

Classification and dynamics of a southern African subtropical coastal lowland forest

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The composition and dynamics of the Dukuduku coastal lowland forest were investigated by means of ordination techniques. Size-class distributions on data from 200 plots were analysed and we also interpreted aerial photographs. An initial classification suggested that there were six widespread communities. Ordination of data of potential canopy species, found in the canopy and in the sub-canopy, was done separately for five of the six communities. A successional trajectory became apparent from this analysis. Understorey composition in a particular community was often more similar to the canopy composition in the next community in the hypothesized time sequence, than to the composition of its own canopy. Analysis of size-class distributions of canopy species for each community supported the concept of a successional gradient. Common canopy species found in early successional communities tended to have negative exponential size-class distributions, whereas these same species were less frequent and had flatter size-class distributions in the later successional stages. Based on the results of the ordinations and size-class analysis, a conceptual model of forest dynamics is presented. It is hypothesized that large-scale disturbances, such as fire, are the dominant forces driving the dynamics of this coastal lowland forest.

Keywords: Forest ordination, size-class distribution, succession, Zululand coastal plain.

Nomenclature: Arnold and De Wet (1993).

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Introduction

In some forests, small disturbances such as branch or tree falls are sufficient to allow saplings of shade-tolerant species to reach the canopy. In these forests, many canopy species regenerate close to adults and forest processes can be described as fine-grained (Midgley *et al.* 1990; Everard *et al.* 1995). At the other extreme, large-scale disturbances such as vulcanism are needed to ensure regeneration of shade-intolerant species (e.g. Veblen *et al.* 1992). These shade-intolerant species are not able to regenerate near their adults and forest processes are therefore coarse-grained. Between these two extremes of shade-tolerance lies a continuum along which most forest communities fit. This continuum has recently been described for southern African forests (Everard *et al.* 1995). Investigations into the relationship between woody plant species diversity and grain have revealed that a direct relationship exists between these two parameters (Everard *et al.* 1994). Coarse-grained forests tend to have higher levels of diversity than their fine-grained counterparts. In this article, differences in grain between communities of a single forest are investigated.

The indigenous forests of south-eastern Africa have been broadly classified into two types, the Afromontane forests of the uplands and the lowland subtropical forests of the Indian Ocean Coastal Belt (Moll & White 1978). The subtropical forests can further be subdivided into dune, coastal lowland, sand, swamp and riverine forests. The Dukuduku forest is the largest and best-preserved coastal lowland forest in South Africa. It covers an area of 3 500 ha, which constitutes 40% of the present coastal lowland forests in the country. This forest type has largely been cleared for agriculture and Cooper (1985) estimated that 90% of the former range of coastal lowland forests has been lost to sugar cane production. Despite the importance of the Dukuduku forest, very little has been published about its floristics and dynamics. A superficial description of the species composition of the forest is

given by Henkel *et al.* (1941) and Bayer & Tinley (1966), and a classification was proposed by Gordon (1983). The aim in this study was to formulate a preliminary description of its successional dynamics. The need for an understanding of successional patterns is now all the more pressing because of increasing human pressure on the forest caused by a recent influx of local people and their associated disturbances of the forest.

Study site

Dukuduku forest (28°25'S, 32°17'E) is situated on the northern banks of the Umfolozi River floodplain. The natural vegetation surrounding the forest has largely been cleared for agriculture, with sugar cane plantations occurring on the artificially drained floodplain to the south. To the north, a grassland/forest mosaic has been replaced by exotic timber plantations (Figure 1).

The topography of the area comprises some minor north-south-trending dune ridges. These occur on a low plateau which rises to a maximum of 60 m above sea level. This plateau is surrounded by floodplains to the east, south and south-west, i.e. the St. Lucia, Umfolozi and Futululu alluvial plains respectively.

Soils are deep and predominantly derived from recent wind-deposited sands. They are prone to rapid leaching, and therefore poor in nutrient content. Lower-lying drainage lines result from intermittent streams and are associated with a higher organic fraction and clay content (Hobday 1979). These lower-lying areas are mostly situated in the eastern portion of the forest, with the western area having more relief. The aeolian deposits generally end along the southern and western boundary of the plateau area, and weathered outcrops of Cretaceous aged sand and silt-stones occur there.

A summary of the climatic data as recorded at Futululu Forestry Research Station (28°26'S, 32°18'E) is presented in Figure 2. Mean annual rainfall is 1 243 mm. North-east and south-west winds predominate with the rain-bearing winds being from the

