Regeneration of a Natal coastal dune forest after fire

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The composition of a coastal dune forest in the Mlalazi Nature Reserve, Natal was studied three years after a fire and compared with adjacent unburnt forest. The two communities had similar plant densities but there was a marked decrease in biomass and diversity in the burnt community. Measured as density, basal area or canopy volume, *Trema orientalis* contributed over 70% of the regenerating burnt forest. Saplings of some forest trees were present but those of *Mimusops caffra*, the dominant tree of the unburnt community, were absent from the burnt area.

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Die samestelling van 'n kusduinwoud te Mlalazi-natuurreservaat, Natal is drie jaar na 'n brand bestudeer en met aangrensende ongebrande woud vergelyk. Die twee gemeenskappe se plantdigtheid was dieselfde, maar daar was 'n merkbare afname in biomassa en verskeidenheid in die gebrande gemeenskap. Gemeet as digtheid, basale oppervlakte of blaredak-volume het *Trema orientalis* meer as 70% van die regenererende gebrande woud bygedra. Lote van sommige woudbome was aanwesig maar dié van *Mimusops caffra*, die dominante boom van die ongebrande gemeenskap, was afwesig in die gebrande gebied.

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Introduction

Reports on the effects of fire on forest communities in Africa have been confined largely to accounts of how frequent burning, often in combination with shifting cultivation or biotic influences, has led to the replacement of forest communities by derived savannas and grasslands (e.g. Swynnerton 1918; Aubreville 1947; Beuchner & Dawkins 1961; West 1971). Very little attention has been paid to the effects of 'natural' forest fire regimes in Africa although it is likely that forest communities in the region have always experienced periodic fires, albeit predominantly on the margins. The incidence of forest fires would probably have been highest in subtropical forests as a result of their smaller dimensions and relatively isolated occurrence and often also because of their somewhat less humid setting (Phillips 1974). White (1983) has pointed out that large extents of Afromontane forests have been destroyed by fire and replaced by secondary grassland.

A recent study of the vegetation of the coastal dunes of Zululand (Weisser 1978) has indicated that periodic fires were essential for the maintenance of the extensive areas of open grassland that occurred here at the advent of European settlement (mid 19th century). These grassland areas are interdigitated with the dune forest and thus it is probable that fires have been entering the afforested areas periodically since the Iron-age occupation of this region (3rd century AD) (Hall 1984).

In other parts of the world the importance of periodic forest fires in maintaining a diversity of seral stages has long been recognized and fire is used in forest management for both production and conservation purposes (Kozlowski & Ahlgren 1974). It has been suggested that the high species diversity of tropical rain forests can be maintained only where the forests are kept in a 'non-equilibrium state' (Connell 1978). Thus it is important to know the effects of fire in communities such as the Natal coastal dune forests. This article reports on short-term regeneration after a fire in this community.

Description of the site

The Mlalazi Nature Reserve is situated on the coast of Natal at latitude 28°58′S and longitude 31°47′E. The coastline at this point is rapidly prograding (Weisser *et al.* 1982) and there is a system of sharply undulating sand dunes of recent origin up to 8 m in height. There is a marked succession from bare beach, through open dune vegetation to coastal dune forest. The more recent (seaward) portion of the forest is characterized by a ground layer dominated by the fern *Phymatodes scolopendria* while the more mature portion of the forest has a dense understorey of the acanthaceous shrub *Isoglossa*

woodii. The climate is subtropical with mean summer and winter temperatures of 28°C and 18°C and an average annual rainfall of 1 400 mm (1945 – 1983; I.F. Garland, personal communication).

The fire occurred on 14 August 1975 and burnt as both a crown fire and in the litter layer in the older section of the forest and burnt less intensely in the younger portion. An area of 8,4 ha of the dune forest was burnt in the fire.

Methods

A survey of the burnt area and of the neighbouring unburnt forest was conducted in September 1978, approximately three years after the fire. Five 20 m × 20 m quadrats were placed in each of the burnt and unburnt areas. Because of the heterogeneous nature of the forest, quadrats were located subjectively. Three were located in the younger portion of the forest and two in the older section and as far as possible quadrats in the burnt and unburnt area were 'paired' with respect to dune age (distance from the sea) and aspect.

