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MICROMAMMALS AND BARN OWLS IN THE FREE STATE, SOUTH AFRICA: PREY DISTRIBUTION AND PREDATOR BEHAVIOUR

by

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*[1]Iziko Museums of Cape Town, P.O. Box 61, Cape Town, 8000 South Africa. *E-mail for correspondence: mavery@iziko.org.za. [2] Free State Dept of Tourism, Environment & Economic Affairs, PO Box 264, Bloemfontein, 9300 South Africa*

ABSTRACT

Avery, D.M., Avery, G. & Colahan, B.D. 2003. Micromammals and barn owls in the Free State, South Africa: prey distribution and predator behaviour. Navors. nas. Mus., Bloemfontein 19(1): 1-18. Barn owl pellets were collected from Koppies Dam, Soetdoring and Tussen die Riviere Nature Reserves between 1992 and 2000. The micromammalian component included 25 species (16 rodents, six insectivores, two bats, one elephant shrew), of which the most prominent were the multimammate mouse *Mastomys coucha* in Koppies Dam and Soetdoring, and the highveld gerbil *Tatera brantsii* at Tussen die Riviere. More support is provided for the inclusion of Saunders's vlei rat *Otomys saundersiae* in the Free State species list and range extensions are recorded for the tiny musk shrew *Crocidura fuscomurina* and the forest shrew *Myosorex varius*. Regular collections from Soetdoring Silo during 1992–5 show a change in dominance from the Cape serotine bat *Neuromicia capensis* during the early part of the series to *Mastomys coucha* thereafter. Variation in representation of age classes in the latter species agrees with previous evidence for year-round breeding but with a peak immediately following the main summer rainfall season. Evidence from two pairs of roosts at Soetdoring Purple Grove and Tussen die Riviere Aasvoelkop suggest some degree of separation in hunting ranges by neighbouring birds. These data, together with the change in prey composition over time at Soetdoring Silo, help inform the debate on the extent to which barn owls are opportunistic hunters. **(barn owls, distribution, Free State, micromammals, South Africa)**

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CONTENTS

INTRODUCTION

The distribution of micromammals in the Free State has been studied by staff members of the National Museum in Bloemfontein since the early 1970s (Lynch 1975, 1983, 1985; Herholdt 1986; Avenant 1996, 1997, 2000; Avenant & Watson 2002). However, apart from the sample reported by Herholdt (1986), all previous results were based on trapping and mist-netting whereas the present collections come entirely from barn owl pellets. Although the Free State has been widely surveyed by conventional methods (Lynch 1983), it is clear that data generated by barn owls can still make a significant contribution to existing knowledge of micromammalian distributions. They can also inform on temporal variation in prey population size and structure when repeat collections are made from one locality, as discussed, for instance, by Hanney (1963) and Wirminghaus (1989). Data discussed here from Soetdoring Nature Reserve add to these observations.

Additionally, the behaviour of the owls themselves is reflected in the contents of their pellets. Previous work has shown that the barn owl *Tyto alba* is both selective and opportunistic in its choice of prey. In southern Malawi, for instance, Hanney (1963) consistently recorded more multimammate mice *Mastomys natalensis* from barn owl pellets than from trapping at the same time, thereby implying that barn owls tend to preferentially hunt this species. While *Mastomys* spp. have been found frequently to dominate pellet samples from across southern Africa, collections from a wide range of localities show that the preferred prey species varies considerably; at least 25 species have so far been found to dominate one or more of 186 samples comprising 50 or more individuals (published sources listed in Avery 1999; DMA unpubl. data). Even in a relatively restricted area such as KwaZulu-Natal, there is appreciable variation among sites (Avery *et al.* 2002).

On a smaller scale barn owls have also been found to partition the landscape when two or more roosts occur in close proximity. Near Mumbwa in Zambia barn owls were observed to fly directly out from multiple roosts around a small isolated hill, thereby partitioning the surrounding landscape, which comprised cultivated land, open deciduous woodland and a dambo (seasonally waterlogged area) (DMA & GA, pers. obs.). This partitioning was reflected in the fact that, although *Mastomys natalensis* comprised about 75% of prey from 12 roosts, there was discernible variation in composition of the remaining 25% (DMA unpubl. data). Differences in composition of two samples from close roosts in the West

Coast National Park were interpreted as indicative of similar landscape partitioning (Avery 1992) while resource partitioning has been recorded for co-existing barn owls and spotted eagle owls *Bubo africanus* in the Namib Desert (Tilson & LeRoux 1983). Present data amplify this information.

MATERIAL AND METHODS

Samples of barn owl pellets or pellet residue were collected by the authors from three nature reserves (Koppies Dam, Soetdoring and Tussen die Riviere) under the control of the Free State Dept. of Tourism, Environment & Economic Affairs (Fig. 1; Table 1). Material was first assembled by BDC in 1992–5 and subsequently by DMA and GA in 2000. The Soetdoring Silo sample was collected over a period of three years (Table 2) whereas all other samples are single collections representing an unknown period. The Soetdoring Purple Grove samples were obtained from two adjacent buildings and the Tussen die Riviere Aasvoelkop samples from two roosts about 50 m apart on a cliff. The location of the 2000 sites was established using a GPS and of the earlier sites from the 1:50 000 maps. Approximate altitudes were established from the same maps. DMA and GA were informed of barn owl activity at the Caledon Gate of Tussen die Riviere NR, although pellets had already been cleared from this location, and recovered two pellets each from Middelpunt and Groenvlei in the same reserve. A few pellets were also acquired by BDC in 1993 from sheds at Grootfontein and Werda in the reserve. None of these small samples is considered further as no additional information is added to that from the larger samples. All material is housed in the Natural History Division (South African Museum) of Iziko Museums of Cape Town.

