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VERTEBRATE PESTS IN NEW ZEALAND; RESEARCH AND CONTROL

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New Zealand has been considered a classic among the world's natural laboratories where free-roaming wild mammals demand, and obtain, a rather overwhelming national attention. The enormous devastation by erosion processes is the consequence of intentionally introducing exotic species of mammals, for food, for sport and for fur.

By its isolation in the Pacific, the flora of New Zealand evolved in the absence of a grazing and browsing fauna. There were no native mammals, save for the seals and two species of bats. The land has been the home of a most diverse fauna of flightless birds - kiwis, the giant moa, the rails, such as pukeko and kakapo, and flightless parrots. Many of its flighted bird species nest near the ground. It supports one of the oldest known reptiles - tuatara. The land, despite predominance of weak sedimentary and metamorphic rocks, has high and steep mountain ranges covered by dense forests and alpine grasslands. Torrential rain is characteristic of many mountainous regions. The flora exhibits a high rate - 60% - of endemism and exceptional incidence of polymorphism and hydridism. Briefly, the land has all the hallmarks of a delicately balanced array of evolutionary excesses made possible only by the absence of man and the absence of a fauna of browsing mammals in all the niches from mountain tops to the sea.

Into this balanced order came Man. First, the Polynesians - the moa hunters, Morioris, during the 9-14th centuries, and the Maoris from that time - burned off the forests, exterminated the moas and initiated changes in the vegetation which are still only known in outline. Then, in the early 19th Century, European Man came and set about burning vast stretches of forest and the native grassland vegetation to make room for his sheep, cattle, goats and pigs. Somewhat later, when he had time for leisure and sport, he introduced the world's more popular game and fur-bearing animals.

He introduced: Eight species of deer,
the chamois and thar,
the European hare (Lepus europaeus) and
the European rabbit (O. cuniculus),
the goat (Capra hircus),
six species of Australian wallabies,
the brush-tailed opossum,
the European hedgehog, rats and mice,
birds - a long list of finches, Corvids, ducks and geese.

All these have been added to the primitive landscape in the brief span of 130 years.

The effects have been appalling: Scarcely a Forester, Hydrologist or Botanist visits the country without recording his utter dismay at the evidence of erosion, the havoc and dilapidation of the biota. Thus, accelerated erosion caused by the removal of the protective vegetative cover brings about extensive flooding of the lowland river plains where the country's principal industry, sheep and cattle farming, is carried out.

Of the land area of New Zealand - 66 million acres - some 34 million acres is devoted to farming; the remaining 32 million acres is almost all hill and mountain country clothed in forest and scrub or barren rock. About one-tenth of the total area of the North Island is mountainous, in the South Island mountains cover half of the total area.

This then is our predicament, sketched for you in an altogether immodestly brief outline. The damage done to the grassland vegetation by rabbits in the lower pastural lands, by hares in our forest plantations, by opossums in the marginal lands and rain forests, by deer in the river valley watersheds and mountain bush, by chamois in the high tussock lands, and by thar in the higher alpine regions - this damage, this often complete denudation - must be seen to be believed.

We are committed to a prolonged and persistent attempt to achieve and maintain control of these pest populations. It is easy to recite examples or occasions of the impact of these animals. No two situations are alike in extent and type of control pressure. In fact, a campaign of control against one single species in one particular watershed habitat may require entirely different strategies when carried out against the same species in a neighbouring region. It is therefore an utmost necessity that close collaboration is maintained among the several disciplines involved in control campaigns and forest inventories.

My trade is biochemistry and pharmacology, in particular the toxicology of intoxication and detoxication phenomena. In the context of our animal control campaigns this discipline leans heavily on those of populations dynamics, animal behaviour, and the ecology of habitats. I have termed this inter-relationship ecological biochemistry - and the significance of the label lies in the concept, rather than in the formation of a new discipline.

I shall now sketch for you in outline an example of this collaborative effort - at both research and operational levels - and my example concerns the Australian brush-tailed opossum (*Trichosurus vulpecula*).

In the quest for establishing a fur industry the opossum was introduced into New Zealand by official consent, and by private trappers, from 1840 until the 1920's. With no natural predators this animal increased to extremely high numbers once it had been successfully acclimatised. This was an easy venture since the majority of endemic plants were highly palatable. However, by the early 1950's, the anticipation of a valuable fur resource paled with the realisation that the very high opossum populations were, in many cases, wiping out important seral plant associations (e.g. kamahi, mahoe, fuchsia, ribbonwood) and climax forests (e.g. hinau, rata, kamahi). Also, they were causing acute problems in orchards, pine plantations, and on pastures along the edge of native bush.

