The effect of fire on a small mammal community

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Information is provided on the survival of a small mammal community monitored before and after fire passed through part of a grassland study area. *Praomys natalensis* and *Lemniscomys griselda* populations were not affected by the fire itself. Possible survival strategies are discussed. All the *L. griselda* survivors were retrapped in the unburnt grassland after the fire. Some of the *P. natalensis* survivors were retrapped in unburnt grassland whilst some remained in the burnt area. Post-burn mortality of the latter group was high. Factors involved in post-burn habitat selection are discussed.
S. Afr. J. Zool. 1981, 16: 232 – 236

Inligting word voorsien omtrent oorlewing van 'n kleinsoogdier gemeenskap wat voor en na 'n gedeelte van die grasveld studiegebied afgebrand het, gemonitor is. *Praomys natalensis* en *Lemniscomys griselda* is nie deur die vuur self beïnvloed nie. Moontlike oorlewendes van *L. griselda* is in ongebrande grasveld hervang na die brand. Sommige *P. natalensis* oorlewendes is in die ongebrande grasveld hervang terwyl party in die gebrande gebied gebly het waar hulle mortaliteit hoog was. Faktore wat habitat seleksie na die brand beïnvloed, word bespreek.
S.-Afr. Tydskr. Dierk. 1981, 16: 232 – 236

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Received 17 November 1980; accepted 12 June 1981

Fire caused by natural phenomena (e.g. lightning) and man, both primitive and recent has always been an integral part of the African savanna regions (West 1969). Normally these fires occur during the dry seasons and often annually (Delany & Happold 1979). The extent of the fires varies considerably according to the vegetation present, wind direction, season and natural or artificial barriers. Eltringham (1976) recorded variations in total area burnt from 1,0% to 32,7% in three successive years in Rwenzori Park, East Africa. During this period it was estimated that 55% of the total area was burnt at least once.

Because of the regularity and extent of burns it has been stated that fire, more than any other factor, is responsible for the production and maintenance of grassland and open woodlands in Africa (West 1969). It is presumed therefore that fire, both indirectly through its effect on the vegetation, and directly, would influence mammal populations in these areas. An accidental fire which passed through part of a grassland area in which small mammal populations were being studied provided an opportunity to monitor the effect of fire on such a community.

Study area

The study area was situated on the farm Merton Park (17°52′S/30°46′E), in the Norton district of the Mashonaland highveld, 35 km west of Salisbury, Zimbabwe. Rain (784 mm p.a.) falls during summer (October to April) with little chance of rain during the rest of the year. The summer temperatures in January are moderately high: maximum 29,2 °C; minimum 12,8 °C. Winters are cool (average temperatures in June: maximum 24,8 °C; minimum 3,0 °C) with occasional ground frost. The soil throughout the study area is characterized by moderately deep red clay loams with good permeability.

Trapping was carried out in natural grassland and adjacent agricultural land. The latter was cropped under a system of continuous cultivation with soyabeans (December – April) alternating with irrigated wheat (May – October). The adjacent grassland comprised a dense sward of *Hyparrhenia* (mainly *H. dissoluta*) interspersed with very few bushes (*Albizia* sp.) and trees (*Acacia karoo*).

Part of this grassland area (Figure 1) was burnt in the early evening of May 30, 1977. The grass cover was reduced to a charred stubble with the exception of small patches where grass stems not entirely burnt were left standing. In time these were blown down. Bushes and trees were only scorched.

Within a fortnight most of the grass tufts had begun to produce new leaves, but, because of low temperatures and lack of moisture, regrowth was very slow. Aerial cover in the burnt area, as provided by grass regrowth, was therefore very poor during the entire winter period. With the onset of the rains, and higher temperatures during November, the growth of the tufts was accelerated and by the end of December provided good aerial cover.

