees were either smothered out by weeds, browsed extensively by rabbits, or girdled by small mammals. In 1959, rows of white pine *(Pinus strobus* L.) and white spruce *(Picea glauca* (moench) Voss) were planted between the rows of remaining hardwoods and from 1960 to 1965, dead trees were replaced each spring and the grass and weed cover, which had become profuse between the trees, were cut each summer. Despite the application of 2 pounds of Phosbait rodenticide per acre in the autumn of most years, the small mammal population appeared to persist at a high level. Tree losses from girdling damage was especially severe during the winter of 1967-68.

In 1971, the Canadian Wildlife Service was requested to assess small mammal populations on the Coulson Tract and, hopefully, develop a more effective means of reducing the tree girdling type of damage. At that time the plantation consisted of several rows of white pine alternating with several rows of white spruce. Only scattered remnants remained of the 1958 white ash - basswood plantings. By late summer waist to shoulder high wild carrot *(Daucus carota* L.), Canada thistle *(Cirsium arvense* L.), wild aster *(Aster* spp.) and goldenrod *(Solidago* spp.) dominated the entire area. Abundant grasses - quackgrass *(Agropyron repens* L.), chess *(Bromus secalinus* L.), downy brome grass *(Bromus tectorum* L.) and timothy *(Phleum pratense* L.) provided a most suitable habitat for a large population of small mammals, particularly *Microtus pennsylvanicus*.

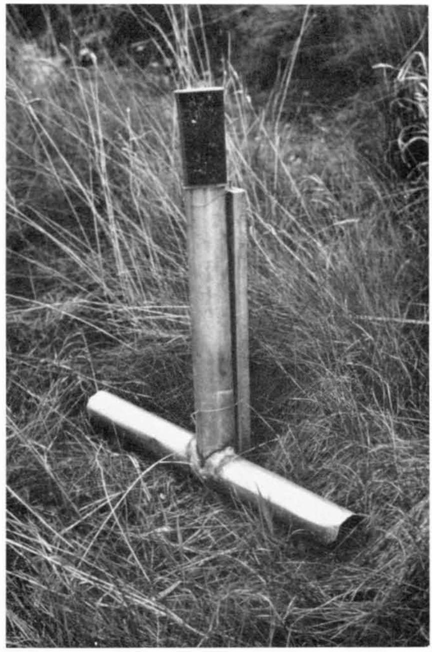
A live trapping-tagging, release and recapture program conducted on the Coulson Tract in Fall 1971 indicated as many as 33 mice per acre existed at that time on an 8.3 acre study grid. Of these 78% were meadow voles *(Microtus pennsylvanicus)*. Having established the population level the opportunity presented itself to field test a new anticoagulant rodenticide (Rozol). The poison was applied to whole oat groat bait and broadcast as recommended by the manufacturer at a rate of 2 pounds of treated grain per acre. An area of 20 acres were poisoned, including that of the study grid. Retrapping of the area following poisoning indicated the small mammal population had not been reduced and laboratory tests conducted subsequently on the treated grain suggested a higher rate of poison application both on the grain and in the field would be needed. (Active ingredient of the Chlorophacinone anticoagulant increased from 0.01% to 2.0% and field application of treated grain increased from 2 lb/acre to 15 lb/acre).

Sixteen mice per acre were found on the study area when it was retrapped in Spring 1972. Rozol-treated grain (.005% conc. anticoagulant) was again broadcast over the area now at a rate of 15 lbs per acre. Of over 100 animals tagged prior to application of the poisoned grain - not one was captured in the post-treatment trapping period. In 10 days of post-treatment trapping only nine small mammals were captured and as none of these had been tagged before, they were assumed to have been new animals moving into the depopulated area from surrounding pastures, hay and corn fields. The resident population appeared to have been totally eliminated.

The same area was studied again in September 1972. By that date, through rapid breeding and reinvasion, the small mammal population had already reached levels of 12 animals per acre. Once more the population was eliminated by a broadcast application of Rozol-treated (.005% CPN) oat groat bait and, as before, no previously tagged animals were recaptured in the post-treatment trapping period.

As applied, the broadcast application method appeared to be an effective means of reducing markedly the population of harmful small mammals but had the inherent characteristic of being reliable but for a short, undetermined and unpredictable duration. A heavy rainfall arriving within a few days after field application of the treated grain could largely negate the effectiveness of the entire program. What was needed was an inexpensive and long term method of dispensing a poisoned bait which would continue to be effective irrespective of weather conditions. Development of such a method was the prime objective when the study was resumed in 1973.

On the same study area where small mammal populations had been virtually eliminated twice the year before, there now existed in May 1973, 58 small mammals per acre. To dispense poisoned bait to this population and at the same time shelter it against loss by rain or dense vegetation, the Radvanyi poisoned bait feeder station was developed and field tested. The feeder station consisted of two 24" lengths of 2 inch diameter galvanized metal tubing welded together to form an inverted T, tied to a short wooden stake and filled with approximately 28 ounces of treated whole oat groat grain. On the basis of previous *Microtus* home range data, it was decided to use 10 feeder stations per acre. Within three weeks following set up of 200 feeder stations, in June, small mammal populations on the study grid had been reduced from 58 to 29 animals per acre. By September 1973 only 2.7 per acre remained on the grid and a large percentage of these were *Peromyscus* - a non-girdling species. The percentage of *Microtus* had been reduced from 98.5% in the high population of June to 52.0% in the few animals remaining in September 1973.



