Gomez, I.; Sans-Coma, V. (1975): Edad relativa de *Crocidura russula* en egagrópilas de *Tyto alba* en el nordeste ibérico. Misc. Zool. **63**, 209–212.
Gosálbez, J.; López-Fuster, M. J.; Durfort, M. (1979): Ein neues Färbungsverfahren für Hodenzellen von Kleinsäugetieren. Säugetierkdl. Mitt. **27**, 303–305.
Hellwing, S. (1971): Maintenance and reproduction in the white-toothed shrew, *Crocidura russula monacha* Thomas, in captivity. Z. Säugetierkunde **36**, 103–113.
— (1973): The postnatal development of the white-toothed shrew, *Crocidura russula monacha* in captivity. Z. Säugetierkunde **38**, 257–270.
— (1975): Sexual receptivity and oestrus in the white-toothed shrew, *Crocidura russula monacha*. J. Reprod. Fert. **45**, 469–477.
Kahmann, H.; Kahmann, E. (1954): La musaraigne de Corse. Mammalia **18**, 129–158.
Niethammer, J. (1970): Über Kleinsäuger aus Portugal. Bonn. zool. Beitr. **21**, 89–118.
Röben, P. (1969): Die Spitzmäuse (Soricidae) der Heidelberg Umgebung. Säugetierkdl. Mitt. **17**, 42–62.
Saint-Girons, M. C. (1973): Les Mammifères de France et du Benelux (faune marine exceptée) Paris: Doin.
Sans-Coma, V.; Gomez, I.; Gosálbez, J. (1976): Eine Untersuchung an der Hausspitzmaus (*Crocidura russula* Hermann, 1780) auf der Insel Meda Grossa (Katalonien, Spanien). Säugetierkdl. Mitt. **24**, 279–288.
Vesmanis, I.; Vesmanis, A. (1979): Ein Vorschlag zur einheitlichen Altersabstufung bei Wimperspitzmäusen (Mammalia: Insectivora: *Crocidura*). Bonn. zool. Beitr. **30**, 7–13.
Vogel, P. (1972): Beitrag zur Fortpflanzungsbiologie der Gattungen *Sorex, Neomys* und *Crocidura* (Soricidae). Verh. Naturf. Ges. Basel **82**, 165–192.

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Feeding habits of two syntopic small mammals in northern Zimbabwe

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Abstract

Investigated the feeding habits of two syntopic small mammals, the musk shrew *(Crocidura hirta)* and the multimammate mouse *(Praomys natalensis)* inhabiting *Panicum* grassland and *Cyperus articulatus* during the dry season by live-trapping and faecal analysis. Fourteen faecal samples from *C. hirta* were examined and 21 different food types were identified. 64 % of all dietary occurrences comprised adult insects, chiefly hemipterans, coleopterans, isopterans and formicids, but other invertebrates, particularly araneids, were eaten. Plant material, especially seeds, was also taken. Fifty faecal samples from *P. natalensis* were examined and 20 different food types were recognised. Approximately 44 % of all dietary occurrences comprised leaves and stems of grasses and dicotyledons, and 29 % was seeds. Approximately 27 % of the diet of *P. natalensis* was invertebrates, mainly insects such as hemipterans and isopterans. There was considerable dietary overlap between these small mammals in the variety and proportions of insects eaten.

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Introduction

Shrews are known to be voracious predators of a wide variety of invertebrates, particularly insects. Their predatory activities coupled with their frequent occurrence suggests that they may have an important role as secondary consumers (for example, Holling 1959; Pernetta 1976; Churchfield 1982a, 1984). Some of the most common and widespread of shrews belong to the genus *Crocidura* which is particularly well-represented in Africa. While numerous species of African crocidurines have been described, very little is known about their habits in the wild. For example, apart from the brief study of Churchfield (1982b), there have been no detailed studies of the feeding habits of wild crocidurines in Africa.

