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THE RAT CONTROL PROGRAM ON THE ISLAND OF ST. HELENA

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ABSTRACT: St. Helena is an Atlantic Ocean island lying 1,200 miles off the coast of Angola. Both species of commensal *Rattus* occur on the island, the ship rat (*R. rattus*) having possibly arrived as early as 1502, the year of the island's discovery, and the brown rat (*R. norvegicus*) in the 1700s. Today, rats are widespread and common over the entire island, including the arid wastes, the inhabited and agricultural areas, and into the National Park around the central peaks. The impact of invasive rats on the endemic flora and fauna (predominantly invertebrate with many endemic species of snail, spider, and weevil being recorded) is unknown. The only natural enemies of rats on the island are occasional feral cats, raptors, and other predators being absent. In 1924, the Agriculture and Forestry Department started a 50 year poisoning campaign against rats which ended in 1956 when the brown rat was considered to be almost extinct. Since that time a continuous island-wide suppression campaign has been carried out by the Department of Public Health. This consists of placing anticoagulant baits in and around the inhabited areas of the island (and, on demand, in the agricultural and forested land) routinely, checking baits at least every two weeks and more often if take is high. On average, 20 tons of bait are laid every year. Data on baits placed, takes, and dead rats found were examined for the years 1995 to 1998. *R. norvegicus* was found to be the most common species, with the two species approaching 1:1 in only three areas of the island. A number of recommendations for the improvement of the rodent control program have been made with the overall aim of raising the professional status of the operators from that of "rat baiters" to that of professional pest control technicians. This will effectively raise the professional status of the Environmental Health Section as a whole. The aim is also to involve the public as partners for improvements in their own health and welfare.

KEY WORDS: *Rattus norvegicus*, *Rattus rattus*, St. Helena, control, environmental health, eradication

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INTRODUCTION

St. Helena lies 1,200 miles off the west coast of Angola in the Atlantic Ocean and consists of a single island 47 square miles in area, of which two-thirds are classified as barren waste. The population is around 5,000 persons, living mainly on the leeward, or northern side of the island. Lying just within the southern tropics the climate is mild, with seasonal maximum and minimum temperatures of 29°C and 24.5°C in summer, and 24°C and 19.6°C in winter at the coast. Temperatures inland are 7° to 8°C cooler. Annual rainfall is 700 mm but there is considerable variation of both rainfall and temperatures around the island. Figure 1 shows a map of the island.

St. Helena is unusual in that both species of *Rattus* occur on the island, the ship rat (*R. rattus*) and the brown rat (*R. norvegicus*). Rowlands et al. (1998) consider it likely that the ship rat first arrived on the island at the time of its discovery in 1502 with repeated invasions from subsequent ships, and this seems a reasonable assumption. All specimens of *R. rattus* which have been examined belong to the cream bellied frugivorous race, and the absence of any dark forms suggests that no or few recent additions to the population have been made, as the dark forms are considered typical of recent immigrations of ship rats (Patton et al. 1975).

The brown or Norwegian rat is considered to have arrived around 200 years later and by 1732 both species were found in most parts of the island (Rowlands et al. 1998). The other two islands in the group, Tristan da Cunha and Ascension, both possess only the ship rat,

introduced in 1882 to Tristan and around 1701 to Ascension island (Atkinson 1985).

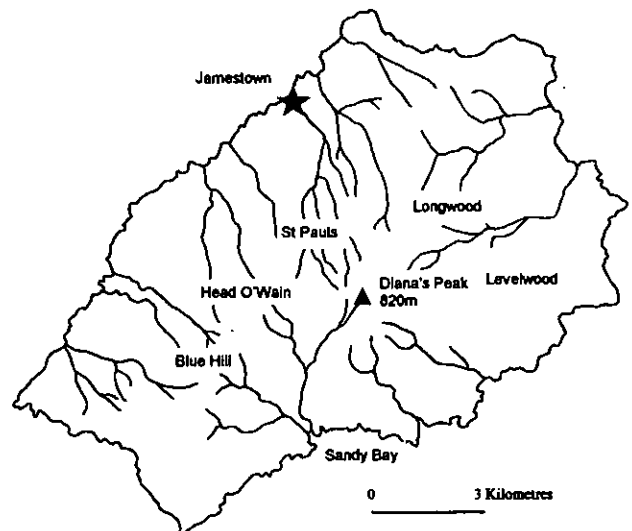


Figure 1. Island of St. Helena, showing the main geographic features.

