

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

Rats on Kapiti Island, New Zealand: Coexistence and diet of  
Rattus norvegicus Berkenhout and Rattus exulans Peale.

A thesis presented  
in partial fulfilment of the requirements  
for the degree  
of Master of Science  
in Zoology  
at  
Massey University

Andrew Mark Philip Dick

1985

599.3233099361

DIC

DC20

ABSTRACT

Snap-trapping information and diet analysis were used to investigate the coexistence of Rattus norvegicus and Rattus exulans with one another and with indigenous avifauna on Kapiti Island (1,965ha, 40<sup>0</sup> 51'S., 174<sup>0</sup> 56'E.). The period of trapping was one year (May 1983 to April 1984) and a diversity of habitat types were involved. Areas were trapped for a three day period after three days of prebaiting and most areas were trapped three times during the year. Reproductive and morphometric parameters were also recorded for the rat populations and an alternative form of estimating density, nocturnal rat counts, was tested. Attempts were also made to measure the arboreal activity of rats using chalk dust tracking paper.

The density estimate for the combined populations (15.06 rats/100 trap-nights) is high when compared with mainland rat populations. Density varied with habitat and season, the highest density index being obtained in lowland grass, the lowest along a stony beach. A Standard Minimum estimate of 63 rats/ha was derived for the lowland grass area. Changes in density with season varied from area to area although there was a particular tendency for variations in spring. Species composition was different between habitats. Of eight areas trapped R. norvegicus was the predominant species in five. R. exulans was the predominant species in three areas and occurred in six. Seasonal fluctuations in species ratios were observed and in the three R. exulans areas a high negative correlation existed between the abundance of each species. Male R. exulans were heavier ( $\bar{x}$ =85.92g) than females ( $\bar{x}$ =78.98g) although the reverse situation

occurred in R. norvegicus, (male  $\bar{x}$ =209.76g, female  $\bar{x}$ =222.07g). Reproduction in both species was seasonal with breeding activity peaking in summer and spring. Length of breeding season, average frequency of litter production and mean foetus number were greater in R. norvegicus. R. exulans showed greater fluctuations in age structure.

Of the three main food categories measured, invertebrates, vegetation and seeds, the invertebrate fraction was, in terms of mean percentage volume and frequency of occurrence, the most important for both species. R. exulans had a less varied diet and was more reliant on invertebrates. Lepidopteran larvae were the most frequently eaten invertebrates with Araneida, Coleoptera, Orthoptera, Dipteran larvae and Chilopoda also occurring. Invertebrates formed a greater part of the diet in summer months. Diet strongly reflected the habitat in which rats were trapped. Distinctly different diets were noted in animals inhabiting forest when compared with those from grassland. The proportion of exotic vegetation and seed was more pronounced in the grassland habitats. Although the overlap in diet was considerable, particularly with the invertebrate types eaten (52 types identified, 17 eaten by only one species) the differences in volumes eaten were substantial. Birds did not feature heavily in rat diet and no instances were recorded of kiore having eaten bird remains. Nocturnal rat counts appear an unreliable alternative to trapping as a density measure and kiore do not appear to forage arboreally.

The changes in species ratio, density and diet with area are discussed in terms of competition theory. It is hypothesised that

R. norvegicus is competitively superior and excludes R. exulans from mutually desirable habitats. The mechanisms of the competition are unclear although available evidence suggests that competition for food rather than competition for space is the more likely.

### ACKNOWLEDGEMENTS

Many people have assisted in compiling this project. My supervisor, Dr. John Skipworth, was always on hand when needed and his contribution is greatly appreciated.

While on Kapiti the Daniel family were hospitable and encouraging and I am indebted to them. Trevor Hook, Geoff Alexander, Bob Cairns, Tony Beauchamp and Tim Lovegrove provided enjoyable company and offered ideas, advice and rats. Tony Beauchamp kindly assisted in identifying invertebrate fragments.

Dr. Henrik Moller (Ecology Division, D.S.I.R., Lower Hutt) willingly contributed information and advice on rodent ecology as did Dr. Ian Atkinson (Botany Division, D.S.I.R., Lower Hutt), Dr. Phil Moors (Wildlife Service, Wellington), Duncan Cunningham (Wildlife Service, Wellington), Ian McFadden (Wildlife Service, Auckland) and Dr. Kamierz Wodzicki (Zoology Department, Victoria University).

Keith Young (Ministry of Agriculture and Fisheries, Palmerston North) and Margaret Bulfin (Botany Division, D.S.I.R., Christchurch) identified seed remains and I appreciate their effort. Jan McKenzie (Canterbury University), Prof. R. Pilgrim (Canterbury University) and Riccardo Palma (Dominion Museum, Wellington) kindly identified the parasites. Peter McGregor (Entomology Division, D.S.I.R., Palmerston North) helped identify insects.