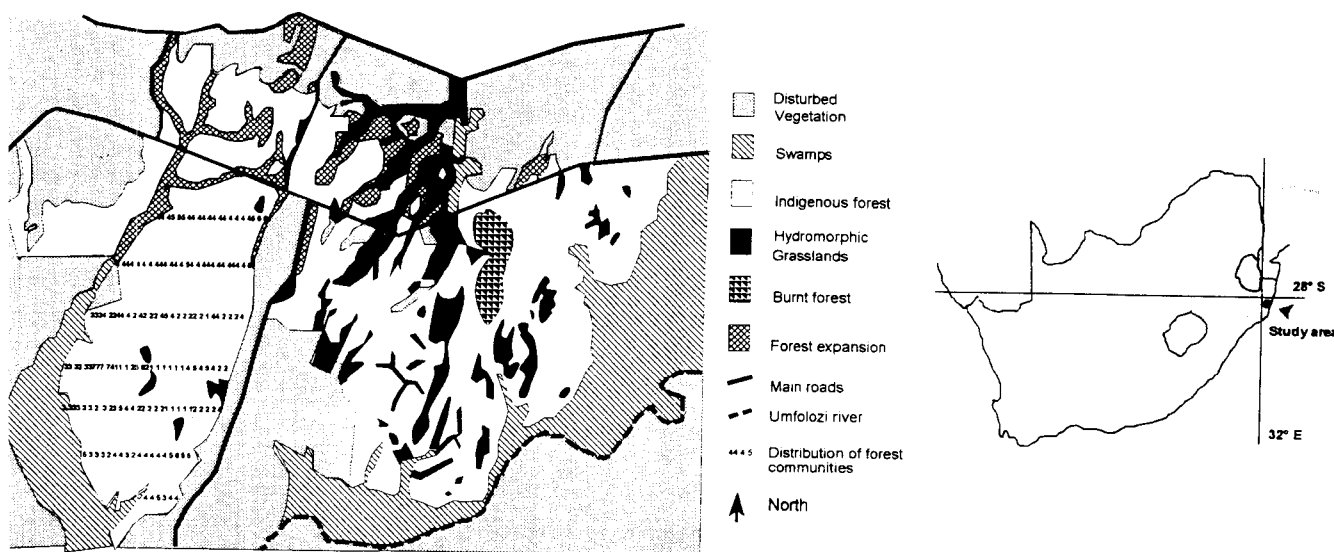


Figure 1 A map of Dukuduku forest and surrounding area. Transects through the sampled forest are shown, and the sample plots are coded according to which forest community (1 to 7) they belong to. These codes are explained in Table 1.

th-west. Rainfall is seasonal with 60% of precipitation falling in the summer months.

Methods

This analysis is based on a classification of quantitative floristics, an interpretation of a sequence of aerial photographs, a comparison of canopy to sub-canopy floristics and analysis of size-classes [see Gley & Gobetz (1993) for a similar approach].

We used a large data base of 200 sample plots, each 0.04 (20 × 20 m) in size. Transects were laid out in an east-west direction. The transects were 1 km apart (Figure 1) and plots were sampled every 100 m along these transects. All woody plants which were rooted in these plots were recorded and their diameter at breast height (DBH) and height were measured.

Statistical techniques

The samples were classified with the hierarchical classification package TWINSpan (Hill 1979a). Stems per plot were used as species importance values. Creepers and lianas were deleted from the data as problems were experienced in devising a consistent sampling method. For the TWINSpan algorithm, all options were set to default but pseudospecies cut levels were set at 0, 2, 5, 10, 20, 40 and 100 (see Hill 1979a).

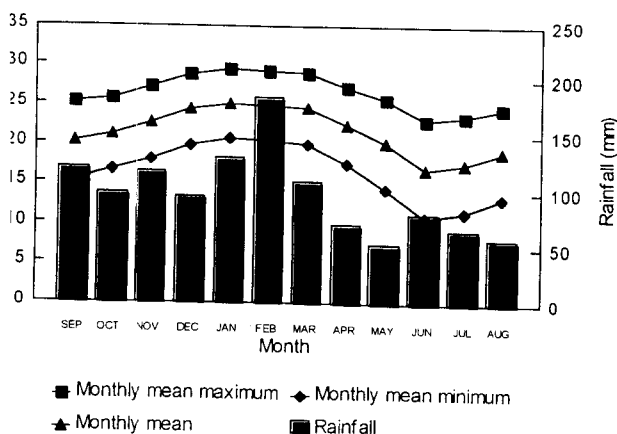


Figure 2 Mean rainfall and temperatures for Dukuduku forest, Africa.

For gradient analysis purposes, the entire data set was ordinated with the detrended correspondence analysis (DCA) subroutine of the program DECORANA (Hill 1979b). Species importance values used in this analysis were stems per plot. TWINSpan groupings were then superimposed on the resultant scatter plot, and it was found that one group consisting of five plots appeared to distort the ordination to the extent that little meaningful interpretation could be made. Analysis of aerial photographs and on-site inspections indicated that this *Acacia karroo* community was found on old disbanded cultivated lands. This group was therefore deleted from further analyses.

Subsequent analyses concentrated on the remaining communities, which comprised the bulk of the area. This data subset was again ordinated with DCA. The resultant scatterplot indicated that five of the six forest communities were separated along the first ordination axis, while the sixth community was separated from the rest along the second ordination axis.

In order to formulate a better understanding of the major variation in the data set (ordination axis 1), further analyses were done on the five communities that were separated by this axis. Centroids were calculated for each of the five communities. Ten plots per community with coordinates closest to the community centroids were used for further analysis. This was necessary to reduce excessive noise due to the high species richness of the area, and the large number of plots.

Further analyses only considered tree species capable of reaching the canopy. Individual plots were separated into canopy (tree species taller or equal to 5 m in height) and sub-canopy (tree species less than 5 m in height) sub-plots. To investigate the similarity between the canopy and sub-canopy sub-plots, this data set was re-ordinated with DECORANA. Species importance values used in this analysis were stems per plot.