There seems to be little difference of habitat use between the two species of *Rattus* outside human habitations where the ship rat tends to occur in the roof and ceiling and the brown rat at floor level or below. In the agricultural land and Crown Waste both species can be found in any one area, and the two species appear to be sympatric over the entire island. Few detailed studies have been made of habitat use, diet, and ecology of either species. Davis, in 1965, spent just over three weeks on the island studying the rats and the control program in operation, but this seems to be the only study made (Davis 1965). He thought that the ship rat was more common in the waste lands and even occurred in treeless areas sympatrically with the brown rat.

The house mouse also occurs all over St. Helena island and was introduced sometime before 1599 (Rowlands et al 1998). The species present is believed to be the short-nosed house mouse of the Iberian Peninsula, (*Mus musculus brevirrostris*) and a number of color varieties exist (Loveridge 1965). It is unusually tame and conspicuous on the island, presumably as a result of having few or no natural predators here. Compared to the rats, house mice are not seen as major pests and little attention is focused directly on them.

PEST STATUS

Rats are mainly nuisance pests on the island, although damage to forestry plantations can be severe. Weils disease (leptospirosis) is believed present on the island, although of the three reported cases in the last five years none was confirmed. In forestry plantations rats are known to attack only one species, the silky oak (*Grewillea robusta*) which comprises 20 to 25% of all trees planted. Trees are vulnerable at the thicket stage, 5 to 10 years old, and up to 50% of all trees planted suffer from bark stripping although few are completely ring barked. Bark stripping is commonest in March and April, at the end of summer, and following clearing in the plantations, suggesting that it is lack of alternative foods which triggers the attack. Only sweet potato is vulnerable to rat attack and damage is infrequent. Mice will also damage sweet potato, as well as occasionally sweetcorn. Neither of these crops are particularly important in St. Helena.

Perhaps the most important (but least understood) damage is that to endemic fauna and flora. This is particularly relevant for an oceanic island with large numbers of endemic species but the conservation importance of rats has never been studied on St. Helena. The effect of rats on nesting and roosting seabirds in other islands is well documented and the St. Helena wirebird (*Charadrius santahelenae*, a type of plover and the island's only remaining endemic bird species) is vulnerable. Reproduction in rats tends to be limited by the available protein in their diet of which one potential source is nesting seabirds and another is invertebrates. Snails are particularly vulnerable. Rats also affect vegetation by their consumption of seeds and fruiting bodies, and seeds of invasive plants such as guava and tomato can be spread by rats in their droppings (Key 1993, 1994). By influencing plant communities and invertebrate populations rats cause changes in vegetation cycles, the nutrient status of the soil and decomposition. St. Helena's endemics have been poorly studied but there

are known to be 14 endemic species of fern and six of flowering plants and over 200 endemic invertebrate species, including weevils, snails, and spiders, and all are potentially at risk.

THE FIRST RAT ERADICATION CAMPAIGN

In 1924 the Department of Agriculture and Forestry began a campaign of rat poisoning which continued to 1957, at which time the brown rat was considered to be possibly extinct. Loveridge (1961) disproved this happy idea by catching three adult male brown rats and the species has recovered since then to what may approach its previous levels. It was noted that this poisoning campaign had little effect on the ship rat which, if anything, increased its numbers (Anon. 1964). Baits used were presumably cereal based and, therefore, less attractive to the ship rat which is also less susceptible than the brown rat to warfarin poisoning. Ship rats need to feed for up to 12 days before complete mortality is achieved, compared with 4 to 7 days for the brown rat (Meehan 1984). A release from competition with the larger, more aggressive brown rat would have allowed the surviving ship rats to spread into previously brown rat-occupied habitat, leading to an overall increase in numbers as well as perhaps more sightings in areas where previously they had not been able to venture. Since the end of the eradication campaign, a continual rodent suppression program has been in operation and details of this are given below.

