The Effects of Fire Regime on Small Mammals in S.W. Cape Montane Fynbos (Cape Macchia[1]

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Abstract: Small mammal species richness, abundance and biomass were determined in representative S.W. Cape montane fynbos habitats of various post-fire ages, and in riverine and rocky outcrop habitats respectively too wet and too poorly vegetated to burn. In fynbos the parameters measured displayed bimodal distributions, with early (2,4 years) and late (38 years) peaks and intervening troughs (10-14 years). Correlations with plant succession are discussed. In comparison with other ecotypes, recolonisation of burns by small mammals occurs more slowly in fynbos. Species richness, abundance and biomass of small mammals was consistently higher in riverine habitats than on rocky outcrops. The former may serve as major sources of recolonisation after fire.

There is no published information on the effects of fire on small mammals in fynbos although ecosystem dynamics cannot be fully understood without knowledge of these effects. Three studies have been undertaken (Toes 1972; Lewis In prep; Bigalke and Repier, Unpubl.),and Bond and others (1980) commented on potential fire effects in the Southern Cape mountains. The present pilot study took place in S.W. Cape montane fynbos preparatory to intensive investigation of the effects of fire regime on non-fossorial small mammals. The project has been temporarily suspended, and preliminary conclusions are presented here.

METHODS

Trapping was undertaken from August to November 1979 at selected sites in three Department of Forestry mountain catchment reserves, Jonkershoek (33°59'S, 18°59'E; ± 400m), Wemmershoek (33°48'S, 19°02'E; ± 8OOm) and Lebanon (34°09'S, 19°09'E; ± 900m). 34 sites were trapped, 22 in representative fynbos and 6 each in riverine habitats and rocky outcrops. The riverine and rocky outcrop habitats appeared respectively too wet and too poorly vegetated to burn; they were sampled to ascertain their potential as refuge habitats after fire (Vesey-Fitzgerald 1966), when the surrounding vegetation had been destroyed. The fynbos study areas were selected on the basis of' the post-fire age of the vegetation (2, 4, 10, 14 and 38 years old). The effects of variables other than post-fire age were largely neutralised by sampling a number of sites in each area which were analogous to sites in other areas. In this way area effects resulting from differences in aspect, slope, rockiness and proximity to surface water were more or less eliminated. Unavoidable variation occurred in season, altitude and vegetation floristics and physiognomy. In the 2-14—year-old areas, trapping sites included vegetation dominated respectively by Proteacea, Ericacea and Restionacea, but this was impossible in the 38-year-old area where *Protea repens* and *Widdringtonia nodiflora* were dominant, although the proteas were dying out, leaving much dead wood on the ground and permitting recolonisation by ericas and restios. The most important feature of these habitats in relation to the study objectives was that while the young (2-and 4-year-old) and old (38-year-old) vegetation could be regarded as productive (i.e. actively growing, the latter due to recolonisation by ericas and restios), the 10-and 14-year-old vegetation was clearly moribund, and floristic and physiognomic diversity was consistently lower than in either the young or senescent habitats. In an attempt to obtain an overview of small mammal preferences for these habitats, data are combined where areas of the same general type (i.e. riverine or rocky outcrop habitats, or ones of the same post-fire age) were sampled in different catchments.

A summary of sampling effort in each type of habitat is given in Table 1. In the fynbos and mesic refuge habitats, trapping took place on transect lines of variable length (10-20 stations, depending on local conditions), with 15m between stations. Trapping on rocky outcrops was more or less *ad libitum*, with traps set at places where they seemed most likely to make a catch. 2 live-traps were used at every station, 1 Sherman 230 x 80 x 90 mm and 1 PVC tunnel trap 250 x 65 x 78 mm (after Willan 1979). Traps were set within 1m of station markers abutting small mammal runways if present, and checked morning and evening for a total of 4 days and nights. Bait was a mixture of rolled oats, raisins and sunflower oil; pre-baiting was not employed. Animals were released at the point of capture after species and mass

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Table 1--Sampling effort (station-nights) in various S.W. Cape fynbos habitats. The number of sites sampled within each area is given in brackets.