Size-class distributions

Few tree species are useful for dendrochronology in South Africa (Lilly 1977). In the absence of a useful technique of ageing, size was used as a surrogate for age. We were interested in determining whether different species have different size-class distributions and whether size-class differed between community types. For example, species with a preponderance of adults in some communities and not in others may, upon further investigation, be seen as pioneers. Species which always have a preponderance of juveniles may be shade-tolerant climax species. Usually size-class information is analysed in terms of a negative exponential distribution (e.g. Midgley *et al.* 1990).

Table 1 The forest communities of Dukuduku as classified by the TWINSpan analysis of 200 plots, each 400 m². Numbers in parentheses refer to the codes used in Figures 3 and 4 and Appendix 1

Developing forests		
	<i>Acacia karroo</i> (7)	
	<i>Hymenocardia</i>	<i>Hymenocardia</i> thickets (6)
		<i>Hymenocardia</i> forests (5)
Core Forests		
Peripheral core	Northern peripheral	(4)
	Southern peripheral	(3)
Central core	<i>Strychnos decussata</i>	(2)
	<i>Diospyros natalensis</i>	(1)

To increase frequencies per size class to facilitate interpretation, we reduced the analysis of the six forest communities (excluding the *Acacia karroo* community) to three groups, the developing forests, peripheral forests and core forests (Table 1). Size-class distributions were determined by summing occurrences by species per community. The resultant distribution was visually inspected and classified into three categories, i.e. negative exponential ('inverse J') (much recruitment), flat (little recruitment), and unimodal (no recruitment). All common species (densities > 20 stems ha⁻¹ per community) were investigated in this fashion. Species were then classified into types based on density and size-class distribution shape.

The common canopy trees were classified as either predominantly multi- or single-stemmed. Fifteen trees of a particular species with DBH > 0.25 m were chosen at random and the height at which the first branch (diameter > 0.5 m) occurred was recorded. Individual trees were considered multi-stemmed if the first branch occurred at or below 0.25 m from ground level. Tree species were considered predominantly multi-stemmed if more than 66% of the sampled trees were multi-stemmed.

Aerial photograph interpretation

We studied a time sequence of aerial photographs from 1937, 1960 and 1988. From these we mapped areas of forest on successive photographs and determined the extent of increase in forest area. On-site inspection of 'young' forest sites (i.e. sites that were grassland in 1937 and 1960) were used to corroborate interpretations of ordinations and size-class distributions.

Results

Description of communities

Dukuduku forest can be described as a mixed, predominantly evergreen subtropical forest. The canopy was mainly closed and averaged 10 to 15 m in height. Widely spaced trees with large-diameter canopies typify the area. At Dukuduku, tree density averaged 275 stems ha⁻¹ (> 100 mm DBH).

The floristic classification was meaningful to three cut-off levels and resulted in the identification and characterization of seven forest communities. The first TWINSpan division (eigenvalue = 0.329) divided the forest according to the presence of *Apodytes dimidiata* and *Canthium inerme* on the one hand, and *Strychnos decussata*, *Ochna natalitia*, *Hyperacanthus amoenus*, *Pavetta gerstneri* and *Erythrococca berberidea* on the other hand. We argue later that this first separation represents 'young' or developing forest, and 'core' forest respectively. All the plots in the 'young' forest group were identified from aerial photographs as being areas that have only recently become forest.

The developing forest was further divided into sub-groups (eigenvalue = 0.295) consisting of *Acacia karroo* thicket (Community 7 in Table 1 and Appendix 1) and *Hymenocardia* forest. The latter group was separated into a *Hymenocardia ulmoides*/*Canthium inerme* thicket community (6) and a *Celtis africana*/*Chaetachme aristata* forest community (5). The *Acacia karroo* thicket occurred in the central western portion of the forest. These areas showed evidence of shifting agriculture on old aerial photographs and were herbaceous communities up to 1970.

The rest of the forest was divided into a core forest community with indicator tree species *Mimusops obovata* and *Diospyros natalensis*, and peripheral forest (eigenvalue = 0.201). The latter was divided into two communities which, due to their location, may be described as southern (4), and northern (3) peripheral forest (eigenvalue = 0.160). The core forest was further divided into two identifiable communities, a *Diospyros natalensis* community (2), and a *Strychnos decussata* community (1) (eigenvalue = 0.165).

Species composition and occurrence of these species in the seven communities are given in Appendix 1.

An ordination diagram of six communities (Figure 3) supports the TWINSpan classification, in that communities generally cluster together in ordination space. Axis 1 separates five of the six communities, while the southern peripheral forest is separated from the rest by axis 2.

Succession

The scatter diagram (Figure 4) produced by DECORANA analysis of the canopy and sub-canopy sub-plots indicated that most of the variation within the five communities is explained by Axis 1, with developing forests to the right and core forests to the left on this axis. Sub-canopy sub-plots lie consistently toward the left of the canopy sub-plots and the trajectory from developing, through peripheral, to core forests is fairly consistent in both the canopy and sub-canopy. It seems as though the analyses are justified through temporal phenomena, rather than environmental gradients *per se*.