Dr. Tom Hassard and Greg Arnold (Statistics Department, Massey University) freely provided assistance with the multivariate statistics used.

My room-mates John Mitchell and Alan Nixon often offered advice most of which was pertinent and all of which was appreciated. Gavin Williamson (Zoology Department, Massey University) shared his cuticle analysis techniques with me.

The Lands and Survey Department provided financial assistance over the summer spent on Kapiti and this plus their initial permission for the study is appreciated.

Colin Cook (Real Estate Agent, Palmerston North) kindly provided the use of a word processor while Sheryl Hollow (Public Relations Organisation, Palmerston North) was helpful with final photocopying. Peter McGurk (Palmerston North) assisted with final proof reading.

My parents, Natalie and Ian Dick (Napier) were a constant source of encouragement. My fiance, Sandy Bacon, patiently typed the thesis, was a ready source of comfort, diligently travelled to Paraparaumu Beach to pick me up after my Kapiti sojourns and applied the pressure needed to finish the thesis.

TABLE OF CONTENTS

	Page
TITLE PAGE	i
ABSTRACT	ii
ACKNOWLEDGEMENTS	v
LIST OF FIGURES	ix
LIST OF TABLES	x
LIST OF PLATES	xii
CHAPTER 1. INTRODUCTION	1
1.1 PREAMBLE	1
1.2 DESCRIPTION OF RATS	3
1.2.1 Norway rats	3
1.2.2 Kiore	6
1.3 RATS ON KAPITI ISLAND	7
1.4 KAPITI ISLAND	8
1.4.1 General description	8
1.4.2 Climate	9
1.4.3 Geology	9
1.4.4 Vegetation	11
1.4.5 Fauna	13
1.4.6 Cultural influences	14
CHAPTER 2. AIMS	16
CHAPTER 3. METHODS	17
3.1 TRAPPING	17
3.2 DESCRIPTION OF STUDY AREAS	19
3.3 FIELD EXAMINATIONS, MORPHOMETRICS AND REPRODUCTION	27
3.4 LABORATORY EXAMINATIONS, REPRODUCTION AND DIET	28
3.5 ARBOREALITY	31
3.6 NOCTURNAL RAT COUNTS	32
3.7 STATISTICS	32
CHAPTER 4. RESULTS	34
4.1 TRAPPING	34
4.1.1 Density indexes	34
4.1.2 Species ratio	34
4.1.3 Correlation between density and species ratio	39
4.1.4 Density and species ratio of areas trapped once	39
4.2 MORPHOMETRICS	42
4.3 REPRODUCTION	47
4.3.1 Sex ratio	47
4.3.2 Age (weight) classes	47
4.3.3 Reproductive activity	52
4.3.4 Maturity	54
4.4 DIET	54
4.4.1 Invertebrates	54
4.4.2 Foliate vegetation	57
4.4.3 Seed and fruit	63

	Page
4.4.4 Other categories	64
4.4.5 Diet analysis, species differences	64
4.4.6 Diet analysis, area differences	64
4.4.7 Diet analysis, seasonal differences	69
4.5 PARASITES	70
4.6 ARBOREALITY	70
4.7 NOCTURNAL RAT COUNTS	71
4.8 MISCELLANEOUS RESULTS	71
4.8.1 Edge Effect	71
4.8.2 Prebaiting	71
4.8.3 Post breeding season females	74
4.8.4 Weight of non pregnant females	74
4.8.5 Norway rat sex ratio on Line 3	74
CHAPTER 5. DISCUSSION	75
5.1 METHODS USED	75
5.1.1 Trapping	75
5.1.2 Reproduction	77
5.1.3 Diet	79
5.2 DENSITY AND SPECIES RATIO	80
5.3 MORPHOMETRICS	84
5.4 REPRODUCTION	85
5.4.1 Norway rats	85
5.4.2 Kiore	88
5.5 DIET	89
5.5.1 Introduction	89
5.5.2 Kiore	89
5.5.3 Norway rats	92
5.5.4 Lepidoptera larvae and prairie grass seed	94
5.5.5 Summary	95
5.6 ARBOREALITY AND NOCTURNAL RAT COUNTS	96
5.7 COEXISTENCE AND COMPETITION	97
REFERENCES	102
Appendix 1 Vegetation types of Kapiti Island.	120
Appendix 2 Location of possum trap lines mentioned in the text.	121
Appendix 3 Raw trapping results.	122
Appendix 4 Density indexes with confidence limits.	123
Appendix 5 Seasonal density indexes with confidence limits.	124
Appendix 6 Two-way ANOVA of kiore weight with sex and area.	125
Appendix 7 Monthly female sexual condition.	126
Appendix 8 Relative frequency of occurrence for nine food classes.	127
Appendix 9 MANOVA and D.F.A. parameters.	128
Appendix 10 Seasonal % volume results for the invertebrate, vegetation and seed fractions.	131