A number of alien invasive species occurred in the burnt area but as control measures were underway, these were not recorded. Every woody tree or shrub species greater than 1 m in height rooted on the quadrats was identified and the following measurements were made:

(i) Stem circumferences. On large trees circumference was measured 1 m above ground. If branching occurred below 1 m, circumference was measured below the branch. Where branching occurred at or below ground level, i.e. multi-stemmed individuals, the circumference of each stem was recorded separately. Where coppicing was evident the circumference of a single representative stem was measured and the number of coppice shoots noted.

(ii) Top of canopy. With large trees this was measured to the nearest 0,5 m using segmented poles. With smaller plants this was measured to 0,1 m. Canopy top was measured relative to the ground at the base of the stem. Because many trees lean quite considerably and the ground undulates markedly it was necessary to standardize measurements in this way.

(iii) Bottom of canopy. This was measured as for canopy top. Where small leaf-bearing shoots occurred below an otherwise well-defined canopy bottom, these were ignored.

(iv) Canopy diameter. This was measured to the nearest 0,1 m at what was considered to be the average canopy width. Where a canopy was markedly elliptical in the horizontal plane, the diameter was taken as the mean of the major and minor axes.

(v) Origin of the plant. For plants occurring in the burnt area of the forest it was assessed whether the plant had arisen from seed since the fire, coppiced from ground level, had regrown from above ground parts or had survived the fire intact.

For each species the following parameters were derived:

(a) Frequency. For frequency determinations each quadrat was subdivided into sixteen 5 m × 5 m subquadrats.

(b) Density (plants ha^{-1} ground area).

(c) Stem basal area (m^2 ha^{-1} ground area).

(d) Canopy area (m^2 ha^{-1} ground area). For this it was assumed that individual canopies were circular in the horizontal plane.

(e) Canopy volume (m^3 ha^{-1} ground area). It was assumed that the canopies were cylindrical in shape with a depth equivalent to (canopy top − canopy bottom).

It is appreciated that considering the canopies to be cylindrical is a very crude approximation. However, the spatial distribution of individual plant canopies was so complex as to defy accurate description and assuming any other shape would not have increased the accuracy of the estimates of canopy areas and volumes. No attempt was made to assess the canopy dimensions of lianes. Thus the values for frequencies, densities and basal areas include lianes, but for canopy structure exclude lianes.

Results

As could be expected there were marked differences between the unburnt forest and the regenerating area, with respect to both species occurrence and species abundance. Table 1 shows the gross differences between the two areas. Although plant density was similar in the two communities, individual plants were much smaller in the burnt community: basal area was reduced by a factor of five and canopy volume by a factor of six in the burnt relative to the unburnt area. Canopy areas of 1,6 ha ha^{-1} ground area for the burnt and 4,5 ha ha^{-1} for the unburnt communities indicate a more complex canopy layering in the unburnt area of the forest.

Table 1 Overall composition of the burnt and unburnt areas of the forest. Figures in parentheses are one standard deviation

	Burnt	Unburnt
Density (plants ha^{-1})	5770 (1541)	5710 (2215)
Basal area (m^2 ha^{-1})	9,5 (53,7)	50,2 (130,5)
Canopy area (m^2 ha^{-1})	16133 (102325)	44761 (107850)
Canopy volume (m^3 ha^{-1})	32118 (194573)	200860 (611382)

Differences in species occurrence are shown in Table 2 which lists the frequencies and densities of species in the two communities. Of the species limited to the burnt area, only *Trema orientalis* makes any significant contribution to the composition of this area, but its contribution is overwhelming. Table 3 lists the species that were present in either the burnt or unburnt areas only.

These differences based on densities and frequencies do not give a true reflection of the actual differences between the two communities as they do not account for the sizes of the individual plants. In the case of this study many large forest trees had been killed by the fire and replaced by coppices or saplings and so differences between the two communities are greater than indicated by simple density measurements. The basal area, canopy area and canopy volumes are listed in Table 4. Table 5 gives the relative values of these parameters listed in order of increasing basal area (this being a more reliable measurement than canopy volume) in the unburnt forest. The distribution of canopy volume through the depth of the canopy is shown in Figure 1 and the contribution of the most important species in each community is shown in different shadings. The number of species contributing to each canopy interval is also given.

The recruitment strategies of the most important species in the burnt area are shown in Table 6.