Size-class distributions

Three groups of species can be identified, based on the shape of the size-class distribution curve and densities of individual species per forest type (Figure 5 and Appendix 1). The first group of

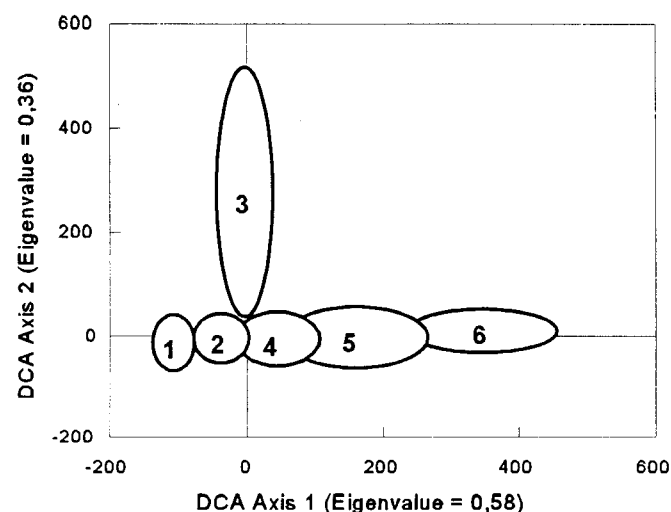


Figure 3 An ordination diagram (DCA) of six of the seven forest communities in Dukuduku forest. Numbers refer to the communities in Table 1.

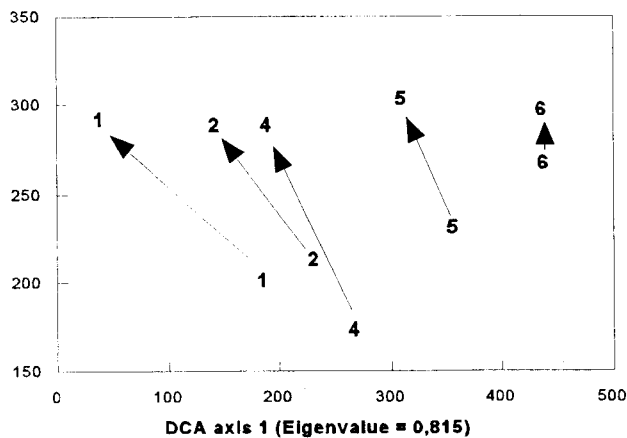


Figure 4 The position of community centroids after an ordination (DCA) of the canopy and sub-canopy (point closest to the arrow head) plots. Numbers refer to the communities in Table 1.

species (1 in Appendix 1) has highest densities in the developing forests. They have intermediate densities in the peripheral forests and are generally absent from the core forests. In the developing forests, these species tend to have an 'inverse J' size-class distribution, while in the peripheral and core forests, the size-class distribution of these species are flat to unimodal (Figure 5a). These species are mostly multi-stemmed and occur in adjacent grasslands where they are maintained as multi-stemmed shrubs through recurrent fires.

The second group of species (2 in Appendix 1) are generally less frequent in the developing forests and they too tend to occur in the peripheral and core forests as large individuals with little recruitment (size-class distributions generally flat or unimodal). These species are single- or multi-stemmed (Figure 5b).

The third group of species occur mainly in the core forests where they generally have 'inverse J' size-class distributions. We suspect these to be typical shade-tolerant species which regenerate in understorey conditions. They are all single-stemmed (Figure 5c).

Spatial dynamics of Dukuduku forest

The changes in the size of the forest are indicated in Figure 1. The area of forest has increased from 3 164 ha in 1937 to 3 500 ha in 1988. Encroachment by forests was primarily through ecotone advancement of forest in the northern and north-western portion. In the east, a series of forest clumps expanded and some of these merged, forming larger contiguous forests. In the western drainage line, swamp forests (not sampled in this survey) have developed, while the eastern swamp forests have remained relatively stable in size. Forest expansion occurred mainly after 1960, indicating that forest succession can proceed rapidly in this sub-tropical area.

Discussion

The results suggest that a successional continuum exists at Dukuduku forest. A directional trajectory is evident in the ordination. This is probably not due to variation in environmental factors because the area is relatively homogeneous (level topography with deep, sandy soils). This finding is supported by size-class distributions, which show successional tendencies among communities when arranged along a chronosequence.

If the above interpretation is correct, then the data indicate that only a small area in the centre of the forest is approaching a phase where *in situ* regeneration by presumably shade-tolerant species such as *Diospyros natalensis*, *D. inhacaensis* and *Mayte-*