The series of 25 samples from Soetdoring Silo covers the period November 1992 to May 1995 (Table 2). Collections were made at approximately monthly intervals except in a few cases. On each occasion all pellets were cleared from the site and no old pellets were collected. For the purposes of analysis individual collections were grouped by year, season and month (Table 2). According to convention the seasons were taken as autumn (March—May), winter (June—August), spring (September—November) and summer (December—February). Three samples were not assigned to a season: the first collection, made on an unrecorded day in November 1992, because the period of accumulation was indeterminate; the second because the day of collection in December 1992 was unrecorded and spring and/or summer may have been represented, depending on when the first collection was made; and the December 1994 collection because it covered November and December, i.e., parts of spring and summer. Samples were also assigned to season-plus-year, e.g. autumn 93 (Table 2). Only samples collected within four days of the end of a month were assigned to the month of, or preceding, their collection. Correlation analyses were carried out to establish whether there was a connection between precipitation (seasonal and mean annual) (unpublished data from the South African Weather Bureau) and percentage representation of various micromammalian taxa. Correlation analyses were also carried out on log normal transformations of minimum numbers of individuals in different seasons and months to examine hunting tactics.

Individual pellets were measured and weighed, then prepared in a solution of sodium hydroxide to dissolve hair. Mandibles and maxillae were also extracted from bulk samples of decomposed pellets. Identification and counting of individual micromammals, represented by mandibles and maxillae, was undertaken by DMA. The largest number of any one jaw (left and right mandible or maxilla) of a species constitutes the minimum number of individuals of that species in the sample. A more detailed discussion of identification methods is given in Avery *et al.* (2002).

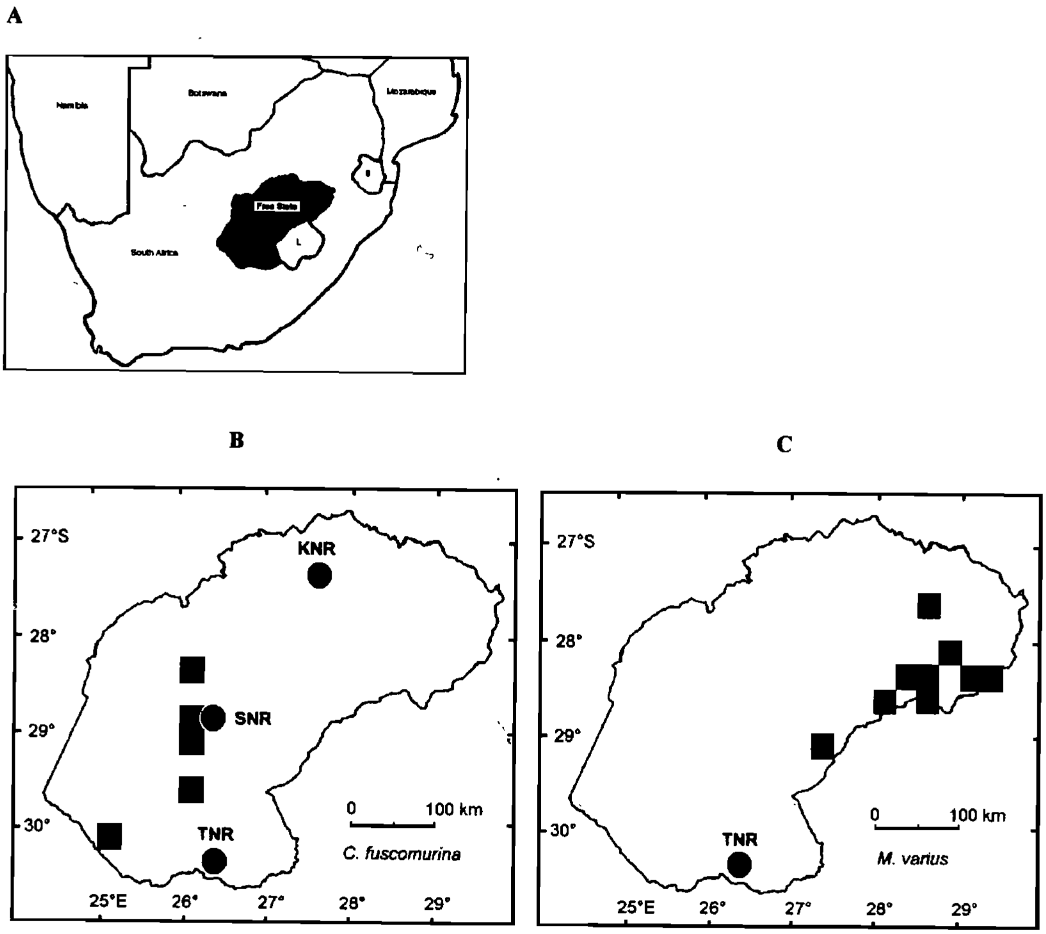

Fig. 1: Location of the Free State in southern Africa (L = Lesotho) (A) and of reserves discussed (B). Distribution of *Crocidura fuscomurina* (B) and *Myosorex varius* (C) in the Free State. Squares: published data from Lynch (1983). Circles: current data. KNR – Koppies Dam NR; SNR – Soetdoring NR; TNR – Tussen die Riviere NR.