Study areas	Month sampled	Montane fynbos - age in years					Mesic refuges	Rocky outcrops	Totals
		2	4	10	14	38			
Wemmershoek	August	130 (2)			180 (3)		180 (3)	200(4)	690 (12)
Lebanon	September			300 (6)			40 (1)	100(2)	440 (9)
Jonkershoek	November	80 (2)	430 (6)			180 (3)	100 (2)		790 (13)
Totals		210 (4)	430 (6)	300 (6)	180 (3)	180 (3)	320 (6)	300(6)	1920 (34)

had been recorded and to avoid interfering with proposed trap-mark-release studies, they were marked only by clipping the fur. Results are interpreted as indices of relative abundance, expressed as trap-success/station-night of effort, where "station-night" described trapping for a 24-hour period with two traps/station. Data of this type may be expressed in terms of "trap-success" (e.g. Meester and others 1979; Mentis and Rowe-Rowe 1979), but in the present report this would have been misleading since it was uncommon (less than 3 percent of captures) for more than one animal to be trapped at the same station at the same time. Relative biomass was calculated as total biomass divided by sampling effort, hence as g/station-night.

Otomys spp. are difficult to distinguish in the field, and while J. Meester (pers. comm.) identified as O. irroratus all specimens in a small voucher series from the 3 catchments, O. laminatus and O. saundersae also occur in fynbos (Davis 1974), with O. saundersae previously recorded from Jonkershoek (Stewart 1972). The possible irroratus/laminatus/saundersae complex present in the sample is referred to as Otomys throughout, although the great majority were probably O. irroratus. This approach appears reasonable in view of the similarity in habits of Otomys spp. (Roberts 1951; Kingdon 1974).

RESULTS

A total of 460 rodents and insectivores, representing 12 taxa, were captured during the study (table 2), 83 percent of which were Aethomys namaquensis, Otomys spp., Rhabdomys pumilio and Mysorex varius.

Species richness (fig. 1) was highest in the riverine habitats, where all but one species (Elephantulus edwardii) were present, and lowest on rocky outcrops and in 14-year-old fynbos. In the fynbos habitats it was variable, with early (4-year) and late (38-year) peaks, and an intervening (10-and 14-year) trough.

Relative abundance (fig. 2) was highest in the riverine habitats, and lowest on rocky outcrops. In the fynbos habitats, relative abundance displayed early and late peaks, with an intervening trough, but within the overall bi-modality considerable species-specific variation existed. The most important characteristics of the distribution illustrated in figure 2 are as follows:

1--Abundance of Aethomys namaquensis, Mus minutoides and Dendromus melanotis declined with increasing age of the vegetation, and D. mesomelas replaced D. melanotis as the vegetation became more rank.

2--Otomys spp. were initially (2 years) poorly represented, but thereafter maintained an important presence.

3--Rhabdomys pumilio was most abundant in young (2-and 4-year-old) and old fynbos, but declined in middle age; ad libitum trapping in an area of younger fynbos (specific age unknown) adjoining the 10 year-old habitat showed this species to be present at Lebanon.

4--Acomys subspinosus was generally poorly represented, and was absent from 2 and 14 year-old habitats.

5--Insectivores were absent from 2 year-old fynbos; small numbers of Crocidura cyanea and C. flavescens were present only in the 4 year-old habitat, but Myosorex varius showed an almost linear increase with increasing age of the vegetation (r = 0.985; P< .01).

6--Praomys verreauxi and Elephantulus edwardii were respectively restricted to riverine and rocky outcrop habitats. P. verreauxi is, however, not generally restricted to riverine habitats, occurring on scrubby hill-slopes or forest margins in the Knysna area (Davis 1974), and on well-vegetated slopes in the Southern Cape mountains (Bond and others 1980).

