Micromammalian distribution and abundance in the Western Cape Province, South Africa, as evidenced by Barn owls *Tyto alba* (Scopoli)

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Abstract

The history of Western Cape mammalogy began almost 200 years ago with Thunberg (1811) and has been augmented periodically ever since. The present paper follows Vernon (1972) and Grindley et al. (1973) in eliciting information from material in Barn owl *Tyto alba* (Scopoli) pellets. Analyses are based on identified and counted mandibles and maxillae. The Laminate vlei rat, *Otomys laminatus* Thomas and Schwann, and Krebs’s fat mouse, *Steatomys krebsii* Peters, are shown to have wider distributions than were previously recorded. The Southern multimammate mouse, *Mastomys coucha* (A. Smith), is apparently expanding its range westwards, a move probably enabled by changes in vegetation due to farming practices. There appears to be some correspondence between proportional representation of some species and rainfall, either its amount per annum or its seasonality. Variation in alveolar length in Cape gerbils, *Tatera afra* (Gray), taken as a proxy for mean individual mass, suggests that mean size in this species may be influenced by rainfall seasonality. Although the Vlei rat, *Otomys irroratus* (Brants), is known to breed throughout the year, the present evidence indicates that in the West Coast National Park births peak in late spring and early summer, some two months after maximum rainfall. The Western Cape data support the concept that *T. alba* is a selective opportunist. Sample structure and co-occurrence of species in individual pellets both show that in some cases the owls are more nearly opportunistic while in others they appear to be considerably more selective.

Keywords: Abundance, Barn owl, distribution, micromammals, South Africa

Introduction

As Rookmaker (1989) pointed out, the Cape of Good Hope was one of the first regions of Africa to attract the attention of European naturalists. Unfortunately, few of the records concerned micromammals although the Cape golden mole, *Chrysochloris asiatica* (Linnaeus), various molerats of the family Bathyergidae, the Striped field mouse, *Rhabdomys pumilio* (Sparrman), and the round-eared elephant shrew, *Macroscelides proboscideus* (Shaw), were noted (Rookmaker 1989). Perhaps the first scientific lists of mammals from the Cape Province were those of Thunberg (1811) and Smuts (1832).
Some 70 years later the first systematic collections were made in southern Africa by C. B. H. Grant, one of whose expeditions was made near Knysna in the present Western Cape (Thomas and Schwann 1906). A further 30 years elapsed before Shortridge undertook his historic work in the western part of the subcontinent, including the Cedarberg Mountains (Shortridge and Carter 1938; Shortridge 1942). During the last 40 years publication has been more regular, if still sparse, on micromammal distributions in the (now Western) Cape Province. Most of these have been by Western Cape Nature Conservation and South African National Parks staff or concerning reserves administered by these bodies (e.g. De Hoog 1967; Robinson 1976; Stuart and Braack 1978; Stuart et al. 1978; Lawson 1982; De Graaff and Rautenbach 1983; Avery et al. 1990). Apart from the preliminary distribution maps of Stuart and Lloyd (1978) no publication has concentrated on bringing together all available biogeographic information on the mammals of the province, such as has been done for other provinces by, for example, Lynch (1983, 1989) and Rautenbach (1982). General studies that include Western Cape distributional data are those of Meester et al. (1986), Skinner and Smithers (1990), and Mills and Hes (1997), as well as those on rodents (De Graaff 1981), some shrews (Crocidura spp., Meester 1963; Suncus spp., Meester and Lambrechts 1971) and selected micromammals (Davis 1974). Most recently, Friedmann and Daly (2004) have collated all data known up to 2002–3, including some forming part of this study.

The contribution of the Barn owl, Tyto alba (Scopoli), to our knowledge of micromammalian distributions is generally well documented though there have been few records from the Western Cape. Vernon (1972) recorded a collection from Little Brak River near Mossel Bay and Grindley et al. (1973) reported collections from Stanford near Hermanus and Oesterval on the Langebaan Lagoon. Additionally, we have published some of the samples discussed here in other contexts (e.g. Avery 1977, 1982, 1992, 1999; Avery et al. 1990). The present paper, which comprises the third in a series of reports on micromammalian data obtained from Tyto alba pellets from different provinces of South Africa (Avery et al. 2002, 2003), examines for the first time all Western Cape micromammalian information collected through the agency of Tyto alba over the last 30 years (Table I; Figure 1).

Material and methods

Tyto alba pellets and bulk pellet residues were collected from sites throughout the Western Cape Province. In some cases more than one collection was made from the same site and in three areas regular collections were made over a period of years. These latter are the West Coast National Park (Bottelary and Geelbek), the De Hoop Nature Reserve (De Hoop and Potberg) and Vrolijkheid Nature Reserve. In cases where regular collections were made, the sites were initially cleared of all pellets and residual material. Thereafter, all fresh pellets were removed on each occasion. This ensured that, after the first collection, the period of pellet deposition was known, which is essential for analysis of seasonal variation. Samples were grouped by season for analysis, using the South African conventional quarterly subdivisions of summer (December to February), autumn (March to May), winter (June to August), and spring (September to November).

Individual pellets were measured and weighed, then prepared in a solution of sodium hydroxide to dissolve hair (Scheuler 1972; Longland 1985). 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
Table I. Quarter-degree squares in the Western Cape Province from which *Tyto alba* pellets have been collected and incorporated into the collections of Iziko South African Museum.