Discussion

Assuming that the basal area of the burnt community prior to the fire was the same as the unburnt community at the time of the survey, then only 4% of the basal area survived

Table 2 Frequencies and densities of species present in the burnt and unburnt areas of the forest. Figures in parentheses are one standard deviation

Burnt				Unburnt			
Species	Frequency	Density (plants ha^{-1})	Relative density (%)	Species	Frequency	Density (plants ha^{-1})	Relative density (%)
Trema orientalis	0,72	4240 (1385)	73,5	*Monanthotaxis caffra*	0,50	985 (863)	17,3
Euclea natalensis	0,42	425 (215)	7,4	*Rhoicissus sp.*	0,51	735 (351)	12,9
Brachylaena discolor	0,20	210 (100)	3,6	*Euclea natalensis*	0,52	570 (242)	10,0
Vepris undulata	0,14	195 (255)	3,4	*Peddiea africana*	0,50	535 (235)	9,4
Canthium ventosum	0,10	115 (171)	2,0	*Rhoicissus rhomboidea*	0,24	400 (380)	7,0
Peddiea africana	0,10	90 (123)	1,6	*Maytenus spp.*	0,35	300 (194)	5,3
Sideroxylon inerme	0,11	85 (75)	1,5	*Tricalysia sonderiana*	0,24	235 (195)	4,1
Putterlickia verrucosa	0,06	65 (37)	1,1	*Sideroxylon inerme*	0,25	225 (124)	3,9
Mimusops caffra	0,09	55 (110)	1,0	*Vepris undulata*	0,22	225 (184)	3,9
Maytenus spp.	0,06	50 (69)	0,9	*Olea woodiana*	0,15	160 (242)	2,8
Ekebergia capensis	0,04	45 (68)	0,8	*Dovyalis rhamnoides*	0,11	155 (127)	2,7
Ochna natalitia	0,09	45 (33)	0,8	*Putterlickia verrucosa*	0,10	145 (167)	2,5
Tricalysia sonderiana	0,06	45 (56)	0,8	*Kraussia floribunda*	0,17	140 (90)	2,5
Allophyllus natalensis	0,05	40 (58)	0,7	*Dalbergia armata*	0,15	115 (174)	2,0
Monanthotaxis caffra	0,05	40 (58)	0,7	*Mimusops caffra*	0,20	110 (124)	1,9
Dovyalis longispina	0,04	35 (37)	0,6	*Dovyalis longispina*	0,16	105 (66)	1,8
Dovyalis rhamnoides	0,05	35 (34)	0,6	*Asparagus falcatus*	0,17	100 (35)	1,8
Ficus capensis	0,06	30 (29)	0,5	*Rhoicissus tomentosa*	0,13	100 (108)	1,8
Scutia myrtina	0,04	30 (40)	0,5	*Scolopia zeyheri*	0,14	85 (68)	1,5
Passerina rigida	0,06	25 (27)	0,4	*Ochna natalitia*	0,13	70 (62)	1,2
Clerodendrum glabrum	0,01	20 (29)	0,3	*Bersama lucens*	0,15	65 (34)	1,1
Cussonia zuluensis	0,02	20 (40)	0,3	*Psychotria capensis*	0,07	55 (75)	1,0
Bersama lucens	0,02	15 (20)	0,3	*Carissa bispinosa*	0,05	45 (29)	0,8
Macaranga capensis	0,01	15 (20)	0,3	*Acacia kraussiana*	0,02	30 (48)	0,5
Maesa lanceolata	0,01	15 (30)	0,3	*Brachylaena discolor*	0,01	30 (48)	0,5
Calpurnia aurea	0,01	10 (20)	0,2	*Ekebergia capensis*	0,04	30 (37)	0,5
Canthium obovatum	0,02	10 (12)	0,2	*Scutia myrtina*	0,04	30 (37)	0,5
Carissa bispinosa	0,02	10 (12)	0,2	*Cissampelos torulosa*	0,02	25 (32)	0,4
Acalypha glabrata	0,01	5 (10)	0,1	*Pavetta revoluta*	0,06	25 (0)	0,4
Cissampelos torulosa	0,01	5 (10)	0,1	*Acokanthera oblongifolia*	0,02	20 (40)	0,4
Crotalaria capensis	0,01	5 (10)	0,1	*Allophyllus natalensis*	0,04	20 (19)	0,4
Cussonia spicata	0,01	5 (10)	0,1	*Canthium obovatum*	0,04	20 (29)	0,4
Eugenia capensis	0,01	5 (10)	0,1	*Apodytes dimidiata*	0,02	15 (30)	0,3
Ficus natalensis	0,01	5 (10)	0,1	*Canthium ventosum*	0,02	10 (12)	0,2
Halleria lucida	0,01	5 (10)	0,1	*Clerodendrum glabrum*	0,02	10 (20)	0,2
Rhus nebulosa	0,01	5 (10)	0,1	*Cussonia zuluensis*	0,02	10 (20)	0,2
				Embelia ruminata	0,02	10 (20)	0,2
				Adenia gummifera	0,01	5 (10)	0,1
				Capparis tomentosa	0,01	5 (10)	0,1
				Ficus natalensis	0,01	5 (10)	0,1
				Rhoicissus digitata	0,01	5 (10)	0,1
				Sarcostemma viminale	0,01	5 (10)	0,1
				Xeromphis obovata	0,01	5 (10)	0,1