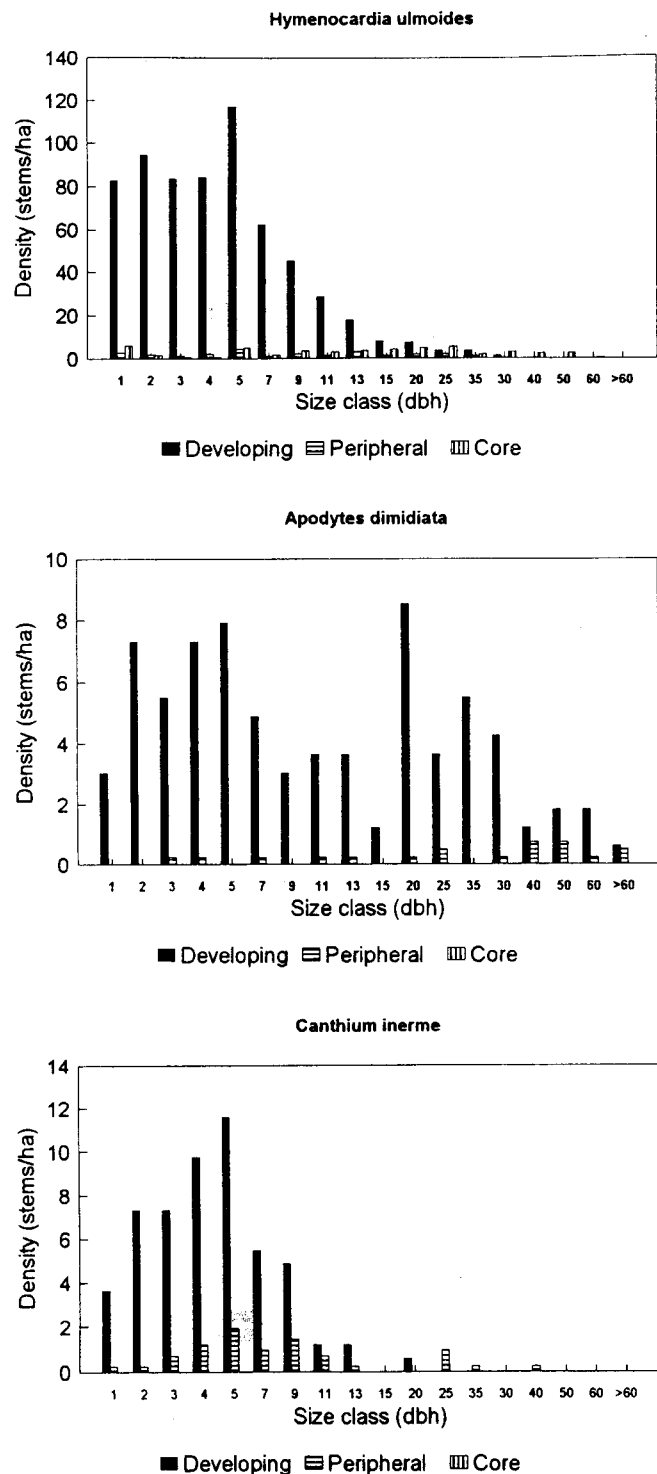


Figure 5 a. Size-class distribution of three typical developing forest species. In the developing forests, these species have a negative exponential size-class distribution, while in the peripheral forests, the distribution tends to be flat or unimodal. These species are generally absent from the core forests.

nus undata is occurring (Figure 1). Interestingly, there are no large differences in diversity along this successional gradient when compared on a plot basis (Table 2). However, total number of woody and tree species per community are lower in the core forests. We suspect that in the absence of major disturbance, many of the 'pioneer' species (i.e. Group 1 and 2 species) will gradually be eliminated from the core forest. At present, Group 1 species such as *Hymenocardia ulmoides*, *Apodytes dimidiata* and