| Square | Site                          | Code  | SAM-CT | Collection year | Collector                  | N    |
|--------|-------------------------------|-------|--------|-----------------|----------------------------|------|
| 3118CA | Papendorp Moreson            | PDM   | 0020   | 1984           | R. K. Brooke               | 36   |
| 3218AB | Steenbokfontein N kopje       | SFN   | 0012   | 1978           | D. M. Avery, G. Avery     | 168  |
|        | Steenbokfontein S kopje       | SFS   | 0013   | 1979, 1980     | D. M. Avery, G. Avery     | 729  |
|        | Wadrisfoutpan                 | WSP   | 0040   | 1985, 1987     | N. G. Palmer               | 245  |
| 3218AD | Elands Bay (=?=Verlorenvlei)  | EBY   | 0044   | 1987           | N. G. Palmer               | 8    |
|        | Verlorenvlei                  | VLR   | 0063   | 1988           | Unrecorded                | 120  |
|        | Verlorenvlei 2                | VLV   | 0069   | 1989           | D. M. Avery, G. Avery     | 146  |
| 3218BB | Andriesgrund                 | AGA   | 0001   | 1970s          | D. M. Avery, G. Avery     | 729  |
|        | Clanwilliam Dam              | CMD   | 0052   | 1988           | R. K. Brooke               | 76   |
| 3218BC | Schyunskaal                  | SNK   | 0004   | 1973, 1978     | D. M. Avery, G. Avery, J. E. Parkinson | 100 |
| 3218BD | Algeria Road                 | AGR   | 0027   | 1984           | Unrecorded                | 114  |
|        | Olifants River               | ORI   | 0005   | 1975, 1978     | G. Avery                   | 334  |
|        | Renbaan                       | RBN   | 0059   | ~1988          | D. M. Avery, G. Avery     | 100  |
|        | Rondegat                     | RGT   | 0010   | 1977, 1978     | G. Avery, A. B. Smith     | 255  |
| 3218CB | Brakkukil Farm               | BKL   | 0144   | 2000           | G. eSilva                  | 136  |
|        | St Helenafonetin             | SHF   | 0039   | 1985, 1987     | Mr Jordaan                 | 232  |
| 3218CD | Berg River Soutpan Farm      | BR3   | 0085   | 1992           | R. K. Brooke, J. Roff      | 10   |
|        | Berg River Station           | BR2   | 0084   | 1992           | R. K. Brooke, J. Roff      | 49   |
|        | Berg River Viervlei          | BR1   | 0083   | 1992           | R. K. Brooke, J. Roff      | 110  |
| 3219AA | Klipfonteinrand              | KFR   | 0135   | 1970s          | D. M. Aver, G. Avery       | 76   |
| 3219BD | Ouedebaaskraal               | OBK   | 0067   | 1989           | G. P. Lochner              | 212  |
| 3222BC | Karoo NP Zigzag Kloof        | KNP   | 0045   | 1987           | R. A. G. Davies            | 250  |
| 3318AA | Abrahamskaal Hall            | ABK   | 0026   | 1990–4         | D. M. Aver, G. Avery, R. K. Brooke et al. | 2009 |
|        | Abrahamskaal House           | ABH   | 0076   | 1990, 1992     | D. M. Aver, G. Avery, R. K. Brooke et al. | 274 |
|        | Bottelary                    | BTY   | 0050   | 1988–94        | G. Avery, R. K. Brooke, B. van Lente | 2208 |
|        | Geelbek Cottage               | GBK   | 0028   | 1984–8         | D. M. Aver, G. Avery, R. K. Brooke | 2825 |
|        | Geelbek Silo                  | GBS   | 0014   | 1979–81        | D. M. Avery, G. Avery      | 804  |
|        | Saldanha Quarry              | SDQ   | 0046   | 1987           | N. G. Palmer               | 311  |
|        | Smutskaa A                   | SKA   | 0089   | 1992–3         | B. van Lente               | 956  |
|        | Smutskaa B                   | SKB   | 0087   | 1992           | B. van Lente               | 284  |
| 3318AD | Rondeberg Quarry             | RBG   | 0093   | 1995           | Unrecorded                | 7    |
| 3318BB | Matjiesriver Porterville     | MRP   | 0058   | 1988           | R. K. Brooke               | 420  |
|        | Pampoenkraal                 | PPK   | 0068   | 1989           | R. K. Brooke               | 510  |
| 3318CB | Koeberg Power Station        | KBG   | 0095   | 1995–6         | G. Avery, R. K. Brooke     | 328  |
| 3318DA | Philadelphia                 | PDP   | 0092   | 1994           | C. Higgo                   | 6    |
| 3318DC | Contermanskloof Farm         | CMK   | 0077   | 1991           | Unrecorded                | 47   |
|        | Durbanville                  |       |        |                 |                            |      |
|        | Kraaifontein                 | KFN   | 0033   | 1985           | G. V. Hobbs                | 125  |
|        | Parow Caravan Park           | PCP   | 0086   | 1992           | B. van der Welt            | 71   |
| 3318DD | Stellenbosch Airfield        | STB   | 0073   | 1989, 1990     | N. G. Palmer               | 146  |
|        | Vlottenberg                  | VTB   | 0137   | 1989, 1990     | Unrecorded                | 7    |
| 3319CA | Slangrivier                  | SLR   | 0153   | 1989, 1990     | Unrecorded                | 30   |
| 3319DA | Mowers Siding                | MWS   | 0079   | 1991–3         | R. K. Brooke               | 1154 |
|        | Nuy                          | NUY   | 0075   | 1990           | R. K. Brooke               | 72   |
| 3319DD | Vrolijkheid NCS (huis nr 7)  | VNC   | 0065   | 1988–9         | V. Munnik                  | 2059 |
| 3321DA | Calitzdorp                   | CDP   | 0051   | 1988           | D. M. Avery, G. Avery, G. Malan | 89   |
The largest number of any one jaw (left and right mandible or maxilla) constitutes the minimum number of individuals represented. A more detailed discussion of identification methods is given in Avery et al. (2002). The nomenclature of Bronner et al. (2003) has been followed.

Averaged rainfall and temperature data (Weather Bureau 1986) for stations near the collection sites were accumulated to ascertain if there were any correlations between these data and species proportions in samples (squares and individual sites) of 100 or more individuals. Only those species that occurred in at least 75% of the samples were considered. In the case of Geelbek in the West Coast National Park and De Hoop in the De Hoop Nature Reserve, 50 individuals was taken as the minimum seasonal sample size. Climate data were averaged for the same season as the pellet collection period and for the preceding season. On the premise that rainfall during the season of collection and during the preceding season may have differing effects on species composition, both were tested for possible correlation with proportions of various species in the samples.

Maximum overall lengths of cheektooth alveoli in maxillae and mandibles were measured in adult Tatera afra as two possible proxies for individual size to establish whether there was a correlation between size and mean annual precipitation (MAP). Six maxillary and five mandibular samples, all of over 50 individuals, were considered (Table II). Two-sample t tests (Velleman 1988) were conducted using DataDesk 6 to establish whether there was significant difference in the size structure of samples from sites with different MAP.