Shrews usually coexist with rodents but their interactions have seldom been studied. One potential area of overlap is feeding habits. While rodents are recognised as being primarily herbivorous, they frequently feed on invertebrates, especially insects (for example Holisova 1966; Flake 1973; Field 1975; Obrtel et al. 1978; Perrin 1980) and thus may compete with shrews, particularly in seasons of low food productivity. Together, these small mammals may have an important impact on invertebrate populations including potential pest species.

This paper reports the results of a brief study of the feeding habits and dietary overlap of two commonly-occurring and syntopic small mammals, the lesser red musk shrew, *Crocidura hirta* (Peters, 1852) and the multimammate mouse, *Praomys natalensis* (A. Smith, 1834) during the dry season at Kariba, north-west Zimbabwe.

Material and methods

Trapping the small mammals

Trapping was carried out in two areas of contrasting vegetation beside Lake Kariba at the University of Zimbabwe's Research Station at Kessessee, near Kariba, north-west Zimbabwe. One was an area of dry grassland dominated by *Panicum repens* and *P. maximum* and interspersed with tall mopane trees, *Colophospermum mopane*. Here, 30 Sherman live-traps were set singly at intervals of approximately 10 m to occupy an area of 2000 m^2. The other area was much damper and comprised a belt of vegetation dominated by *Cyperus articulatus* and *C. involucratus* occupying the shore-line of Lake Kariba. Nineteen Sherman live-traps were set singly at approximately 10 m intervals covering an area of some 1100 m^2.

The traps were baited with peanut butter and set for 8 days and nights during July/August 1983. They were checked each morning and evening for captures. Small mammals were marked by toe-clipping and released at the point of capture. Faecal pellets produced by small mammals in the traps were collected and preserved in 70 % alcohol for examination of food remains.

Diet analysis

The diets of *Crocidura hirta* and *Praomys natalensis* were analysed by microscopic examination of food remains in faecal pellets collected from the traps. For *C. hirta*, as many pellets as possible were collected from each trapped individual and these constituted a single sample. A mean of 12 pellets per sample was collected (range 9–12). *P. natalensis* produced much larger and more discrete pellets which could be collected singly. A single pellet, selected at random from a trapped individual, constituted a sample. For further analysis and criticisms of the technique, particularly as regards sample numbers, see Churchfield (1982a, 1984).

The results of the diet analyses were expressed in terms of the percentage composition of the diet (the number of occurrences of a named food item divided by the total number of occurrences of all items). In addition, for *P. natalensis*, the relative volumes of invertebrates, seeds and green plant material in each sample was estimated.

Results

Captures of small mammals

A total of 14 individuals of *C. hirta* and 95 individuals of *P. natalensis* were captured in the two study areas. Both species were found in approximately equal numbers in each study area, with an overall capture rate of 3.6 per 100 trap nights for *C. hirta* and 24.2 per 100 trap nights for *P. natalensis*. All captures were sustained between dusk and the following dawn trap-round.

Diets of small mammals

Crocidura hirta

Fourteen samples of faecal pellets from *C. hirta* were examined, all of which contained identifiable food remains. Between 4 and 11 different food types were recognised in each faecal sample (mean 7). The variety of prey items found and their percentage composition are shown in Table 1, where results from both study areas are combined. Twenty-one different food types were recognised and all were invertebrate with the exception of some vegetable matter. The most important dietary occurrences were adult insects, particularly coleopterans, hemipterans, isopterans and formicids. It was not possible to count the numbers of each prey type found in a sample owing to the fragmentation of most of the remains. However, the numbers of isopterans and formicids could be estimated by counting the distinctive head capsules or mandibles which had remained undamaged: for example, 270 isopterans and 110 formicids were counted in one faecal sample.

The diets of shrews caught in the two study areas were much alike and any differences probably reflected the availability of certain prey items in the two sites. For example, isopterans and formicids were taken most frequently in the dry grassland, and coleopteran larvae and lumbricids in the damper *Cyperus* area. However, the small number of faecal samples collected did not permit a detailed analysis.