7--The riverine small mammal communities were dominated by Otomys spp. and R. pumilio, and rocky outcrops by Aethomys nanaquensis.

Relative biomass (fig. 3) was bi-modally distributed in the fynbos habitats, with peaks at 4 and 38 years. The high incidence of Otomys spp.

Table 2--Numbers of small mammals trapped in various S.W. Cape fynbos habitats.

Species	Montane fynbos - age in years					Mesic	Rocky	
	2	4	10	14	38	refuges	outcrops	Totals
Rodents:								
<u>Acomys</u> <u>subspinosus</u>		12	5		2	7		26
<u>Aethomys</u> <u>namaquesis</u>	23	4	2			11	14	54
<u>Dendromus</u> <u>melanotis</u>	6					1		7
<u>Dendromus</u> <u>mesomelas</u>			8		3	3		14
<u>Mus</u> <u>minutoides</u>	9					4	1	14
<u>Otomys</u> spp.	1	62	22	15	15	32		147
<u>Praomys</u> <u>verreauxi</u>						6		6
<u>Rhabdomys</u> <u>pumilio</u>	18	36			15	38		110
Insectivores:								
<u>Crocidura</u> <u>cyanea</u>		1				3		4
<u>Crocidura</u> <u>flavescens</u>		1				3		4
<u>Elephantulus</u> <u>edwardii</u>							2	2
<u>Myosorex</u> <u>varius</u>		3	16	12	27	14		72
Totals	54	119	53	30	62	122	17	460

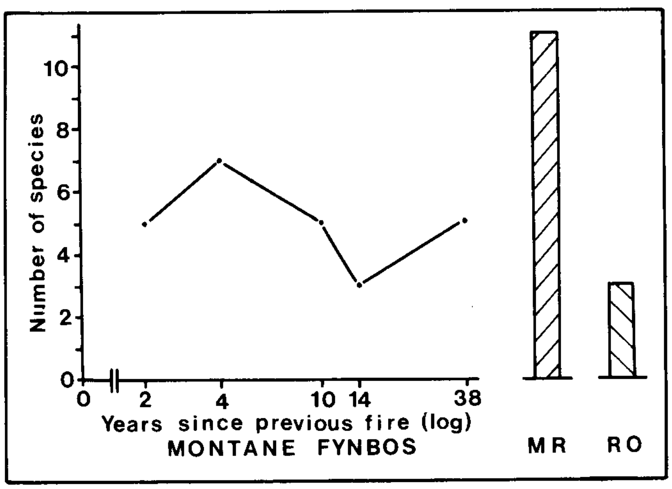

Figure 1--Species richness of small mammals in various S.W. Cape fynbos habitats. MR = mesic refuges; RO = rocky outcrops.

($\overline{X}$ = 99g) in 4-year-old fynbos (52 percent of total captures) and the reduced importance of this taxon at 28 years (24 percent), together $\overline{X}$ with high 38-year numbers of <u>M</u>. <u>varius</u> (44 percent; X = 12g), largely explains the shift of the higher peak from 38 years (abundance; fig. 2) to 4 years (biomass; fig. 3). Relative biomass in the mesic habitats was identical to that in 4-year-old fynbos (19.0g/station-night), while rocky outcrops (2.5g/station-night) supported only 27 percent of the biomass of the next lowest habitat (10-year-old fynbos; 9.1g/station-night).

DISCUSSION

<u>Successional Trends</u>

The available data demonstrate the existence of bimodal distributions of small mammal species richness, abundance and biomass in respect of post-fire age of montane fynbos, with early and late peaks, and intervening troughs. The <u>de</u> <u>facto</u> existence of a decline in middle-aged fynbos is supported by the fact that Toes (1972) recorded only 3 small mammal species in a 14 year-old <u>Protea</u> <u>repens</u> stand at Jonkershoek, and Lewis (in prep.) found only 1 species to be present at the same site when the vegetation was 17 years old. It is significant that small carnivores, as evidenced by tracks and scats observed during the present field work, and by interference with traps, were only active in 4-and 38-year-old fynbos, and in riverine habitats, where small mammals were most abundant.