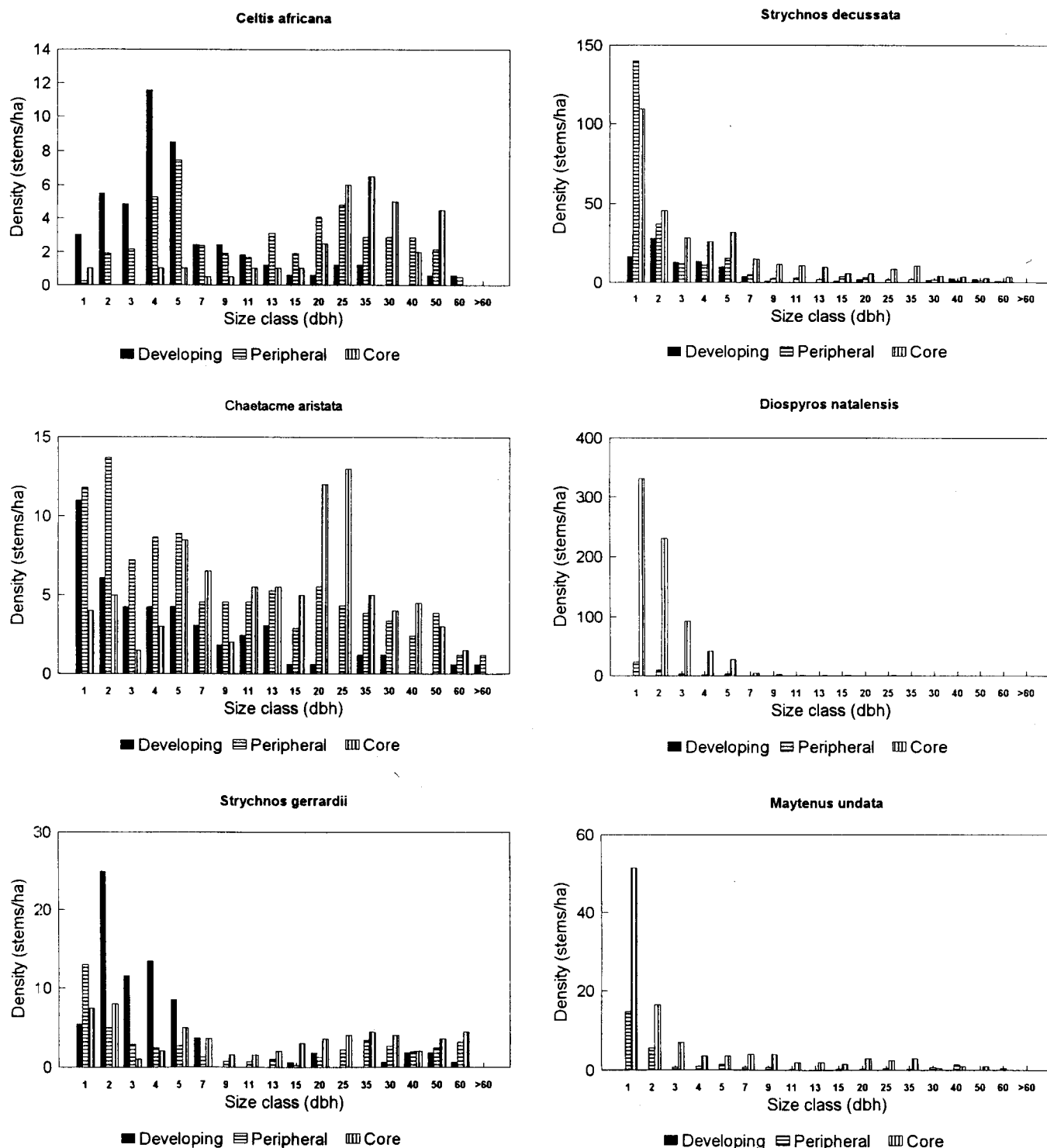


Figure 5 b, Size-class distribution of three typical peripheral forest species. In the developing forest, the distribution tends to be negative exponential, flat in the peripheral forest, and unimodal in the core forest. c, Size-class distribution of three typical core forest species. These species are generally absent from the developing forests, occasional in the peripheral forests and prominent in the core forests. In both the latter forest types, the size-class distributions are negative exponential.

Psydrax obovata, and Group 2 species such as *Strychnos gerrardii*, *Celtis africana* and *Chaetacme aristata* are only represented as large individuals, and are not regenerating.

A conceptual model of the dynamics of Dukuduku forest is presented in Figure 6. Phase 1 occurs as the forest invades adjacent burnt grasslands, or regenerates by resprouting in burnt forest. This process is associated with a change in fire frequency and intensity, and a maturing of a cohort of fire-stunted individuals within the grasslands. The developing forest is poorly strati-

fied, even-aged and thicket-like in appearance. These forest pioneering species, such as *H. ulmoides*, *A. dimidiata*, *Canthium inerme* and *P. obovata* are mostly multi-stemmed, fire tolerant and can be described as ruderal (*sensu* Grime 1977).

The second phase is characterized by a maturing cohort of shade-intolerant species. Size-class distributions within this community tend to be flat due to the lack of *in situ* regeneration of the more 'pioneer' species. Species characterizing this phase are predominantly single-stemmed (*C. africana*, *Balanites maughamii*),

Table 2 Species richness per community type of the Dukuduku forest. Mean richness represents means of numbers of woody species per plot per community

Community	No of plots	Mean richness	Total woody species	Total tree species
Central core (<i>Diospyros</i>)	17	24.88	80	34
Central core (<i>Strychnos</i>)	33	26.54	104	48
Northern peripheral	26	26.03	102	54
Southern peripheral	77	22.23	119	51
<i>Hymenocardia</i> forests	26	22.03	127	60
<i>Hymenocardia</i> thickets	15	19.07	86	45
<i>Acacia karroo</i>	5	16.00	72	35

with a few species persisting as multi-stemmed individuals (*S. gerrardii*, *C. aristata*). This guild of species can be described as competitors (Grime 1977) as they establish in gaps of tree falls created by the maturing pioneer species and therefore are fast-growing, shade-intolerant species. Some of the peripheral forest species survive forest disturbances through an ability to resprout.

The final phase involves the establishment of shade-tolerant species (stress-tolerants). These species have a bank of advanced regeneration, as indicated by their size-class distributions. They are all single-stemmed and include species such as *D. natalensis*, *D. inhacaënsis* and *Maytenus undata*.

Forest dynamics of Dukuduku forest are therefore varied in scale, depending on time since last disturbance. In the frequently disturbed developing forests, species survive through sprouting, and when these species reach senescence, a guild of competitive species establish and persist. After a prolonged period of non-disturbance, shade-tolerant species invade, and it can be argued that these species will eventually dominate the forest, should the forest be protected from periodic disturbances. The

dynamics of Dukuduku forest therefore seemingly conform to the facilitation model of forest dynamics (Connell & Slatyer 1977).

Life-history attributes of the various guilds of species need further research. Many of the Group 1 species appear to have dry fruits (*Hymenocardia ulmoides*, *Albizia adianthifolia* and *Brachylaena discolor*) and they are generally extremely fire-tolerant. We suspect that these species are also shade-intolerant and therefore incapable of regenerating under forest canopies of the peripheral and core forests. Most of the Group 2 and 3 species have fleshy fruits and are less fire-tolerant. Midgley *et al.* (1995) have recently analysed leaf attributes for many species in this forest. Their data provide collaborating evidence for the above groupings by, for example, showing that core forest species such as *Strychnos decussata*, *Diospyros natalensis* and *Mimusops obovata* have the low specific leaf area expected of shade-tolerant species.

