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Rattus rattus on the Shiant Islands
A study of distribution and abundance

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Introduction

In the first week of July 1995, a team of scientists from Scottish Natural Heritage visited the Shiant Islands in order to carry out a week of intensive survey work. This expedition was the third in a series of such expeditions in the Western Isles over the last three years, the purpose being to collect as much information as possible about the lesser known (remote) sites in the Western Isles, with particular reference to EC Directive sites (SPA/pSAC). As well as collecting scientific data, the expeditions have also proved to be invaluable as training exercises.

The Shiants expedition had several objectives: botanical survey, to produce a detailed map of the National Vegetation Classification (NVC) communities; ornithology, counts of breeding seabirds; invertebrate survey, to further the knowledge of invertebrate distribution in the Western Isles; small mammals, investigation of presence of small mammals; ship rat, to look at the distribution, population density and morphology of this unusual British population.

Rattus rattus - the ship rat or black rat - on the Shiant Islands

Background

The population of rats on the Shiants has been known about for some years, with references being made by Atkinson (1949), Scott-Moncrieff (1952), Darling & Boyd (1964), Brooke (1972), MacInnes (1974), Boyd & Boyd (1990) and Angus & Hopkins (1995). The literature often refers to infestations of both brown (*Rattus norvegicus*) and black (*Rattus rattus*) rats on the Shiants. Trapping work by a group from the Nicolson Institute in 1974 found no evidence of *Rattus norvegicus* (MacInnes 1974). A specimen trapped by a Scottish Natural Heritage team in 1994 was positively identified as *Rattus rattus* by the National Museum of Scotland (Angus & Hopkins 1995).

The aim of our work on the Shiants was to further the understanding of the population of *Rattus rattus* on the Shiants, given the less than clear understanding referred to in the past.

Methods

Throughout the course of the week, three different approaches were taken to the problem:

1 live trapping
2 rat sticks
3 faeces sampling.

1 Live Trapping

Throughout the week, we had at our disposal 11 mink traps, which have proved to be suitable for trapping rats in the past (pers comm Kenny Maclennan, Angus & Hopkins 1995). The traps were set in a variety of habitats on Garbh Eilean and Eilean an Tighe, whenever weather conditions allowed. A surplus of fresh fruit (apples) left by the owner, Adam Nicolson, proved to be ideal bait for the traps. The traps were set in the evening and checked in the morning (unless weather conditions deteriorated, when the traps would be closed).

Handling the rats proved to be a much easier operation than we had anticipated. The rat could easily be cornered at one end of the cage by slotting a number of sticks (rat sticks) through the mesh of the cage (with one exception - a rat which quickly learnt to throw the sticks aside!), whilst the door of the trap was opened manually and locked up with an adapted tent peg. At this point, a small area of the rat was sprayed with sheep dye for future recognition. A strong polythene bag was then placed over the opening of the trap. Once secure, the sticks were removed allowing the rat to enter the bag. In the bag, the rats were weighed and sexed before release. Throughout this process, the handler wore heavy duty leather gauntlets. Care was taken to ensure that people washed well after handling rats in order to minimise the risk of contacting Weil's disease.

Some problems were encountered with the traps. In a number of cases, the traps could not be set sensitive enough for the rat to spring the mechanism - resulting in stolen bait and no rat. Sometimes a trap which was set very sensitively was recovered with the mechanism set at a much coarser degree - presumably a factor of trap design exacerbated by wind. More seriously, one trapped rat managed to squeeze its head through one of the meshes, and was discovered in this position. The folds of skin underneath its chin prevented the rat from getting out of this position, although it was apparent that it had tried so hard that it had injured its head. We managed to release the rat after a considerable degree of manipulation, but the injury and stress were a worry. We would recommend that future trapping research should employ custom built rat traps with a finer mesh size and more sensitive spring mechanism than mink traps.

2 Rat Sticks

To supplement the trapping activities, we decided to set up a network of grids and transects of rat sticks so that we could get a clearer picture of the distribution of *Rattus rattus* on the Shiants.

