Seasonal abundance patterns and dietary preferences of hedgehogs at Trounson Kauri Park

Richard Hendra
School of Environmental and Marine Sciences
University of Auckland
Private Bag 92-019
Auckland
New Zealand

Published by
Department of Conservation
Head Office, PO Box 10-420
Wellington, New Zealand

This report was commissioned by Northland Conservancy.

ISSN 1171-9834

Reference to material in this report should be cited thus:

Hendra, R., 1999.
Seasonal abundance patterns and dietary preferences of hedgehogs at Trounson Kauri Park.
Conservation Advisory Science Notes No. 267, Department of Conservation, Wellington.

Keywords: hedgehog, *Erinaceus europaeus*, diet analysis, abundance, Trounson Kauri Park.

Abstract

The hedgehog has not been widely studied in the conservation context in New Zealand. As an introduced mammal, its role in New Zealand ecosystems is not well understood. Through the use of three years of trapping data from Trounson Kauri Park in Northland, and the analysis of 51 gut samples taken over a one-year period from Trounson, seasonal patterns of abundance and diet of hedgehogs were investigated.

Fluctuations in hedgehog numbers occurred throughout the three-year period, with lows in winter and peaks in late summer and autumn. A decrease in hedgehog abundance was noted in the second year following control.

Seasonal diet patterns were also observed, with a range of prey items being taken, depending on their availability throughout the year. Agricultural pest species such as *Heteronychus arator* and *Teleogryllus commodus* were commonly taken prey items.

1. Introduction

Trounson Kauri Park in the Northland conservancy is a 445 hectare remnant patch of mixed kauri/broadleaf forest. It contains a resident population of North Island brown kiwi (*Apteryx mantelli*) and other endangered bird and invertebrate fauna (e.g. North Island robin (*Petroica australis*), kauri snail (*Paryphanta busbyi busbyi)* etc.).

The Department of Conservation, as part of its Mainland Island Project, currently manages Trounson. Both poison and trapping are used as part of the control programme to reduce the numbers of known pests and predators, such as mustelids (*Mustela furo*, *M. erminea*, *M. nivalis*), cats (*Felis catus*), rodents (*Rattus rattus*, *R. norvegicus*, *Mus musculus*), and possums (*Trichosurus vulpecula*).

Fenn traps are set up around the perimeter of the park to catch both resident and invading pests. Hedgehogs (*Erinaceus europaeus*) have turned up as a bycatch of this trapping regime. Since trapping began in August 1996, 733 hedgehogs have been captured in the Fenn traps.

Very little is known about this species in New Zealand, especially from a conservation perspective. The common belief has been that hedgehogs do not occur in areas of native bush. However, a recent study undertaken at Pureora Forest Park (King et al. 1996) found large numbers of hedgehogs in the interior of undisturbed native forest.

Previous studies on hedgehogs in New Zealand have been few and far between and have tended to focus on coastal areas or modified habitat (such as

pasture or urban settings) (Brockie 1959; Campbell 1973). These studies have shown that hedgehogs are quite general in their diet, consuming a wide range of small vertebrate and invertebrate fauna. Studies in Twizel have also recorded, on infra-red camera, predation by hedgehogs of the eggs of banded dotterel *(Charadrius bicinctus)* (J Dowding, pers. comm.).

As an invertebrate eater, concerns have also been raised for many native mollusc and insect species.

The objectives of this study are:

- To investigate and describe the seasonal dietary preferences of hedgehogs in Trounson Kauri Park.
- To investigate and describe the annual fluctuations in hedgehog numbers in Trounson, based on trap catch data.

2. Methods

2.1 SEASONAL ABUNDANCE PATTERNS

Records of trap captures have been kept at Trounson since the current trapping programme began in August 1996. The data for hedgehog captures were separated out and analysed independently from the capture records for other species. Total captures per month were initially looked at, then these data were converted to a capture rate per 100 trap nights - to correct for variations in trapping effort - by dividing by the corrected trap nights per month. However, the corrected number of trapping nights for the data from July 1998 onwards was unavailable at the time of preparing this report. The total captures per month were therefore used when analysing the final 11 months worth of data.

