SHORT COMMUNICATION

Skink predation by hedgehogs at Macraes Flat, Otago, New Zealand

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Abstract: The stomach contents of 158 hedgehogs captured at Macraes Flat, Otago, New Zealand, over two summers in 2000 and 2001 were examined for the occurrence of lizards. The remains of at least 43 skinks (both *Oligosoma nigriplantare polychroma* and *O. maccanni*) and one gecko (*Hoplodactylus* sp.) were found. Twenty-one percent (n = 33; 8 males and 25 females) of the examined hedgehogs had fed on skinks. Female hedgehogs ate significantly more skinks than did males. Our results suggest that the presence of large numbers of hedgehogs can have a high impact on native reptile populations in New Zealand and therefore they should be targeted in future trapping programmes.

Keywords: conservation; *Erinaceus europaeu*s; introduced mammals; *Oligosoma*; predation

Introduction

The European hedgehog (*Erinaceus europaeus*) is an introduced species that has become abundant in New Zealand, and is known to prey on endemic New Zealand lizards (Jones & Sanders 2005). The Macraes Flat area of Otago is home to the largest remaining populations of the grand and Otago skinks (*Oligosoma grande, O. otagense)*, as well as the common gecko (*Hoplodactylus* aff. *maculatus* 'Otago/Southland large'; Hitchmough 1997), the green skink (*O. chloronoton*), the cryptic skink (*O. inconspicuum)*, the common skink (*O. nigriplantare polychroma)* and the McCann's skink *(O. maccanni*). The current study was undertaken to investigate whether hedgehogs have the potential to influence population sizes of skinks in the long term.

Materials and methods

The study area (45°25' S; 170°25' E) was 5 km due south of Macraes Flat village, North Otago. The landscape is a mosaic of native tussock grassland, exotic pasture and shrubs; for a detailed description see Tocher (2006) and Wilson et al. (2007). The area where hedgehogs were trapped included both tussock grasslands (predominantly *Chionochloa rigida*, with *C. rubra, Poa cita* and *Festuca novae-zelandiae*) and improved ryegrass–clover pasture, encompassing a total area of 2690 ha.

A predator control operation was undertaken by the Department of Conservation at Macraes Flat from May 1999 to May 2002 targeting feral cats (*Felis catus)*, but also capturing large numbers of ferrets (*Mustela furo*) and hedgehogs as by-catch (Tocher 2006). A total of 170 soft-jaw 'Oneida Victor® Soft Catch® 1½' leg-hold traps (Oneida Victor Inc., PO Box 32398 Euclid, Ohio 44132, USA) were baited with rabbit (*Oryctolagus cuniculus*) meat. Traps were cleared daily and captured hedgehogs were killed. Hedgehogs were collected on various days in the periods from 10 January 2000 to 17 February 2000 and from 27 November 2000 to 5 May 2001. The total number of days that hedgehogs were collected was not recorded. After collection, the hedgehogs were sexed and had their stomachs removed. Stomachs were examined for the occurrence of lizards on the same day. Other prey items were not identified. It was assumed that the presence of $1 \leq 4$ feet in one stomach meant the hedgehog had eaten at least one skink. Additionally, when two similar feet (for example two left hind feet) were found, this was counted as the consumption of at least two skinks.

Species were distinguished as 'small' (*O. n. polychroma* and *O. maccanni)* or 'giant' skinks (*O. otagense* and *O. grande*) by examining foot size. Skink remains were stored in 100% ethanol. The difference in the proportions of female and male stomachs containing skinks was assessed with a chi-square contingency test.

Results

The stomach contents of 158 hedgehogs (77 males and 81 females) were analysed. The remains of at least 43 skinks and one common gecko were identified (Table 1). Few intact or partly intact skinks were found in the stomachs. Instead, feet, toes and/or scales and pieces of skin were usually found. Sometimes the complete skin of the back of a skink was recovered. On one occasion only skink skin and scales were recovered and this was counted as the consumption of one skink. All skink remains were identified as 'small skinks'. The gecko was identified as *Hoplodactylus* sp. Twenty-one percent (n = 33; 8 males and 25 females) of hedgehogs had fed on skinks. Stomachs of female hedgehogs contained from 0 to 3 individual skinks (mean = 0.44); stomachs of males contained 0–1 skinks (mean = 0.1). A significantly greater proportion of female stomachs contained skink remains compared with male stomachs (P = 0.003). Between November 2000 and May 2001, skink consumption by female hedgehogs was high compared with that of males, with a peak in December (Fig. 1).