A rat stick is an incredibly simple piece of scientific equipment. It consists of a piece of wood approximately 15cm long by 2cm square, which is soaked in liquid margarine. The simplest way we could find to make sufficient sticks (over 1000!) was to melt 4 gallons of

margarine in a wheelbarrow with the aid of a blowtorch, then dip the sticks in the liquid. Rat sticks have been used in the past to identify locations of *Rattus norvegicus* in the Sound of Harris (A Rothwell pers comm) and on Ailsa Craig (Zonfrillo and Monaghan, 1995). The technique has been shown to be effective in estimating relative abundance.

We employed two different techniques in laying out the sticks, using transects and grids.

Grids of 100 or 50 sticks at 10m spacings were set out on the three main islands in various locations (fig 1). The purpose of this technique was to obtain a relative measure of abundance which would be comparable throughout the islands (% sticks chewed over a standard time). Line transects (10m spacings) were set up throughout the islands (fig 1) in order to identify the presence/absence of rats at various points throughout the islands. The sticks were intended to be revisited several times over succeeding months to examine changes in both abundance and distribution.

Originally, we intended to put sticks out on the Galtachean, but regrettably due to weather conditions encountered during the week we were unable to do so.

3 Faeces Sampling

The presence of rats on seabird islands is a contentious issue, both in the UK and other parts of the world. Examples of problems include Ailsa Craig, where brown rats were exterminated in a bid to encourage puffins to return to breed. This seemed to be successful, although the first puffins to return were caught by peregrines! Lundy is also facing problems with a high rat population and dwindling numbers of puffins.

The situation does not appear so clear cut on the Shiants, as rats and seabirds have co-existed in considerable abundance for over 100 years, presumably following the invasion by rats after a ship wreck in the late 19th century (it is possible that the rats appeared beforehand). However, it must be emphasised that the details and any consequences of this relationship have never been previously investigated to any extent. Nevertheless, the Shiants are recognised as one of Europe's most important seabird breeding stations, and this situation has come about with the presence of *Rattus rattus*. The lack of winter feeding is presumably helping to keep the population at a low enough level to ensure that the integrity of the seabird colonies is not at threat.

We felt that it would be useful to collect samples of faeces from a range of locations for two reasons: faecal analysis could give us dietary information and finding faeces is also a good indicator of distribution.

Results

1 Live trapping

The data obtained from the trapping exercise was as follows:

Date	Sex	Mass (g)	Location	Colouration
2.7.95	♂	240	Garbh Eilean (NE)	Charcoal
3.7.95	♂	220	Eilean an Tighe, house beach	Brown
3.7.95	♀	160	Eilean an Tighe, Airigh	Brownish, white belly
3.7.95	♂	240	Eilean an Tighe, house beach	Greyish brown, white belly
3.7.95	♀	190	Eilean an Tighe, house beach	Greyish brown, white belly
3.7.95	♀	220	Garbh Eilean (N)	Brown
3.7.95	♀	280 (pregnant)	Garbh Eilean (N)	Brown
3.7.95	♂	250	Garbh Eilean (N)	Charcoal
3.7.95	♀ R	160	Eilean an Tighe, Airigh	Brownish, white belly. Retrap.
5.7.95	♀	205	Eilean an Tighe, house beach	Brown
7.7.95	♂	210	Eilean an Tighe, house beach	Charcoal
7.7.95	♂	240	Eilean an Tighe, house beach	Charcoal

R = retrap

Total sample: 11 rats

Total ♂: 6 rats
Total ♀: 5 rats

Mean mass ♂: 233.33g
Mean mass ♀: 193.75g (not including pregnant individual)
211g (including pregnant female)

Overall mean mass: 217.5g (not including pregnant female)
223.18g (including pregnant female)

Number of retraps: 1

Colouration Pattern	Number Caught
Charcoal	4
Greyish brown, white belly	2
Brownish, white belly	1
Brown	4

All the rats trapped were identified as *Rattus rattus*, with no evidence of presence of *Rattus norvegicus* being discovered.