2.2 SEASONAL DIETARY PREFERENCES

Dietary analysis began in January 1998 and continued until October 1998. Fenn traps set around the perimeter of the park, mainly in edge or open habitat, provided the animals for the dietary analysis. Hedgehogs caught during this time, that were not in too advanced a state of decomposition, were brought back from the field for analysis. Animals were weighed and sexed, and the stomach and intestine were removed. The contents were then washed into a petri dish through a fine mesh sieve and sorted. Prey items were preserved in a 70% isopropyl solution for later identification.

In order to aid in the identification of prey items, pitfall trapping was undertaken. These traps consisted of 2 litre drink bottles cut in half and with the top half inverted and placed inside the bottom half. These were buried to their rim in 10 locations around the park and covered with a raised cover, to

keep rainwater out. These were checked every two weeks and invertebrates caught were preserved in 70% isopropyl to provide a reference collection.

The preserved samples were examined under a binocular microscope and identified to family level or better (where possible). Items were not scored as to their relative importance in the gut sample, but as present/absent. This cumulative total gives a percentage occurrence of each prey item in the diet, which can be broken down to seasonal levels for analysis.

3. Results

3.1 SEASONAL ABUNDANCE PATTERNS.

Ideally trap capture records should be corrected to take into account the number of trapping nights undertaken. This was only possible for the first two years of trapping records. The corrected hedgehog abundance for the period August 1996 - June 1998 can be seen in Fig. 1.

As can be seen from Fig. 1, the number of hedgehogs per 100 trap nights fluctuated throughout the year, reaching lows in winter 1996, 1997, and 1998. Peaks for the year are more spread out, with relatively high numbers of hedgehogs being caught through spring, summer, and autumn. There is also a considerable drop in the number of hedgehogs caught per 100 trap nights in the second year of trapping.

The third year of trapping data (July 1998 - May 1999) could not be corrected due to the unavailability of the data for corrected trap nights at the time of writing. However, the total numbers of hedgehogs captured per month for the entire 3-year control period has been included in order to draw some comparisons between the corrected and uncorrected data (Fig. 2). A similar trend to that observed in the corrected data can be seen.

The peaks and the troughs for the first two years of trapping occurred in the same places. The peak for the second year was also considerably smaller than that in the first year. With the third year of data added, it can be noted that hedgehog numbers once again reached a low in August 1998 and rose again to peak in March 1999. There were also more captures of animals in the third year (August 1998 - May 1999) - an average of 21.5 per month - than in the second year (August 1997 - July 1998) - an average of 15 per month.

The average number of hedgehogs caught per month fluctuated from year to year, as seen in Fig. 3. The difference between years one and two is significant ($p=0.036$; t-test, 95%, d.f.=16), but the differences between years one and three ($p=0.178$; t-test, 95%, d.f.=16) and two and three ($p=0.318$; t-test, 95%, d.f.=16) are not.

3.2 SEASONAL DIETARY PREFERENCES.

Various patterns can be seen in the diet of the hedgehogs at Trounson from the gut samples taken throughout the year. The seasonal breakdown and total percentage occurrence of all prey items from the gut samples is shown in Table 1. The taxonomic classification of the items can be found in Appendix 1. The seasons mentioned cover the following periods:

- Summer: 13/1/1998 - 29/2/1998
- Autumn: 1/3/1998 - 31/5/1998
- Winter: 1/6/1998 - 31/8/1998
- Spring: 1/9/1998 - 15/10/1998

The main dietary items have been separated out and graphed to show seasonal differences in their occurrence. These can be seen in Figs 4 - 8. Some items are highly seasonal. Field crickets occurred in 53% of the samples during summer, and almost 90% during autumn, but not at all during the winter or spring months. Green chafer beetles appeared in one-third of the summer samples, but not at all throughout the rest of the year. Ichneumon wasps also appeared only in the summer samples. Other differences to note are:

- the drop in autumn of the proportion of samples with earthworm remains (Fig. 5),
- the increase in winter of the proportion of samples with slug remains (Fig. 6),
- earwigs present in the smaller sample size months of winter and spring, but not in the larger sample size months of summer and autumn.