A similar bimodality has previously been described in humid montane grassland (Natal Drakensberg; Mentis and Rowe-Rowe 1979). These authors proposed that the reason for the bimodality they observed is that different species (including small mammals, antelope and francolin) are adapted either to frequently burned (fire accessible) or infrequently burned (fire inaccessible) habitats, but not to moribund habitats of intermediate post-fire age. It seems more economical to argue that some species are preadapted to recently burnt environments, exploit the resources available there and decline in the later seral stages. The second peak results from the presence of core species and those confined to old unburnt habitats.

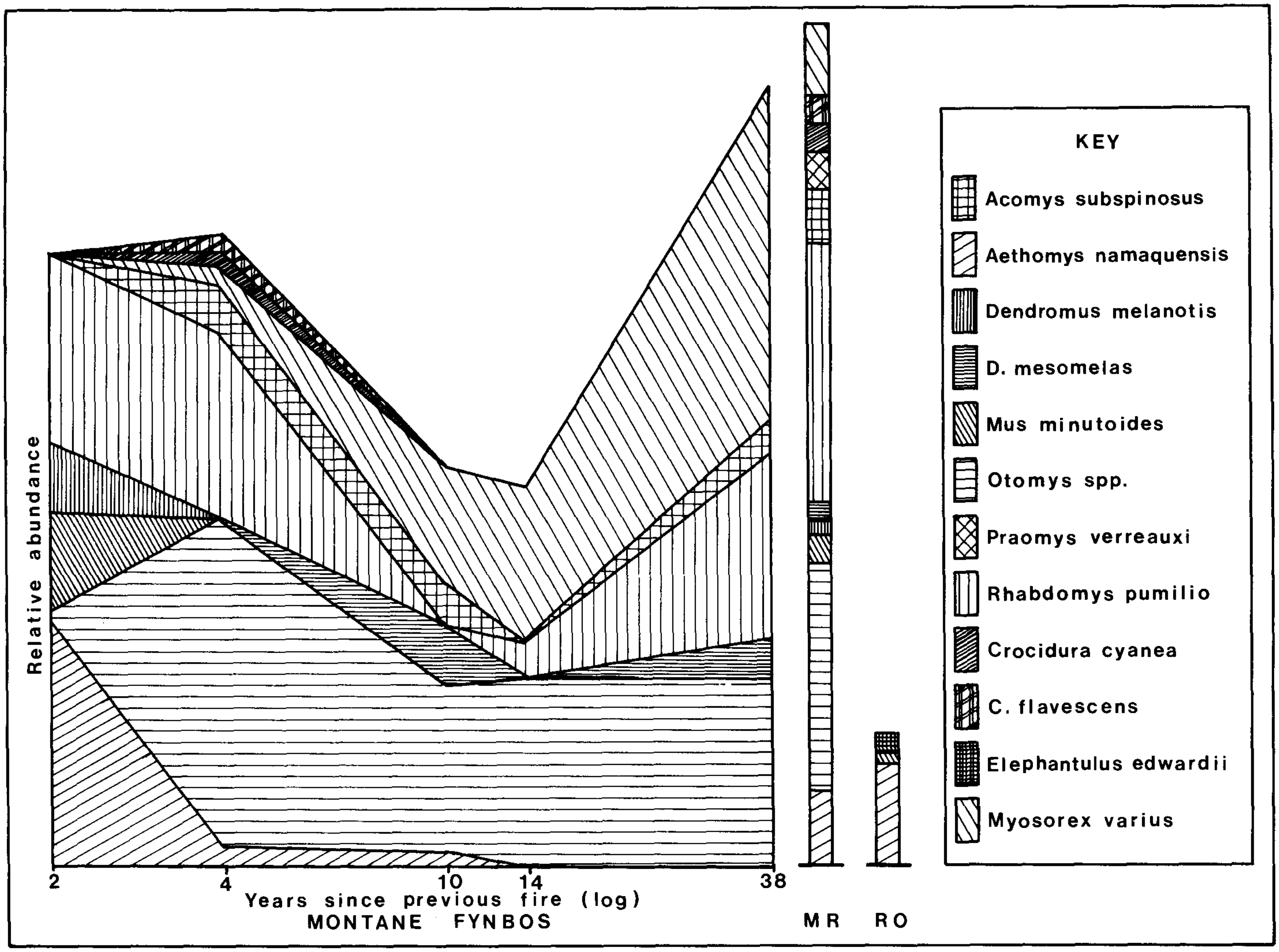

Figure 2--Relative abundance of small mammals in various S.W. Cape fynbos habitats. MR = mesic refuges; RO = rocky outcrops. Relative abundance calculated by dividing total captures for each species by sampling effort (station-nights).

On present knowledge the successional pattern in fynbos indicated by our results is not easy to explain fully. Limited cover and food may both restrict small mammal species richness and density on young burns. Cover requirements of Aethomys namaquensis are low and Rhabdomys pumilio prefers "grassy" ground cover, which includes Poaceae as well as the Cyperaceae and Restionaceae prominent in young fynbos (Bond and others 1980). The small size of Mus minutoides may enable it to use small residual patches of shelter (Bigalke and Willan in press). 