Discussion

According to Middlemiss (1995), cats are potentially the most effective predators of skinks, with an average of approximately four lizards consumed per individual per day during summer and autumn. Our study supports the suggestion made by Jones et al. (2005) that hedgehogs in New Zealand may be a more significant predator of skinks than has been previously recognised. We found an even higher incidence of skinks in the stomachs of hedgehogs (21%) than found by Jones et al. (2005), or by Moss (1999) (6% in the Waitaki Basin and 9% in the Mackenzie Basin, respectively).

The dichotomous key for distinction between the species *O. n. polychroma* and *O. maccanni* as developed by Patterson and Daugherty (1990) could not be used as only the feet (and not always hind feet) were recovered and therefore midbody scales could not be counted.

In our study, most skink remains occurred in female hedgehogs. Jones et al. (2005) found the same significant difference between the sexes. The reason why female hedgehogs ate more skinks than males is unclear. Home range sizes of males are typically 2–3 times larger than those of females (Moss & Sanders 2001), and movement patterns differ between the sexes (Shanahan et al. 2007). Jones et al. (2005) suggested that hedgehogs are able to exploit rich aggregations of prey. They may also change

Table 1. Total estimated number of skinks and geckos eaten based on remains found in male and female hedgehog stomachs for the entire sampling period (10 January 2000 – 5 May 2001).

Hedgehogs	*n*	Skinks	Geckos
Male	77	8	0
Female	81	35	1
Total	158	43	1

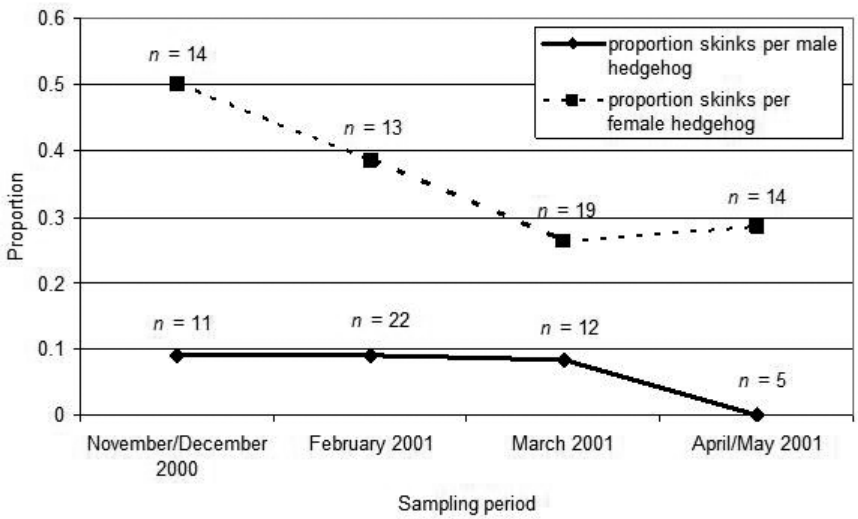

Figure 1. Proportion of skinks eaten per male and female hedgehog over one whole active season (November 2000 – May 2001). No data were collected in January. n = number of hedgehogs sampled for each time period.

their foraging behaviour upon learning the location of a rich food source (Cassini & Krebs 1994). Possibly the higher site tenacity of females and their suggested exploitative feeding behaviour explain their larger dietary component of skinks. Additionally, the breeding season starts at the end of the hibernation period (Moss & Sanders 2001; Jackson 2005) and female hedgehogs can give birth to several litters; therefore, the period that female hedgehogs need access to high nutritional food encompasses almost their whole active season. Although it could not be proven, it is suggested that the unequal feeding pattern between the sexes is explained by differences in their seasonal and spatial behaviour and dietary requirements.

Hedgehogs are nocturnal. They have a simple stomach, and the majority of food items pass through the gut within 12–16 hours after ingestion (Reeve 1994). We therefore assume that all skinks found in stomachs were eaten during the night of capture. However, the period of time between capture and when hedgehogs were collected from traps and killed, which varied from early morning to afternoon, was unknown and variable. During this period, some skink remains may have passed into the intestines, which were not examined, and some may have passed out of the digestive tract. Therefore, the stomach contents are likely to represent an underestimate of the number of skinks actually eaten.

Hedgehogs were trapped as by-catch in large numbers at Macraes Flat. Over the 3-year period, 1312 hedgehogs were trapped. The number of hedgehogs that were caught each year remained relatively constant (n = 435; 411; 466), suggesting a constant predation rate on small skinks in this area. We agree with the statement made by Jones et al. (2005) that hedgehogs may have a high impact on native reptile populations, because of the combination of the high predation level as is presented in this study and the large numbers of hedgehogs in the Macraes Flat area. Therefore, hedgehogs should be targeted in future trapping programmes, and the effect of the hedgehog predation rate on the survival of skink populations should be further assessed.

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