Other prey items such as weevils, black beetle, moth larvae, spiders, and wetas occurred in samples throughout the year in moderate numbers.

In all but one case, the occurrence of birds in the diet was seen by the presence of a single feather in the stomach. In one sample, however, multiple feathers, flesh, and bone fragments were found in the gut.

The presence of mice was also indicated, in most cases, by fur. In one case however, flesh and teeth were also noted.

Vegetation regularly occurred in the samples, mainly in the form of moss, grass, clover leaves, and dead podocarp leaves. Seeds also formed a part of the diet (Table 1). These were in most cases single occurrences of grass seeds, probably picked up accidentally. However, one sample from autumn contained 22 unidentified berry seeds, showing that the animal had actively selected these items.

Relative importance of items was not considered, though observations were made in some cases as to which items were present in large numbers. Items

such as moth larvae, black beetle, crickets, and earthworms often made up the bulk of some samples. One male caught in mid January 1998 had more than 50 moth larvae in its stomach as a result of one night feeding. Another large (730 g) female in late September had a minimum of 24 earthworms and 20 black beetles in its stomach, also the result of one night feeding.

4. Discussion

4.1 SEASONAL ABUNDANCE PATTERNS

Because of the unavailability of the corrected number of trapping nights for the last 11 months of data, concrete conclusions on seasonal abundance over the three years cannot be drawn. However, based on the corrected data for the first two seasons, an obvious trend is seen. Hedgehog numbers drop to very low levels in winter. This trend is supported by the uncorrected data as well. Why this should happen is unsure. The hedgehogs in New Zealand originated from Europe where they are known to enter into a state of hibernation during winter (Reeve 1994). They are also known to hibernate in colder parts of New Zealand (Brockie 1990), though it has only been speculative as to whether they will hibernate in the warmer climate of the Northland region. The drop in numbers of animals caught in traps during winter may be an indication that hibernation does occur in Northland, New Zealand. An alternative explanation is that there is a high degree of winter mortality of hedgehogs. The Dargaville region has a high winter rainfall and Brockie (1990) has suggested that hedgehogs avoid areas of high rainfall due to a shortage of dry nest sites. Flooding of burrows, and unsuitable winter nests, would also lead to a drop in hedgehog numbers in winter. Further study would be required to determine the main cause for the drop in winter.

The total numbers of hedgehogs caught varied from year to year. The drop in numbers from the first to the second year is seen in both the corrected and uncorrected data. There may be various reasons for this. The first year for which I have data is the first year in which control was carried out. The drop in numbers may be due to the effects of the control programme (i.e. poisoning and trapping). Without corrected data for the third year it is not possible to see if this trend continues. Based on the uncorrected data, the total numbers of hedgehogs increase again in the third year, though whether this is due to a greater abundance of animals or to increased trapping effort is impossible to say.

The second reason for the reduction in numbers may be climate based. The summer of 1997/98 was extremely wet with lots of surface flooding (pers. obs.). A lack of dry nest sites and consequent high degree of burrow mortality may account for the drop in numbers in the second year. The actual cause may well be a combination of both the control programme and the climate.

4.2 SEASONAL DIETARY PREFERENCES

Hedgehogs appear to he quite catholic in their diet. Studies in New Zealand and overseas (Campbell 1973; Brockie 1990; Reeve 1994) have found that a large range of invertebrate and small vertebrate prey items can make up the diet of hedgehogs. There is therefore the potential for hedgehogs to be a predator of endangered indigenous species of invertebrates or small vertebrates.

From the results obtained in this study, the diet of the hedgehog appears to change throughout the year, depending on the availability of different prey items.

