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Barn owl pellets : a useful tool for monitoring small mammal communities?

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ABSTRACT. Monthly fluctuations in the diet of Barn owl *Tyto alba* were compared to prey availability in a typical South African dry sandy highveld grassland over a 12 month period. Mice, shrews, bats, birds and insects were all major prey items, and their contribution in pellets fluctuated significantly over months. Barn owl proved to be very efficient samplers of the small mammal prey group : not only was the owl more successful than museum personnel in sampling the variety of species present during a specific time of year, but peaks in prey utilization were also more characteristic of actual fluctuations than that found by traps. Owl pellet analysis is a valuable asset during small mammal monitoring studies, and is especially useful for sampling small mammal indicator species during environmental impact assessments. However, owl pellet analysis should never be seen as an alternative for small mammal trapping when small mammal community structure is the focus of study.

KEY WORDS : Barn owl, small mammal, monitoring, sampling method

INTRODUCTION

Lately, small mammal communities have been used as indicators of habitat integrity (see AVENANT, 2000a, 2003; AVENANT & KUYLER, 2002; AVENANT & WATSON, 2002). A growth curve (Fig. 1) has been postulated for a number of animal & plant groups (see WANG et al., 1999), whereby highest species richness increase with succession (= primary productivity) up to a point of climax, and then decrease to a point where equilibrium is reached. Species number fluctuates around this point until disturbance takes place. Depending on the measure and speed of disturbance the number of species for the specific animal group may follow the curve backwards, with highest species numbers found at intermediary disturbance, and lowest species number found at/after extreme disturbance. "Relatively few ruderal species dominate when disturbances are frequent, and relatively few highly competitive species dominate when disturbances are rare; intermediate levels of disturbance allow succession to proceed but limit the ability of competitive species to dominate the community" (VALONE & KELT, 1999). The number of microhabitats and primary productivity is also high at the point of climax, and able to sustain a number of individuals from different species. The data of a number of longer term small mammal studies in southern Africa can be fitted to this curve (e.g. ROWE-ROWE & LOWRY, 1982; ROWE-ROWE, 1995; FERREIRA & VAN AARDE, 2000), while our relatively short-term studies (AVENANT, 2000a, b; KUYLER pers. comm.; AVENANT & KUYLER, 2002; AVENANT & WATSON, 2002), where small mammal communities were correlated with the abundance of pioneer plant species and/or ecological value of the veld in the Free State province, indicate that a similar curve can be expected. The latter studies have also indicated that small mammal Shannon-diversity and Evenness (E_{var}) may be good indicators of ecosystem integrity, as it increases from (a) to (b) in Fig. 1. Generalist species (or species with a wide habitat tolerance) were generally found to dominate small mammal numbers on the lower part of the curve, with the opposite true for specialist species, which increase in number towards the end of the curve. Together, these findings led to the idea that the direct monitoring of small mammals be used as a relatively quick and inexpensive method of indicating ecological disturbance/habitat integrity, and therefore a useful tool for wildlife managers and environmental consultants.

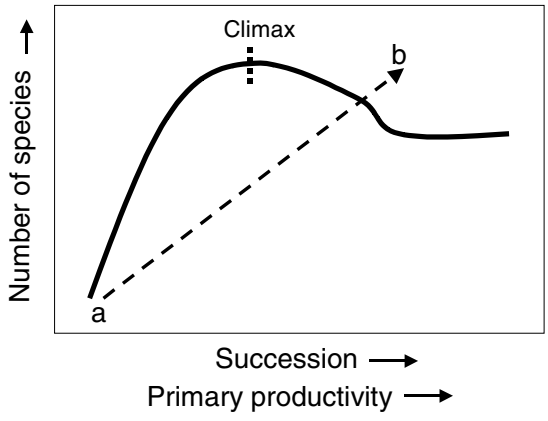

Fig. 1. – Correlation between number of small mammal species and succession / primary productivity. See text for a description of letters a, b.