the fire (from Tables 1, 2 & 6). Three years after the fire there was a similar density but a marked reduction of biomass in the burnt community (Table 1). The burnt area consisted of an almost monospecific stand of *Trema orientalis*. The next two most important species (*Mimusops caffra* and *Euclea natalensis*) were derived totally from trees present before the fire, by either coppicing or regrowth above ground level. All other species present in the burnt area contributed only 7% of the total basal area and 8% of the canopy volume. This monospecific dominance of the tree layer of tropical and subtropical forests regenerating after disturbance is a well known phenomenon (Whitmore 1978). Representatives of the genus *Trema* are often important in post-disturbance forest succession throughout the tropics and subtropics (Opler *et al.* 1977; Hartshorn 1978; Whitmore 1978).

The unburnt community showed a much higher diversity. Four species each contributed between 10 and 20% of the total basal area and a further five each contributed between 2 and 10%. Similarly, two species contributed more than 20% each to the canopy volume, with a further seven contributing between 2 and 10% each.

Of the species restricted to the burnt community, *Passerina rigida* and *Eugenia capensis* are characteristic of the dune scrub. Others are characteristic of disturbed forests (e.g. *Calpurnia aurea* and *T. orientalis*) or forest margins (e.g. *Halleria lucida* and *Maesa lanceolata*) (Palgrave 1977). The species recorded only in the unburnt forest included two canopy trees (*Apodytes dimidiata* and *Olea woodiana*), several lianes (e.g. *Asparagus falcatus, Dalbergia armata, Rhoicissus* spp.) and shade tolerant understorey shrubs (e.g. *Acokanthera oblongifolia, Pavetta revoluta* and *Psychotria capensis*). Species that were common to both the burnt and unburnt

Table 3 Species occurring in either the burnt or unburnt area only

Burnt	Unburnt
Calpurnia aurea	*Acacia kraussiana*
Crotalaria capensis	*Acokanthera oblongifolia*
Cussonia spicata	*Adenia gummifera*
Eugenia capensis	*Apodytes dimidiata*
Ficus capensis	*Asparagus falcatus*
Halleria lucida	*Capparis tomentosa*
Macaranga capensis	*Cussonia zuluensis*
Maesa lanceolata	*Dalbergia armata*
Passerina rigida	*Embelia ruminata*
Rhus nebulosa	*Kraussia floribunda*
Trema orientalis	*Olea woodiana*
	Pavetta revoluta
	Psychotria capensis
	Rhoicissus digitata
	Rhoicissus rhomboidea
	Rhoicissus tomentosa
	Rhoicissus sp.
	Sarcostemma viminale
	Scolopia zeyheri
	Xeromphis obovata