THE PRESENT RODENT CONTROL PROGRAM

The aim of the present program is suppression of the rat population. It is both reactive and proactive in that a continual baiting regime is carried out in and around houses and gardens and along roads, and in response to complaints of rat infestation by members of the public. The present team consists of 11 field operators supported by an office-based team consisting of three persons working under the Head of Section. They have the use of two dedicated vehicles which are used to transport labor, materials, and equipment around the island. Each operator is responsible for baiting his own area and does not have individual transport; the operators can request to be assisted by one of the two vehicles where the work requires it. In some areas this can mean a daily walk of several miles in steep terrain, carrying the baits and other materials. Large bins of bait are positioned around the island and regularly topped up by the teams with vehicles as dumps of bait for the operators who are not normally able to carry enough bait for an entire day's work.

Some of the operators have been employed by Environmental Health for many years and were recruited for the job of laying rodent baits alone. Over the past few years all the pest control activities in their areas have been passed on to them and they are now also responsible for insecticide spraying and other treatments which are requested. These are mainly against cockroaches, fleas, and bird lice.

Baiting and Baits

Rodent baits are placed in bamboo bait tubes to minimize exposure to non-target species, their site located by a spot of yellow paint. The aim is to place around

0.25 lbs (113 g) of bait, with tubes around 25 m apart. Each bait tube is visited every week or every other week (with a few exceptions where lack of transport makes such frequent visits impossible) and take is noted as complete, partial or none. Where infestations are active checks are made daily.

Weekly worksheet data from 1995 to 1998 were available and were entered into an Excel database for analysis. This was limited by gaps in the data and inconsistencies between different operators in data entry.

Between 1995 and 1998 seven different active ingredients in various formulations were used: warfarin, chlorofacinone, coumatetralyl, bromodiolone, difenacoum, difenacoum+calciferol, and brodifacoum. The reasons for this variation was: to match formulation with specific situation (indoors versus outdoors, rats versus mice, etc.); allow rotation of active ingredient to avoid the development of resistance; to test new products; and finally for reasons of cost in that some years there are insufficient funds to buy the preferred product and cheaper alternatives have to be sought. On average a total of around 20 tons of rodenticidal bait is placed each year.

The amount of bait placed by each operator is very variable, with a mean low of 70 g for one operator and a mean high of 330 g for another. Any one operator was reasonably consistent in under or overbaiting. Essentially all operators deliberately aim to place a surplus of bait at each point in a system of continuous surplus baiting, and even with advanced anticoagulants such as brodifacoum no attempt at pulsed baiting was made.

It can be argued that placing more bait results in better control. As all dead rodents found in each area are recorded this can be examined, although only crudely as many of the rodents killed by poisoning will die undiscovered, and it is impossible to estimate the proportion which die unseen. However, operators have a strong incentive to spot dead rats as they can claim an allowance for each one disposed of, and each operator covers a broadly equivalent area in terms of vegetation and habitat types. It is noted that rats are normally very active on the roads at night, and many can be seen dead and dying on the roads following poison baiting. Figure 2 shows the numbers of dead rats of both species reported by each of the operators. Some operators consistently found more rats than others, presumably due either to the characteristics of the area covered or the ability of the operators to spot them.

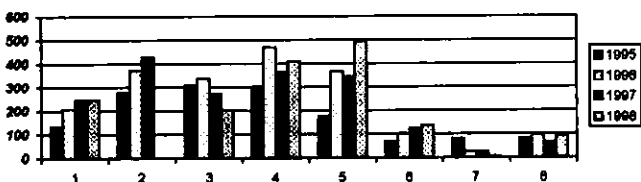


Figure 2. Number of dead rats found by operators 1 to 8 in 1995, 1996, 1997, and 1998.