Table 1. Information on sites in the Free State from which barn owl pellets were collected in 1992–5 and in March 2000. Accession numbers (Acc. No.) refer to collections housed in the Natural History Division (South African Museum) of Iziko Museums of Cape Town. Vegetation types after Low & Rebelo (1996).

Acc. No. SAM-CT	Site	Location & Altitude	Collector & Date	Notes
0018	Koppies Dam Office (KDO)	27°16'S; 27°41'E, 1417 m	B.D. Colahan 1993/4	Ceiling in part of office block. Open thornveld and garden. Moist Cool Highveld Grassland.
0117	Koppies Dam Silo (KDS)	27°16'S; 27°41'E, 1417 m	D.M. Avery, G. Avery 12 March 2000	Old silo on edge of reserve. Open grassland with scattered thorn trees, and sunflower field in immediate vicinity. Blue glum coppice and dam further away. Moist Cool Highveld Grassland.
0016	Soetdoring Silo (SDS)	28°48'S; 26°06'E, 1280 m	B.D. Colahan November 1992 to June 1995	Old silo among sheds surrounded by rows of blue gums. River, with riparian bush and reed beds, and some thornveld, nearby. Dry Sandy Highveld Grassland.
0118	Soetdoring Purple Grove (SPG1 & 2)	28°48'S; 26°07'E, 1280 m	D.M. Avery, G. Avery, S. van der Walt 13 March 2000	Old farm buildings in open grassland with some gum trees. Dry Sandy Highveld Grassland. Two samples from adjacent farm buildings.
0120	Tussen die Riviere Duplooysrust (TRD)	30°30'S; 26°16'E, 1370 m	D.M. Avery, G. Avery 14 March 2000	Old farm house and buildings in open grassland with a few thorn bushes, gum trees and poplars. Bats roosting. Eastern Mixed Nama Karoo.
0121	Tussen die Riviere Aasvoelkop (TRA1 & 2)	30°27'S; 26°19'E, 1370 m	D.M. Avery, G. Avery 12 March 2000	Two roosts approx. 50 m apart on ledge of cliff overlooking emergency gate near Caledon River approx. 2 km distant. Bushy vegetation on hillside, open grassland elsewhere. Eastern Mixed Nama Karoo.

Table 2. Dates of collections made at Soetdoring Silo with month, season and year to which individual samples were assigned for grouped samples. No assignment indicates the sample was omitted from the relevant group (see text for further details). Season: SP = spring, SU = summer, AU = autumn, WI = winter.

Coll. No	Coll. Date	Year	Season	Single Season	Month
01	Nov 92	1992			
02	Dec 92	1992			
03	11 Feb 93	1993	SU	SU92/3	
04	26 Apr 93	1993	AU	AU93	Apr
05	29 Jul 93	1993	WI	WI93	Jul
06	31 Aug 93	1993	WI	WI93	Aug
07	30 Sep 93	1993	SP	SP93	Sep
08	9 Nov 93	1993	SP	SP93	
09	30 Nov 93	1993	SP	SP93	Nov
10	1 Jan 94	1993	SU	SU93/4	Dec
11	3 Feb 94	1994	SU	SU93/4	Jan
12	28 Feb 94	1994	SU	SU93/4	Feb
13	31 Mar 94	1994	AU	AU94	Mar
14	1 Apr 94	1994	AU	AU94	Mar
15	2 May 94	1994	AU	AU94	Apr
16	1 July 94	1994	WI	WI94	Jun
17	2 Aug 94	1994	WI	WI94	Jul
18	7 Sep 94	1994	WI	WI94	
19	1 Nov 94	1994	SP	SP94	Oct
20	30 Dec 94	1994			
21	1 Feb 95	1995	SU	SU94/5	Jan
22	28 Feb 95	1995	SU	SU94/5	Feb
23	1 Apr 95	1995	AU	AU95	Mar
24	3 May 95	1995	AU		Apr
25	5 Jun 95	1995	AU		

The new records were added to the 1/16th degree grid square maps based on Lynch (1983). The general vegetation near a site was noted at the time of collection and the vegetation types were subsequently established by inspection of the distribution given by Lynch (1983) after Acocks (1975) and Low & Rebelo (1996) (Table 1; Fig. 1).

