Notes and records

Vegetation composition of natural gaps in Moribane forest (Mozambique)

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Introduction

The land cover map of Mozambique (Marzoli, 2007) indicates that Moribane forest (144 km²) is part of a larger swath of evergreen tropical forest and woodlands of 820 km² in central Mozambique (Fig. 1). Evergreen forests in eastern and southern Africa are patchy and are thought to be remnants of formerly vast forests, which would have occurred under more humid climate in the early Holocene (Hamilton, 1981; Lovett, 1993).

Since the early twentieth century, Moribane forest has been intensively exploited, first for natural rubber (*Landolphia kirkii* Dyer ex Hook. f.) and later for timber, particularly the species *Khaya anthotheca* (Welw.) C. DC., *Milicia excelsa* (Welw.) C.C. Berg and *Millettia stuhlmannii* Taub (Ghiurghi, Dondeyne & Bannerman, 2010). Over the last decades, the area has also been much affected by wildfires and shifting agriculture. So far, very few studies have been carried out on the vegetation composition of the area. For Moribane, Müller, Siteo & Mabunda (2005) described two broad vegetation types: a moist, evergreen forest dominated by *Newtonia buchananii* (Baker) G.C.C. Gilbert & Boutique, *Celtis mildbreadii* Engl, *Erythrophloeum*

suaveolens (Guill. & Perr.) Brenan and *M. stuhlmannii* Taub.; and a transitional forest type at the northern edge of the forest, where the most important species were *Bersama abyssinica* Fresen, *M. stuhlmannii* Taub., *Pтелиopsis myrtifolia* (M.A. Lawson) Engl. & Diels, *Tabernaemontana elegans* Stapf and *Xylopia parviflora* (A. Rich.) Benth.

Moribane forest (19°41'–19°48' S and 33°16'–33°24' E) is currently part of the Chimanimani Transfrontier Conservation Area¹ where nature conservation and eco-tourism are promoted in partnership with local inhabitants (Ghiurghi, Dondeyne & Bannerman, 2010; Dondeyne, Kaarhus & Allison, 2012). As the area is still rich in forest, local people could benefit from carbon trading and from strategies aiming to reduce carbon emission by reducing deforestation and forest degradation. It, therefore, seemed important to obtain better insight into the vegetation dynamics and the forest regeneration capacity. By studying the composition of sapling in natural gaps, we aimed to improve our knowledge on forest types and examine whether forest degradation has reduced the role of typical forest species in forest regeneration.

Materials and methods

Moribane forest is allocated in hilly country between 400 and 550 m above sea level. The rainy season last from November to April, and the average annual precipitation is 1500 mm. The average temperature ranges between 23 and 25°C in January and between 17 and 19°C in July (Ghiurghi, Dondeyne & Bannerman, 2010).

The fieldwork was carried out in August–November 2007. A Global Positioning System was used to locate 11 sites for which random geographic coordinates had been generated (coordinates in Appendix). The first natural gap encountered in the vicinity of each site was examined. The length of the fallen tree was measured, and the presence/absence of saplings of different species was

¹This Transfrontier Conservation Area consists of the Chimanimani National Park (155 km²) in Zimbabwe and the Chimanimani National Reserve (660 km²) together with its buffer zone (1681 km²) in Mozambique (Fig. 1)

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Fig 1 Extent of evergreen forests and woodlands in the Chimanimani Transfrontier Conservation Area (adapted from Marzoli, 2007) and location of study sites in Moribane forest, central Mozambique

recorded. Saplings were defined as woody species with diameter of less than 10 cm at a height of 1 m above ground. The species were identified in the field by local people. Photographs and samples were taken for identification in the herbarium. Our local experts did not distinguish *T. elegans* from *Tabernaemontana ventricosa*, nor did they distinguish *Strychnos madagascariensis* from *Strychnos spinosa*. The texture of the topsoil and subsoil was assessed in the field using a soil auger.

To assess species diversity, the Shannon index was calculated on the basis of the presence/absence data. The association of the woody species was analysed using TWINSpan (McCune & Meord, 1999). The hypothesis that the vegetation groups differed in terms of gap characteristics and species richness was verified with the Kruskal–Wallis test.

Results and discussion

All gaps were created by a single fallen tree and with *N. buchananii* as the most common gap maker (Table 1). The texture of the topsoil varied from sandy loam (SL) to sandy clay loam (SCL), and the clay content increased in the subsoil. Muscovite micas were commonly observed, indicating that the soils are not highly weathered. Neither the direction of the gaps nor the species richness and diversity seemed to be related to the soil properties.