For some cases, it has been estimated that these populations rose to the order of 25-50.000 lb biomass per sq. mile in peak circumstances. In low densities, prevailing biomass is in the order of 12.000 lb/sq. mile. These figures are high to extremely high for temperate ecosystems, anywhere. They outstrip the values of their native Australian habitats by 2-4 orders of magnitude.

Control of the opossum was undertaken by Government in the late 1940's. This control took the form of cyanide baiting and trapping. Somewhat later, mid 1950, with the development of aerial bait sowing techniques - gleaned from agricultural aerial topdressing practices - experiments of large-scale poisoning began. It was no longer necessary to think in terms of the individual man in pursuit of the individual animal.

The Forest Service then started on a series of aerial poison experiments using pollard/molasses/"1080" baits in an effort to establish effective working limits. We found that, provided there were more than 4-5 opossums/acre, that body condition (fat reserves) was low, and that the herbaceous vegetation was not dense (affecting movement on the ground and searching for bait) there was a good working chance of poisoning at least 70-95% of a population. These findings were put into operational practice. Control campaigns against opossums now use up to 500 tons of chopped carrot, sown by air, at up to 15 lb/acre. The toxic content is up to 2 lb of "1080" per ton of carrot.

Since these operations began, a decade ago, many quantitative results and impressions have filtered through from field staff and biologists to the doorstep of the animal ecologist and toxicologist. Also, many observations were made which could not have come to light in small-scale laboratory or enclosure studies. For instance, in some areas where mortality rates were initially assessed at some 40-60% curiously protracted deaths showed up for months after the actual poison operation. We now believe that this feature seems more related to sociological disturbance among survivors rather than to the pharmacology of "1080." In some cases, response of the population has fallen so far behind the recovery rate expected by normal demographic calculations, as to suggest that the initial check by poisoning has been complemented, in effect, by the sudden disruption of the opossum's habitat. The vast majority of preferred nests were contaminated by dead animals, the tracks and social sign-posting were lost. These factors, and perhaps others, are argued by some field men and ecologists to have been as important a check on the population as the primary intoxication effects.

Thus, the toxicologist associated with pest control in New Zealand has just as formidably a problem as his counterparts in North America, or anywhere else. In addressing this problem from the biochemical point of view, I, as a member of a small research group, have had to very seriously consider the pro's and con's of a wide range of investigations before committing my research colleagues, and the Forest Service, to any particular pursuit. Our operational commitments are reduction in numbers of noxious animals. Our research commitments are evaluation of techniques to achieve this reduction.

In the absence of effective biological control measures, i.e. decreasing the birth rate, we are left with the other alternative, i.e. increasing the mortality rate, by mechanical control - shooting, trapping - and by chemical control - poisoning.

However, if poison we must, let it be done in a humane manner, aimed at a specific target species, without accumulation of toxic residues in the forest environment and downstream surface waters.

Our toxin of choice has for a long time been sodium fluoroacetate ("1080") since this compound fulfills many of the requirements of ethics, selectivity and detoxication. Its pharmacological and physiological reaction imposes on the victim an early state of unconsciousness. Its species selectivity leaves our protected native bird populations relatively unmolested. Its breakdown by soil micro-organisms into relatively non-toxic inorganic fluoring creates little hazard to downstream agricultural lands and human communities.

Nonetheless, having extolled the virtues of "1080" - if that is the right term, working as we do somewhat in an ethical vacuum - the toxin also has some exceedingly nasty vices. There is, as yet, no reliably effective antidote to counter accidental poisoning in human operators. We have a research programme in progress to investigate this problem. Also, "1080" is widely used in the control of rabbits on agricultural lands where it creates a real hazard for shepherd and hunting dogs, and also for sheep and cattle. In addition, the extreme water-soluble property of "1080" imparts to many of our control campaigns in high-rainfall forests a sense of futility because of the rapid leaching of the toxin out of baits. As a counter measure we are often obliged to use very high toxic doses to attain adequate residual toxicity in the baits, with added hazards by non-target species.

We are investigating more hydrophobic organofluorine derivatives of "1080" which, whilst retaining the pharmacological characteristics of the parent toxin, also impart more favourable aspects to our field control measures.

In our preoccupation with "1080" and other organofluorine toxins it is essential that efficient toxicological-analytical procedures monitor the dispersal and residues of these toxins in the forest environment and their effects on population densities. To this purpose, highly efficient, rapid and reliable analytical procedures have been developed by our research organisation.

Despite the undoubted progress in our total endeavour to achieve a measure of control of the havoc by our noxious wildlife we are aware of our many shortcomings and mumble over our preconceived interpretations. In the words of the French philosopher Laplace: "Ce que nous connaissont est peu de chose, ce que nous ignoront est immense." That what we know is a trifle to what we ignore.