In Northland, in summer and autumn, large numbers of field crickets are observed in the pasture. They are considered to be a significant pasture pest due to their large numbers and voracious feeding habits. During this time, crickets were found in the diets of the majority of hedgehogs sampled. Advantage was also taken of the increase in numbers of other seasonally occurring species (such as the summer appearance of the adult green chafer beetles). However, the hedgehogs do not appear to rely entirely on these species, and a range of other prey items is still included in the diet.

Besides the field crickets, other agricultural pest species occur as an important part of the diet. The black beetle, an introduced pest from South Africa, can do considerable damage to pasture in Northland and can be more of a pest than grass grub (*Costelytra zealandica*) (Helmore 1982). This species was found in a large proportion of the diets in winter and spring, but due to the small sample sizes in these seasons, it is hard to draw many conclusions. Moth larvae were also an important dietary item throughout the year. These were most probably porina moths (*Wiseana* sp.), another pasture pest species, but I was unable to be certain of the identification of them.

Some of these species have been noted in the diet of the North Island brown kiwi. Watt (1971) found both field crickets and black beetles in the kiwi gizzards he examined. Because of the high abundance of these pest species, their appearance in both hedgehog and kiwi diets is not surprising. Beetle larvae (Order: Coleoptera) are also known to make up a large part of kiwi diets (T. Chan, University of Auckland, pers. comm.) but none were found in any of the samples I examined. There is a need for more work investigating the possible niche overlap of hedgehogs and kiwis.

Birds and other vertebrates appear to make up only a small part of the diet. It is possible, and quite likely, that the hedgehogs had scavenged dead animals and this would account for the unidentified flesh, feathers and bone found in a couple of samples. Whether through scavenging or active predation, vertebrates were not a significant part of the diet at all.

The kauri snail (*Paryphanta busbyi busbyi*) is a large native, endangered land snail, occurring in Trounson. There was no evidence found of predation on this species. The snail has a thick shell, and trials undertaken by Natasha Coad suggest that the hedgehogs were unable to pierce it to get at the snail inside (Natasha Coad, University of Auckland, pers. comm.).

Few indigenous species appeared in large proportions in the diet, although some exceptions to this were found. Bush wetas appeared relatively frequently (in up to 60% of the diets in spring). These species are quite common and it is unlikely that hedgehogs would pose a threat to them. However, in areas where threatened species of wetas are present the hedgehog could be a potential threat.

5. Acknowledgements

Thanks to Paul Craddock for all his help with identifying the insect fragments in the diet samples. Thanks also to all the staff, students and volunteers at Trounson for their help throughout the year in providing access to the hedgehog trapping data and for collecting the animals caught in the trapping programme.

6. References

Brockie, R.E. 1959: Observations on the food of the hedgehog (*Erinaceus europaeus* L.) in New Zealand. *New Zealand Journal of Science* 2:121-136.

Brockie, R.E. 1990: European hedgehog In: King, C.M. (ed.) *The Handbook of NZ Mammals.* Oxford University Press, Auckland. p 99-113.

Campbell, PA. 1973: The feeding behaviour of the hedgehog (*Erinaceus europaeus* L.) in pasture land in New Zealand. *Proceedings of the NZ Ecological Society. 20:* 35-40.

Helmore, D. 1982: Drawings of New Zealand insects. *Bulletin of the Entomological Society of New Zealand No 8.* 52p.

King, C.M.; Innes,J.G.; Flux, M.; Kimberly, M.O.; Leathwick, J.R.; Williams, D.S. 1996: Distribution and abundance of small mammals in relation to habitat in Pureora Forest Park. *NZ Journal of Ecology. 20(2):* 215-240.

Reeve, N.J. (1994) *Hedgehogs.* T & A D Poyser Ltd, London.

Watt, J.C. 1971: The North Island kiwi: A predator of pasture insects. *The New Zealand Entomologist 5(1):* 25-27.