The brown rat was the most common species found dead, with a total of 6,228 rats over the four years, compared with 999 ship rats, and 220 unidentified or unidentifiable rats. Ship rats were found mainly in three areas, St. Pauls, Blue Hill to Head O'Wain, and Willow Bank to Hutts Gate (see Figure 1). In these areas the ratio of ship rats to brown rats was approximately 1:1 (972 ship rats to 958 brown rats), while in the remaining areas ship rats were hardly known (195 brown rats to every 1 ship rat found).

A more accurate method of assessing efficacy is in terms of bait takes. As complete and partial takes could be a result of disturbance to the bait tubes, takes by birds or by house mice rather than takes by rats, records of no takes are considered more reliable evidence of reduction in rat activity. Note that this does not allow for differences in rat populations in the areas due to variations in habitat, vegetation or human habitations. As no information is available on this aspect they are assumed to be equal. Figure 3 shows the percentage of no takes recorded by each of the eight operators. A weak correlation was found between the average amount of bait placed at each bait point by each operator and the total number of rats he found ($r = +0.2$), suggesting that more bait equals more rats to some extent. Similarly, fewer records of no take were found by operators who placed more bait per point on average, supporting this ($r = -0.38$). As at least half of the bait used were first generation anticoagulants this reflects their use in a system of continual surplus baiting.

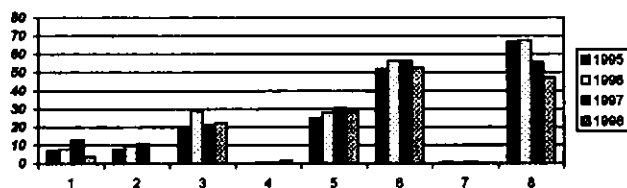


Figure 3. Percentage of no take recorded by operators 1 to 8 for 1995, 1996, 1997, and 1998.

Previously, operators did not do inspections of sites when dealing with new infestations or responding to call-outs from members of the public. While there was an awareness of the need to do these, the reason cited was that the public expects an immediate and comprehensive response and will not readily tolerate "poking about." As a result considerably quantities of rodenticides and insecticides are probably wasted as entire areas are treated unnecessarily.

Annual Trends in Infestation Levels

The winter is the wettest time on St. Helena, and rainfall tends to be about three times greater in June and July than for October, November, and December—normally the driest months of the year. However, rainfall

is characteristically variable, not only from year to year but also around the island, making an examination of the rather crude operator records difficult. Rat infestations are considered by the operators to be worse over the winter months, June to September, and lower in summer. This was examined in terms of dead rats found (Figure 4) and percentage of no takes recorded (Figure 5) over the year for 1995 to 1998. It can be seen that there is no clear trend in numbers of dead rats found over the year or percentage of no-takes. There is also no clear relationship between the number of dead rats found and take. There is also no particular increase in the amount of bait placed over the winter months, and if anything, there is a trend for more bait to be placed early in the year and to fall off slowly as the year progresses. It is possible that the perception of more rats over the winter months refers to an increase in infestations in premises rather than in the wider environment, as would be seen in the records of the island-wide program, above. There was insufficient reliable data to examine this. Similarly, it was not possible to analyze rats found dead and local habitat type, or species of rat found dead and habitat due to gaps in the workbook records.



Figure 4. Total number of rats (both species) found dead over the year for four years.



Figure 5. Percentage of no takes recorded over the year for four years.

Sewer systems accessed by manholes occur in Jamestown, Prince Andrew School, and at Piccolo Hill in Longwood. Those in Jamestown are baited every three months using non-toxic baits (sausage rusk) as a check for

rats (following a treatment with insecticides to kill cockroaches which otherwise take the baits), but rats are rarely detected in the sewer system. The other two systems have no record of rat infestations and are only treated for cockroaches.