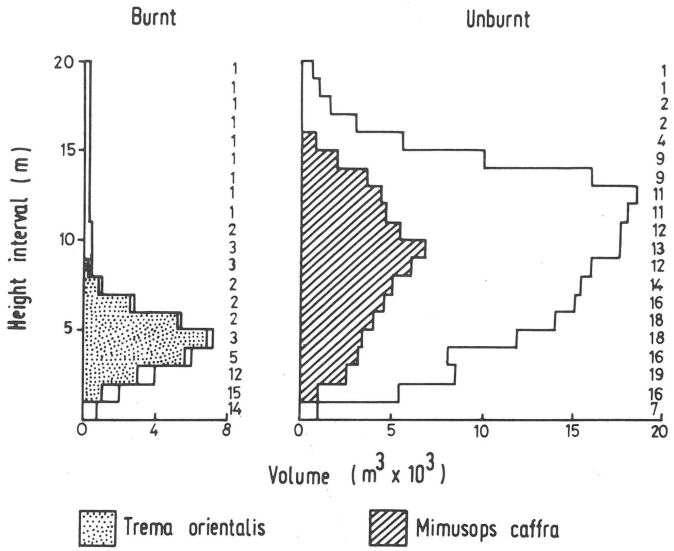

Figure 1 The distribution of canopy volume through the depth of the canopy in the burnt and unburnt forest. The contributions of *T. orientalis* and *M. caffra* to the burnt and unburnt communities respectively, are shown. The figures to the right of the histograms indicate the number of species contributing to each 1-m canopy interval.

Table 4 Basal areas, canopy areas and canopy volumes of species present in the burnt and unburnt areas of the forest. Figures in parentheses are one standard deviation

	Burnt				Unburnt			
Species	Basal area (m^2 ha^{-1})	Canopy area (m^2 ha^{-1})	Canopy volume (m^3 ha^{-1})		Species	Basal area (m^2 ha^{-1})	Canopy area (m^2 ha^{-1})	Canopy volume (m^3 ha^{-1})
Trema orientalis	7,029 (1,807)	13574 (3073)	25735 (10480)		*Mimusops caffra*	10,725 (6,698)	8964 (5800)	55990 (42234)
Mimusops caffra	1,747 (3,494)	346 (692)	2323 (4684)		*Vepris undulata*	9,179 (13,083)	7628 (8018)	46273 (61371)
Euclea natalensis	0,353 (0,398)	485 (302)	1394 (1704)		*Ekebergia capensis*	8,227 (16,414)	1880 (3734)	15972 (31912)
Canthium ventosum	0,129 (0,252)	281 (542)	571 (1113)		*Sideroxylon inerme*	6,176 (8,355)	4517 (4951)	18530 (17688)
Vepris undulata	0,128 (0,135)	223 (328)	285 (402)		*Olea woodiana*	3,487 (5,183)	2885 (4041)	10367 (15402)
Brachylaena discolor	0,081 (0,063)	307 (287)	524 (576)		*Canthium obovatum*	2,557 (4,207)	883 (1236)	4165 (6133)
Sideroxylon inerme	0,080 (0,094)	132 (120)	297 (310)		*Euclea natalensis*	2,112 (1,754)	6260 (6950)	14343 (9856)
Cussonia spicata	0,045 (0,089)	35 (70)	35 (71)		*Apodytes dimidiata*	1,702 (3,405)	1355 (2710)	9608 (19215)
Allophyllus natalensis	0,044 (0,085)	87 (161)	99 (190)		*Maytenus spp.*	1,367 (0,796)	4251 (2854)	11658 (8836)
Ochna natalitia	0,021 (0,040)	35 (54)	50 (82)		*Rhoicissus sp.*	1,160 (0,951)	–	–
Peddiea africana	0,017 (0,025)	33 (43)	38 (50)		*Scolopia zeyheri*	0,626 (0,617)	886 (756)	2819 (3087)
Calpurnia aurea	0,015 (0,031)	60 (120)	75 (151)		*Dovyalis rhamnoides*	0,455 (0,512)	1160 (1350)	2220 (2650)
Maytenus spp.	0,014 (0,018)	35 (43)	37 (47)		*Tricalysia sonderiana*	0,427 (0,421)	998 (910)	3036 (2486)
Dovyalis rhamnoides	0,012 (0,022)	15 (19)	17 (23)		*Rhoicissus rhomboidea*	0,296 (0,338)	–	–
Ekebergia capensis	0,012 (0,019)	57 (101)	54 (94)		*Dovyalis longispina*	0,295 (0,242)	703 (461)	2256 (1794)
Ficus capensis	0,010 (0,015)	24 (35)	46 (81)		*Peddiea africana*	0,192 (0,062)	577 (329)	731 (468)
Putterlickia verrucosa	0,007 (0,005)	42 (36)	39 (36)		*Monanthotaxis caffra*	0,144 (0,077)	397 (467)	455 (517)
Tricalysia sonderiana	0,007 (0,010)	14 (17)	22 (28)		*Dalbergia armata*	0,134 (0,191)	–	–
Dovyalis longispina	0,006 (0,008)	47 (51)	51 (70)		*Xeromphis obovata*	0,134 (0,268)	13 (26)	76 (153)
Scutia myrtina	0,006 (0,008)	126 (158)	203 (250)		*Putterlickia verrucosa*	0,112 (0,135)	410 (633)	539 (876)