Identifying small mammal remains from animal scats and pellets is an indirect method of monitoring small mammals. In the past it has been a useful tool for animal-ecologists and wildlife managers : it does not only reflect the hunting and feeding behaviour of the predator, but are

also useful for studying the systematics, geographical distribution, population ecology and craniology of prey animals. Fossil remains derived from owl pellets have also made an important contribution in the reconstruction of palaeo-environments (see DAVIS, 1959; AVERY, 1982, 1987, 1991, 1992, 1999).

In the present study the indirect method of the analysis of modern Barn owl, *Tyto alba affinis* Blyth, 1862, pellets were compared to our direct method of monitoring small mammals, and the relevance of these results to the study of habitat integrity considered.

MATERIAL AND METHODS

Study area

Between March 1998 and September 2000 more than 400 pellets of the Southern African Barn Owl, *Tyto alba*, were collected on a daily basis from a single locality at Florisbad Research Station (28°46'S; 26°04'E), central interior of South Africa. The vegetation is typical Dry Sandy Highveld Grassland (Veld type 37 - LOW & REBELO, 1996). Mean annual precipitation in this summer rainfall area is *c.* 450mm, and mean daily maximum and minimum temperatures ranges from *c.* 31°C and 14°C in January to *c.* 16°C and -1°C in July (WEATHER BUREAU, 1986).

Fresh pellets were individually placed in paper bags, air-dried and later teased apart. Large, easily diagnosed fragments of prey were macroscopically identified while hair, teeth and feathers were identified under a stereo microscope at 25x or 50x magnification. Prey items were identified to species level where possible by comparing undigested remains with a reference collection and from published results, e.g. scales on hair imprints (KEOGH, 1983 a, b) and tooth form (DE GRAAFF, 1981; PERRIN, 1982; BOWLAND & BOWLAND, 1989).

Both *percentage volume* (a prey item's percentage contribution to total volume ingested) and *percentage occurrence* (a percentage of the number of pellets in which a prey item was present) of prey items in pellets were determined, and an *Importance Value* calculated (IV = *percentage volume* x *percentage occurrence* / 100). The computer programme Statistica for Windows (Statsoft Inc., 1995) was used to do the statistical analyses. Analysis of Variance (ANOVA) tests were used to detect inter-group differences. The 95% level ($p<0.05$) was regarded as statistically significant for all tests.

Small mammals were sampled during late-summer and late-autumn at the six most diverse habitats in the Florisbad Research Station grounds :

(1) Exotic *Kikuju* sp. grass & *Eucalyptus* sp. trees (28°46.052'S; 26°04.248'E); (2) Open eroded area (28°46.044'S; 26°04.303'E); (3) Low bushes on post-climax grassland (28°45.893'S; 26°04.243'E); (4) Vegetation (mostly sedges) around a swampy area (28°46.045'S; 26°04.268'E); (5) "Open" *Themeda triandra* grassland (28°46.039'S; 26°04.352'E); (6) "Dense" *Themeda triandra* grassland (28°45.910'S; 26°04.186'E). Sites 1 and 2 were considered the most influenced by man, and sites 5 and 6 the least.

The standardized method prescribed to EIA consultants working in the Free State grassland (AVENANT, 2000b; FERREIRA & AVENANT, 2003) were used to sample small mammal communities : One hundred snap traps were placed per transect. These were spaced 5m apart and left open, checked and re-baited in the early morning and late afternoon for four consecutive days and nights. Bait used was a mixture of peanut butter, rolled oats, sunflower oil and *marmite* (yeast extract). Rodents and shrews trapped were sexed, weighed, measured, dissected and study skins and skulls deposited in the National Museum (Bloemfontein, South Africa) collection. Trap success (or percentage success) is the number of small mammals captured per 100 trap nights. Variety is the number of species found, while diversity, calculated using the Shannon index (MAGURRAN, 1988), is a measure of both the number of species and equality of representation of the individuals of all species.