LIST OF FIGURES

Figure		Page
1.	LOCATION OF KAPITI ISLAND AND AREAS TRAPPED DURING THE STUDY.	10
2.	TOTAL DENSITY INDEXES FOR AREAS TRAPPED MORE THAN ONCE.	35
3.	SEASONAL CHANGES IN DENSITY INDEX AND SPECIES RATIO.	
	3A. Line 1	36
	3B. Line 2	36
	3C. Line 3	36
	3D. Line 4	36
	3E. Line 5	37
	3F. Line 7	37
	3G. Grid 1	37
4.	STANDARD REMOVAL DENSITY ESTIMATE FOR GRID 1.	38
5.	TOTAL SPECIES RATIO FOR AREAS TRAPPED MORE THAN ONCE.	40
6.	CHANGES IN WEIGHT CLASS FREQUENCY WITH SEASON.	50
	6A. Kiore	
	6B. Norway rats	
7.	CHANGES IN WEIGHT CLASS FREQUENCY WITH AREA.	51
	7A. Kiore	
	7B. Norway rats	
8.	SEASONAL CHANGES IN REPRODUCTIVE PARAMETERS.	53
	8A. Norway rats	
	8B. Kiore	
9.	FREQUENCY OF OCCURRENCE OF NINE MAJOR FOOD ITEMS FOR BOTH RAT SPECIES.	58
10.	FREQUENCY OF OCCURRENCE OF NINE MAJOR FOOD ITEMS IN:	
	10A. Line 1	65
	10B. Line 2	65
	10C. Line 3	65
	10D. Line 4	65
	10E. Line 5	66
	10F. Line 6	66
	10G. Line 7	66
	10H. Grid 1	66

Figure		Page
11.	DIFFERENCES IN THE VOLUMES OF INVERTEBRATE, SEED AND VEGETATION EATEN DISPLAYED AS DISCRIMINANT FUNCTION AXES FOR:	67
	11A. Kiore trapped seasonally in Grid 1	
	11B. Kiore trapped seasonally in Line 4	
	11C. Kiore trapped seasonally in Line 3	
	11D. Norway rats trapped seasonally in Grid 1	
	11E. Norway rats trapped seasonally in Line 2	
	11F. Norway rats trapped seasonally in Line 1	
	11G. Norway rats and kiore	
12.	DIFFERENCES IN THE VOLUMES OF INVERTEBRATE, SEED AND VEGETATION EATEN DISPLAYED AS DISCRIMINANT FUNCTION AXES FOR:	68
	12A. Norway rats in Norway rat areas	
	12B. Kiore in kiore areas	
13.	LOCATION OF RATS SIGHTED DURING NOCTURNAL COUNTS AROUND THE RANGATIRA TRACK SYSTEM.	73

LIST OF TABLES

Table		Page
1.	TRAP EFFORT AND MONTHS TRAPPED FOR EACH AREA.	18
2.	SIGNIFICANCE OF SEASONAL CHANGE IN SPECIES RATIO.	41
3.	CORRELATION COEFFICIENTS BETWEEN SPECIES RATIO AND DENSITY INDEX FOR SEASONAL CHANGES.	41
4.	TOTAL WEIGHT RESULTS.	43
5.	AREA WEIGHT DIFFERENCES TESTED BY t TEST AND ANOVA.	
	5A. Norway <u>rats</u>	44
	5B. Kiore	45
6.	SEASONAL WEIGHT CHANGES.	46
7.	SEX RATIOS.	48
8.	SIGNIFICANCE OF CHANGES IN WEIGHT (AGE) CLASS.	49
9.	RATIO OF OLD TO YOUNG RATS.	49
10.	DIET PERCENTAGE OCCURRENCE RESULTS FOR SPECIES AND AREA.	55
11.	DIET PERCENTAGE VOLUME RESULTS FOR SPECIES AND AREA.	56
12A.	FREQUENCY OF OCCURRENCE OF INVERTEBRATE FOOD ITEMS.	59
12B.	FREQUENCY OF OCCURRENCE OF SEED FOOD ITEMS.	61
12C.	FREQUENCY OF OCCURRENCE OF PLANT FOOD ITEMS.	62
13.	NOCTURNAL RAT COUNTS.	72
14.	COMPARISON BETWEEN HYPOTHETICAL DENSITY INDEXES.	77
15.	DESCRIPTION OF PREFERRED HABITATS.	83

LIST OF PLATES

Plate		Page
1.	KIORE.	4
2.	NORWAY RAT.	4
3.	LINE 1.	20
4.	LINE 2.	20
5.	LINE 3.	22
6.	LINE 4.	22
7.	LINE 5.	24
8.	LINE 6.	24
9.	LINE 7.	26
10.	GRID 1.	26