Samples of Otomys irroratus (Brants) from an abandoned cottage near Geelbek were examined for evidence of changes in population structure. Estimates of age at death were based on the amount of wear on the lower right first molar. Generally, age classes are based

| Square     | Site                | Code | SAM-CT | Collection year | Collector                      | N  |
|------------|---------------------|------|--------|----------------|--------------------------------|----|
| 3322AC     | Boomplas B          | WGR  | 0088   | 1992          | G. Malan                       | 283|
| 3322AC     | Boomplas C          | BPC  | 0008   | 1976–7        | D. M. Avery                     | 426|
| 3322AC     | Nooigedacht         | NGT  | 0011   | 1977, 1979    | D. M. Avery, G. Avery           | 914|
| 3322AC     | Osgat               | OGT  | 0006   | 1976          | D. M. Avery                     | 43 |
| 3322DC     | Glentyre            | GNT  | 0009   | 1976, 1977, 1979 | D. M. Avery, G. Avery           | 1281|
| 3322DD     | Eilandvei           | EDV  | 0047   | 1987          | N. G. Palmer                    | 147|
| 3419AB     | Boontje Kraal Farm  | BKF  | 0143   | 1996          | N. G. Palmer                    | 126|
| 3419BC     | Bakenskop           | BAK  | 0080   | 1992          | Unrecorded                      | 34 |
| 3419CB     | Windheuvel          | WHL  | 0003   | 1970s         | G. Avery                        | 36 |
| 3419CB     | Byneskranskop       | BNP  | 0002   | 1970s         | D. M. Avery, G. Avery, V. A. Scott | 799|
| Die Kelders| DKD                 | 0049 | 1987, 1996, 1997 | G. Avery                      | 336|
| 3419DA     | Groot Hagelkraal    | GHK  | 0055   | 1988          | I. Bell, R. K. Brooke           | 99 |
| 3419DA     | Klein Hagelkraal    | KHK  | 0015   | 1980          | D. M. Avery, G. Avery           | 624|
| 3420AD     | De Hoop NR          | DHP  | 0029   | 1984–93       | A. Scott et al.                 | 1612|
| 3420BC     | Potberg             | PTB  | 0041   | 1986–9        | A. Scott et al.                 | 5085|
| 3420CA     | Armscor             | ACA  | 0066   | 1987–8        | WCNC staff                      | 424|
| 3421AD     | Blombos             | BBS  | 0099   | 1998          | D. M. Avery, G. Avery           | 1028|
| Stillbay   | SBY                 | 0131 | 2000   | Unrecorded    |                                | 56 |
on discrete changes in the pattern of the teeth as wear progresses (e.g. Hanney 1963). In the case of *O. irroratus*, however, the lamellar nature of the teeth precludes the use of this method. The lower first molar was chosen because Perrin (1979) has established that variation in its occlusal length correlates well with eye-lens weight, which is commonly used to estimate age. However, to discount the possible effect of overall tooth length on occlusal length at a given age, as discussed in Avery (1984), the difference between length of wear

Figure 1. Location of the Western Cape Province in South Africa (A) and of Western Cape Province quarter-degree squares yielding *Tyto alba* pellet samples discussed in this paper (B).
surface and maximum length of tooth was calculated as a proportion of the latter. The observed range in this occlusal index has been found to be between 0.50 in very young (neo-natal) animals to zero in old animals (Avery 1984). The age of the old animals is taken to be 24 months, which is the observed maximum longevity in this species (Davis 1973). This occlusal index also has the merit of providing an index that decreases with age, thereby allowing the data to be transformed using Spinage’s (1971) square-root function, $y = y_0(1 - \sqrt{t/n})$ where $y_0$ is the index at age 0, $t$ is the age in months and $n$ is the maximum age (here taken as 24 months). This function was employed to accommodate the fact that occlusal length does not increase at a steady rate throughout life. Ages were estimated to the nearest month and then grouped into 3-month age classes, the first of which represents the pre-reproductives (Davis and Meester 1981). Differences among and between months and seasons, based on occlusal indices, were examined using $F$ and $t$ tests. Only samples for which the month of collection was circumscribed (i.e. where all pellets had been removed the preceding month) were included in these analyses.

**Results**

Samples were collected from 64 sites in 33 quarter-degree squares (Table I; Figure 1). The number of individual micromammals recorded from individual sites varies from six at Philadelphia to 2825 at Geelbek Cottage; by quarter-degree square the range is between six in 3318DA (Philadelphia) and 9945 in 3318AA (West Coast National Park). In all, 56 species are represented, of which the great majority (33) are rodents; the remainder are bats, shrews, golden moles, and elephant-shrews (Table III). The most frequently represented species is the Pygmy mouse, *Mus minutoides* A. Smith, which was recovered from 91% of sites and 97% of squares; the most common species is *Tatera afr* (Gray), which dominated 30% of samples by site and by square (Table IV; Figures 2–6). Between 19 and 28 species were recorded from three provincial nature reserves and the West Coast National Park (Table V). The specific identity of two species [the Cape marsh rat, *Dasymys capensis* (Roberts), and the Southern multimammate mouse, *Mastomys coucha* (A. Smith)] is based on present distribution and therefore queried in Table III because it is not currently possible to separate these species consistently from *D. incomtus* (Sundevall) and *M. natalensis* (A. Smith), respectively, on cranial remains.

*Otomys irratus* was the only one of seven species considered to show any significant overall correlation between percentage representation and climate variables. Correlation tended, however, to depend on two outlying samples where large percentages coincide with high rainfall. When these outliers are removed, the only significant correlation ($r=0.568,$

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Table II. Details of samples (>50 individuals) examined in analysis of size variation in mandibles of *Tatera afr*.  

| Site | Square | Mandibles | Maxillae | MAP | % Win |
|------|--------|-----------|----------|-----|-------|
| SFN  | 3218AB | 56        | 139      |     | 74    |
| SFS  | 3218AB | 109       | 95       | 139 | 74    |
| AGA  | 3218BB | 54        | 65       | 248 | 74    |
| BBS  | 3421AD | 76        | 82       | 464 | 54    |
| KFN  | 3318DC | 67        | 73       | 569 | 74    |
| STB  | 3318DD | 58        | 57       | 629 | 70    |

Mandibles and maxillae, number of mandibles and maxillae measured; MAP, mean annual precipitation. % Win, proportion of rainfall in the winter half year; SFN and SFS, Steenbokfontein North and South; AGA, Andriesgrond; BBS, Blombos; KFN, Kraaifontein; STB, Stellenbosch Airfield.
Table III. Micromammalian taxa represented in *Tyto alba* pellets from the Western Cape Province (list according to Bronner et al. 2003 and Musser and Carleton 1993 for introduced species).