Public Relations and Morale

Relations with the public are generally reasonable, although the operators comment that they are expected to do what the public tells them rather than the other way around. Generally, people do not clear up or adopt good housekeeping practices to assist in controlling rodent infestations, preferring to rely on the rodenticides and blame the operators if the treatment fails. In a small community such as St. Helena, it is very difficult for individuals to exert pressure on the public. The public refuse collection system can also cause problems. Few houses are equipped with a plastic dustbin, and rubbish is put out for collection in plastic bin liners. As the refuse trucks pass some areas very early in the morning bags tend to be put out at night where they are vulnerable to cats, dogs, and rats, and a lot of spilt litter can result.

Relations between office and field based staff are on the whole good, but field based staff can feel unappreciated and isolated. There is a lack of regular communication between office and field based staff.

SECOND ERADICATION PROGRAM

The original eradication program failed, although after 50 years it appears to have been nearly successful for the brown rat. St. Helena is a small, remote oceanic island and, if rats were eradicated, it would be relatively easy to maintain that state as at the moment the only point of possibly entry is the wharf. A number of successful eradication programs have been achieved within the last few decades of both species of *Rattus* on increasingly large islands, primarily due to the development of the single feed advanced anticoagulant rodenticides such as brodifacoum in a wax block formulation. These are easy to distribute by air to give uniform cover of an even dose rate. These eradications have all been done on islands which tend to be either uninhabited or only inhabited by light house keepers, wardens, or similar. Experience in clearing these islands suggests that only a few years of action are necessary (in some cases, only one) to knockdown the population, but note that baits are nearly always distributed by air. A long monitoring period is then required to spot residual populations and treat them before they can spread. Eradication of inhabited islands tends to be far more difficult and few attempts have been made. The complication arises with the need to involve all inhabitants in terms of access, removing harborage and alternative foods, and general cooperation.

One important question to be asked is would it be worth it? Benefits of a rat free island are large—rats carry a number of human and livestock diseases, they damage goods and materials, they cause fire by damaging electrical wires, they attack crops, they damage trees, and they can be important conservation pests. However, the cost of a full eradication is high, while a continued suppression is relatively low when costed on an annual basis. A recent proposal for the eradication of rats and cats on neighboring Ascension Island is still seeking

funding, despite very clear conservation benefits (Bell and Ashmole 1995) and it would be difficult to justify the attempt for St. Helena at present.

An island wide suppression of the rat population could readily be achieved on St. Helena by mass-baiting with an anticoagulant such as brodifacoum. This suppression could then be sustained by improvements in hygiene and public education, together with well planned and organized continual baiting using cheaper products such as bromadiolone, along the lines of that done on the Isle of Man (Walsh, DLGE, pers. comm). On St. Helena baits and baiting strategy needs to include consideration of both species of *Rattus* with their different behavioral ecology or the more arboreal, frugivorous *R. rattus* will be neglected again. However, note that Bell (pers. comm.) considers that a kill rate of over 95% is required in order for any significant recovery of the ecology. Whether a complete eradication is possible is another question. The high proportion of difficult or inaccessible terrain which harbor rats is a problem in the absence of an airport; inaccessible areas and lack of public cooperation limited success in a recent attempt to eradicate the Mediterranean Fruit fly from the island (Key 1999). Moors (1995) makes two important points for rat eradication programs: do not underestimate the problem, and do not assume that the absence of signs means they have gone. A successful program requires a long planning period, and an even longer follow-up period to find the "last rat"—this is the most expensive rat to kill and the most important one. These two phases of a program are the ones hardest to support as the public perception of the team is that it is "doing nothing" (Key 1995).

If the Environmental Health Section is serious in considering a second eradication program, it is suggested that a feasibility study be carried out, including some basic research on the behavioral ecology of the two rat species.

