THE FEEDING BEHAVIOUR OF THE HEDGEHOG (*ERINACEUS EUROPAEUS L.*) IN PASTURE LAND IN NEW ZEALAND

P. A. CAMPBELL

Lincoln College, Canterbury

SUMMARY: A population of hedgehogs (*Erinaceus europaeus* L.) in pasture land in Canterbury was found to vary between less than four and eight per hectare. Feeding habits were studied through stomach contents and analysis of faeces. Grass grub beetles (*Costelytra zealandica)* and porina moths *(Wiseana cervinta),* both important pasture pests, were relatively important food items. Estimates of the number of grass grubs eaten in relation to their density and that of hedgehogs in pastures show that hedgehogs are potentially capable of consuming 10-40 percent of adult populations.

INTRODUCTION

The most significant general works on the European hedgehog (*Erinaceus europaeus* L.), (Herter 1938 and 1965, Burton 1969) provide comprehensive accounts of the systematics, anatomy, physiology, distribution, ecology, behaviour and economic significance of the hedgehog. However, apart from Brockie (1958) and Morris (1969), little significant field work has been carried out on this animal.

Apart from the study of Brockie (1959), which lists the food items eaten by hedgehogs in suburban areas, sand dunes and pasture lands in the Wellington province, little is known of the feeding habits of the hedgehog in New Zealand. It was felt, therefore, that further observations, particularly in pasture lands, were warranted. The present study investigates the size, distribution, dispersal behaviour and feeding ecology of a natural population of hedgehogs in this habitat. It attempts to establish their significance as predators of pasture pests.

The study area (Fig. 1) comprised two adjacent, four hectare blocks of the Lincoln College experimental dairy farm. The dominant soil type in the area was Wakanui silt loam. This supported an eight year old white clover (*Trifolium repens)* and ryegrass *(Lolium perenne)* pasture. Long grass provided cover adjacent to all hedges and in the plantation. The pasture within the study area was grazed by a dairy herd and this kept it short enough to enable satisfactory hedgehog observations to be carried out during most of the year. Both blocks were irrigated from the beginning of December to the end of February each year.

Both blocks were divided into 20 x 20m plots by systematically labelled corner pegs. These enabled the observer to plot, on a scale map, the positions of hedgehogs found in the area during regular searches.

METHODS

Individual hedgehogs were located, at night, during weekly spotlight searches. These were timed to coincide with the period of maximum hedgehog activity (2100 to 2400 hours) (Campbell 1973a). When first captured each hedgehog was weighed, sexed and individually marked by clipping its spines and spraying the clipped areas with silver paint. The marking code used utilized 10 different areas of the body as shown in Figure 2. Numbers from one to nine were identified by a single spot on the appropriate part of the body. For numbers greater than nine two spots were used, that for the tens digit being the larger. Where both digits were the same a single cross was used. These methods enabled up to 100 hedgehogs to be identified. The advantages of this marking system were that the paint reflected the spotlight