To increase our species list, 100 PVC live traps (on separate, 10 m distant parallel transects), 10 pitfall traps (15 cm diameter, 20 cm deep; at random trap stations on each transect), and spades (to search in disused termitaria) were also used.

RESULTS & DISCUSSION

The main prey items (i.e. contributing > 40% to the volume of the majority of pellets in which it occurs) were : mice (mean monthly IV = 68.0), birds (IV = 1.4), insects (IV = 0.7; orders Coleoptera, Lepidoptera, Orthoptera & Mantodea), shrews (IV = 0.4) and bats (IV = 0.01) (Table 1). Molerat and plant material were present in < 0.5% of pellets. No reptile remains were found. All main prey items, except bats, fluctuated significantly ($p<0.05$) over months (Fig. 2). The fluctuation pattern of mice, the major prey item in the diet of the Barn owl, did not simply follow their densities (density significantly highest in late-autumn/early-winter, and lowest just before the start of their breeding season at the end of winter : see AVENANT, 2000a, b), but were, nevertheless, more accurate than our small mammal trapping over the past six years in indicating real densities (sampling with traps have, among others, been found to be influenced by differences in age group structure and the availability of natural food). The other prey items generally follow the inverse pattern of mice, being highest from *c*. October to May.

TABLE 1

Mean monthly Percentage Occurrence, Percentage Volume, and Importance Value (IV) of prey items of the southern Barn Owl *Tyto alba* at Florisbad Research Station, 1998 – 2000.

Prey item	% Occurrence	% Volume	IV
Mice	85.4	79.6	68.0
Shrews	10.7	4.1	0.4
Molerats	0.5	6.1	0.03
Bats	2.3	0.6	0.01
Birds	13.4	10.6	1.4
Insects	14.2	4.6	0.7
Plants	0.3	0.1	0.0003

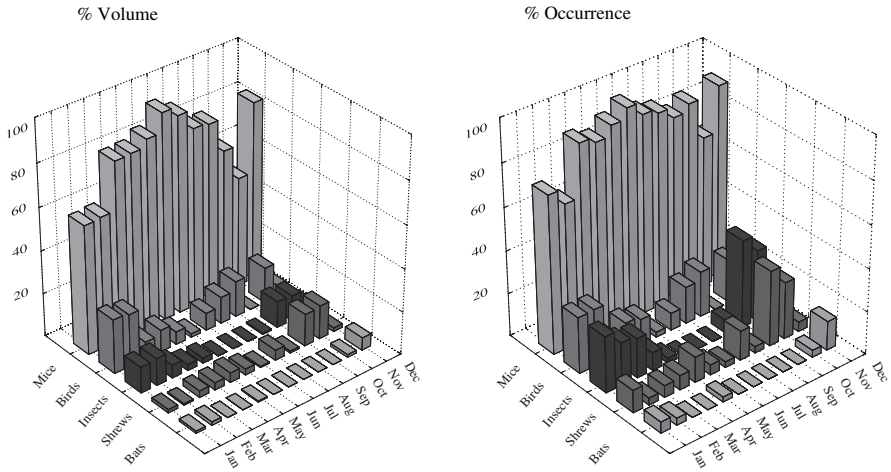

Fig. 2. – Monthly fluctuations of the main prey items in the diet of southern African Barn owl *Tyto alba* at Florisbad Research Station.

The nocturnal small mammal species *Mastomys coucha* and *Tatera* spp. contributed by far the highest percentage to the volume of prey ingested (Fig. 3). From September to April, however, the crepuscular *Rhabdomys pumilio* and diurnal *Otomys irroratus* became more important as prey. *Does this mean that the owl forages at different times during the warmer and colder months, or is it that the crepuscular and diurnal prey become inactive earlier during the winter days as soon as the temperature drops?*- no answer could be found in the literature.