Appendix 1. Taxonomy of dietary items of hedgehogs

Common Name	Phylum	Class	Order	Family	Genus	Species
Earthworm	Annelida	Oligochaeta	Opisthopora	Lumbricidae		
Spider	Arthropoda	Arachnidae	Araneae			
Trombidiforme mite	Arthropoda	Arachnidae	Acarina			
Giant centipede	Arthropoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Cormocepbalus*	*sp.*
Thread centipede	Arthropoda	Chilopoda	Geophilomorpha	Geophylidae		
Millipede	Arthropoda	Diplopoda	Opisthospermophora			
Unidentified insect	Arthropoda	Insecta				
Unidentified beetle	Arthropoda	Insecta	Coleoptera			
Ground beetle	Arthropoda	Insecta	Coleoptera	Carabidae		
Longhorn beetle	Arthropoda	Insecta	Coleoptera	Cerambycidae		
Weevil	Arthropoda	Insecta	Coleoptera	Curculionidae		
Green Chafer beetle	Arthropoda	Insecta	Coleoptera	Scarabidae	*Chlorochiton*	*suturalis*
Black beetle	Arthropoda	Insecta	Coleoptera	Scarabidae	*Heteronychus*	*arator*
Rove beetle	Arthropoda	Insecta	Coleoptera	Staphylinidae		
Earwig	Arthropoda	Insecta	Dermaptera	Forficulidae	*Forficula*	*auricularia*
Unidentified Diptera	Arthropoda	Insecta	Diptera			
Housefly	Arthropoda	Insecta	Diptera	Muscidae	*Musca*	*domesticus*
Maggot	Arthropoda	Insecta	Diptera	Muscidae	*Musca*	*domesticus*
Bumblebee	Arthropoda	Insecta	Hymenoptera	Axidae	*Bombys*	*sp.*
Ant	Arthropoda	Insecta	Hymenoptera	Formicidae		
Ichneumon wasp	Arthropoda	Insecta	Hymenoptera	Ichneumonidae		
Moth larvae	Arthropoda	Insecta	Lepidoptera	Hepialidae		
Black Field cricket	Arthropoda	Insecta	Orthoptera	Gryllidae	*Teleogryllus*	*commodus*
Bush weta	Arthropoda	Insecta	Orthoptera	Stenopelmatidae	*Hemideina*	*sp.*
Bird feather	Chordata	Aves				
Unidentified fur	Chordata	Mammalia				
Mouse fur or teeth	Chordata	Mammalia	Rodentia	Muridae	*Mus*	*musculus*
Black slug	Mollusca	Gastropoda	Stylommatophora	Limacidae		
Slug	Mollusca	Gastropoda	Stylommatophora	Limacidae		
Garden snail	Mollusca	Gastropoda	Stylommatophora	Helicidae	*Helix*	*aspersa*

Table 1. Percentage occurrence of dietary items in hedgehog stomach samples.

Common Name	Summer (n=15)	Autumn (n=25)	Winter (n=6)	Spring (n=5)	Year Total (n=51)
Ant	6.7	8	0	0	5.9
Bird feather	13.3	0	16.7	20	7.8
Black beetle	20	32	33.3	80	33.3
Black field cricket	53.3	88	0	0	58.8
Black slug	0	8	0	0	3.9
Bumblebee	0	4	0	0	2
Bush weta	13.3	20	33.3	60	23.5
Ground beetle	6.7	0	16.7	0	3.9
Earthworm	33.3	4	33.3	40	19.6
Earwig	0	0	16.7	20	3.9
Garden snail	13.3	8	0	0	7.8
Giant centipede	0	12	0	20	7.8
Housefly	0	8	0	0	3.9
Ichneumon wasp	20	0	0	0	5.9
Longhorn beetle	20	8	0	0	9.8
Maggot	0	4	0	0	2
Green Chafer beetle	33.3	0	0	0	9.8
Millipede	0	4	16.7	0	3.9
Moth larvae	33.3	44	66.7	20	41.2
Mouse fur or teeth	6.7	0	16.7	0	3.9
Rove beetle	6.7	0	0	0	2
Seeds	20	8	16.7	0	11.8
Slug	6.7	24	66.7	20	23.5
Spider	6.7	16	50	40	7.8
Thread centipede	0	4	0	20	3.9
Trombidiforme Mite	13.3	12	0	0	9.8
Unidentified beetle	13.3	12	33.3	0	13.7
Unidentified Diptera	0	0	16.7	0	2
Unidentified flesh	6.7	0	0	0	2
Unidentified fur	6.7	8	0	0	5.9
Unidentified insect	0	4	0	0	2
Vegetation	40	36	33.3	60	39.2
Weevil	40	32	33.3	0	31.4