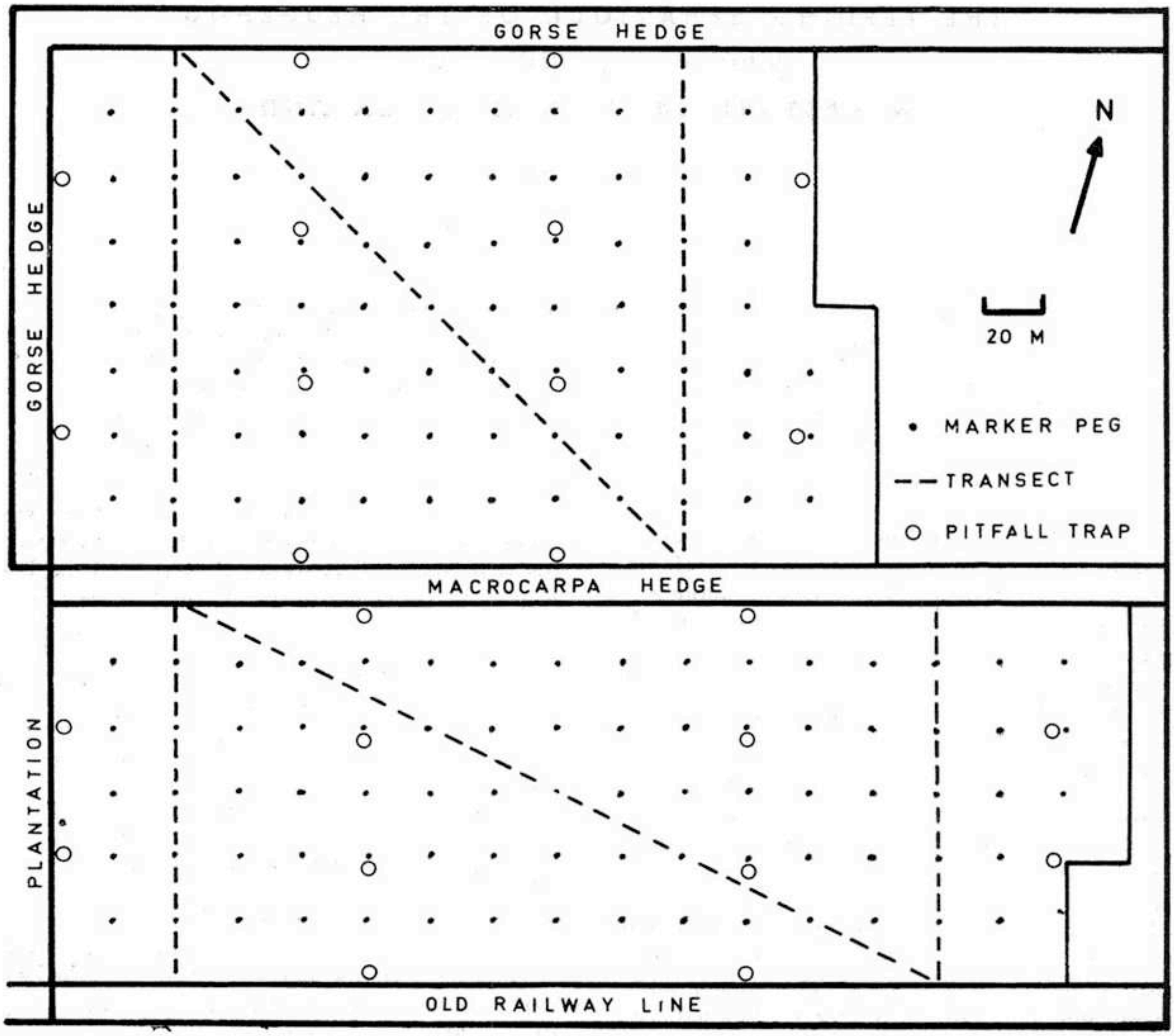

FIGURE 1. *The study area.*

beam, the markings lasted more than a year, caused minimum disturbance to the animals and were easily renewed as necessary.

POPULATION SIZE

An estimate of the population size within the study area was made using a computer programme devised by White (1971) from a stochastic capture-recapture model (Jolly 1965). The results showed that the population of the eight hectare area varied from less than 30 in the winter of 197(to 64 in March 1971. (<4 to 8/ha).

Winter was the period of highest mortality the autumn increase was caused by the season' young being incorporated into the resident popu lation.

POPULATION DISTRIBUTION

Over a period of two and a half years 1C hedgehogs were captured in the study area. /