| Family | Genus and species | English common name |
|--------|-------------------|---------------------|
| **Order: AFROSORICIDA**<br>Chrysochloridae Gray, 1825 | Cryptochloris zyli Shortridge and Carter, 1938 | De Winton’s golden mole |
| | Cryptochloris asiatica (Linnaeus, 1758) | Cape golden mole |
| | Eremitalpa granti (Broom, 1907) | Visagie’s golden mole |
| | Chlorotalpa duthiae (Broom, 1907) | Duthie’s golden mole |
| | Chlorotalpa sclateri (Broom, 1907) | Sclater’s golden mole |
| | Amblysomus hottentotus (A. Smith, 1829) | Hottentot golden mole |
| **Order: MACROSCELIDEA**<br>Macroscelididae Bonaparte, 1838 | Macroscelides proboscideus (Shaw, 1800) | Round-eared elephant-shrew |
| | Elephantulus rupestris (A. Smith, 1831) | Western rock elephant-shrew |
| | Elephantulus edwardii (A. Smith, 1839) | Cape rock elephant-shrew |
| **Order: RODENTIA**<br>Bathyergidae Waterhouse, 1841 | Bathyergus suillus (Schreber, 1782) | Cape dune mole-rat |
| | Bathyergus janetta Thomas and Schwann, 1904 | Namaqua dune mole-rat |
| | Cryptomys hottentotus (Lesson, 1826) | African mole-rat |
| | Cryptomys damarensis (Ogilby, 1838) | Damaraland mole-rat |
| | Georychus capensis (Pallas, 1778) | Cape mole-rat |
| | Macroscelides proboscideus (Shaw, 1800) | Round-eared elephant-shrew |
| | Elephantulus rupestris (A. Smith, 1831) | Western rock elephant-shrew |
| | Elephantulus edwardii (A. Smith, 1839) | Cape rock elephant-shrew |
| Myoxidae Gray, 1821 | Graphiurus ocularis (A. Smith, 1829) | Spectacled dormouse |
| | Graphiurus murinus (Desmarest, 1822) | woodland dormouse |
| Muridae Illiger, 1815 | Acomys subspinous (Waterhouse, 1838) | Cape spiny mouse |
| | Rhabdomys pumilio (Sparrmann, 1784) | Four-striped grass mouse |
| | Dasymys capensis (Roberts, 1936) | Cape marsh rat |
| | Grammomys dolichurus (Smuts, 1832) | Woodland thicket rat |
| | Mus minutoides A. Smith, 1834 | Pygmy mouse |
| | Mus musculus Linnaeus, 1758 | House mouse |
| | Mastomys coucha (A. Smith, 1836) | Southern multimammate mouse |
| | Myomyscus verreauxi (A. Smith, 1834) | Verreaux’s mouse |
| | Aethomys namaquensis (A. Smith, 1834) | Namaqua rock mouse |
| | Aethomys chrysophilus (De Winton, 1897) | Red veld rat |
| | Rattus rattus (Linnaeus, 1758) | Ship rat |
| | Parotomys brantsii (A. Smith, 1834) | Brants’s whistling rat |
| | Parotomys littledalei Thomas, 1918 | Littledale’s whistling rat |
| | Otomys laminatus Thomas and Schwann, 1905 | Laminate vlei rat |
| | Otomys saundersiae Roberts, 1929 | Saunders’s vlei rat |
| Family | Genus and species | English common name |
|--------|------------------|---------------------|
| Otomys irroratus (Brants, 1827) | Vlei rat |
| Otomys unisulcatus F. Cuvier, 1829 | Bush vlei rat |
| Desmodillus auricularis (A. Smith, 1834) | Cape short-tailed gerbil |
| Gerbillurus paeba ((A. Smith, 1836) | Hairy-footed gerbil |
| Tatera atra (Gray, 1830) | Cape gerbil |
| Mystromys albicaudatus (A. Smith, 1834) | White-tailed mouse |
| Saccostomus campestris Peters, 1846 | Pouched mouse |
| Malacothrix typica (A. Smith, 1834) | Gerbil mouse |
| Dendromus melanotis A. Smith, 1834 | Grey climbing mouse |
| Dendromus mesomelas (Brants, 1827) | Brants’s climbing mouse |
| Steatomys krebse Peters, 1852 | Krebs’s fat mouse |
| Myosorex varius (Smuts, 1832) | Forest shrew |
| Suncus varilla (Thomas, 1895) | Lesser dwarf shrew |
| Suncus infinitesimus (Heller, 1912) | Least dwarf shrew |
| Crocidura fuscomurina (Heuglin, 1865) | Tiny musk shrew |
| Crocidura flavescens (I. Geoffroy, 1827) | Reddish-grey musk shrew |
| Crocidura cyanea (Duvernoy, 1838) | Greater red musk shrew |
| Tadarida aegyptiaca (E. Geoffroy, 1818) | Egyptian free-tailed bat |
| Miniopterus schreibersi (Kuhl, 1817) | Schreibers's long-fingered bat |
| Neoromicia capensis (A. Smith, 1829) | Cape serotine bat |
| Myotis tricolor (Temminck, 1832) | Temminck’s hairy bat |
| Eptesicus hottentotus (A. Smith, 1833) | Long-tailed serotine bat |
| Nycteris thebaica E. Geoffroy, 1813 | Egyptian slit-faced bat |
| Rhinolophus clivosus Creutzschmar, 1828 | Geoffroy’s horseshoe bat |
| Rhinolophus capensis Lichtenstein, 1823 | Cape horseshoe bat |
Table IV. Number of quarter-degree squares and sites with sample number at least 100 in which each species is represented (total) and is dominant (dom.), with the range of percentage representation of the dominant species (min–max %).