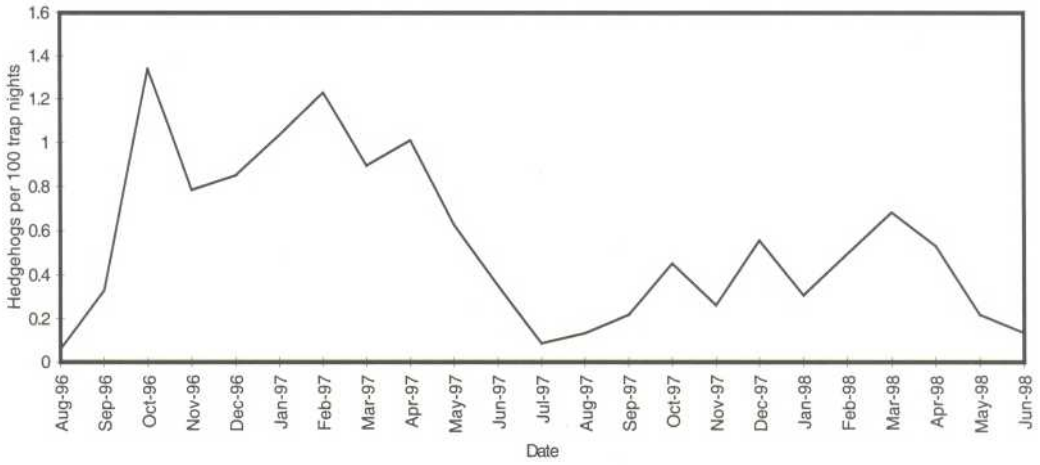

Figure 1. Corrected hedgehog abundance, August 1996 - June 1998.

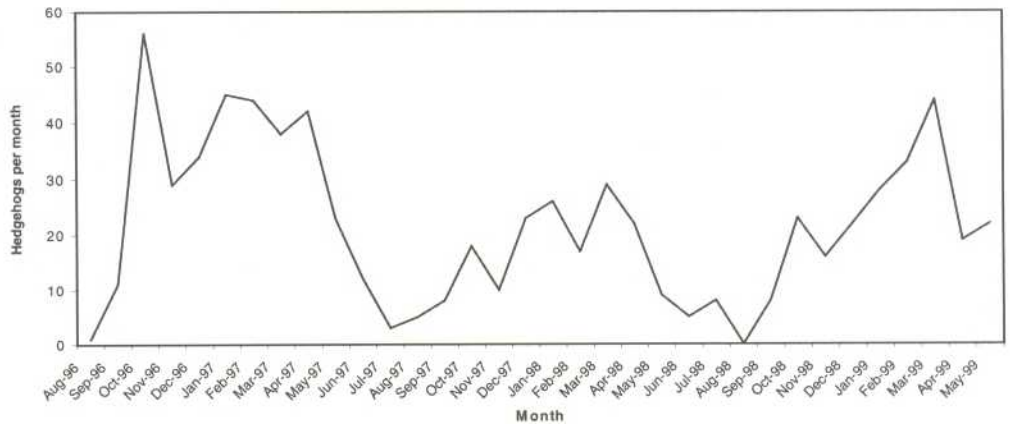

Figure 2. Total hedgehog captures per month,August 1996 - May 1999.