A preliminary assignment of upper first molars of *Mastomys* sp. from Soetdoring Silo (SDS) to the six age classes determined by Davis (1959) on the basis of surface wear was made. (Davis's [1959] age classes are based on increasing wear to the occlusal surface of the first upper molar, ranging from very little wear in juveniles of class 1 to extremely heavy wear in old adults of class 6.) Although Hanney (1963) suggested that tooth wear was an unsatisfactory measure of age, palatal length, which he advocated, cannot normally be applied due to fragmentation of specimens from owl pellets. Proportional representation of the age classes and overall proportions of *Mastomys* sp. in the samples were compared with monthly rainfall (unpubl. data from the South African Weather Bureau) to assess the possible effect of the latter on this species.

RESULTS

Twenty-five species of micromammals were recovered from the samples (Table 3). Of these, six were insectivores, two bats, one an elephant shrew and the remainder rodents. Details of proportional representation in each sample are given in Table 4. The Koppies Dam samples are distinguished by very high proportions (±80%) of the multimammate mouse *Mastomys* sp. According to Avenant (1996) and Venturi et al. (2003) only *M. coucha* occurs in the Free State province. Although the same species is dominant at Soetdoring it only comprises about 31% of the samples. The Soetdoring samples are unique in containing *Tatera leucogaster* while Soetdoring Silo (SDS) is further distinguished by relatively high proportions of the Cape serotine bat *Neoromicia capensis*. The Tussen die Riviere samples contain several species not found in samples from the other two reserves. Prominent among these are highveld gerbil *Tatera brantsii*, which is the best-represented species, and Saunders's vlei rat *Otomys saundersiae*. The records for most of the species found in the pellets are new for the relevant 1/16th degree squares. *Otomys saundersiae* was not recognised by Lynch (1983) as occurring in the province but it has recently been found at four localities (N.L. Avenant, pers. comm.). The range of the forest shrew *Myosorex varius* and the tiny musk shrew *Crocidura fuscomurina* (*C. bicolor* of Lynch 1983) is extended considerably in this province (Fig. 1).

The Soetdoring Silo samples indicate some seasonal variation in proportions of species in the samples and variation from one year to the next (Table 5). Yearly grouping shows the Cape serotine bat *Neoromicia capensis* to be dominant during 1992 and 1993, being replaced by *Mastomys coucha* in 1994 and 1995. When the samples are grouped by season *N. capensis* is the best-represented species in summer and *M. coucha* in all other seasons. However, when the samples are grouped by individual season, it becomes clear that *N. capensis* was the major prey species during summer1992/3 and autumn 1993, and again during spring 1993. At all other times, apart from summer 1993/4, when the bushveld gerbil *Tatera leucogaster* replaced it, *M. coucha* was the dominant species.

Correlation between rainfall and proportional representation of *Mastomys coucha* and *N. capensis* was not found to be significant at the p=0.01 level. Although it was difficult to be sure of Davis's (1959) age classes in the absence of diagrams, it is clear that there was seasonal variation in the proportions of young *Mastomys coucha* individuals in the samples from different seasons. Juveniles are best represented in autumn while the two oldest age classes are represented in spring and summer (Fig. 2). Seasonal and monthly variation in numbers of *Mastomys coucha*, *Mus minutoides* and *Tatera leucogaster* were found to be significant at the p=0.01 level (Fig. 3).

Table 3. List of species represented. Taxonomy according to Wilson & Reeder (1993) and common names after Meester *et al.* (1986). Codes used in other table and figures.

Order	Genus	Species	Common Name	Code
Insectivora	*Crocidura*	*cyanea*	reddish-grey musk shrew	Ccya
		fuscomurina	tiny musk shrew	Cfus
		mariquensis	swamp musk shrew	Cmar
	Myosorex	*varius*	forest shrew	Mvar
	Suncus	*infinitesimus*	least dwarf shrew	Sinf
		varilla	lesser dwarf shrew	Svar
Chiroptera	*Neuromicia*	*capensis*	Cape serotine bat	Ncap
	Tadarida	*aegyptiaca*	Egyptian free-tailed bat	Taeg
Rodentia	*Saccostomus*	*campestris*	pouched mouse	Scam
	Dendromus	*melanotis*	grey climbing mouse	Dmel
	Malacothrix	*typica*	large-eared mouse	Mtyp
	Desmodillus	*auricularis*	sort-tailed gerbil	Daur
	Tatera	*brantsii*	highveld gerbil	Tbra
		leucogaster	bushveld gerbil	Tleu
	Aethomys	*namaquensis*	Namaqua rock mouse	Anam
	Mastomys	*coucha*	multimammate mouse	Mast
	Mus	*minutoides*	pygmy mouse	Mmin
		musculus	house mouse	Mmus
	Rattus	*rattus*	house rat	Rrat
	Rhabdomys	*pumilio*	striped mouse	Rpum
	Mystromys	*albicaudatus*	white-tailed rat	Malb
	Otomys	*irroratus*	vlei rat	Oirr
		saundersiae	Saunders's vlei rat	Osau
	Cryptomys	*hottentotus*	common molerat	Chot
Macroscelidea	*Elephantulus*	*myurus*	rock elephant shrew	Emyu

Table 4. Percentage representation of micromammal species and sample size (MNI = minimum numbers of individuals) from individual sites. See Table 1 for details of sites and Table 3 for full species names. Highest proportions in each collection underlined.