| Genus and species                  | Squares |          |          | Sites |          |          |
|-----------------------------------|---------|----------|----------|-------|----------|----------|
|                                   | Total   | Dom.     | Min–max %| Total | Dom.     | Min–max %|
| Cryptochloris zyli                | 1       | 1        | 19.0     | 33    | 2        | 27.9–36.8|
| Chrysochloris asiatica            | 19      | 32       |          |       |          |          |
| Eremitalpa granti                 | 5       | 14       |          |       |          |          |
| Chlorotalpa duthiae               | 3       | 3        |          |       |          |          |
| Chlorotalpa sclateri              | 3       | 4        |          |       |          |          |
| Amblysomus hottentotus            | 2       | 2        |          |       |          |          |
| Macroscelides proboscideus        | 3       | 4        |          |       |          |          |
| Elephantulus rupestris            | 3       | 4        |          |       |          |          |
| Elephantulus edwardii             | 10      | 12       |          |       |          |          |
| Bathynurges suillus               | 2       | 3        |          |       |          |          |
| Bathynurges janetta               |         | 1        |          |       |          |          |
| Rhabdomys pumilio                 | 30      | 1        | 17.5     | 54    | 1        | 39.6     |
| Dasymys ?capensis                 | 2       | 2        |          |       |          |          |
| Grammomys dolichurus              | 1       | 1        |          |       |          |          |
| Mus minutoides                    | 32      | 4        | 23.8–55.1| 58    | 5        | 23.8–69.5|
| Mus musculus                      | 14      | 18       |          |       |          |          |
| Mastomys ?coucha                   | 5       | 8        |          |       |          |          |
| Myomyscus verreauxi               | 11      | 16       |          |       |          |          |
| Aethomys namaquensis               | 19      | 29       | 17.7     |       |          |          |
| Aethomys chrysophilus             | 1       | 1        |          |       |          |          |
| Rattus rattus                     | 7       | 8        |          |       |          |          |
| Parotomys brantsii                | 1       | 1        |          |       |          |          |
| Parotomys littledalei             | 1       | 1        |          |       |          |          |
| Otomys laminatus                  | 4       | 7        |          |       |          |          |
| Otomys saundersiae                | 20      | 30       |          |       |          |          |
| Otomys irroratus                  | 29      | 4        | 16.6–57.8| 49    | 7        | 15.1–57.8|
| Otomys unisulcatus                | 12      | 2        | 28.1–29.9| 23    | 3        | 26.7–32.8|
| Desmodillus auricularis           | 9       | 1        | 35.4     | 11    | 1        | 53.4     |
| Gerbillurus paeba                 | 16      | 35       |          |       |          |          |
| Tatera afr'a                      | 24      | 9        | 31.5–60.4| 49    | 16       | 20.1–80.9|
| Mystromys albicaudatus            | 3       | 3        |          |       |          |          |
| Saccostomus campestris            | 5       | 8        |          |       |          |          |
| Malacothrix typica                | 4       | 4        |          |       |          |          |
| Dendromus melanotis               | 28      | 48       |          |       |          |          |
| Dendromus mesomelas               | 12      | 23       | 19.5     |       |          |          |
| Steatomys krebsii                 | 17      | 31       |          |       |          |          |
| Myosorex varius                   | 24      | 2        | 17.2–20.3| 46    | 1        | 22.3     |
| Suncus varilla                    | 22      | 3        | 18.9–39.3| 43    | 5        | 18.9–47.0|
| Suncus infinitestimus             | 1       | 1        |          |       |          |          |
| Crocidura fuscomurina             | 1       | 1        |          |       |          |          |
| Crocidura cyanea                  | 21      | 31       |          |       |          |          |
| Crocidura flavescens              | 10      | 12       |          |       |          |          |
| Tadarida aegyptiaca               | 8       | 10       |          |       |          |          |
| Miniopterus schreibersii          | 6       | 6        |          |       |          |          |
| Neoromicia capensis               | 15      | 21       |          |       |          |          |
annual precipitation. Maximum and minimum temperatures appear to have no influence. Combined samples from the neighbouring sites of Geelbek and Bottelary on the banks of the Langebaan Lagoon in the West Coast National Park show a significant negative correlation \((r = -0.630, df = 15, P = 0.01)\) between same-season rainfall and proportions of *Suncus varilla* (Thomas) (Figure 7A). In the same park, a significant positive correlation was found between same-season minimum monthly temperature and proportions of *Steatomys krebsii* Peters \((r = 0.608, df = 16, P = 0.01)\) (Figure 7B) as well as a negative correlation between previous-season minimum monthly temperature and proportions of *S. varilla* \((r = -0.615, df = 17, P = 0.01)\) (Figure 7C).

There is demonstrable variation in mean maxillary alveolar length in *Tatera atra* in samples greater than 50 (Figure 8). Two-sample *t* tests of mean maxillary alveolar measurements indicate that Blombos differs significantly (at the 0.01 level) from each of the other five samples (Table VI). No significant differences were found between the mandibular samples. Nor is there any significant variation between mean length of maxillary alveoli and mean annual rainfall.

Pre-reproductive (age class 1, age 1–3 months) *Otomys irroratus* were found to constitute a much higher proportion of the summer sample than of samples for other seasons, especially winter (Figure 9). This pattern is also observable for individual months, with December containing the greatest number of pre-reproductives and July the smallest number (Figure 9). However, apparent neonates (month 1, third molar not fully erupted) were recovered in February, April, July, November, and December. The *t* tests show significant differences at the 0.01 level between December and each of the months of May to September and there is also a significant difference between summer and winter, and between autumn and winter (Table VII). During the period May to September age classes 3 and 4 are better represented than they are at other times of the year while second-year animals (classes 5–8) are not well represented at any time of the year. When estimated ages were translated into month of birth the proportions of individuals estimated to have been born in a given month varied between 4.3% in June and 11.3% in September (Figure 10).

**Discussion**

**Geographic distribution**

While there are recent publications that include the generalized distribution of micromammalian species in the Western Cape Province (e.g. Mills and Hes 1997), the lack of up-to-date detailed maps makes it difficult to establish the extent to which the
present data add to what was previously known. However, Stuart and Lloyd’s (1978) preliminary maps suggest that the general pattern of distribution of some species has been reasonably well known for some time. Judging by the number of squares in which they have been recorded, species such as *Tatera afra* and *Rhabdomys pumilio* appear to be much commoner than other species. It is quite possible, however, that this commonness is at least partly a function of visibility, perceived nuisance value and/or trapability. Thus, *R. pumilio*
is mainly diurnal, unlike most southern African micromammals, so that it is frequently seen; it is also readily identifiable because of the stripes along its back. *Tatera afra*, on the other hand, is regarded as a pest by farmers and gardeners so, pro rata, its presence will be very well reported. Its burrow entrances are also clearly visible since they tend to occur in groups in open ground.

In some other cases the present data may confirm previously suggested ranges, extend ranges or help fill apparent gaps in distribution. For instance, although there were few

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Figure 3. Distribution of Murinae whose remains have been found in *Tyto alba* pellets from 10 or more Western Cape Province quarter-degree squares. White circles indicate dominance in squares yielding remains of at least 100 individuals.
data points, *Suncus varilla* (Meester and Lambrechts 1971; Stuart and Lloyd 1978, listed as *S. etruscus*) appeared to have a fairly wide distribution in the Western Cape, which is confirmed by the present data (Figure 5D). In other species, such as *Otomys laminatus* Thomas and Schwann, which was previously only recorded from one square (3319CC: Davis 1974; Stuart and Lloyd 1978; De Graaff 1981), even the modest addition of four further squares is of consequence. *Steatomys krebsii* was shown by Stuart and Lloyd (1978) to be present in two squares in the extreme south-west whereas present data

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**Figure 4.** Distribution of Otomyinae (A–C) and Dendromurinae (D–F) whose remains have been found in *Tyto alba* pellets from 10 or more Western Cape Province quarter-degree squares. White circles indicate dominance in squares yielding remains of at least 100 individuals.
Another interesting case is that of *Mastomys* spp. The species in the Western Cape is probably *M. coucha* (Friedmann and Daly 2004; Venturi et al. 2004) although it is not currently possible to confirm this with cranial evidence alone. According to Stuart and Lloyd (1978) the species they called *Praomys natalensis* occurred no further west than 3423AB. Neither do De Graaff’s (1997) generalized maps show either species of *Mastomys*.
as occurring in the Western Cape. However, Van Niekerk (2001) has recorded its presence in the De Hoop Nature Reserve (3420AD). Present data confirm that the species has reached as far west along the coast as 3420CA (Armscor); it is also present in the Oudthoorn area, in the Cango Valley and near Calitzdorp. Either *Mastomys* sp. was previously overlooked or it is extending its range south-westwards. The latter is the more likely alternative, given its semi-commensal habit and its propensity for taking advantage of disturbance such as that created by the clearing of vegetation for farming (Meester et al. 1979). This also accords with the situation in the Free State Province where high numbers of *M. coucha* in the Willem Pretorius Nature Reserve and Korannaberg Conservancy have recently been taken to indicate habitat disturbance (Avenant 2000, 2003).