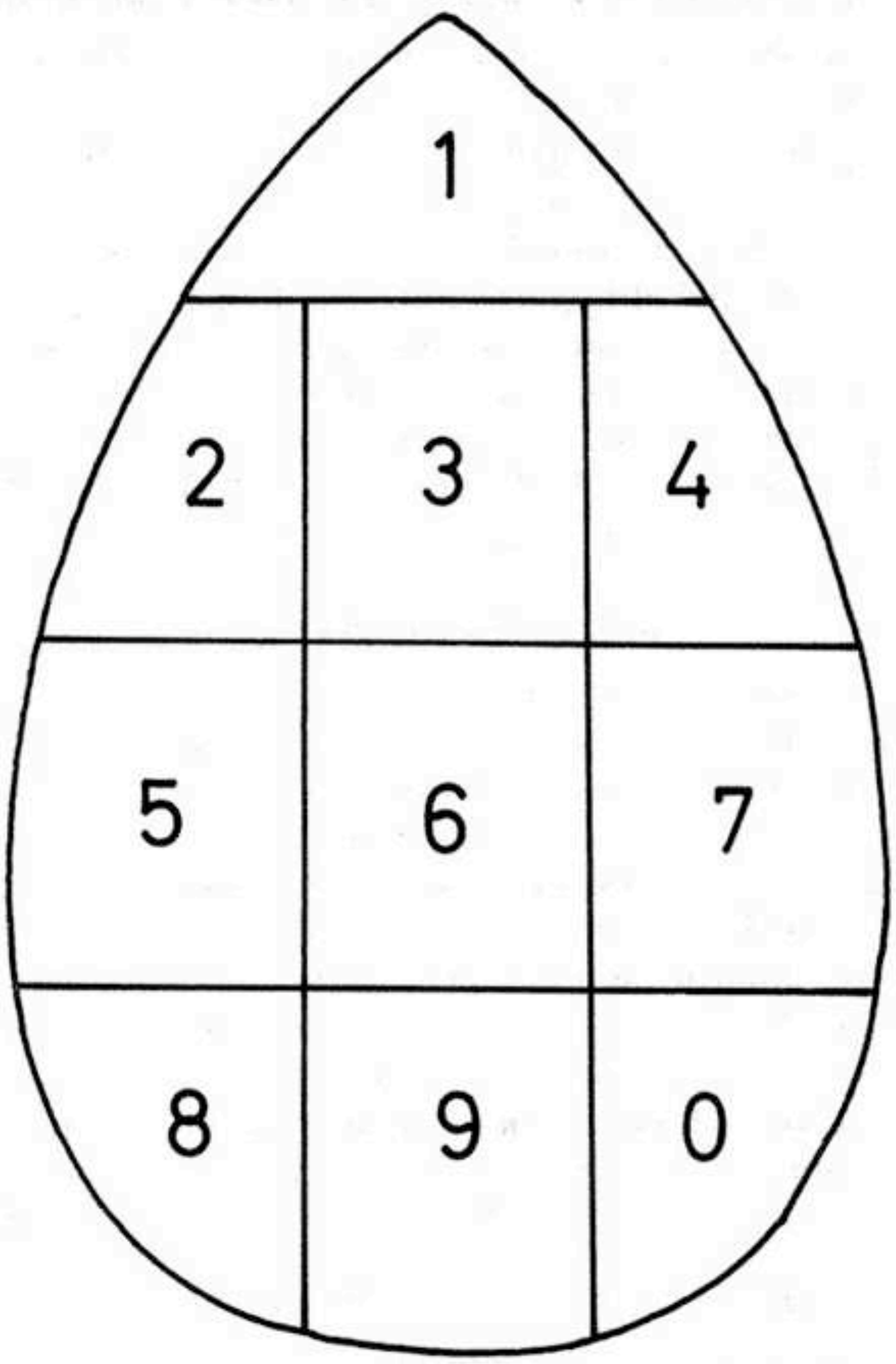

FIGURE 2. *Body areas used in marking hedgehogs.*

least 20 of these were considered to be resident because they were captured between 10 and 46 times. Six of these were resident throughout the entire study period and were, therefore, over three years of age by the completion of the study.

The home range areas obtained are essentially minimum summer feeding ranges, as hedgehogs did not nest in the open pasture and it proved impossible to find their nests in the adjacent cover.

When first captured, seven of the 20 resident animals were adult males, seven adult females, three juvenile males and three juvenile females. The average minimum feeding range areas, plotted by means of convex polygons, for these four classes were 2.4, 2.8, 1.9, and 2.0 ha respectively. Values for individuals ranged from 0.8 to 4.6 ha. Females had slightly larger feeding ranges than males, except during the breeding season when males appeared to expand their ranges and become nomadic. During this season a number of males were captured either once or twice only. They appeared to be passing through the study area.

AVAILABILITY OF FOOD IN THE STUDY AREA

A survey was made of the availability of suitable foods in the study area by placing 12 pitfall traps in each block (Fig. 1). These were cleared each Monday evening and Tuesday morning for a period of one year. This gave an overnight catch and a catch for the remainder of the week. Both blocks were net swept each Tuesday night during the same period.

To determine if grass grub and porina larvae were present in the study area a total of 100 random spade square samples were taken to a depth of 10 cm from each block. These were collected in groups of twenty, at two-monthly intervals, from October 1969. In addition, twelve 10 cm diameter core samples to a depth of 10 cm were taken from each block in August 1969. No grass grub or porina larvae were found in any of these samples.

The collections from the pitfall traps and sweep netting declined from mid-May until the end of August, both in numbers and in species. These collections yielded 101 identified species, many unidentified species of small dipterans, and larvae of various types. The identified species included 76 insects, 16 arachnids and 9 other invertebrates.

STOMACH CONTENT AND DROPPING ANALYSES

To determine the food actually eaten by hedgehogs in pasture lands, 60 animals were caught in similar pastures to those of the study area and the contents of their stomachs analysed. In addition, 230 hedgehog droppings were collected from two Z-shaped transects within the study area (Fig. 1).