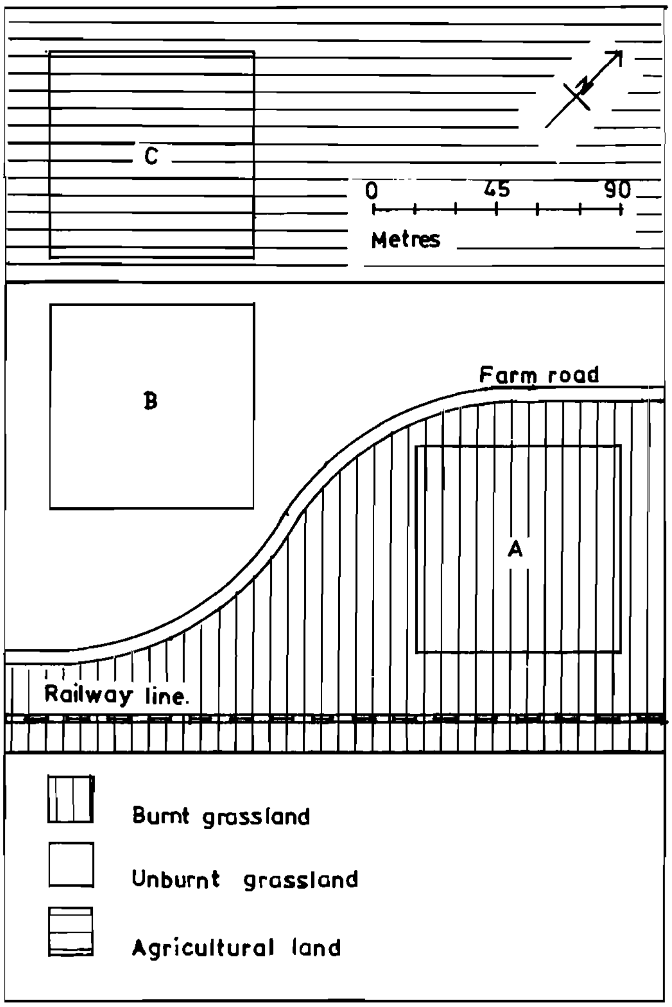

Figure 1 Map of the study area showing the location of the study grids (A, B and C) and the extent of the burnt area.

Methods

Three live-trapping study grids were monitored, one in a cultivated area and two within the neighbouring grassland (Figure 1). Each grid comprised six rows, 15 m apart and each row contained six traps at 15-m intervals. This formed a square grid containing 36 traps covering an absolute area of 0,56 ha.

Trapping was carried out at intervals during 1977. There were three trapping periods: May – June (early winter); August – September (late winter), and December (summer). Each trapping period extended over a month and was broken up into shorter sessions of either six or ten days (Swanepoel 1978).

Sherman-type live traps were used and were baited with a mixture of peanut butter and rolled oats. Trapped animals were identified, weighed, sexed, marked, if not previously captured, and their breeding condition noted before being released at the capture site. On release, where possible, the escape route of the animal was noted, i.e. into cover or into burrows. All mice trapped were grouped into one of five possible age classes based on mass and toothwear correlates (Swanepoel 1978).

Results

The numbers of animals of each species trapped during each trapping season are given in Table 1. Survival rates, as suggested by the percentage of those animals trapped before the fire and then retrapped in subsequent trapping sessions, are given in Table 2.

Praomys natalensis

Of the original sample of 41 animals trapped 10 days before the fire, 24 animals survived the fire itself (Table 2). Of these, 16 were trapped in the burnt area; six in the neighbouring unburnt grassland, and two, initially trapped in the unburnt area, were retrapped in the burnt area two weeks after the fire.

The sex ratio of the sample trapped before the fire

Table 1 The number of individuals of each species trapped during consecutive trapping sessions in the area which burnt

Species	Trapping sessions							
	21.5.77 to 30.5.77	5.6.77 to 12.6.77	14.6.77 to 18.6.77	25.8.77 to 31.8.77	5.9.77 to 12.9.77	28.11.77 to 5.12.77	7.12.77 to 14.12.77	19.12.77 to 25.12.77
Praomys natalensis	41	9	13	1	4	16	31	30
Lemniscomys griselda	8	–	–	–	3	5	6	7
Saccostomus campestris	2	–	1	2	3	1	5	7
Otomys angoniensis	4	–	–	–	–	–	–	–
Dendromus melanotis	2	–	–	–	–	–	–	–

Table 2 Temporal changes in survival rate, expressed as a percentage of the number of individuals trapped before an accidental fire passed through the study area on 31.5.77. Figures in parentheses refer to the size of the population trapped before 31.5.77, and are given for both the area which burnt (B) and the unburnt grassland (UB)