**Climate influences**

Although overall the only significant correlation with climate is that between *Otomys irroratus* and rainfall during the spring quarter, there is some indication that dominance in a sample may coincide broadly with mean annual rainfall and/or percentage rainfall during the winter half year (Table VIII). *Tatera afra*, which is the dominant prey species in nine squares (Figure 7), is apparently affected by rainfall seasonality rather than by amount. Its restriction to near-coastal sites in the south and west of the province where winter rainfall is at least 59% accords with the fact that *T. afra* is endemic to the Western Cape, which is predominantly a winter-rainfall region. Conversely, *Otomys irroratus* and *Suncus varilla*, which have much wider distributions, dominate where rainfall is approximately 230–470 mm, no more than about 65% of which falls in winter. This reflects the fact that these
two species dominate samples from the east and south of the province. *Mus minutoides* flourishes under a similar but more seasonal (65–74% winter) rainfall regime in the Western Cape.

Logically, one might expect that if there were any significant correlation between numbers or proportional representation of individual species and climate variables it would be with conditions that occurred at some time before the period being sampled. Thus, for example, if there were particularly large numbers of species A in a sample collected during the spring quarter, the high number should reflect the influence of prevailing climatic

| Genus and species          | DHNR | KNP | VNR | WCNP |
|---------------------------|------|-----|-----|------|
| Cryptochloris zyli        |      | x   |     |      |
| Eremitalpa granti         |      |     |     |      |
| Chlorotalpa sclateri      |      | x   |     |      |
| Macrocelides proboscideus |      |     |     |      |
| Elephantulus rupestris    | x    |     |     |      |
| Elephantulus edwardii     | x    |     |     |      |
| Cryptomys hottentotus     | x    | x   |     |      |
| Georychus capensis        | x    |     | x   |      |
| Acomys subspinosus        | x    |     |     |      |
| Rhabdomys pumilio         | x    | x   | x   | x    |
| Mus minutoides            | x    |     | x   | x    |
| Mus musculus              | x    |     |     |      |
| Mastomys fusciceps        | x    |     |     |      |
| Myomyscus verreauxi      | x    |     | x   | x    |
| Aethomys namaquensis      |      |     |     |      |
| Aethomys chrysophilus     | x    |     |     |      |
| Rattus rattus             |      |     |     |      |
| Otomys saundersiae        |      |     | x   | x    |
| Otomys ironatus           |      |     |     |      |
| Otomys unisulcatus        |      |     |     |      |
| Desmodillus auricularis   |      |     |     |      |
| Gerbillurus paeba         |      | x   |     | x    |
| Tatera afra               | x    |     |     |      |
| Saccostomus campestris    |      | x   |     |      |
| Malacothrix typica        |      | x   |     |      |
| Dendromus melanotis       |      |     | x   | x    |
| Dendromus mesomelas       |      |     | x   | x    |
| Steatonyx krebii          |      | x   |     |      |
| Myosorex varius           |      |     |     |      |
| Suncus varilla            |      | x   |     | x    |
| Crocidura fuscomurina     |      |     |     |      |
| Crocidura cyanea          |      | x   |     | x    |
| Tadarida aegyptiaca       |      |     |     |      |
| Miniopterus schreibersii  |      |     |     |      |
| Neoromicia capensis       |      | x   |     | x    |
| Myotis tricolor           |      | x   |     |      |
| Eptesicus hottentotus     |      |     | x   |      |
| Nycteris thebatica        |      |     | x   |      |
| Rhinolophus chivosus      |      |     | x   |      |
| Rhinolophus capensis      |      |     | x   |      |
Figure 7. Significant correlation of seasonal variation in percentage representation of *Suncus varilla* and *Steatomys krebsii* and climate variables in the De Hoop Nature Reserve (Geelbek and Bottelary). (A) Same-season rainfall and proportions of *S. varilla*; (B) same-season minimum monthly temperature and *S. krebsii*; (C) previous-season minimum monthly temperature and *S. varilla*. See text for further details.

Figure 8. Variation in (A) maxillary and (B) mandibular alveolar length in *Tatera afra* from selected sites with mean annual precipitation increasing from left to right. SFN and SFS, Steenbokfontein North and South (139 mm); AGA, Andriesgrond (248 mm); BBS, Blombos (464 mm); KFN, Kraaifontein (569 mm); STB, Stellenbosch Airfield (629 mm).

Table VI. Differences, significant at the 0.01 level, between sample means of maxillary alveolar length based on two-sample *t* tests for samples greater than 50.

| Samples     | *t*     | df | *P*   |
|-------------|---------|----|-------|
| BBS–AGA     | −2.657  | 138| 0.0088|
| BBS–KFN     | −4.917  | 116| ≤0.0001|
| BBS–SFN     | −4.26   | 172| ≤0.0001|
| BBS–SFS     | −2.657  | 100| 0.0092 |
| BBS–STB     | −3.107  | 143| 0.0023 |

BBS, Blombos; AGA, Andriesgrond; KFN, Kraaifontein; SFN and SFS, Steenbokfontein North and South; STB, Stellenbosch Airfield.
conditions during the preceding winter quarter when breeding took place. This does not appear to be the case in the Western Cape except in one instance where percentage representation of *Suncus varilla* shows a significant negative correlation with average...
minimum monthly temperature of the quarter preceding that in which the sample was collected. Correlation with climate conditions during the season when the sample was collected must have one or more other causes. Possibilities include improved survivorship of prey individuals, deleterious impact on other possible prey species and effect of vegetation cover on predator behaviour.