The stomach contents and droppings were analysed by the freeze-drying method described by Campbell (1973b).

The data obtained from these analyses were treated by three different methods. The first of these was by presence or absence, as used by Brockie (1959) and Wood (1970). Using this method it was possible to calculate the frequency of occurrence of all food items. The second method was that of relative volume, as employed by Brockie (1959). This method uses a one to five scale for increasing order of abundance, and volume estimates were calculated as a proportion of the identifiable material only. With this method estimates of relative volume are obtained for materials that are otherwise difficult to count, such as plant matter and earthworms. The third method employed direct counts. Because of difficulties associated with fragmentation and the separation of food items, this method is seldom used. However, the advantages gained by using a freeze-drying technique (Campbell 1973b) permitted accurate counts to be made of the contents of both stomachs and droppings. The results obtained using each of these methods are presented in Table 1.

Hedgehog hair was found in 30 percent of stomachs and 50 percent of droppings. Although cannibalistic behaviour in hedgehogs has been reported (Prakash 1953, Otway 1965), this hair was probably ingested during grooming. Dirt and grit, presumably ingested with food, were found in 50 percent of stomachs and droppings.

Plant material showed the highest percentage of occurrence in both stomachs and droppings, the bulk being grasses, but white clover, seeds and various other remains occurred in small quantities.

The major animal species occurring in both stomach and droppings were lepidopteran larvae, earwigs, unidentified beetles, spiders, harvestmen, grass grub beetles, slugs and earthworms. The remaining food items in both stomachs and droppings each contributed less than one percent of the total diet.

FOOD RECOVERY EXPERIMENTS

Because loss may have occurred between ingestion of food items and their evacuation, recovery checks were carried out in the laboratory to obtain correction factors for the various food items found in the droppings. One hedgehog, an adult male, was used, and he was accustomed to captivity before commencing the experiments.

A glass tank (60 x 30 x 30 cm) was used for the actual feeding of the prey species. The floor was covered with 30mm of grass turf to provide as natural an environment as possible and to enable the prey species to hide in available cover. The

TABLE 1. *Food Items Found in 60 Hedgehog Stomachs and 230 Hedgehog Droppings.*

	STOMACHS			DROPPINGS			
FOOD ITEM	% of occurrence	% of Diet	Total No. of Animals	% of occurrence	% of Diet	Total No. of Animals	Corrected Total No. of Animals
Plant Material	88	12	—	95	17	—	—
Lepidopteran L.	65	9	258	46	8	465	—
Forficula auricularia	63	9	290	55	10	823	941
Unknown Coleopterans	52	7	102	23	4	60	73
Lycosidae	47	6	35	17	3	42	84
Opilio opilio	47	6	53	33	6	144	320
Costelytra zealandica	35	5	1,275	14	3	569	811
Agriolimax sp.	32	4	38	30	5	206	210
Apis mellifera	23	3	25	4	1	11	—
Allolobophora caliginosa	22	3	—	22	4	—	—
Megadromus antarcticus	18	2	33	3	1	8	9
Odontria striata	17	2	17	2	<1	4	—
Sarcophaga milleri	15	2	87	32	6	121	160
Wiseana cervinata	10	1	37	3	<1	19	104
Porcellio scaber	8	1	15	17	3	217	449

turf was replaced for each feeding experiment. The tank was kept at a temperature of 21±2°C and a relative humidity of 65±2 percent. The only lighting was from fluorescent tubes, controlled by a time switch to operate between 0600 and 2100 daily.

Every second evening, after being starved for one day, the hedgehog was placed in the tank, together with the selected prey species. The following morning the hedgehog was transferred to its "sleeping cage". Thereafter, the animal was starved and fed on alternate nights. The starvation period was provided to allow all the food consumed during each experiment to pass completely through the alimentary canal. As a further precaution, different prey species were fed to the animal in each successive experiment. The period of starvation also ensured that the hedgehog was hungry and would consume all the food provided.

The twelve major prey species tested were presented alive, in single species lots of 200, and as mixtures of different species also totalling 200. Each species was tested at least three times.

Droppings found in both the feeding tank and sleeping cage over the two-day period of each trial were collected and their contents analysed. The colour, consistency and the number of droppings produced differed for each prey species. The average recovery of diagnostic parts of the different prey species ranged from 18 percent for porina antennae to 98 percent for slug radulae. The correction factors obtained from these experiments were applied to the direct count data for the major food items found in droppings. A corrected list of the numbers of the various prey species eaten appears in Table 1.