The number of trap nights employed were as follows:

Date	Number of Traps	Location
1st - 2nd	4	Garbh Eilean
	2	Eilean an Tighe (Airigh and shore)
2nd - 3rd	4	Garbh Eilean
	1	Eilean an Tighe (Airigh)
	6	Eilean an Tighe (house beach)
3rd - 4th	0	
4th - 5th	6	Eilean an Tighe (house beach)
5th - 6th	0	
6th - 7th	6	Eilean an Tighe (house beach)

Total trap nights: 29
Total number of rats trapped: 12 (inc retrap)

Catch per unit effort measure : 12/29 = 0.414 or 1/2.42 (ie 1 rat for every 2.42 trap nights)

2 Rat Sticks

The network of rat sticks was set up on the three main islands as shown in the accompanying maps.

In total, 589 sticks were placed, as follows:

Garbh Eilean	316
Eilean an Tighe	184
Eilean Mhuire	89

Ideally, we would have liked to have put sticks on the Galtachean. Hopefully this can be done in the future. The extra rat sticks proved to be excellent fire lighters!

On 6 and 7 July 1995, we checked as many of the sticks as we could. Although they had only been out for a couple of days, 5 sticks had been chewed - in an area where we had already caught a rat. This figure seemed pretty low, but at least it demonstrated that the method worked, and gave hope that subsequent visits would be successful in detecting chewed sticks.

Follow up visits to monitor the rat sticks took place in August 1995 and April 1996. During these visits, all of the transects and grids were checked for evidence of chewing by rats. The raw data recorded is found in Appendix 1. In cases where more sticks appear to have been found on the second visit than on the first, this is simply due to a more successful count - no sticks were replaced during the first visit.

The information gathered from the transects and grids can be summarised as follows (for details of exact locations of grids and transects, refer to figure 1):

Garbh Eilean

Transect 1 (Puffinry)

Out of 30 sticks, 20 were found in August 1995, of which 50% were chewed. 27 were found in April 1996, 85% of which were chewed (all of the sticks traversing the actual puffinry were chewed).

Transect 2 (Puffinry)

Out of 16 sticks, 15 were found in August, of which 87% were chewed. 14 were found in April, 100% of which were chewed.

Transect 3 (Cliff top, Mullach Buidhe)

Out of 20 sticks, 18 were found in August, of which 78% were chewed. 17 were found in April, of which 76% were chewed (most of which seemed to have been chewed a long time ago - no fresh marks).

Transect 4 (south from Mullach Buidhe)

Out of 20 sticks, 20 were found in August, of which 45% were chewed. 17 were found in April, of which 88% were chewed.

Transect 5 (cross section from Glaic na Crotha, south to the shore)

Out of 40 sticks, 40 were found in August, of which 42% were chewed. 38 were found in April, of which 71% were chewed.

Transect 6 (Stocanish)

Out of 20 sticks, 20 were found in August, of which 65% were chewed. 19 were found in April, of which 37% were chewed (no fresh signs and hard to be sure if chewing had/had not taken place).

Transect 7 (cliff to cairn at SE end of island)

Out of 20 sticks, 18 were found in August, of which 50% were chewed. 16 were found in April, of which 62% were chewed.

Grid 1 (feannagan near Toll a'Roimh)

Out of 100 sticks, 98 were found in August, of which 43% were chewed. 90 were found in April, of which 74% were chewed.

Grid 2 (Airighean na h-Annaid)

Out of 50 sticks, 49 were found in August, of which 21% were chewed. 50 were found in April, of which 62% were chewed.

Eilean an Tighe

Transect 8 (shore to cliff top, NW -SE)

Out of 52 sticks, 39 were found in august, of which 52% were chewed. 43 were found in April, of which 56% were chewed. Interestingly, the area around the shielings in the middle of the island had large numbers of rat holes present, indicating that the shelter provided by the shielings is insufficient for the number of rats in the area.

Transect 9 (cliff top to shore, E - W)

Out of 42 sticks, 34 were found in August, of which 44% were chewed. 41 were found in April, of which 51% were chewed.

Transect 10 (Mianish)

Out of 40 sticks, 36 were found in August, of which 56% were chewed. 16 were found in April, of which 94% were chewed. Many sticks were lost here, probably due to interference by gulls/geese. There were large numbers of freshly dug holes found in this area, which were of such a size that rats seemed to be the only likely explanation.