It has previously been suggested that Tatera afra may conform to Bergmann’s Rule on the basis of variation in the length of mandibular alveoli of this species in several archaeological sites although it was noted at the time that the evidence from the maxillary alveoli did not agree with that from the mandibular alveoli (Avery 1982). The present data confirm that variation in maxillary alveolar length in adults is not consistent with that in mandibular alveolar length (Figure 9). Neither does variation in the mean of the two measurements correlate significantly. Moreover, the lack of any significant difference between mean maxillary alveolar length and rainfall suggests that observed variation is probably due to other factors. The influence of rainfall on reproduction, and hence on mean individual size, is not a factor since only the jaws of adult individuals were included in the calculations. One possibility, however, is that the small mean size of the BBS material reflects the location of this site in square 3421AD, which is near the eastern extremity of the recorded range of the species. This location is characterized by 54% winter rainfall (Table II), which is below the minimum in squares where T. afra is dominant (Table VIII; Figure 7). Towards the northern extreme of its range T. afra also tends towards smaller mandibles than is the case in the centre of its distribution (Figure 9). However, T. afra dominates several of the northern squares, where rainfall is low but seasonality high, leading to the conclusion that rainfall seasonality is more important to this species than is mean annual precipitation; certainly it breeds after the winter rains (Perrin 1997) when the danger of burrow flooding is past and food is more abundant.

In the case of Otomys irroratus from Geelbek, although there are young individuals throughout the year, their proportional representation varies seasonally. This variation does not appear to be directly connected with rainfall although there is some indication that
breeding is offset by a month or more from rainfall. According to the present evidence births peak in spring and early summer, two months after highest rainfall (Figure 10). One possibility for the delay is that the area needs time to drain after the rains before vegetation can re-grow. Conversely, the low proportion of births in June at Geelbek could reflect low rainfall in late summer. It is probably less likely that night-time temperatures are sufficiently low to influence breeding as they do in the Van Riebeeck Nature Reserve, near Pretoria, where frost is a factor (Davis 1973) since temperature varies much less in the West Coast National Park than it does at Pretoria. Moreover, the trough in *O. irroratus* breeding occurs a month before the lowest mean minimum temperature, possibly due to the fact that vegetation re-growth has not yet occurred. In the Andries Vosloo Kudu Reserve near Grahamstown breeding was repressed during mid-summer (Perrin 1980), which appears to suggest a negative correlation with rainfall although breeding was not thought to be markedly influenced by rainfall (Bronner et al. 1988).

**Predator behaviour**

As has been previously noted (Avery et al. 2003), *Tyto alba* is a selective opportunist; its preferred prey varies from location to location, depending on which species is most easily obtainable due to large numbers or accessibility. Selective opportunism is potentially reflected in variation in aspects of prey composition such as number, identity, mean mass and habitat of prey species as well as their proportional representation in the sample.

In the Western Cape there is considerable variation in the structure of samples comprising more than 100 individuals per quarter-degree square (Table IX) and per individual site. Shannon indices of general diversity range between 1.39 and 2.58. The lowest values are generally caused by heavy concentration on *Tatera afra*, which comprise up to 60% of a sample, although the number of species per square also varies considerably, ranging from 8 to 28. The number of species recorded from Steenbokfontein (3218AB) is higher than expected of such a low rainfall region (139 mm) but this may be due to the existence nearby of a small inter-dune dam. Certainly, the expected dominance of one species results in a low value for the general diversity index (Table IX). This pattern of one very well-represented species, in this case *T. afra*, and low numbers of all other species is to be expected in the unpredictable climate of the north-west coast. It would appear therefore that the owls were hunting opportunistically, optimizing the micromammalian food supply in terms both of available species richness and of individual abundance. Another picture emerges at the eastern end of the West Cape coast. Here, though there is high, year-round rainfall, diversity is also relatively low despite quite high numbers of species. In this case the dominant species is *Otomys irroratus*, whose high proportions (53% and 58% for adjoining squares 3322DC and 3322DD near Wilderness) are not what one would expect in the equable climate of the area. There are, however, extensive reed-beds round a series of lakes, which are likely to be favoured hunting grounds for the owls. In this case, therefore, it is not clear whether the owls were selectively hunting *O. irroratus* or whether it really was extremely well represented in the landscape. The former possibility is supported by the fact that even adult *O. irroratus* appear to be a favoured prey of *Tyto alba* in many parts of the Western Cape Province in spite of their surprisingly large size (up to about 120 g) relative to that of the birds (about 340 g) (Table IV) and of the fact that they are predominantly diurnal (Kerley 1997).

It has previously been noted that there is frequent co-occurrence of various prey species in *T. alba* pellets from the West Coast National Park (Avery 1992). At the time this was
taken as evidence that the species concerned inhabited the same or nearby microhabitats. It could, however, equally imply that during the course of hunting a particular habitat the owls will tend to catch whatever suitable prey they see so that, in that sense, they will be acting opportunistically. When the data from four sites were examined, it became clear that there was no generally consistent pattern of co-occurrence among the 10 best represented species, with the possible exception of *Dendromus mesomelas* (Brants), which was found more frequently with *Myosorex varius* (Smuts) than with any other species in the three out of four sites (Table X). Conversely, one small species co-occurred most frequently with five or more of the other best represented species in each of the four samples. Almost certainly this partly reflects the fact that the small species are more likely to be found with other species in a single pellet than are the larger species. However, the commonly co-occurring species are neither the only nor necessarily the best represented small species in the samples. It seems likely that closer inspection of the patterns of co-occurrence will provide some insight into owl hunting behaviour to augment other lines of evidence. For instance, at Vrolijkheid Nature Reserve, at a roost near the reserve headquarters, *Mus minutoides* far outnumbers other species (30% of the top 10 species and 43% co-occurrence with at least