Table 4 *Continued*

Burnt				Unburnt			
Species	Basal area (m^2 ha^{-1})	Canopy area (m^2 ha^{-1})	Canopy volume (m^3 ha^{-1})	Species	Basal area (m^2 ha^{-1})	Canopy area (m^2 ha^{-1})	Canopy volume (m^3 ha^{-1})
Clerodendrum glabrum	0,006 (0,007)	83 (122)	83 (122)	*Cissampelos torulosa*	0,088 (0,111)	–	–
Cussonia zuluensis	0,004 (0,007)	< 1	< 1	*Scutia myrtina*	0,087 (0,089)	–	–
Bersama lucens	0,003 (0,004)	7 (9)	6 (8)	*Kraussia floribunda*	0,081 (0,055)	334 (323)	806 (954)
Passerina rigida	0,002 (0,002)	3 (4)	3 (4)	*Asparagus falcatus*	0,073 (0,124)	–	–
Ficus natalensis	0,002 (0,003)	3 (6)	2 (4)	*Clerodendrum glabrum*	0,061 (0,122)	64 (127)	126 (252)
Maesa lanceolata	0,002 (0,003)	26 (51)	54 (108)	*Bersama lucens*	0,056 (0,081)	103 (133)	201 (337)
Halleria lucida	0,001 (0,003)	4 (8)	3 (6)	*Brachylaena discolor*	0,038 (0,076)	59 (116)	89 (176)
Macaranga capensis	0,001 (0,002)	7 (12)	2 (3)	*Allophyllus natalensis*	0,037 (0,065)	53 (69)	157 (239)
Monanthotaxis caffra	0,001 (0,002)	11 (18)	33 (63)	*Rhoicissus tomentosa*	0,033 (0,041)	–	–
Canthium obovatum	< 0,001	3 (6)	6 (12)	*Ochna natalitia*	0,032 (0,044)	66 (71)	78 (83)
Rhus nebulosa	< 0,001	11 (23)	11 (23)	*Pavetta revoluta*	0,027 (0,030)	61 (74)	66 (79)
Carissa bispinosa	< 0,001	2 (3)	< 1	*Psychotria capensis*	0,019 (0,032)	154 (299)	156 (306)
Acalypha glabrata	< 0,001	< 1	< 1	*Rhoicissus digitata*	0,013 (0,026)	–	–
Cissampelos torulosa	< 0,001	9 (18)	13 (26)	*Cussonia zuluensis*	0,012 (0,024)	25 (50)	49 (98)
Crotalaria capensis	< 0,001	3 (5)	3 (6)	*Acacia kraussiana*	0,010 (0,019)	–	–
Eugenia capensis	< 0,001	< 1	< 1	*Embelia ruminata*	0,010 (0,019)	–	–
				Canthium ventosum	0,008 (0,010)	–	–
				Acokanthera oblongifolia	0,008 (0,015)	20 (41)	19 (38)
				Capparis tomentosa	0,006 (0,013)	–	–
				Carissa bispinosa	0,005 (0,004)	46 (45)	59 (67)
				Ficus natalensis	0,004 (0,007)	4 (8)	6 (12)
				Adenia gummifera	0,003 (0,006)	–	–
				Sarcostemma viminale	< 0,001	–	–

forest showed different levels of importance in the two communities. For example, *Canthium ventosum*, which is characteristic of disturbed forests, was 13 times denser in the burnt than in the unburnt area and *Brachylaena discolor*, a species common in coastal dune scrub and dune forest margins had a density 11 times greater in the burnt than in the unburnt community. The shade tolerant understorey shrubs *Tricalysia sonderiana* and *Monanthotaxis caffra* had four times the density in the unburnt compared with the burnt community.