Grid 3 (feannagan near house)

Out of 50 sticks, 45 were found in August, of which 24% were chewed. 45 were found in April, of which 73% were chewed.

Eilean Mhuire

Transect 11 (from shore north through St Mary's Chapel)

Out of 29 sticks, 20 were found in August, of which 0% were chewed. 13 were found in April, of which 0% were chewed (suspect interference from gulls).

Transect 12

Out of 21 sticks, 16 were found in August, of which 0% were chewed. 2 were found in April, of which 0% were chewed (suspect interference from gulls).

Grid 4

Out of 50 sticks, 42 were found in August, of which 0% were chewed. 2 were found in April, of which 0% were chewed (suspect interference from gulls).

Summary Table

Transect number	**% Sticks chewed**	
	August 1995	**April 1996**
1	50	85
2	87	100
3	78	76
4	45	88
5	42	71
6	65	37
7	50	62
8	52	56
9	44	51
10	56	94
11	0	0
12	0	0
Grid number		
1	43	74
2	21	62
3	24	73
4	0	0

3 Faeces Sampling

On 6 and 7 July 1995, time was spent searching Eilean an Tighe and Garbh Eilean for rat droppings. The places where droppings were found were quite obvious: shielings, walls, rock crevices etc. The distribution of sites where we found and sampled faeces are shown on fig 2.

The faeces samples were examined by Martin Goulding, Manchester Metropolitan University, and written up in : "Report on the diet of the black rat (*Rattus rattus*) inhabiting the Shiant Isles by analysing faecal material". Martin Goulding. SNH Report No. NW 614 (Appendix 2).

The summary of this report is as follows:

> "A total of 120 faecal pellets were collected in July 1995. Contents showed that diets of black rats in the Shiants included a high proportion of vegetational matter (stems, leaves, grass seeds and moss) supplemented by Coleoptera and larval Lepidoptera. Occasional feathers suggested scavenging or predation and the presence of small (rat) bones indicated possible cannibalism."

Discussion

Live trapping

The sample of rats obtained was not large enough to make any significant statistical statements. The data obtained has allowed us to make some interesting observations which could be followed up in the future if necessary.

Mass

The overall mean mass (not including the pregnant female) was 217.5g, from a sample of 10 individuals. It is interesting to note that the sample of 15 rats weighed in April 1973 (MacInnes) had a mean mass of 165g. Although the sample sizes are small, there appears to be a significant difference. The Nicolson Institute expedition was in April 1973. The difference in mass seems to be related to food supply, with the rats being in poor condition in spring following the rigours of winter, but rapidly putting on weight in late spring / early summer as the available food supply increases.

Within our small sample the mean male mass (233.33g) seems to be greater than the mean female mass (193.75g). In order to test this, a much greater sample would be required, although Corbet & Southern (1977) point out that the male is usually bigger.

It is interesting to note that *Rattus rattus* "usually weigh 150-200g" (Corbet & Southern, 1977). Although the sample we obtained was small, the mean weight we recorded appears to be greater than that recorded elsewhere in the UK.

Rat Sticks

The network of transects and grids of rat sticks proved to be a very effective method for assessing the distribution of *Rattus rattus* on the Shiants.

The survey demonstrated that *Rattus rattus* is widespread, but not uniformly so, on both Garbh Eilean and Eilean an Tighe. No evidence of presence was discovered on Eilean Mhuire. *Rattus rattus* appears to favour similar conditions on the Shiants as *Apodemus sylvaticus* does on other offshore islands. Habitat preference is very similar, with both

species favouring rocky areas (old buildings, walls, natural crevices etc) to shelter within and range out from.

The transects showed that the rats are found from the seashore to the highest cliff tops. Activity seemed to be highest in the vicinity of the main puffin colony (high degree of chewing on each stick). It was interesting to note that the transects along the cliff tops on Garbh Eilean did not seem to have any fresh marks in April - suggesting that rat activity near the cliffs is higher during the summer months (when seabirds are present), with the rats moving back inland in the winter. Transect 6 also showed this (65% in August, 36.84% in April) - the apparent reduction in percentage of chewed sticks being explained by the lack of fresh marks in April, with the old marks from the previous summer being difficult to recognise.