	KDO	KDS	SDS	SPG1	SPG2	TRA1	TRA2	TRD
Ccya			0.4	1.1	0.9			
Cfus	5.1	2.4	5.0	4.7	6.4	0.4	0.8	1.9
Cmar	1.0	1.4						
Mvar						0.8		2.6
Sinf						1.5		2.6
Svar	1.5	2.1		0.7	0.7	8.0	2.5	10.2
Ncap	0.3		12.4	4.2	1.1	0.4		1.9
Taeg			0.5				0.8	
Scam						4.9	5.9	2.3
Dmel						0.8		3.0
Mtyp	0.3	0.3	5.8	8.0	10.8	2.7	5.9	1.1
Daur			1.6	1.3	0.5	1.1	5.0	2.3
Tbra						<u>22.1</u>	<u>19.3</u>	<u>13.2</u>
Tleu			14.9	14.7	13.5			
Anam						1.9	1.7	7.1
Mast	<u>82.7</u>	<u>78.4</u>	<u>31.3</u>	<u>29.4</u>	<u>31.8</u>	9.9	6.7	6.8
Mmin	1.3	2.1	12.0	13.6	13.7	1.1	0.8	6.0
Mmus	0.3	0.3			0.1			3.4
Rrat	0.3				0.1			
Rpum	3.0	2.7	6.7	14.0	10.0	2.3	2.5	3.0
Malb			1.7	0.7	1.2	1.9	0.8	
Oirr	4.3	10.3	5.6	5.3	6.7	9.9	13.4	6.4
Osau						19.4	17.6	9.0
Chot			1.9	2.2	2.6	10.6	14.3	15.4
Emyu						0.4	1.7	1.9
MNI	394	291	1368	449	1478	263	119	266

Table 5. Percentage representation of micromammal species constituting 10% of at least one sample and total sample size (MNI = minimum numbers of individuals) from Soetdoring Silo (SDS) samples grouped by years, seasons and individual seasons. See Table 2 for details of individual samples included in each group and Table 3 for full species names. SU = summer. AU = autumn. WI = winter. SP = spring. Highest proportion in each sample underlined.

Period	Cfus	Ncap	Mtyp	Tleu	Mast	Mmin	Rpum	Oirr	MNI
YEAR									
1992	9.8	54.5	1.8	5.4	3.6	5.4	10.7	0.9	112
1993	3.7	22.9	9.3	14.8	18.9	8.8	7.7	5.9	454
1994	5.0	0.4	3.9	16.6	42.3	15.3	5.5	6.4	747
1995	7.3	3.6	12.7	12.7	40.0	7.3	7.3	1.8	55
SEASON									
SU	11.6	19.7	7.5	16.3	11.6	4.8	11.6	8.8	147
AU	4.2	1.9	7.4	15.4	38.1	13.8	7.7	4.8	312
WI	3.4	0.6	5.5	18.8	39.4	17.4	3.8	5.5	495
SP	3.6	25.5	5.8	11.7	30.3	7.7	5.1	6.2	274
INDIVIDUAL SEASON									
SU92/3	6.1	34.7	2.0	10.2	4.1	2.0	20.4	6.1	49
AU93	3.6	21.4	14.3	17.9	10.7		14.3	10.7	28
WI93	4.3	1.4	9.0	19.9	25.6	16.1	6.2	9.0	211
SP93	1.4	49.6	10.6	7.1	19.1	2.8	2.8	0.7	141
SU93/4	13.6	12.3	11.1	19.8	11.1	7.4	7.4	12.3	81
AU94	4.5		5.3	15.9	40.7	15.9	6.9	4.5	246
WI94	2.8		2.8	18.0	49.6	18.3	2.1	2.8	284
SP94	6.0		0.8	16.5	42.1	12.8	7.5	12.0	133
SU94/5	17.6	11.8	5.9	17.6	35.3		5.9		17
AU95	2.6		15.8	10.5	42.1	10.5	7.9	2.6	38

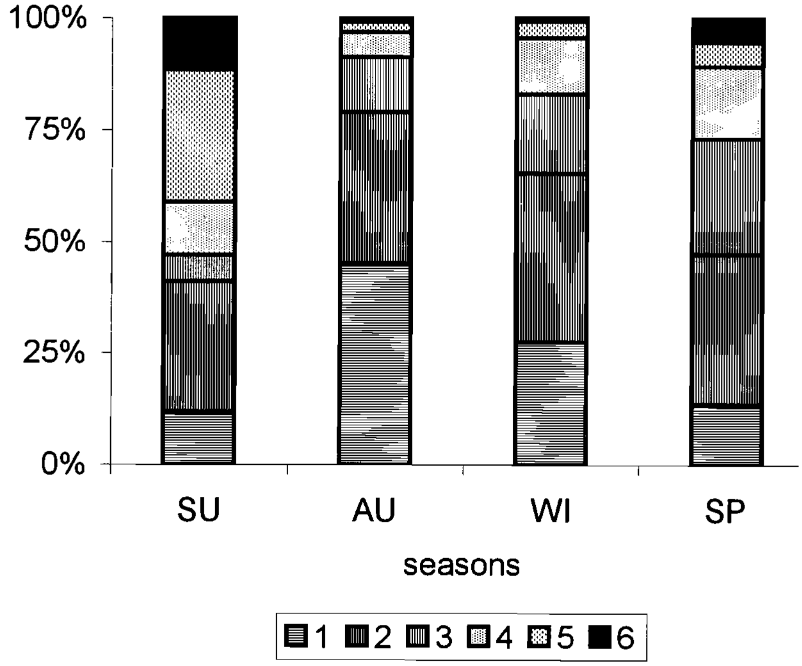

Fig 2: Seasonal variation in percentage representation of age categories in *Mastomys* sp. from Soetdoring Silo. Age categories (1-6) after Davis (1959) but see text for further details. SU=summer. AU=autumn, WI=winter, SP=spring.