		Trapping sessions							
Species	Area	21.5.77 to 30.5.77	5.6.77 to 12.6.77	14.6.77 to 18.6.77	25.8.77 to 31.8.77	5.9.77 to 12.9.77	17.9.77 to 24.9.77	29.10.77 to 30.10.77	28.11.77 to 5.12.77
P. natalensis	UB	(62)	69,4	58,1	37,1	29,0	25,8	1,6	0
	B	(41)	58,5	41,5	7,3	7,3	7,3	0	–
L. griselda	UB	(8)	100	100	25,0	12,5	12,5	0	–
	B	(8)	62,5	62,5	37,5	25,0	25,0	25,0	0
S. campestris	UB	(1)	100	100	100	100	100	0	–
	B	(2)	0	–	–	–	–	–	–
O. angoniensis	UB	(0)	–	–	–	–	–	–	–
	B	(4)	0	–	–	–	–	–	–
D. melanotis	UB	(0)	–	–	–	–	–	–	–
	B	(2)	0	–	–	–	–	–	–

(1 ♂ : 0,75 ♀; n = 41) did not differ significantly (χ^2 = 0,03; df = 1) from that of the survivors (1 ♂ : 0,71 ♀; n = 24). Similarly, the mean age, as suggested by body mass, of the pre-burn sample did not differ significantly (t = 0,91; df = 63) from that of the survivors. There was no significant difference in sex ratio when surviving residents in the burnt area were compared to emigrants (χ^2 = 0,39; df = 1) or age (t = 1,32; df = 22).

The *Praomys* sample trapped during the period before the fire was divided into those which had been trapped three or more times during this period (residents) and those which were only trapped once or twice (nomads). Eight of the residents survived the fire, all being retrapped in the burnt area. Sixteen of the nomads survived, of which eight were retrapped in the burnt and eight in the unburnt area.

There is, furthermore, a moderate (contingency coefficient = 0,22), but statistically significant (χ^2 = 14,12; df = 6) relationship between study site (burnt or unburnt) and survival rate as suggested by trapping (Table 2). This demonstrates a weak but definite influence of fire on survival. This influence is not marked in the period immediately after the fire (χ^2 = 0,27; df = 1) but between the periods 14.6.77 – 18.6.77 and 27.8.77 – 31.8.77 (χ^2 = 3,89; df = 1).

On release, *Praomys* in the burnt area generally ran into burrows although occasionally they hid in cover such as that provided by rocks or fallen branches.

None of the *Praomys* survivors that remained in the burnt area were retrapped after June. All four *Praomys* recorded in the burnt area during September (Table 1) were new immigrants, not having been trapped previously. Three of these survived until December. The rest of the December population (Table 1) was made up of new immigrants, some of which had been trapped in neighbouring areas during previous trapping sessions. No reproductive activities within the *Praomys* population were observed to occur in the burnt area.

Lemniscomys griselda

Eight *Lemniscomys* (5 ♂ : 3 ♀) were trapped before the fire. Of these, five (2 ♂ : 3 ♀) survived, all being retrapped in the neighbouring unburnt grassland. There is a moderate (contingency coefficient = 0,27) but statistically insignificant (χ^2 = 4,23; df = 6) relationship between study site (burnt or unburnt) and survival rate as suggested by trapping. When considering the trapping periods immediately before and after the fire (Table 2) there is evidence that fire itself had little effect on *Lemniscomys* survival (χ^2 = 0,39; df = 1). Limited sample sizes, however, preclude any meaningful analysis of survival in the successive periods.

In September three *Leminscomys* (Table 1) were trapped in the burnt area. These were all new immigrants, none having been trapped previously. Two of these were retrapped in December, both in the burnt area. The other animals trapped in December (Table 1) included some which had been previously trapped in neighbouring unburnt areas as well as some not previously recorded. On release in the burnt area *Leminscomys* tended to run for areas which would afford some degree of aerial cover, although on two occasions they were noted to utilize burrows.

Saccostomus campestris

Neither of the two animals trapped before the fire (Table 1) were retrapped afterwards. There were three immigrants into the burnt area in September, two of which were retrapped in the same area in December. The one immigrant recorded soon after the fire (16.6.77) was not retrapped.

Otomys angoniensis and *Dendromus melanotis*

These species were only recorded in the May trapping period preceding the fire and neither were recorded during subsequent trapping periods in any part of the study area.

Discussion

Direct effect of fire

From Table 2 it is clear that the fire itself did not cause an increase in mortality in either the *Praomys* or *Lemniscomys* populations higher than that which might normally occur in natural populations. Similarly there was no bias in the effect of fire on either the age or sex of the survivors compared to the original pre-burn populations.