If the successional hypothesis is correct, then it also suggests that disturbance is an important factor in these forests that must be taken into account by conservation managers. It implies that large-scale disturbances, such as periodic fires or possibly the effects of herds of mega-herbivores like elephants, are essential in maintaining forest processes. The disturbance dynamics and functioning of this coastal lowland forest are seemingly on the one extreme of a continuum that exists in southern African forests (Everard *et al.* 1995). For example, Midgley *et al.* (1990) showed that for the Knysna Forest (Afro-montane type), most canopy dominants regenerate *in situ* and most have negative exponential size-class distributions. The Knysna Forest is therefore a fine-grained forest, whereas Dukuduku is coarse-grained. Also unlike the Knysna Forest, many lowland species are multi-stemmed and appear to have the ability to persist by continuous resprouting.

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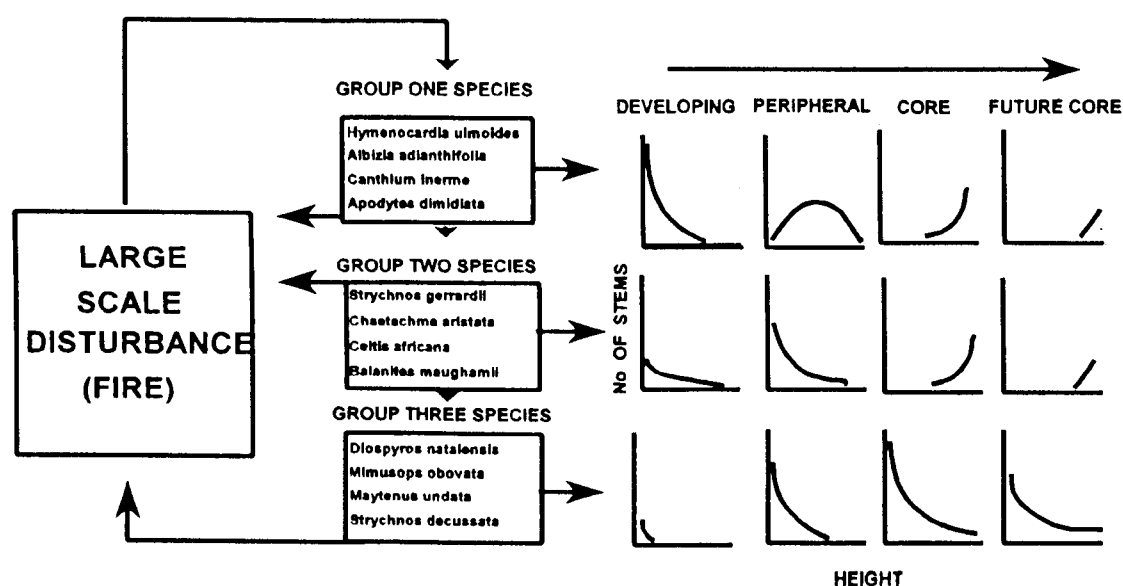


Figure 6 A conceptual model of the dynamics of Dukuduku forest. Group 1 species refer to the developing forest species (Figure 5a, 1 in Appendix 1), Group 2 species refer to peripheral forest species (Figure 5b, 2 in Appendix 1) and Group 3 species are typical core forest species (Figure 5c, 3 in Appendix 1).

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Appendix 1 The occurrence of woody species in the seven communities within Dukuduku forest. Growth forms are s = shrub, t = tree. See Table 1 for description of the forest community types. Numbers in parentheses refer to the species groups as explained in the text

Forest community types		1	2	3	4	5	6	7		
Total plots per community		17	37	22	77	26	15	6		
Growth form	Species	Plots	Total stems	Occurrences in communities						
s	<i>Acalypha glabrata</i> (Euphorbiaceae)	22	134	13	3	2	1	1	2	
s	<i>Drypetes natalensis</i> (Euphorbiaceae)	9	48	6	1		1		1	
s	<i>Maerua racemulosa</i> (Capparaceae)	21	71	8	6		6	1		
t	<i>Strychnos usambarensis</i> (Loganiaceae)(3)	22	130	9	9		3	1		
s	<i>Cola greenwayi</i> (Sterculiaceae)	7	47		5		2			
t	<i>Diospyros inhacaënsis</i> (Ebenaceae) (3)	35	86	9	16	4	6			
t	<i>Diospyros natalensis</i> (Ebenaceae) (3)	76	1634	16	32	10	18			
s	<i>Drypetes arguta</i> (Euphorbiaceae)	35	766	13	17		5	1		
t	<i>Ficus polita</i> (Moraceae)	5	5	1	3		1			
t	<i>Mimusops obovata</i> (Sapotaceae) (3)	39	138	15	17		6	1		
s	<i>Suregada africana</i> (Euphorbiaceae)	4	17	4						
s	<i>Pancovia golungensis</i> (Sapindaceae)	83	350	17	31	11	20	3	1	
s	<i>Erythroxylum emarginatum</i> (Erythroxylaceae)	66	357	10	32	5	14	3	2	
t	<i>Tapura fischeri</i> (Dichapetalaceae)	9	20	5			4			
s	<i>Gardenia thunbergia</i> (Rubiaceae)	34	52	6	10	7	9	2		
t	<i>Eugenia natalitia</i> (Myrtaceae)	51	125	3	12	4	25	6	1	
t	<i>Cussonia sphaerocephala</i> (Araliaceae) (2)	14	23	1	2	1	8	2		
s	<i>Turraea floribunda</i> (Meliaceae)	40	76	2	4	12	15	4	3	
t	<i>Maytenus undata</i> (Celastraceae) (3)	89	345	17	31	20	15	3	1	2