The grids were designed so as to estimate the relative densities of rats in selected areas. Obviously, the longer the sticks are left, the more chance that they will be chewed. The figures obtained from the grids showed that there was no difference in the level of activity between grid 1 (Garbh Eilean) and grid 3 (Eilean an Tighe) over the course of the year, our information therefore suggests similar densities. However, when checked in August, the degree of activity recorded in grid 1 was virtually double that of grid 3 for the same period, suggesting that there is a lot more rat activity in the vicinity of the puffinry during the summer months. The level of activity recorded on grid 2 (Garbh Eilean) seems to be lower than grids 1 and 3, suggesting that the population densities in inland areas are lower than in areas close to the shore. Grid 4 (Eilean Mhuire) suggested that *Rattus rattus* was absent from Eilean Mhuire.

Better estimates of relative abundance/seasonal variation could be achieved by having grids set up in various locations during the summer months (May - August), and fresh grids in the same locations during the winter months (December - March). The information collected would show quite clearly if there were any significant differences in rat activity in the various locations at different times of year.

Faeces Sampling

The analysis of 120 samples of *Rattus rattus* faeces provided some interesting results. On average, 81% of the remains was vegetation (mostly stems, leaves and seeds of grasses, and moss) and 19% animal (mostly adult Coleoptera and larval Lepidoptera). Only one sample contained feathers, and one contained a fragment of bone from a rat.

To get a more accurate description of the diet of *Rattus rattus* on the Shiants, further analysis of faecal remains (ideally collected fresh at different times of year) coupled with direct sampling from stomach contents would be useful.

Distribution of *Rattus rattus* on the Shiant Islands

Taking into account all of the data collected from this project, a map has been prepared which suggests the main summer and winter ranges for *Rattus rattus* on the Shiants (fig 3).

Conclusion

Rat predation on breeding seabirds is a contentious issue. Concern has been expressed in the past that the population of black rats on the Shiants could present a threat to the internationally important seabird colonies. The aim of this project was to assess the distribution of *Rattus rattus* in an attempt to increase our knowledge of this unique population. The project showed that *Rattus rattus* is widespread on Garbh Eilean and on Eilean an Tighe, but seems to be absent from Eilean Mhuire. The distribution of rats seems to be concentrated around the seabird cliffs during the summer, but spreads out to cover most of the islands during winter. The rats utilise many different food sources throughout the year, but it is interesting to note that vegetative matter appears to predominate, with only 1/120 samples containing feather remains - suggesting a low degree of predation on seabirds. This is in no way conclusive, as rats could well be eating early incubation stage eggs which would be difficult to detect.

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ADDENDUM

Rattus rattus on Eilean Mhuire

Following the completion of the preceeding report, students from Manchester University reported evidence of rats on Eilean Mhuire (Population characteristics of the ship rat, *Rattus rattus*, on the Shiant Islands, Hebrides, Scotland. Gillian Key and Alan Fielding 1996), although this report was not substantiated. Over the years, there have also been rumours / suspicion that rats and/or "a small mammal" are resident on Eilean Mhuire.

Taking the above into account, David Maclennan and Johanne Ferguson visited Eilean Mhuire on 23 July 1997 and set 10 "break-back" rat traps in a transect along the south shore of Eilean Mhuire. The traps were baited with cheese and peanut butter and were all set so as to be inaccessible to other forms of wildlife. Three mouse traps were also set in the remains of St Mary's Chapel in an attempt to trap "other" small mammals. (see figure 4).

On 2 August 1997, we returned to check the traps, accompanied by Calum Macdonald MP, Simon Fraser, and Donald Macdonald. 9 of the rat traps had been sprung, and all the bait removed, but nothing caught. 1 trap contained the remains of a black rat, which was taken back and frozen as evidence. All 3 mouse traps had also been sprung, bait removed, but empty. Fresh rat droppings were discovered in St Mary's Chapel.

This work has provided the first substantiated evidence of the presence of *Rattus rattus* on Eilean Mhuire. In order to reach an understanding of the numbers and distribution of *Rattus rattus* on Eilean Mhuire, further research is required.

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