The vast majority of regeneration in the burnt community was derived from seed, with only 3% of the individual plants and 21% of the basal area in the burnt community being derived from survivors of the fire (from Tables 1, 4 & 6). The appearance of seedlings of *T. orientalis* followed rapidly on the fire (Senior Ranger de Waal, personal communication), implying the presence of a viable soil seed bank, rather than import of seeds by birds subsequent to the fire. Nothing is known of the composition of this seed bank but *T. orientalis* was the first seedling noted in any numbers. This raises questions concerning the fire tolerance or requirements, and light and temperature requirements for the germination of seeds of forest tree and shrub species. Seeds of *T. orientalis* are killed by a three minute exposure to a temperature of 120 °C (unpublished observations).

Granger (1984) and Kruger (1984) have noted the dearth of descriptions of regeneration following forest fire. The only previous study in southern Africa is that of Phillips (1931) on the temperate forests of the southern Cape Province. He described a succession that took approximately 10 – 15 years before the original forest tree species re-established their dominance. The immediate post-fire succession in the Mlalazi forest would appear to differ from that of southern Cape forests; the rapid establishment of woody vegetation without passing through a perennial herb seral stage.

Only three years after the fire in the Mlalazi forest the number of species recorded in the burnt community was not markedly lower than that recorded in the unburnt forest (37 compared with 44, respectively). This includes a number of

Table 5 Relative basal area, canopy area and canopy volume of species present in the burnt and unburnt areas of the forest. Values expressed as a percentage. A zero indicates species absence, a dash indicates canopy not measured

	Burnt			Unburnt		
Species	Basal area	Canopy area	Canopy volume	Basal area	Canopy area	Canopy volume
Trema orientalis	71,8	84,2	80,1	0	0	0
Cussonia spicata	0,5	< 0,1	0,1	0	0	0
Calpurnia aurea	0,2	0,4	0,2	0	0	0
Ficus capensis	0,1	0,1	0,1	0	0	0
Maesa lanceolata	< 0,1	0,2	0,2	0	0	0
Halleria lucida	< 0,1	< 0,1	< 0,1	0	0	0
Passerina rigida	< 0,1	< 0,1	< 0,1	0	0	0
Macaranga capensis	< 0,1	< 0,1	< 0,1	0	0	0
Rhus nebulosa	< 0,1	0,1	< 0,1	0	0	0
Crotalaria capensis	< 0,1	< 0,1	< 0,1	0	0	0
Eugenia capensis	< 0,1	< 0,1	< 0,1	0	0	0
Sarcostemma viminale	0	0	0	< 0,1	–	–
Adenia gummifera	0	0	0	< 0,1	–	–
Ficus natalensis	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1
Carissa bispinosa	< 0,1	< 0,1	< 0,1	< 0,1	0,1	< 0,1
Capparis tomentosa	0	0	0	< 0,1	–	–
Acokanthera oblongifolia	0	0	0	< 0,1	< 0,1	< 0,1
Canthium ventosum	1,3	1,7	1,8	< 0,1	–	–
Embelia ruminata	0	0	0	< 0,1	–	–
Acacia kraussiana	0	0	0	< 0,1	–	–
Cussonia zuluensis	< 0,1	< 0,1	< 0,1	< 0,1	0,1	< 0,1
Rhoicissus digitata	0,	0	0	< 0,1	–	–
Psychotria capensis	0	0	0	< 0,1	0,3	0,1
Pavetta revoluta	0	0	0	0,1	0,1	< 0,1
Ochna natalitia	0,2	0,2	0,2	0,1	0,1	< 0,1
Rhoicissus tomentosa	0	0	0	0,1	–	–
Allophyllus natalensis	0,4	0,5	0,3	0,1	0,1	0,1
Brachylaena discolor	0,8	1,9	1,6	0,1	0,1	0,1
Bersama lucens	< 0,1	< 0,1	< 0,1	0,1	0,2	0,1
Clerodendrum glabrum	0,1	0,5	0,3	0,1	0,1	0,1
Asparagus falcatus	0	0	0	0,1	–	–
Kraussia floribunda	0	0	0	0,2	0,7	0,4
Scutia myrtina	0,1	0,8	0,6	0,2	–	–
Cissampelos torulosa	< 0,1	< 0,1	0,1	0,2	–	–
Putterlickia verrucosa	0,1	0,3	0,1	0,2	0,9	0,3
Xeromphis obovata	0	0	0	0,3	< 0,1	< 0,1
Dalbergia armata	0	0	0	0,3	–	–
Monanthotaxis caffra	< 0,1	0,1	0,1	0,3	0,9	0,2
Peddiea africana	0,2	0,2	0,1	0,4	1,3	0,4
Dovyalis longispina	0,1	0,3	0,2	0,6	1,6	1,1
Rhoicissus rhomboidea	0	0	0	0,6	–	–
Tricalysia sonderiana	0,1	0,1	0,1	0,9	2,2	1,5
Dovyalis rhamnoides	0,1	0,1	0,1	0,9	2,6	1,1
Scolopia zeyheri	0	0	0	1,2	2,0	1,4
Rhoicissus sp.	0	0	0	2,3	–	–
Maytenus spp.	0,1	0,2	0,1	2,7	9,5	5,8
Apodytes dimidiata	0	0	0	3,4	3,0	4,8
Euclea natalensis	3,6	3,0	4,3	4,2	14,0	7,1
Canthium obovatum	< 0,1	< 0,1	< 0,1	5,1	2,0	2,1
Olea woodiana	0	0	0	6,9	6,4	5,2
Sideroxylon inerme	0,8	0,8	0,9	12,3	10,1	9,2
Ekebergia capensis	0,1	0,4	0,2	16,4	4,2	8,0
Vepris undulata	1,3	1,7	0,9	18,3	17,0	23,0
Mimusops caffra	17,9	2,1	7,2	21,4	20,0	27,9