Within the 11 gaps, 30 taxa of saplings were identified. The most common tree species were *N. buchananii*, *M. excelsa*, *Synsepalum brevipes* and *Markhamia obtusifolia*; the most common shrubs were *Tabernaemontana* spp. and *Rothmannia manganjae* (Table 2). Using TWINSpan, it emerged that the saplings could be grouped into two broad

Table 1 Characteristics of eleven natural gaps in Moribane forest

Forest type ^b / Gap	Gap maker		Soil texture ^a			Saplings			
	Species	DBH (cm)	Length (m)	Gap direction	Cause	Topsoil (0–20 cm)	Subsoil (40–60 cm)	Number of species	Shannon Diversity
Evergreen forest									
Gap 03	<i>Newtonia buchananii</i>	68	28	E-W	Wind, uprooted	SCL	SC	6	1.79
Gap 04	<i>N. buchananii</i>	51	26	S-N	Wind, partly uprooted	SCL	SCL	6	1.79
Gap 19	<i>N. buchananii</i>	99	28	S-N	Wind, uprooted	SCL	SC	6	1.79
Median		68	28					6	1.79
Disturbed/Secondary forest									
Gap 08	<i>Pteleopsis myrtilifolia</i>	72	16	S-N	Wind, uprooted	SL	SL	4	1.19
Gap 07	<i>Heteropyxis dehniae</i>	37	16	E-W	Wind, partly uprooted	SC	C	8	2.08
Gap 18	<i>N. buchananii</i>	62	22	S-N	Fire, dead and broken	SL	SL	8	2.08
Gap 05	<i>Trema orientalis</i>	32	14	S-N	Wind, partly uprooted	SCL	SC	9	2.20
Gap 17	<i>N. buchananii</i>	100	22	S-N	Fire, dead and broken	SL	SL	7	1.95
Median		62	16					8	2.08
Transitional forest									
Gap 02	<i>Albizia adianthifolia</i>	40	10	E-W	Wind, dead, and uprooted	SL	SL	6	1.79
Gap 01	<i>Croton sylvaticus</i>	33	18	W-E	Wind, uprooted	SCL	SCL	12	2.93
Gap 09	<i>Parinari curatellifolia</i>	41	20	E-W	Wind, broken	SCL	SC	10	2.69
Median		40	18					10	2.69
<i>P</i> *		0.27	<0.05					0.21	0.21

^aUSDA soil texture classes: SL, sandy loam; SCL, sandy clay loam; SC, sandy clay; C, clay.^bsee table 2

*Probability of equal population medians per vegetation group, assuming chi-square distribution with 2 df (Kruskal–Wallis test).

Table 2 Presence/absence of small woody species (diameter <10 cm, 1 m above ground) in 11 natural gaps of Moribane forest. The species and gap groups were determined using TWINSpan