In two cases samples were collected from within a short distance of each other (Table 4). At Soetdoring Purple Grove *N. capensis* accounts for 4.7% of the sample from an old barn (SPG1) while the sample from the abandoned farmhouse (SPG2) included bones of two house mice *Mus musculus* and a house rat *Rattus rattus*. At Tussen die Riviere Aasvoelkop sample TRA1 contains many more shrews than does TRA2 (8.0% v. 2.5% lesser dwarf shrew *Suncus varilla* and the only examples of *M. varius* and the least dwarf shrew *Suncus infinitesimus*). TRA2, on the other hand, contains 14.3% common molerats *Cryptomys hottentotus* compared with only 10.6% in TRA1.

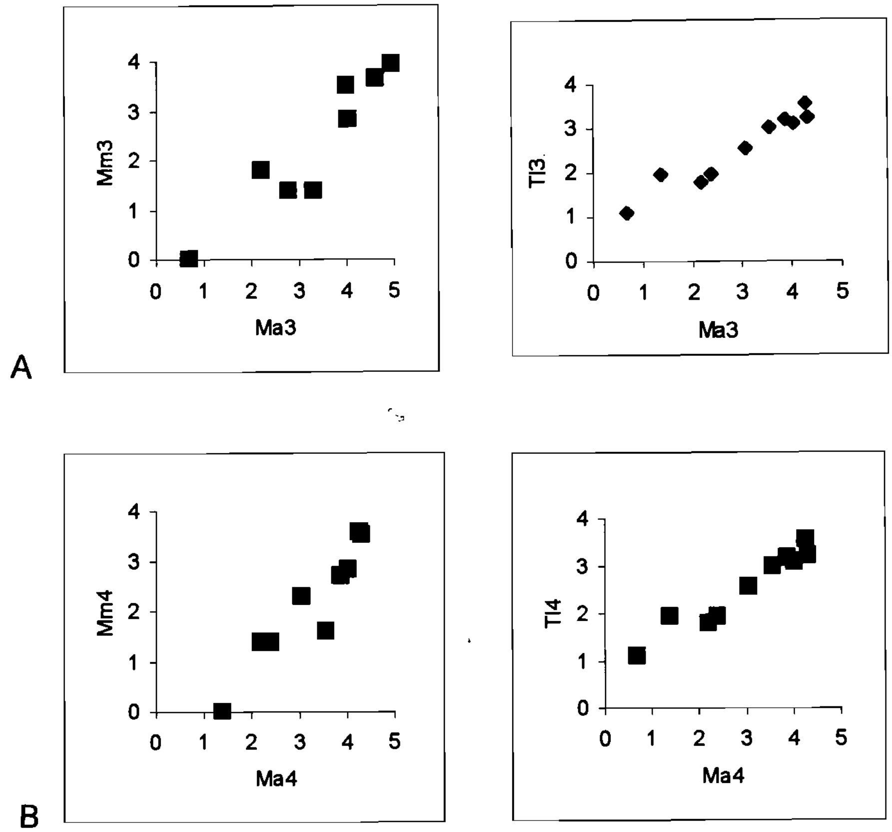

Fig 3: Co-variation of log normalized minimum numbers of individual *Mastomys* sp. (Ma3 & Ma4) with those of *Mus minutoides* (Mm3 & Mm4) and *Tatera leucogaster* (T13 & T14) in Soetdoring Silo samples. A: individual seasons. B: months. Correlations: Ma3/Mm3: r=0.936, df=6. Ma3/T13: r=0.845, df=8. Mm3/T13: r=0.931, df=6. Ma4/Mme: r=0.939, df=7. Ma4/MT14: r=0.967, df=8. Mm4/T14: r=0.886, df=8.

DISCUSSION

Geographic distribution

The Free State barn owl pellet samples discussed here provide useful examples of the type of information available from this source. In the first place, given the small size and nocturnal habit of most micromammals, it is impractical to rely on sightings to develop distribution maps. It is therefore fortunate that, as has been demonstrated before and is confirmed here, barn owls are effective collectors of information on the geographic distribution of micromammalian species. Moreover, since it is well known that all collecting methods have their biases, it makes sense to employ as many different methods as possible in the expectation that their biases will be different and corrected by each other.

Even in the present case, where many of the species are already known to occur widely in the Free State and there is consequently a reduced expectation of important new records, there are three instances in which the information is significant. Lynch (1983, 1989, 1994) found no evidence for *Otomys saundersiae* in the Free State, north-eastern (now Eastern) Cape Province or Lesotho. However, De Graaff (1981) shows a data point in the region of the Tussen die Riviere NR, probably based on Map 35 of Davis (1974), which the current specimens from Tussen die Riviere Aasvoelkop (TRA) support. The barn owl data, together with further specimens recently been found in the Free State (N.L. Avenant, pers. comm.), thus confirm the existence of *O. saundersiae* in the Free State.