dominant canopy species that had been derived from seed (*Ekebergia capensis, Sideroxylon inerme* and *Vepris undulata*). However, no saplings of *Mimusops caffra*, a species characteristic of coastal dune forests, were found. Repeat surveys will give information on the rate of regeneration and any long-term changes in composition that may result from the fire.

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Table 6 Origin of species present in the burnt area expressed as percentage of individual plants or percentage of basal area that has arisen from seed germination subsequent to the fire, coppicing at ground level or regrowth from above ground

	Individual plants			Basal area		
Species	Seed	Ground level	Above ground	Seed	Ground level	Above ground
Acalypha glabrata	100	0	0	100	0	0
Allophyllus natalensis	100	0	0	100	0	0
Bersama lucens	67	33	0	28	72	0
Brachylaena discolor	100	0	0	100	0	0
Calpurnia aurea	100	0	0	100	0	0
Canthium obovatum	100	0	0	100	0	0
Canthium ventosum	91	9	0	48	52	0
Carissa bispinosa	100	0	0	100	0	0
Cissampelos torulosa	0	0	100	0	0	100
Clerodendrum glabrum	100	0	0	100	0	0
Crotalaria capensis	100	0	0	100	0	0
Cussonia spicata	100	0	0	100	0	0
Cussonia zuluensis	100	0	0	100	0	0
Dovyalis longispina	67	17	16	19	64	17
Dovyalis rhamnoides	86	14	0	12	88	0
Ekebergia capensis	100	0	0	100	0	0
Euclea natalensis	82	17	1	28	71	1
Eugenia capensis	100	0	0	100	0	0
Ficus capensis	100	0	0	100	0	0
Ficus natalensis	100	0	0	100	0	0
Halleria lucida	100	0	0	100	0	0
Macaranga capensis	100	0	0	100	0	0
Maesa lanceolata	100	0	0	100	0	0
Maytenus spp.	56	44	0	38	62	0
Mimusops caffra	0	70	30	0	2	98
Monanthotaxis caffra	100	0	0	100	0	0
Ochna natalitia	89	11	0	87	13	0
Passerina rigida	100	0	0	100	0	0
Peddiea africana	81	19	0	64	36	0
Putterlickia verrucosa	100	0	0	100	0	0
Rhus nebulosa	100	0	0	100	0	0
Scutia myrtina	100	0	0	100	0	0
Sideroxylon inerme	71	29	0	40	60	0
Trema orientalis	100	0	0	100	0	0
Tricalysia sonderiana	75	25	0	54	46	0
Vepris undulata	100	0	0	100	0	0

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