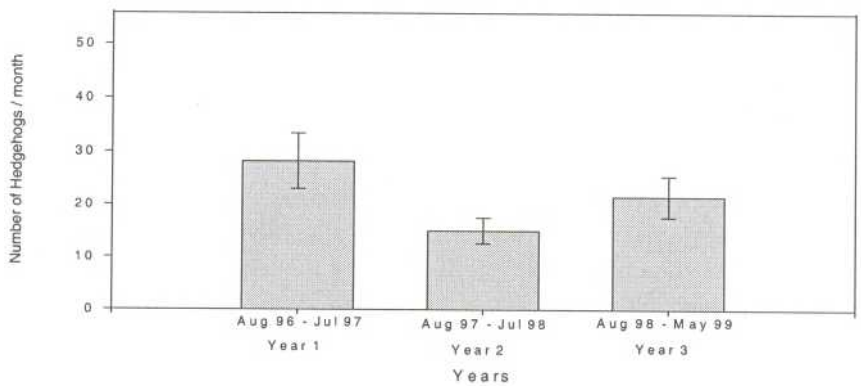

Figure 3. Average number of hedgehogs caught per month.

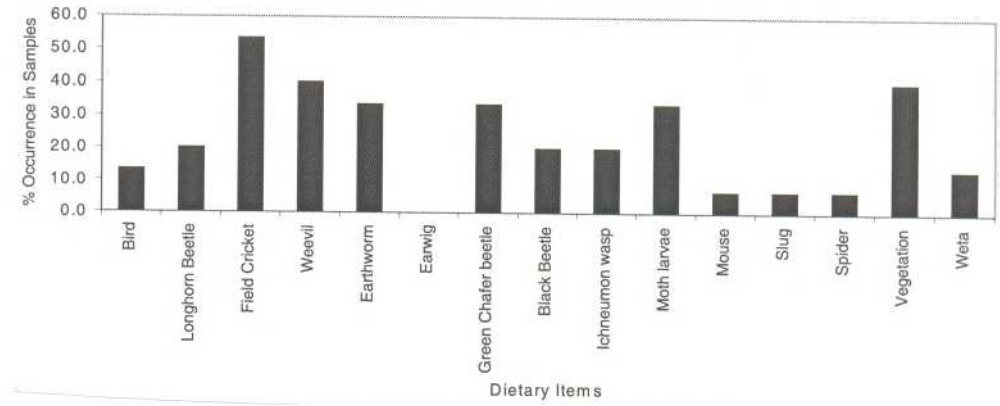

Figure 4. Main diet items - Summer.

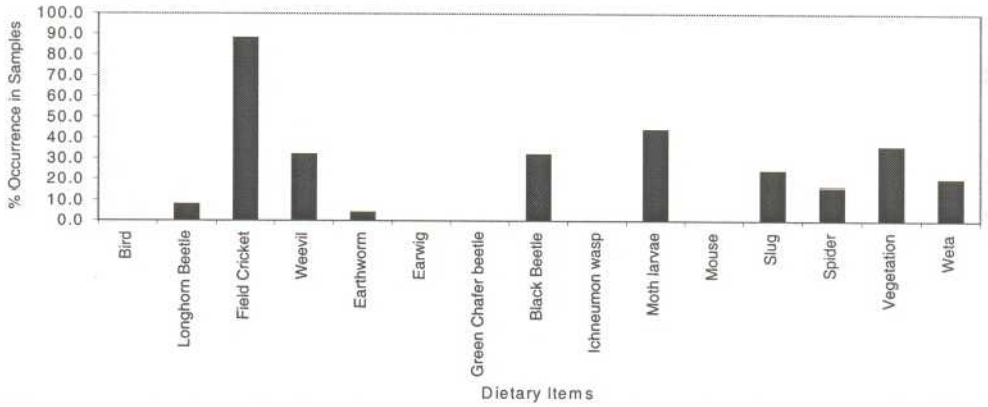

Figure 5. Main diet items - Autumn.