High survival rates after fires in grassland areas have been reported for *Praomys* in other parts of Africa and it has been suggested that they may have found refuge in burrow systems (Delany 1974). In the present study many of the *Praomys* survivors were retrapped in the burnt area soon after the fire, presumably having found safe refuge during the fire in that area. The burrows utilized by *Praomys* in the area were similar to those described by Veenstra (1958) i.e. at least 10 cm deep and normally with two or more entrances. Protection would be afforded to sheltering animals as the heat effect of a grass fire only penetrates *ca*. 5 cm into the soil (Hill 1978), and the two entrances would provide adequate ventilation (Neal 1970).

It is feasible, therefore, that many of the *Praomys* survivors would have found safe refuge in their burrows. However, not all the retrapped survivors were found in the burnt area, some having been captured in the neighbouring unburnt grassland. It is possible that these animals fled from the fire. No differences in age or sex could be discerned between those animals which apparently emigrated and those which took refuge. It is feasible that either strategy could be utilized by individual *Praomys* for survival, perhaps dependent on the prevailing situation.

All *Lemniscomys* survivors retrapped were located in the unburnt grassland area. This suggests that they fled from the fire and found refuge in unburnt areas. Limited sample sizes precluded meaningful analyses for *Saccostomus, Otomys* and *Dendromus* populations which apparently suffered 100% mortality during the fire. Delany (1964) noted that *Dendromus melanotis* survived burning in Uganda, and *Otomys* have been noted fleeing from a fire (Smithers, pers. comm.). The effect of fire on *Saccostomus* populations has apparently not been recorded.

Post-burn survival

After the fire 75% of the *Praomys* survivors which were retrapped remained in the burnt area. The remainder were retrapped in the unburnt grassland. These two groups did not differ in either age or sex and none of the females in either group was apparently gravid. Social structures within the pre-burn population (e.g. residents *cf*. nomads) might have played a role in influencing post-burn area selection. Because of the limited sample size recorded before the burn no meaningful analysis of possible changes in social structure was possible.

There was, however, no difference in the post-burn survival between resident and nomadic animals but there was a noticeable difference in post-burn habitat selection, i.e. none of the surviving residents ($n = 8$) were retrapped in the unburnt grassland, whilst half of the nomadic survivors ($n = 16$) were. There is, therefore, an indication that social organization might play a role in determining post-burn habitat selection for survivors of a grass fire. This is of importance in that the major impact of fire appears to be on those animals remaining in the burnt area.

The only difference in mortality rates, as determined in this study, between the 'burnt population' and the 'unburnt population' occurred after the fire and more specifically between June and September, i.e. 6 – 15 weeks post-burn. During this period the mortality in the 'burnt populaltion's' survivors was higher owing to the apparent mortality of the entire population which had remained in the burnt area over this period.

Delany (1974) also noted that mortality was high in burnt areas. He suggested that fire, by removing the vegetative cover, creates a situation whereby small mammals in the area are exposed to increased effectiveness of predation, increased physical exposure and reduced food availability. None of these factors were investigated in the present study and all may have played a role in accounting for the high mortality as recorded between June and September.

It might be speculated that the mortality factors should have been effective sooner after the fire than indicated,i.e. up to six weeks after the fire there was no difference in mortality between the surviving population and the 'unburnt population'. It is possible that this apparent anomaly might be due to an artificial situation created by the effect of livetrapping, in that the traps provided refuges for those animals caught within them.

All the *Lemniscomys* survivors were retrapped in unburnt grassland and as such might not be expected to have a different mortality rate from those normally resident there. This is indicated by the data in Table 2 although sample sizes are too small for realistic analysis.

In the present study immigration into the burnt area by small mammals was much slower than that reported by Neal (1970). He found that small rodents were more abundant in the burnt area than the unburnt area within four months after the fire. In the present study numbers in the burnt area were much lower than in neighbouring unburnt areas four months after the fire (Swanepoel 1978). This was possibly owing to differences in vegetative cover as noted in the two studies: in Uganda the vegetation cover was assessed as being 'good' (Neal 1970), whilst in the present study there was very little vegetative regrowth and the cover was 'poor'. As regrowth increased so the numbers of small mammals trapped in the area increased. The actual extent of recolonization during this period was confounded by immigration into the area by animals forced out from the neighbouring agricultural lands due to land tillage.

Acknowledgements

I would like to thank Drs R.H.N. Smithers and P. Taylor for their help and guidance, the Director and staff of the Blair Research Laboratory for their invaluable assistance and the University of Zimbabwe for financial assistance.

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