4 of the 5 rodents trapped on the youngest burns (table 2) are omnivorous (Bigalke and Willan in press) and thus able to exploit whatever food resources are available. The fifth, Otomys sp., is a specialist herbivore and only becomes abundant later in response to increasing cover (see below).

Peak small mammal species richness, density and biomass measured at 4 years (table 2, fig. 2) is attained when the vegetation is reaching the end of its youth phase. During this time fynbos becomes dominated by restionaceous and graminoid plants and sprouting shrubs, the herbaceous plants reaching maximum biomass of up to 8000kg/ha. Canopy cover reaches about 80 percent of pre-burn levels and remaining sprouting species attain reproductive maturity (Kruger and Bigalke in press). Food resources are likely to be plentiful and of good quality. For some mammals abundant at this time cover density is known to be important. Bond and others (1980) found a positive correlation between the presence of Acomys and foliage density between 20 and 60cm although high elevation and rocky areas were also significant habitat factors in Baviaanskloof. Otomys spp. also exhibit a marked preference for dense shrubby vegetation (Bond and others 1980).

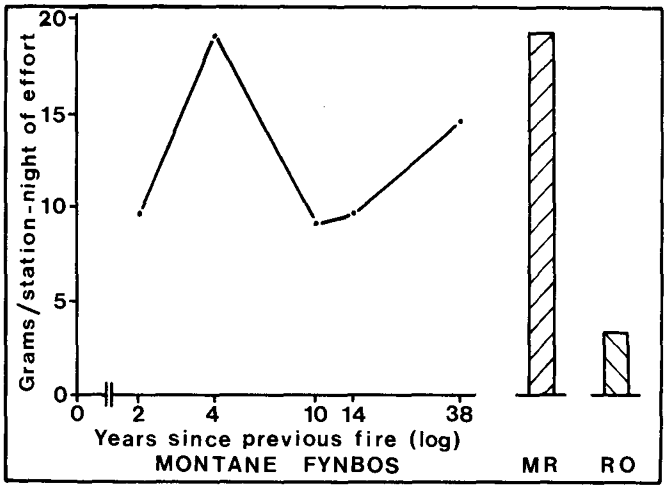

Figure 3--Relative biomass of small mammals in various S.W. Cape fynbos habitats. MR = mesic refuges; RO = rocky outcrops. Relative biomass calculated by dividing total biomass by sampling effort (station-nights).