Table 1

The diet of *Crocidura hirta* at Kariba, northern Zimbabwe, revealed by faecal analysis

Number of samples	Percentage Composition 14	Number of samples	Percentage Composition 14
Food item		Food item	
Chrysomelidae	1	Mantidae	2
Carabidae	7	Coleoptera larvae	3
Coleoptera indet.	5	Lepidoptera larvae	5
Hemiptera	10	Araneae	14
Culicidae	1	Acari	3
Diptera indet.	5	Diplopoda	2
Formicidae	14	Gastropoda	1
Other Hymenoptera indet.	2	Lumbricidae	1
Isoptera	12	Plant material: seeds	4
Trichoptera	1	Plant material: other	3
Blattidae	4		

Praomys natalensis

Fifty samples of faecal pellets of *P. natalensis* were examined. Between two and nine different food types were identified in each sample (mean 5). The percentage composition of different dietary items in the two study areas is shown in Table 2. The most frequently

occurring food item was the leaves and stems of grasses, particularly *Panicum* spp. but dicotyledons were also taken including *Polygonum senegalensis* which was present in large clumps near the lake shore although it did not occur in either of the trapping areas. Seeds of grasses, *Cyperus* spp. and unidentifiable dicotyledons were taken in large numbers. The diet was not restricted to plant material for 24 and 30 % of all dietary occurrences in the *Panicum* grassland and the *Cyperus* areas respectively comprised invertebrates, mostly insects.

The diets of *P. natalensis* from the two study areas differed not so much in the variety of food types as in the relative occurrences of certain foods. For example, grasses were augmented by *Cyperus* spp. and dicotyledons in the more varied habitat of the lake-shore study area, and invertebrates were also taken more frequently here. In terms of volume, invertebrates contributed a mean of 31 % to the diet in the *Panicum* grassland but only 14 % in the *Cyperus* area. Seeds had a mean of 20 % and 30 % in the two areas respectively, and the remainder was green plant material.

Table 2

The diet of *Praomys natalensis* inhabiting *Panicum* grassland and *Cyperus articulatus* at Kariba, northern Zimbabwe, revealed by faecal analysis

	Percentage Composition	
	Panicum	*Cyperus*
Number of samples	25	25
Plant material		
Panicum spp., leaf/stem	19	11
Graminae indet., leaf/stem	17	10
Graminae indet., roots	0	4
Cyperus involucratus, leaf/stem	0	4
Polygonum senegalensis, leaf	1	2
Dicotyledons indet., leaf/stem	8	13
Panicum spp., seeds	3	1
Graminae indet., seeds	3	10
Cyperus involucratus, seeds	4	12
Cyperus articulatus, seeds	1	0
Polygonum senegalensis, seeds	1	4
Dicotyledons indet., seeds	13	5
Animal material		
Coleoptera, adults	0	3
Hemiptera, adults	8	9
Diptera, adults	0	1
Formicidae, adults	4	6
Other Hymenoptera, adults	1	0
Isoptera, adults	16	1
Lepidoptera, larvae	0	1
Araneae	1	3

Dietary overlap between *C. hirta* and *P. natalensis*

An index of similarity provides some direct assessment of the dietary overlap between these two coexisting small mammals. A modification of a simple estimate of Percentage Similarity based on Southwood (1975) was used to compare the composition of the food types in the diets. Here, Percentage Similarity is equal to the sum of the minimum percent compositions of each major food type in the diets to be compared.

If the vegetable component is included, then the overlap between the two species is only 35 % since plant material comprised the bulk of the diet of *P. natalensis.* When the animal

component of the diets is compared alone, the overlap amounts to 61 %. While the variety of invertebrate prey taken by *P. natalensis* was much smaller than that taken by *C. hirta*, there was considerable overlap in the types and proportions of insects eaten, particularly hemipterans and isopterans. However, coleopterans, which were a dominant prey item of shrews, were taken infrequently by *P. natalensis*.