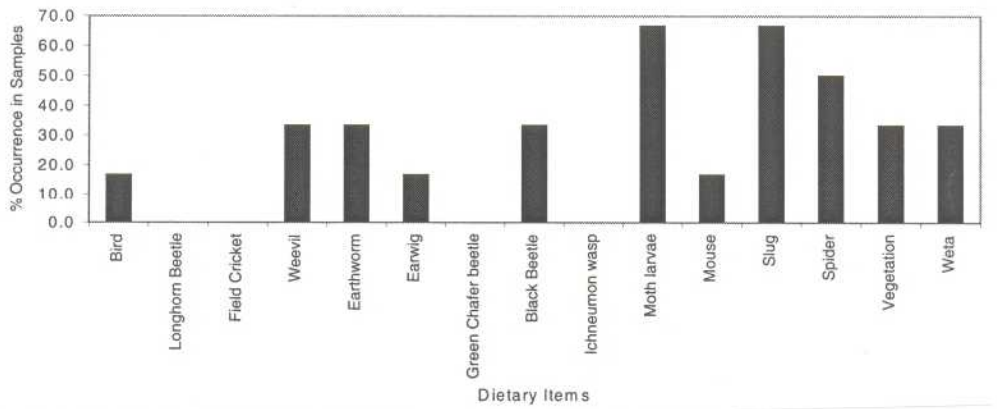

Figure 6. Main diet items - Winter.

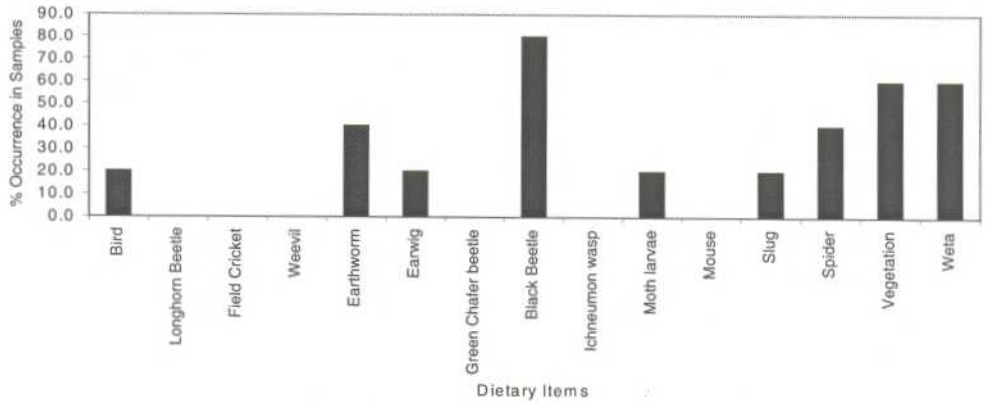

Figure 7. Main diet items - Spring.

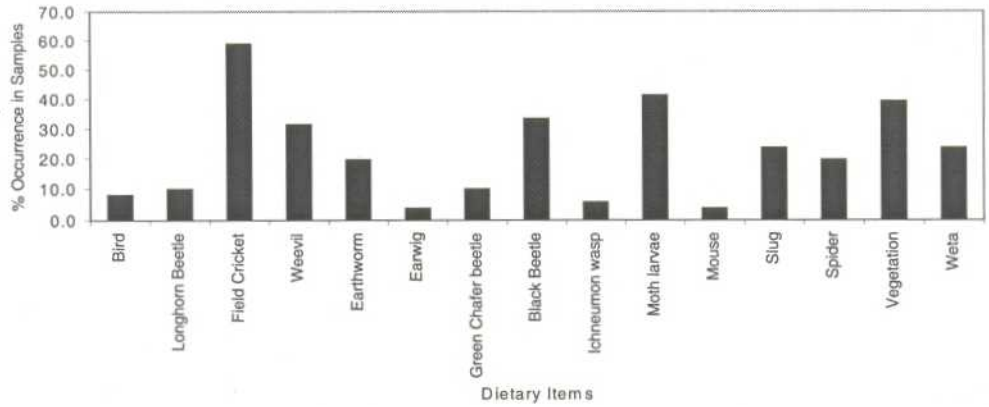

Figure 8. Main diet items - Whole year.