RECOMMENDATIONS FOR IMPROVEMENTS

Despite the continual baiting, rats are very common around the island and are frequently seen running across the roads. Because of this, the Section decided to make a major revision of the program, and a number of recommendations have been made, some of which have already been initiated. Recommendations can be summarized as having the aim of raising the professional status of the pest control operations in the Environmental Health Section, making their work more cost-effective, and involving the public as partners in the management of rodents. They can be divided into three areas, one with no financial implications, one with limited financial implications, and a third with relatively large financial implications. In addition, there are two areas of special concern, resistance management and control of rats around pig units, which received particular attention.

No Financial Implications

- Permanent bait stations to be numbered and mapped.
- The operators to be reorganized with a specialist team covering spraying treatments working separately from those covering just rodent work.
- Quarterly meetings to be held between field and

office based staff to allow communication and feedback.

- A formal training program to be instituted with three elements: basic training for new recruits, advanced training for more experienced staff, and re-training and specialist training on-demand.
- Jobs requiring more than one person for health and safety reasons need to be specified and then should not be done with fewer.
- A public education program to be started, using the radio and news-sheet to inform and educate members of the public.
- Worksheet data to be routinely entered into a database.
- Inspections to be carried out on all new sites for treatment.

Limited Financial Implications

- Monthly newsletters to be distributed from the Section to all staff to improve communication within the Section.
- The landrovers to be fitted with removable, lockable boxes to carry the equipment necessary for rodent and insect treatments.
- All huts to be equipped with water.
- All operators to be issued with three pairs of coveralls.
- The Section to invest in a set of live traps for removal trapping and checks on treatment efficacy.

Large Financial Implications

- Operators working in large areas to be equipped with motorbikes. Ideally all operators should have independent transport.
- All operators to be equipped with radios for communication to headquarters.
- Issue of waste bins to every household.
- Feasibility study of a second eradication program.

Resistance Management

At present, there is no indication of anticoagulant resistance among the rat population and the Section is anxious to maintain this. Resistance management consists of a range of methods, of which one is rotation of products. The genetics of resistance to some products is similar (e.g., warfarin and coumatetralyl), and these should, therefore, be considered as alternatives in any one cycle of rotation. Bait rotation, therefore, follows a schedule of two cycles:

Cycle 1. Alternative baits which could be used:
Warfarin, Coumatetralyl, Chlorofacinone

Cycle 2. Alternative baits which could be used:
Brodifacoum, Difenacoum, Bromadiolone

The best way of managing resistance is to use non-chemical methods for rodent control and, in this case, hygiene and tidiness in and around properties is the key. Members of the public must be encouraged to conform to this as much as possible and not rely on poison on its own to solve their rodent problems. The public education program is important in this respect.

Pig Units

Rat infestations around pig units is seen as one of the biggest problems as, due to fear of secondary (to pigs) and tertiary (to human consumers of pork) poisoning no baits are laid. Hygiene and proofing are very difficult to achieve, and the Environmental Health Section owns few traps. Consequently, pig units can harbor high rat populations and at present the Section does not own any cage traps for removal trapping. Break-back traps have not been found to be very efficient.

First generation anticoagulants such as warfarin have a relatively short biological half life and are also less toxic to pigs than many second generation products. Leaving a gap of two to four weeks between baiting for rats and slaughter of the pigs will minimize the risk when using warfarin. Second generation products have a much longer biological half-life and four to five months minimum would be required. Pig units are therefore treated, where necessary, using first generation products, protecting the baits themselves from pigs and checking the area for dead and dying rats each day, and including a "harvest interval" of one month between baiting for rats and slaughtering of pigs.

CONCLUSION

In the present climate of economic cuts, it is essential that the Section not only become most cost-effective but is also seen to be working more efficiently too. A big step in this direction can be made with no additional financial input, and the power of feedback and communication (both within the section and out to the public) should not be underestimated. The public needs to become partners in the rodent control program, working together with the professional operators to a common goal which is clearly understood by both.

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