Discussion

C. hirta is amongst the commonest of African shrews. Vesey-Fitzgerald (1962), Meester (1963), Sheppe (1973), Smithers and Lobão Tello (1976) and Rautenbach (1982) all report it to be abundant and widespread in eastern and southern Africa where it frequents a variety of habitats from marshes and forests to dry grassland and scrub. Despite being so common and widespread, very little is known about the ecology of this and other African crocidurines. This may be partly due to the fact that these shrews tend to be predominantly nocturnal and solitary (Rautenbach 1982) and they appear to have a low capture rate in traps. For example, Delany (1964) recorded a capture rate of various crocidurines of 3.6 per 100 trap nights which compares well with the present study. Rowe-Rowe and Meester (1982) record a capture rate of only 0.2 −0.7 per 100 trap nights for *C. flavescens*.

Although a wide variety of prey were taken by *C. hirta* in the present study, this shrew was predominantly insectivorous. Plant-feeding hemipterans were an important prey item of this species and also of the larger *C. poensis* (Churchfield 1982b). Meester (1963) says that *C. hirta* is often found in termitaria and, indeed, termites were a major dietary item of these shrews in the present study, particularly in the *Panicum* grassland. Plant material, especially seeds, was also a frequent occurrence, indicating that this shrew is to some extent omnivorous.

Similarly, *P. natalensis* is quoted as being one of the commonest and most widespread rodents in Africa (Coetzee 1965). It can be an agricultural pest, and consequently its ecology is of considerable interest, particularly its feeding habits. Previous studies by Delany (1964), Hanney (1965), Field (1975), Wilson (1975) and Taylor and Green (1976) show that it is predominantly herbivorous, feeding mainly on seeds, fruits and green plant material including grasses and dicotyledons as in the present study. According to Wilson (1975), seeds of *Colophospermum mopane* are eaten, but this was not so in the present study. *P. natalensis* is also known to eat insects such as formicids, isopterans, orthopterans and coleopterans. However, there have been few detailed studies of its diet, particularly with respect to the importance of invertebrate prey. Field (1975) found that insects comprised 20 % by weight of its diet for much of the year which compares well with the proportions found in the present study. As in this study, Field (1975) also found that isopterans were the dominant insect in the diet.

There was some dietary overlap between *C. hirta* and *P. natalensis*, particularly as regards insect prey. This could lead to competition between shrews and rodents at high population densities, especially in the dry season when both fresh vegetation and insects are in short supply. Probably more significant is the combined impact of shrews and rodents as secondary consumers, particularly in the dry season when recruitment into insect populations is low. However, further work is required to discover the full extent of their predatory activities.

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Zusammenfassung

Ernährungsgewohnheiten von zwei syntopen Kleinsäugern im nördlichen Zimbabwe

Untersucht wurden die Ernährungsgewohnheiten von zwei syntopischen kleinen Säugetieren, der Spitzmaus *Crocidura hirta* und der Maus *Praomys natalensis*. Beide kommen sowohl in *Panicum*- als auch in *Cyperus articulatus*-Grasland vor. Während der Trockenzeit wurden Exkremente nach Lebendfang gesammelt und analysiert. In 14 Kotproben der Spitzmaus konnten 21 verschiedene Nahrungsbestandteile identifiziert werden. 64 % aller Anteile waren Imagines von Insekten, hauptsächlich Hemipteren, Coleopteren, Isopteren und Formiciden, aber auch andere Evertebraten, hauptsächlich Araneiden waren nachzuweisen. Pflanzliche Materialien, insbesondere Saat, waren ein Teil zusätzlicher Nahrung.