The decline of small mammals in mature fynbos may reflect responses to dense canopy cover, the reduced importance of lower herbaceous strata and decreasing plant species diversity described by Kruger and Bigalke (in press). During the senescent phase of post-fire succession in fynbos - over about 30 years - these authors show that mortality among shrubs is high, the canopy opens and some seed regeneration may occur. A species such as Rhabdomys presumably again finds adequate food and "grassy" ground cover while the accumulated litter may be an important factor favouring Myosorex.

Recolonisation Rates

Rates of small mammal recolonisation of burns in fynbos appear slower than in other southern African ecotypes. The present study did not include habitats of less than 2 years post-fire age, but trapping on a burn at Duthie Reserve, University of Stellenbosch (33°56'S; 18°52'E; ± 100m), Bigalke and Pepler (unpubl.) found no small mammals to be present until Rhabdomys pumilio moved in 11 months after the fire. Toes (1972) sampled 1-year-old vegetation at Jonkershoek and found only 2 species to be present. In contrast, a number of studies in other regions have shown post-fire pioneer species to be present immediately after burning (Christian 1977; Kern 1978; Meester and others 1979; Mentis and Rowe-Rowe 1979), and as many as 5 species may be present 7 months after fire in Terminalia-Dichrostachys savanna (Kern 1978). These observations presumably reflect the slower rate of regeneration of fynbos relative to other vegetation types. It is of interest in this respect that of the species sampled in this study, 2 may be present immediately after fire in other ecotypes (Mus minutoides and Myosorex varius at Midmar Dam Nature Reserve, Natal - Meester and others 1979; Myosorex varius in the Natal Drakensberg-Mentis and Rowe-Rowe 1979). Other species in which post-fire pioneer status has been documented (Desmodillus auricularis, Gerbillurus paeba, Malacothrix typica - Christian 1977; Tatera leucogaster - Kern 1978; Praomys natalensis - Meester and others 1979, Mentis and Rowe-Rowe 1979) do not occur in the S.W. Cape. Further study may show that Aethomys namaquensis, which as noted above is adapted to low cover densities (Bond and others 1980), survives on fresh burns. Its dominant position 2 years after fire (fig. 2) at least suggests that it recolonizes burns soon after fire. This species did not occur in the vicinity of Duthie Reserve, which represents a small fynbos "island" surrounded by disturbed and largely exotic vegetation.

Refuge Habitats

The data presented above indicate that riverine habitats are more important as refuges during and immediately following fire than are rocky outcrops. The occurrence in riverine vegetation of all 10 species found in the fynbos habitats suggests that recolonisation of burns at the appropriate stage of vegetative regeneration may occur from such refuges rather than surrounding areas of unburned fynbos, where species diversity may be low. In contrast, extensive recolonisation of fynbos from rocky outcrops would be expected to be undertaken only by Aethomys namaquensis.

Conservation

The conservation status of the majority of southern African small mammals is unknown, but 4 species dealt with here (Acomys subspinosus, Otomys laminatus, O. saundersae, Praomys verreauxi) are rare (Dean 1978) S.W. Cape endemics (Davis 1974). Acomys and Praomys are pollinators of geoflorous proteas such as Protea amplexicaulis and P. humiflora (Wiens and Rourke 1978). It seems reasonable to propose, therefore, that the local status of these species (at least) should be ascertained prior to prescribed burning, with a view to their conservation.

It has been shown that the abundance of francolin in the Natal Drakensberg is increased by burning small rather than large areas of veld, thus creating a fine mosaic of vegetation of different post-fire ages (Mentis and Bigalke 1979). Such a policy would appear to have much to recommend it, especially if consideration were given to the question of fire accessibility (Mentis and Rowe-Rowe 1979), so that naturally fire-accessible areas were burnt prior to reaching the moribund phase of vegetative succession, and succession was allowed to proceed ad infinitum in naturally fire-inaccessible areas. In the long term this would be expected to increase overall diversity, abundance, and biomass of small mammals, and hence to encourage proliferation of small carnivores and other predators which feed on them.

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