| Square | $N$  | $s$  | $H$  | $g$  | Major prey species          | %   | MAP | % Win |
|--------|------|------|------|------|----------------------------|-----|-----|-------|
| 3218AB | 1139 | 28   | 1.87 | 73   | *Tatera afra*              | 53.7| 139 | 74    |
| 3218AD | 302  | 24   | 2.20 | 71   | *Tatera afra*              | 41.1| 220 | 75    |
| 3218BB | 627  | 20   | 1.93 | 43   | *Mus minutoides*           | 42.1| 248 | 74    |
| 3218BC | 100  | 12   | 1.58 | 74   | *Tatera afra*              | 55.0| 265 | 76    |
| 3218BD | 802  | 25   | 2.50 | 66   | *Cryptomys hottentotus*    | 19.0| 248 | 74    |
| 3218CB | 368  | 14   | 1.71 | 55   | *Tatera afra*              | 38.0| 228 | 78    |
| 3218CD | 169  | 14   | 1.53 | 72   | *Tatera afra*              | 60.4| 270 | 70    |
| 3219BD | 212  | 8    | 1.77 | 31   | *Desmodillus auricularis*  | 35.4| 79  | 65    |
| 3222BC | 250  | 19   | 2.43 | 65   | *Otomys irroratus*         | 22.4| 230 | 35    |
| 3318AA | 9534 | 21   | 2.35 | 55   | *Myosorex varius*          | 17.2| 277 | 75    |
| 3318BB | 930  | 13   | 1.55 | 23   | *Mus minutoides*           | 55.1| 496 | 73    |
| 3318CB | 328  | 12   | 2.10 | 81   | *Otomys unisulcatus*       | 29.3| 455 | 74    |
| 3318DC | 243  | 16   | 1.94 | 67   | *Tatera afra*              | 45.3| 569 | 74    |
| 3318DD | 242  | 11   | 1.39 | 77   | *Tatera afra*              | 43.4| 629 | 70    |
| 3319DA | 1237 | 18   | 2.34 | 71   | *Otomys unisulcatus*       | 28.1| 239 | 69    |
| 3319DD | 2059 | 22   | 2.43 | 50   | *Mus minutoides*           | 27.7| 252 | 65    |
| 3321DA | 339  | 18   | 2.05 | 42   | *Suncus varilla*           | 39.5| 227 | 44    |
| 3322AC | 1897 | 27   | 2.42 | 51   | *Myosorex varius*          | 20.3| 473 | 50    |
| 3322DC | 1263 | 24   | 1.91 | 78   | *Otomys irroratus*         | 52.7| 718 | 48    |
| 3322DD | 147  | 17   | 1.70 | 87   | *Otomys irroratus*         | 57.8| 718 | 48    |
| 3419AB | 126  | 12   | 2.02 | 29   | *Mus minutoides*           | 23.8| 420 | 66    |
| 3419CB | 1092 | 25   | 2.58 | 52   | *Rhabdomys pumilio*        | 17.5| 469 | 65    |
| 3419DA | 723  | 22   | 2.54 | 44   | *Otomys irroratus*         | 16.6| 469 | 65    |
| 3420AD | 1607 | 20   | 2.11 | 67   | *Tatera afra*              | 31.5| 427 | 59    |
| 3420BC | 4858 | 27   | 2.39 | 34   | *Suncus varilla*           | 18.9| 427 | 59    |
| 3420CA | 424  | 19   | 2.22 | 62   | *Tatera afra*              | 36.6| 480 | 66    |
| 3421AD | 1084 | 14   | 2.03 | 37   | *Suncus varilla*           | 29.3| 464 | 54    |
| Maximum| 9534 | 28   | 2.58 | 87   |                            | 60.4|     |       |
| Minimum| 100  | 8    | 1.39 | 23   |                            | 16.6|     |       |

$N$, number of individuals; $s$, number of species; $H$, Shannon index of diversity; $g$, grams (mean mass); %, percentage representation of major prey item; MAP, mean annual precipitation; % Win, percentage precipitation in the winter half year.
one of these species). In this case it may be supposed that the owls were concentrating on *M. minutoides* that lived around the buildings, only catching other species opportunistically. At Geelbek, on the other hand, it is most likely that the owls concentrated on hunting the edge of Langebaan lagoon where they could most easily locate the relatively large *Otomys irroratus* among the dense reed beds and thick grass. In this case the quite high numbers of *M. varius* and *D. mesomelas* would be a by-product of such a hunting strategy.

**Conclusion**

The Western Cape samples provide further evidence of the potential of *Tyto alba* pellets to provide information on both prey species and predator. Although it is difficult to be certain because of the dearth of prior information, it appears that the known ranges of several micromammalian species have been extended or, at least, confirmed. Beyond this basic information on small mammal distribution and biodiversity, various data indicate that rainfall, whether overall amount or seasonality, influences the proportional representation of some species. Seasonality rather than annual amount seems to affect mean individual size in *Tatera afra*. Likewise, high winter rainfall may encourage greater (or more successful) breeding activity in *Otomys irroratus*. On the other hand, the identity of prey species and their proportional representation in samples can provide some indication of the owls’ hunting methods. Another source of similar information is the contents of individual pellets, which support the contention that *Tyto alba* varies its hunting strategy from locality

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Table X. Principal co-occurrence among 10 best represented species at four sites in different parts of the province.

| Species                        | Geelbek Cottage | Klein Hagelkraal | Nooitgedacht | Vrolijkheid NR |
|--------------------------------|----------------|------------------|--------------|---------------|
| *Acomys subspinosus*           |                |                  |              |               |
| *Rhabdomys pumilio*            | *Myosorex varius* | *Otomys irroratus* and *Suncus varilla* | Myosorex varius |
| *Mus minutoides*               | *Suncus varilla* | *Mastomys coucha* | *Mus minutoides* | *Dendromus melanotis* |
| *Mastomys coucha*              |                |                  |              |               |
| *Myomyscus verreauxi*          | *Suncus varilla* | *Myosorex varius* | *Myosorex varius* | *Mus minutoides* |
| *Aethomys namaquensis*         |                |                  |              |               |
| *Otomys laminiatus*            |                |                  |              |               |
| *Otomys saundersiae*           | *Steatomys krebsii* | *Myosorex varius* | *Myosorex varius* | *Mus minutoides* |
| *Otomys irroratus*             | *Myosorex varius* | *Suncus varilla* | *Myosorex varius* | *Mus minutoides* |
| *Gerbillus paeba*              | *Otomys saundersiae* | *Myosorex varius* | *Myosorex varius* | *Mus minutoides* |
| *Tatera afra*                  | *Myosorex varius* | *Myosorex varius* | *Myosorex varius* | *Mus minutoides* |
| *Dendromus melanotis*          | *Suncus varilla* | *Myosorex varius* | *Suncus varilla* | *Mus minutoides* |
| *Dendromus mesomelas*          | *Myosorex varius* | *Myosorex varius* | *Myosorex varius* | *Mus minutoides* |
| *Steatomys krebsii*            | *Otomys saundersiae* | *Myosorex varius* | *Myosorex varius* | *Mus minutoides* |
| *Myosorex varius*              | *Dendromus mesomelas* | *Suncus varilla* | *Otomys irroratus* | *Mus minutoides* |
| *Suncus varilla*               | *Steatomys krebsii* | *Myosorex varius* | *Aethomys namaquensis* | *Mus minutoides* |
| *Crocidura cyanea*             | *Myosorex varius* | *Suncus varilla* | *Myosorex varius* | *Mus minutoides* |
| Most frequently occurring species | *Crocidura cyanea* | *Myosorex varius* | *Aethomys namaquensis* | *Mus minutoides* |
| Dom. sp.                       | *Dendromus mesomelas* | *Myosorex varius* | *Aethomys namaquensis* | *Mus minutoides* |
| % Dom. sp.                     | 20.7           | 22.3             | 22.3         | 26.5          |
| Sample size                    | 2950           | 624              | 914          | 2059          |

Each sample has a dominant species (Dom sp.) representing approximately one-fifth to one-quarter of the sample (% Dom sp.). The sample size is the number of micromammalian prey individuals in each sample.
to locality. Although some conclusions may be tentative at this stage it should become possible, as more samples are studied, to confirm or modify conclusions reached so far.

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