The two shrews, *Crocidura fuscomurina* and *Myosorex varius*, were known to have restricted distributions in the Free State (Lynch 1983), the former in the western half of the province and the latter in the north-east (Fig. 1). The occurrence of both species in the Tussen die Riviere NR extends their ranges southwards, while the occurrence of *C. fuscomurina* in the Koppies Dam NR represents a significant north-eastern extension of this species. The South African subspecies, *C. f. bicolor*, has a wide habitat tolerance so an extension is not unexpected. Although Lynch (1983) notes its restriction in the Free State to places with rainfall below 500 mm, Meester (1963) is quoted by him and by Meester *et al.* (1986) as correlating the range of the subspecies generally with rainfall above 500 mm. It is therefore not surprising to find the species at Koppies Dam NR where the mean annual rainfall is about 670 mm (Weather Bureau, unpubl. data). At the same time, the mean annual rainfall of about 400 mm at Tussen die Riviere NR (Weather Bureau, unpubl. data) agrees with Lynch's (1983) findings. It should also be noted that Meester *et al.* (1986) reported *C. fuscomurina* as ranging northwards from the northern Free State. As for *M. varius*, while it has mostly been captured in open marshy environments in the Free State, it has also been recovered from mountain slopes (Lynch 1983) and it is therefore entirely unsurprising that it should occur in the mountainous countryside of Tussen die Riviere NR. The fact that this species is found elsewhere under relatively dry conditions as long as there is dense moist vegetation (Skinner & Smithers 1990) indicates that the relatively low rainfall in Tussen die Riviere NR would not be a barrier to its presence, especially in view of the nearness of Aasvoelkop to the Caledon River. Moreover, the Caledon River itself may have acted as a migration corridor for this species. Certainly, the nearest previous record was from Mispah just east of Ladybrand (Lynch 1983), which is within the same river system.

Temporal variation

The serial samples from Soetdoring Silo (SDS) provide an opportunity to assess temporal variation at both seasonal and annual scales (Table 5). Grouping the samples by year shows *Neuromicia capensis* to be the dominant species during 1992–3, to be replaced by *Mastomys coucha* in 1994–5. When the samples are grouped by season, *N. capensis* was prominent during summer and, to a lesser extent, during spring whereas multimammate mice *M. coucha* dominated during the rest of the year. By considering both season and year, it becomes clear that *N. capensis* was particularly well represented during summer 1992/3 and in spring 1993. After this it was hardly present although it is notable that subsequent occurrence were restricted to summer. *M. coucha* on the other hand, is consistently dominant from autumn 1994 onwards. This information suggests that it is inappropriate to base seasonal generalisations on data from relatively short periods and without reference to annual variation. A further consideration is the size of sample since the characteristics of large samples will overwhelm those of small samples. In this case, the 1994 sample is far larger than the other samples (Table 5) so that it has the most influence on the structure for the entire sample (Table 3).

It is probable that *Mastomys coucha* was present on the ground in fairly large numbers at all times since it comprises about a third of the sample in all seasons except some summers (Table 5). A first attempt was made to divide the sample into age classes to gain preliminary insight into population structure. It is likely, however, that the data should be re-assessed in view of the difficulty of comparing results and of Hanney's (1963) assertion that tooth wear is an unsatisfactory method, which should be replaced by proposed palatilar length as a proxy for body length. Using this method, he established that, while some reproduction must have taken place throughout the year, there was a predominance of juveniles between June and September. This, in turn, indicated a peak in reproduction during the first half of the dry season whereas breeding is known to correspond with the rainy season elsewhere in Africa (see Leirs et al 1989). Near Johannesburg most breeding was found to occur after the main summer rainfall season (Coetzee 1965), as it was at Warmbaths some 150 km further north (Dean 1973). In the Free State, however, reproduction begins in early spring with the first rains (N.L. Avenant, pers. comm.) In the present samples, whatever the shortcomings of the ageing technique, it is clear that there is a much higher proportion of juveniles in autumn than at other times of the year (Fig.2). This agrees with the findings of Avenant (pers. comm.) that the highest numbers of juveniles are found at the end of autumn into early winter. It may also agree with the other findings in that the average rainfall for the summer quarter at nearby Bloemfontein comprises about 47% of the annual total of 546 mm (Weather Bureau unpubl. data). Larger samples and a more detailed examination of the age profiles can be expected to improve the accuracy of this observation.