The corrected results show an increased relative importance of grass grub beetles and porina moths in the diet. During the flying seasons of these species they were eaten almost exclusively by most hedgehogs. As many as 424 grass grub beetles were found in a single stomach during these periods. As the hedgehogs taken for stomach analyses were captured between 2200 and 2300, and as observations in the field indicated that the hedgehog feeding rhythm contained a peak of activity between 2100 and 2400, hedgehogs are likely to consume more than this number over a whole night. Porina eggs show up very clearly in hedghog droppings, as the eggs are killed during the intestinal sojourn and remain white. This indicates that gravid females are eaten. Grass grub eggs, if eaten, were completely digested, for none appeared in the analyses. East (1972) suspects that hedgehogs do eat some gravid females.

PREDATION ON PASTURE PESTS

East (1972) calculated a potential daily consumption of 850 adult grass grubs per hedgehog per day, and estimated the adult grass grub population in pastures similar to those of the study area as between 100 and 400/m^2. This represents an adult grass grub population of 1-4 x 10^6/ha. If it is assumed that the eight hedgehogs per hectare found in the present study is representative of their density in pasture lands during the flight season of this pest, and that each hedgehog can eat as many as 850 adult grass grubs per day over an estimated two-month flight season, they have the potential to destroy between 10 and 40 percent of the adult population of these insects.

Many of the lepidopteran larvae eaten by hedgehogs were almost certainly porina larvae. Identification of these larvae to species level was difficult as most of their head capsules were missing. However, their size and general body features were similar to those of porina larvae. Adult porina, including gravid females, were also eaten. Because of the very low recovery of porina moth parts from droppings, uncorrected data underestimate the contribution that this species makes to the hedgehog diet. Hedgehogs also exert some pressure on the populations of this pest species.

Balanced against these beneficial effects is the problem that hedgehogs may be carriers of many diseases—such as ringworm, salmonellosis and leptospirosis. However, the incidence of these is very low in New Zealand, and few people come into actual contact with hedgehogs. Hedgehogs can carry foot and mouth disease, and should this disease ever gain entry into New Zealand, they could become a reservoir of infection.

REFERENCES

BROCKIE, R. E. 1958. The ecology of the hedgehog (*Erinaceus europaeus* L.) in Wellington, N.Z. M.Sc. Thesis, Victoria University of Wellington. 121 p.

BROCKIE, R. E. 1959. Observations on the food of the hedgehog (*Erinaceus europaeus* L.) in New Zealand. *New Zealand Journal of Science* 2 (1): 121-36.

BURTON, M. 1969. *The hedgehog*, Andre Deutsch, London. 111 p.

CAMPBELL, P. A. 1973a. Feeding behaviour of the European hedgehog (*Eriwaceus europaeus* L.) in a New Zealand pasture. Ph.D. Thesis, Lincoln College, University of Canterbury, 237 p.

CAMPBELL, P. A. 1973b. Note on a freeze-drying technique for diet analysis. *New Zealand Journal of Science* 16: In Press.

EAST, R. 1972. Starling (*Sturnus vulgaris* L.) predation on grass grub (*Costelytra zealandica* (White) Melolonthinae) populations in Canterbury. Ph. D. Thesis, Lincoln College. 709 p.

HERTER, K. 1938. *Die biologie der europäischen Igel.* Monog. Wildsäugetiere V, Leipzig. 222 p.

HERTER, K. 1965. *Hedgehogs: a comprehensive study.* Phoenix House, London, 69 p.

JOLLY, G. M. 1965. Explicit estimates for capture-recapture data with both death and immigration—stochastic model. *Biometrika* 52: 225-47.

MORRIS, P. A. 1969. Some aspects of the ecology of the hedgehog (*Erinaceus europaeus*). Ph.D. Thesis. Royal Holloway College. University of London. 260 p.

OTWAY, P. A. 1965. Feeding behaviour of the European hedgehog (*Erinaceus europaeus* L.) in New Zealand. B.Sc. (Hons.) Thesis, University of Otago. 57 p.

PRAKASH, I. 1953. Cannabalism in hedgehogs. *Journal of the Bombay Natural History Society.* 51: 730-1.

WHITE, E. G. 1971. A computer programme for capture-recapture studies of animal populations: A Fortran listing for the stochastic model of G. M. Jolly. *Tussock Grasslands and Mountain Lands Institute Special Publication No. 8.* 33 p.

WOOD, F. B. 1970. Feeding and food preference in the hedgehog (*Erinaceus europaeus* L.) in the Christchurch area. B.Sc. (Hons.) Thesis, University of Canterbury. 30 p.