Forest type/Species	Group	Plant form	Habitat	Evergreen forest					Disturbed and secondary forest					Transitional forest				
				Gap-03	Gap-04	Gap-19	Gap-08	Gap-07	Gap-18	Gap-05	Gap-17	Gap-02	Gap-01	Gap-09	Total			
Disturbed evergreen forest																		
<i>Harungana madagascariensis</i> Lam. ex Poir.	A1	Shrub/small tree	Pioneer forest								1						1	
<i>Trema orientalis</i> (L.) Blume	A1	Shrub/small tree	Pioneer forest								1	1					2	
<i>Dombeya burgessiae</i> Gerrard ex Harv.	A1	Shrub/small tree	Pioneer forest							1							2	
<i>Ficus sur</i> Forssk.	A1	Large tree	Woodland							1							1	
<i>Synsepalum brevipes</i> (Baker f.) T.D. Penn.	A1	Shrub/medium tree	Evergreen forest					1	1	1	1						5	
<i>Macaranga capensis</i> (Baill.) Benth. ex Sim	A1	Medium/large tree	Evergreen forest							1							1	
<i>Millettia excelsa</i> (Welw.) C.C. Berg	A1	Large tree	Evergreen forest					1	1	1	1	1					5	
Evergreen forest																		
<i>Erythrophloeum suaveolens</i> (Guill. & Perr.) Brenan	A2	Medium/large tree	Evergreen forest					1									2	
<i>Aldia micrantha</i> (K. Schum.) Bullock ex F. White	A2	Shrub/small tree	Evergreen forest					1									2	
<i>Rawsonia lucida</i> Harv. & Sond.	A2	Shrub/small tree	Evergreen forest					1									1	
<i>Trichilia emetica</i> Vahl	A2	Medium/large tree	Forest-woodland					1									1	
<i>Newtonia buchananii</i> (Baker) G.C.C. Gilbert & A2	A2	Very large tree	Evergreen forest					1	1	1	1	1	1			1	9	
Boutique																		
Secondary evergreen forest																		
<i>Albizia adianthifolia</i> (Schumach.) W. Wight	A3	Large tree	Forest-woodland							1					1		3	
<i>Millettia stuhlmannii</i> Taub.	A3	Large tree	Forest-woodland							1					1		3	
<i>Rothmannia manginiae</i> (Hiern) Keay	A3	Shrub/small tree	Forest-woodland					1		1	1				1		7	
<i>Tabernaemontana</i> spp.	A3	Shrub/small tree	Forest-woodland					1	1	1	1	1			1	1	9	
<i>Funtumia africana</i> (Benth.) Stapf	A3	Small/medium tree	Evergreen forest					1	1							1	4	
Transitional forest																		
<i>Dombeya rotundifolia</i> (Hochst.) Planch	B	Small tree	Woodland							1							2	
<i>Antidesma venosum</i> E. Mey. ex Tul.	B	Shrub/small tree	Woodland														1	
<i>Parinari curatellifolia</i> Planch. ex Benth.	B	Small/medium tree	Forest-woodland														1	
<i>Strychnos</i> spp.	B	Shrub/small tree	Woodland														1	
<i>Combretum zeyheri</i> Sond.	B	Small/medium tree	Woodland												1	1	2	
<i>Albizia versicolor</i> Welw. ex Oliv.	B	Medium/large tree	Woodland												1		1	
<i>Bersama abyssinica</i> Fresen.	B	Medium tree	Forest-woodland														1	
<i>Combretum molle</i> R.Br ex G. Don	B	Small/medium tree	Woodland														1	
<i>Croton sylvaticus</i> Hochst. ex C. Krauss.	B	Shrub/small tree	Evergreen forest														1	
<i>Pteleopsis myrtifolia</i> (M.A. Lawson) Engl. & Diels	B	Shrub/small tree	Forest-woodland												1	1	2	
<i>Xylopia parviflora</i> (A. Rich.) Benth.	B	Small tree	Evergreen forest												1	1	4	
<i>Markhamia obtusifolia</i> (Baker) Sprague	B	Shrub/small tree	Forest-woodland												1	1	5	
<i>Zaniba golinensis</i> Hiern	B	Shrub/tree	Forest-woodland													1	2	

groups: group A includes mostly forest species and group B is richer in woodland species. The group of forest species could further be subdivided into species mainly associated with 'disturbed forest' (A1), 'evergreen forest' (A2) and 'secondary forest' (A3). Similarly, the gaps could be grouped into 'evergreen forest', 'disturbed or secondary forest' and 'transitional forest' (Table 2).

Owing to the dominance of *N. buchananii*, the length of the gap maker and hence the gap size were significantly larger in the evergreen forest than in the other vegetation types (Table 1). Although, with the Kruskal–Wallis test, species richness and diversity do not appear to be significantly different, the median number of species and the Shannon index are highest in the disturbed/secondary forest and in the transitional forest which can be expected as these vegetation types are of a mixed nature.

The vegetation groups, developed on the basis of the presence/absence of saplings, are in-line with the 'evergreen' and 'transitional' forest types described by Müller, Siteo & Mabunda (2005). Our data, however, also show the high degree of disturbances as reflected by the 'disturbed' and 'secondary' forest types. Most importantly, despite past overexploitation, the widespread occurrence of saplings of forest species such as *S. brevipes*, *N. buchananii*, *M. excelsa*, *M. stuhlmannii* and *E. suaveolens*, gives good hope for the natural regeneration of the forest.

Acknowledgements

This work was financially supported as a study grant to the first author by the Ministry of Foreign Affairs of Denmark (DANIDA). Musa Chipanzeque, Robert Makunda and Annelies Davis are thanked for their assistance in the fieldwork. The authors are grateful to Dr Bartholomeu Soto, Candida Lucas and the staff of the Chimanimani Transfrontier Conservation Area for their kind cooperation.

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(Manuscript accepted 5 July 2011)

doi: 10.1111/j.1365-2028.2011.01281.x

Appendix

Coordinates (m) of the study sites (UTM36s–WGS84).

Gap	X-coordinate	Y-coordinate
Gap-03	533120	7815050
Gap-04	532880	7815040
Gap-19	533250	7818530
Gap-08	536260	7821230
Gap-07	536750	7822720
Gap-18	532900	7819110
Gap-05	536250	7816390
Gap-17	536250	7818120
Gap-02	536210	7822850
Gap-01	536350	7822770
Gap-09	532340	7815360