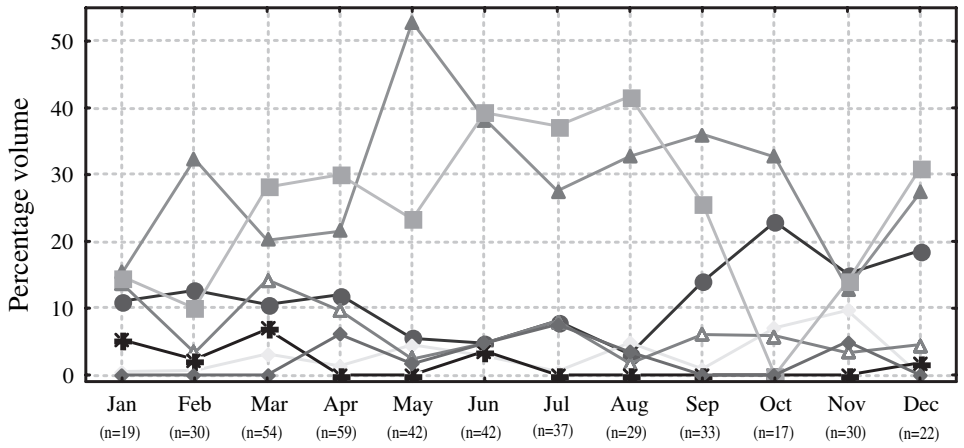

Fig. 3. – Monthly fluctuations of the main small mammal prey species (i.e. contributing > 3% to the volume of pellets in at least one month) in the diet of southern African Barn owl *Tyto alba* at Florisbad Research Station.

, R. pumilio; , M. coucha; , C. cyanea; , O. irroratus; M. albicaudata; , Tatera spp.; , R. rattus

In the present study, analysis of owl pellets proved useful when determining small mammal species present in this grassveld ecosystem. Despite its preference for some species, the Barn owl nevertheless sampled more species than our extensive trapping efforts indicated (Table 2). The presence of *Tatera brantsi*, *Myosorex varius*, and the red listed *Mystromys albicaudatus*, and difficult to sample *Saccostomus campestris* and *Desmodillus auricularis* were only indicated by its presence in owl scats. Although the owl may forage outside of the Florisbad Research Station grounds, all species found in owl pellets are expected to occur within the grounds. Also, four other species sampled by the owl could not be found by traditional trapping methods (see Table 2). This effective sampling of Barn owls has been shown in a number of other studies (e.g. HAPPOLD & HAPPOLD, 1986; DENYS et al., 1999; BA et al., 2000; GRANJON et al., 2002). As in our small mammal studies (see AVENANT, 2003), however, the owl has found the "scarcer" c. 15 percent of the total number of small mammal species sampled only in the late autumn - early winter months, while more than 25 percent of species were not preyed upon in the spring months.

The multimammate mouse *Mastomys coucha*, as well as species richness and diversity, has been used as an indicator of disturbance (see AVENANT, 2000a, b; AVERY, 1991, 1992). In the relatively disturbed habitats at Florisbad this mouse has been found to dominate in four of the six habitats sampled by museum personnel. It was also a

TABLE 2

Terrestrial small mammal species sampled by the southern African Barn owl *Tyto alba* versus small mammal species sampled by personnel of the National Museum. X, sampled by traps; x, sampled by alternative methods (see text).

Small mammal species	Owl	Personnel
Rhabdomys pumilio	X	X
Mastomys coucha	X	X
Otomys irroratus	X	X
Mystromys albicaudatus	X	
Saccostomus campestris	X	
Desmodillus auricularis	X	
Tatera leucogaster	X	X
Tatera brantsi	X	
Mus minutoides	X	X
Mus musculus	X	x
Rattus rattus	X	x
Myosorex varius	X	
Crocidura cyanea	X	X
Suncus varilla	X	x
Cryptomys hottentotus	X	x
Total number of species	**15**	**10**

major prey item of the owl. Commensal species, such as the house mouse and house rat, have being used to describe changes in vegetation / presence of man in palaeontological times. In the present study these two species contributed throughout the year to owl diet – a low contribution, with no significant difference between months or seasons ($p>0.1$) – but were not found in our traps.

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