Predator behaviour

The extent to which barn owls are opportunistic or exercise a degree of choice over the prey they take has yet to be established. It seems likely, in fact, that the owls are what might be termed selectively opportunistic, given that they hunt preferentially the most abundant or easiest prey species within their hunting range. However, the dominant species changes from site to site and over time so that, in this sense, the barn owl is opportunistic (DMA pers. obs.). In the Soetdoring Silo collection, for instance, there is a major shift from one dominant prey species to another, which appears to indicate a degree of opportunism. Being close at hand, bats (*Neuromicia capensis*) would be less energetically expensive to catch than rodents (*Mastomys coucha*) and, for this reason, may have been preferentially hunted when they were present. This assertion is supported by the fact that 198 *N. capensis* were caught over a two-year period even though this species is unlikely to have been present in large numbers since it is solitary or lives in small groups (Fenton 1975). It seems most likely that the high proportions in summer 1992/3 and especially in spring 1993, as well as presence in succeeding summers, indicate that the owls were taking advantage of the bats' breeding season, assuming that observations of late spring breeding at Barkly West and Barkly East (Herselman & Norton 1985) are applicable to the central Free State. The continued high proportions in autumn 1993 are less easy to explain in this way. The significant co-variation in numbers of *Tatera leucogaster* and *Mus minutoides* with those of *M. coucha* (Fig. 3) suggests that the owls were opportunistically catching the first two species while they were concentrating on the main prey species.

Present evidence provides further information on apparent division of the countryside by different owls or pairs of owls. Table 4 shows that, while both samples from Tussen die Riviere Aasvoelkop are generally similar, there are noticeable differences. For instance, the occupant(s) of TRA1 either had a greater preference for shrews or, more likely, happened to hunt where these occurred. On the basis of evidence from elsewhere in the Free State (Lynch 1986), *Suncus varilla* was probably caught while the owl(s) hunted over the flats below the roost. Higher proportions of *Mastomys coucha* in TRA1 than in TRA2 also suggest that the former, which was located to the south of TRA2 (to the left as one faces Aasvoelkop), mainly represents hunting of the area south of the roost. This included the gatekeeper's house, which has a vegetable garden where *M. coucha* is likely to be found. The occupant(s) of TRA2, on the other hand, appear to have hunted more towards the Caledon River, as indicated by a higher proportion of *Otomys irroratus*, and on the flat area below the hill and towards the river. The approximately equal emphasis on *Otomys saundersiae* in both samples indicates hunting by both (all) birds along the hillside, possibly on the way to and from their roosts.

The Soetdoring Purple Grove samples provide even greater detail on hunting activity than do those from Tussen die Riviere Aasvoelkop. Here the evidence implies that barn owls can be truly opportunistic. The greater number of bats taken by the bird(s) in the barn (SPG1) almost certainly resulted from the fact that the bats were roosting in the barn. Conversely, it is likely that the house mice and house rats found in the pellets from SPG2 (house) were captured around the house by the owl(s) roosting there.

These observations may seem trivial but such detailed comparisons allow some assessment of the owls' hunting range and habits in the absence of direct observations. A corollary to this is the possibility of establishing whether owls expand or contract their hunting territory depending on whether their activities are constrained by the presence of near neighbours. Even though the barn owl has received so much attention, it is salutary to realise that there are still areas of its behaviour that are not well known. It is also important to acknowledge the apparent contradiction that the more widespread and catholic a species, the less it is permissible to generalise about its behaviour and the more challenging is the task of learning all there is to know about it.

As a final observation, it may be noted that the barn owl's contribution to our understanding of micromammalian biodiversity appears to have been largely under-appreciated. It therefore bears repeating that not only can barn owl pellets provide cheap, reliable information on micromammalian distribution they can also contain important data for the assessment of small mammal biodiversity present and past. This is particularly true of series of collections from the same locality since these have the additional benefit of recording change over time and potentially allowing correlation with contemporary environmental (climate and vegetation) changes.

OPSOMMING

Nonnetjies-uilballe is vanaf 1992 tot 2000 by die volgende natuurreservate versamel: Koppiesdam, Soetdoring en Tussen-die-Riviere. Die kleinsoogdier-komponent het 25 spesies (16 knaagdier, ses insektivoor, twee vlermuis, een klaasneus) ingesluit. Die vaalveldmuis, *Mastomys coucha*, het oorheersend voorgekom in die uilballe vanaf Koppiesdam en Soetdoring, en die Hoëveldse nagmuis, *Tatera brantsii*, oorheersend in dié vanaf Tussen-die-Riviere. Verdere getuienis is gelewer vir die insluiting van Saunders se vleirot, *Otomys saundersiae*, in die

Vrystaatse spesieslys en uitbreidings tot die verspreidingsgebiede van die dwergskeerbek, *Crocidura fuscomurina*, en die bosskeerbek, *Myosorex varius*, is aangedui. Gereelde versamelings vanaf Soetdoring Silo gedurende die tydperk 1992-5 dui op 'n verandering van dominante prooi, van die Kaapse dakvlermuis, *Neoromicia capensis*, gedurende die eerste deel van hierdie tydperk tot *Mastomys coucha* daarna. Variasie in die voorkoms van ouderdomsgroepe in laasgenoemde spesie steun vorige bewyse dat hierdie spesie regdeur die jaar aanteel, maar met 'n piek aan die einde van die somerreënvalseisoen. Bewyse van twee paar uil-slaapplekke by Soetdoring Purple Grove en by Tussen-die-Riviere Aasvoëlkop, dui 'n mate van skeiding in jaggebied tussen naburige uile aan. Hierdie data lewer 'n bydrae tot die debat oor die opportunistiese jaggedrag van die nonnetjiesuil.

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