In 50 Kotproben von *P. natalensis* wurden 20 verschiedene Nahrungsbestandteile identifiziert. Etwa 44 % all dieser Anteile bestanden aus Grasblättern und -halmen sowie Dicotyledonen, und 29 % war Saat. Etwa 27 % der Nahrungsanteile von *P. natalensis* waren Evertebraten, hauptsächlich Insekten (Hemipteren und Isopteren). Bei den Insekten ergeben sich einige Überschneidungen im Nahrungsspektrum dieser Kleinsäugerarten.

References

Churchfield, Sara (1982a): Food availability and the diet of the common shrew, *Sorex araneus*, in Britain. J. Anim. Ecol. **51**, 15–28.

— (1982b): A note on the diet of the African musk shrew, *Crocidura poensis*. Acta theriol. **27**, 347-350.

— (1984). Dietary separation in three species of shrew inhabiting water-cress beds. J. Zool., London, **204**, 211–228.

Coetzee, C. G. (1965): The breeding season of the Multimammate Mouse *Praomys (Mastomys) natalensis* (A. Smith) in the Transvaal highveld. Zool. Afr. **1**, 29–39.

Delany M. J. (1964): An ecological study of the small mammals in the Queen Elizabeth Park, Uganda. Rev. Zool. Bot. Afr. **70**, 127–147.

Field, A. (1975): Seasonal changes in reproduction, diet and body composition of two equatorial rodents. E. Afr. Wildl. J. **13**, 221–235.

Flake, L. D. (1973): Food habits of four species of rodents on a short-grass prairie in Colorado. J. Mammalogy **54**, 636–647.

Hanney, P. (1965): The Muridae of Malawi (Africa: Nyassaland). J. Zool., London, **146**, 577–633.

Holisova, V. (1966): Food of an overcrowded population of the bank vole, *Clethrionomys glareolus* Schreb., in a lowland forest. Zool. Listy **15**, 207–224.

Holling, C. S. (1959): The components of predation as revealed by a study of the small mammal predation of European sawfly. Can. Entomol. **91**, 293–332.

Meester, J. (1963): A systematic revision of the shrew genus *Crocidura* in southern Africa. Transv. Mus. Mem. **13**, 1–277.

Obrtel, R.; Zejda, J.; Holisova, V. (1978): Impact of small rodent predation on an overcrowded population of *Diprion pini* during winter. Folia Zoologica **27**, 97–110.

Pernetta, J. C. (1976): Diets of the shrews *Sorex araneus* L. and *Sorex minutus* L. in Wytham grassland. J. Anim. Ecol. **45**, 899–912.

Perrin, M. R. (1980): The feeding habits of two coexisting rodents, *Rhabdomys pumilio* and *Otomys irroratus* in relation to rainfall and reproduction. Acta Oecol. Oecol. Gener. **1**, 71–89.

Rautenbach, I. L. (1982): Mammals of the Transvaal. Ecoplan Monograph 1, 1–211.

Rowe-Rowe, D. T.; Meester, J. (1982): Habitat preferences and abundance relations of small mammals in the Natal Drakensberg. S. Afr. J. Zool. **17**, 202–209.

Sheppe, W. A. (1973): Notes on Zambian rodents and shrews. Puku **7**, 167–190.

Smithers, R. H. N.; Lobão Tello (1976): Checklist and atlas of the mammals of Mocambique. Mem. natn. Mus. Rhod. **8**, 1–184.

Southwood, T. R. E. (1975): Ecological Methods. Chapman and Hall.

Taylor, K. D.; Green, M. G. (1976): The influence of rainfall on diet and reproduction in four African rodent species. J. Zool., London, **180**, 367–389.

Vesey-Fitzgerald, D. F. (1962): The habits and habitats of small rodents in the Congo River region of Zambia and Tanzania. Zool. Africana **2**, 111–122.

Wilson, V. J. (1975): Mammals of the Wankie National Park, Rhodesia. Mem. natn. Mus. Rhod. **5**, 1–147.

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