The Radvanyi poisoned bait feeder station.

Small mammals, particularly in northern climates, fluctuate widely in 3-4 year population cycles. The marked reduction in small mammal numbers on the Coulson Tract - from 58 animals per acre to less than 3 - could have occurred in two ways apparent with similar results; 1) a natural population crash, or 2) the extreme effectiveness of the poisoned bait feeder stations. To test which of these alternatives had occurred, a second smaller but similar non-treated study area on the same plantation was established and trapped for 10 days. The control area was only several hundred feet from the first but was separated from it by a mature stand of timber through the length of which ran a stream. On the control area 92.1 small mammals per acre were found and of these 95% were *Microtus*. From this, one must conclude that no small mammal population crash had occurred in the general area and that indeed the reduction in small mammal numbers had been due to the effectiveness of the poisoned bait feeder station approach.

Alberta: In a second but similar rodent problem study in north-eastern Alberta, the Radvanyi poisoned bait feeder station have likewise proven very effective in reducing girdling damage by *Microtus*. In the Athabasca oil sands of that province, open pit mining is being employed to tap a potential 600-800 billion barrels of recoverable oil. One processing plant has been in operation since 1967 (namely Great Canadian Oil Sands Ltd.), a second plant (Syncrude Ltd.) twice as large, will become operational in 1978. In the next decade up to 12 such plants may be built. Should this happen, and the same open pit mining procedure is used by each, up to 22,000 acres of environment a year will be greatly disturbed and will require massive reclamation and afforestation procedures. Long range plans call for planting of deciduous and coniferous trees on the rolling terrain landscape of this reclaimed area.

In the mining operation, the area is first cleared of forest, drained, and the overburden material removed to expose the oil sand. The latter is transported several miles by conveyor belts and massive trucks to the processing plant where one barrel of oil is extracted per 2 1/2 tons of oil sand. Oil, coke, sulphur and sterile white sand are produced. The latter is piped in a water slurry under high pressure to a disposal area outside the plant. In nearly a decade of operation this sand disposal has resulted in creation of a man-made mountain as tall as a 35 story building and approximately three miles in diameter at the base. Unfortunately the Athabasca River flows right past this fragile sand mountain along the south and east side and to prevent a massive erosion problem which would readily occur, a dense grass vegetation cover was established on the steep slopes of the tailings pond dyke. The mountain continues to grow as water and sand are being added to the tailings pond at the top. The grass vegetation on the lower sectors of the slope are now 6 years old; that on the upper sectors three years.

Into the dense grass vegetation between 20 and 40,000 nursery raised trees of a wide variety of species have been planted annually since 1972. Within the first year of planting operation, a completely unanticipated problem of considerable magnitude arose when in some species - particularly deciduous plantings - up to 95% were found to have been girdled by small mammals which had become established in the most ideal habitat inadvertently created for them on the tailings pond dyke. Attempts by GCOS personnel to reduce small mammal populations and damage by snap traps, tumble-in traps, use of poisons (Warfarin) and use of sheet metal guards placed around individual trees all failed and the problem continued to persist year after year.

In 1975 the Canadian Wildlife Service was requested to assess small mammal populations and to develop an effective control method. With the experience earned on the Coulson Tract study in Ontario, the writer was assigned to the tar sands afforestation problem.

Employing similar trapping, tagging and recapture procedures as used in the earlier study, it was determined that up to 60 mice per acre existed in the dense grass vegetation of the GCOS dyke during early summer 1975. Five study areas of 6.9 acres each were established. On three areas, 10 poisoned bait feeder stations per acre were established and filled with Rozol treated whole oat groats (0.005% CPN); the remaining two areas served as untreated controls. Installation of the feeder stations reduced small mammal numbers to less than one animal per acre by the end of October 1975.

Rodent damage during winter 1975-76 on treated areas was less than 1%. On the non-treated control comparison sites up to 36% of some deciduous species planted were recorded as having been damaged despite the fact that only about 1/3 as many mice per acre existed on these areas as had been there during the initial year of the study.

Thus, with a major reduction of girdling damage from an average level of 50% to less than 1% it would appear the poisoned bait feeder station concept has immense potential as a means of reducing numbers of *Microtus pennsylvanicus* and preventing costly girdling damage to valuable trees. While many questions continue to exist dealing with such factors as what is the optimum number of feeder stations needed, how many mice can be tolerated before control measures become imperative, how effective are such devices and rodenticides over long periods of time and against other rodent species, the numerous unanswered aspects of secondary poisoning potentials, and many more questions needing further research, I would propose the approach has been most fruitful in our studies and may have, as mentioned earlier, considerable value should it be applied in an orchard situation. Our proposals to eliminate much of such rodent damage by use of Radvanyi poisoned bait feeder stations in the Canadian orchard situation have been put forth but with the current governmental constraints, these tests have not yet been initiated. I have sufficient confidence in the procedure to suggest it would be like placing a bet on a irrevocably fixed horse race in which one knows beforehand what the outcome will be and it is only the unexpected that one needs to worry about. That is confidence.