Appendix 1 Continued

t	<i>Coddia rudis</i> (Rubiaceae)	62	181	9	25	16	10	1	1
s	<i>Hyperacanthus amoenus</i> (Rubiaceae)	135	1220	17	33	24	56	5	
t	<i>Pleurostyliia capensis</i> (Celastraceae) (2)	8	14		5	1	2		
t	<i>Cassipourea gerrardii</i> (Rhizophoraceae)	38	67	7	9	8	13	1	
s	<i>Erythrococca berberidea</i> (Euphorbiaceae)	109	260	9	28	16	51	4	1
s	<i>Pavetta gerstneri</i> (Rubiaceae)	130	535	17	32	15	58	6	1 1
t	<i>Strychnos decussata</i> (Loganiaceae) (3)	157	1692	16	37	22	71	9	1
t	<i>Vepris reflexa</i> (Rutaceae)	3	6		2		1		
s	<i>Bauhinia tomentosa</i> (Fabaceae)	42	181	5	9	6	19	2	1
s	<i>Carissa bispinosa</i> (Apocynaceae)	130	522	16	34	13	54	10	2 1
s	<i>Mitriostigma axillare</i> (Rubiaceae)	36	60	4	11	1	18	2	
t	<i>Ochna natalitia</i> (Ochnaceae) (2)	165	2596	17	37	19	72	17	3
t	<i>Dovyalis longispina</i> (Flacourtiaceae) (3)	32	51	8	7		15	2	
s	<i>Bequaertiodendron natalensis</i> (Sapotaceae)	24	401	2	5	11	3	3	
t	<i>Teclea natalensis</i> (Rutaceae) (3)	57	556	8	7	20	16	3	3
s	<i>Allocassine laurifolia</i> (Celastraceae)	12	17	3	4		3	2	
s	<i>Vangueria randii</i> (Rubiaceae)	35	51	7	9	3	10	5	1
t	<i>Balanites maughamii</i> (Balanitaceae) (2)	33	135	4	7	5	13	2	2
s	<i>Deinbollia oblongifolia</i> (Sapindaceae)	102	201	13	19	10	47	9	2 2
s	<i>Dovyalis rhamnoides</i> (Flacourtiaceae)	67	319	6	20	11	24	5	1
s	<i>Grewia caffra</i> (Tiliaceae)	31	47	4	2	1	18	8	
t	<i>Maytenus peduncularis</i> (Celastraceae)	59	130	6	18	8	20	5	1 1
s	<i>Pavetta revoluta</i> (Rubiaceae)	53	142		19	4	24	3	3
t	<i>Galpinia transvaalica</i> (Lythraceae) (2)	2	5			1	1		
t	<i>Acacia robusta</i> subsp. <i>robusta</i> (Fabaceae)	7	9		1	5	1		
s	<i>Calpurnia aurea</i> (Fabaceae)	5	9		1	1	3		
t	<i>Maytenus procumbens</i> (Celastraceae)	3	12		1	1	1		
t	<i>Dombeya tiliaceae</i> (Sterculiaceae) (1)	11	27		1	4	4	1	1
t	<i>Harpephyllum caffrum</i> (Anacardiaceae) (2)	4	8			3		1	
s	<i>Hippobromus pauciflorus</i> (Sapindaceae)	5	46			4		1	
s	<i>Rhus gueinzii</i> (Anacardiaceae)	7	12			4	2		1
t	<i>Plectroniella armata</i> (Rubiaceae)	4	17		1	1	1	1	
t	<i>Ziziphus mucronata</i> (Rhamnaceae) (2)	32	36	2	6	1	15	2	2 4
t	<i>Cordia caffra</i> (Boraginaceae)	14	18	2		5	4	2	1
s	<i>Allophylus melanocarpus</i> (Sapindaceae)	6	9			2	2		2
t	<i>Celtis durandii</i> (Ulmaceae)	5	42			2		1	2
t	<i>Ficus sur</i> (Moraceae)	2	17			1			1
t	<i>Celtis africana</i> (Ulmaceae) (2)	118	384	5	23	18	52	15	1 4
t	<i>Chaetacme aristata</i> (Ulmaceae) (2)	150	677	12	31	22	63	17	2 3
s	<i>Clausena anisata</i> (Rutaceae)	138	675	9	27	14	62	13	7 6
t	<i>Strychnos gerrardii</i> (Loganiaceae)	156	464	12	32	14	69	18	10 1
s	<i>Tarenna junodii</i> (Rubiaceae)	41	82	3	9	3	17	7	1 1
s	<i>Xylothea kraussiana</i> (Flacourtiaceae)	61	161	3	16	4	25	8	5

Appendix 1 Continued

t	<i>Euclea natalensis</i> subsp. <i>natalensis</i> (Ebenaceae) (2)	103	257	4	22	15	47	10	3	2
s	<i>Lagynias lasiantha</i> (Rubiaceae)	57	91	4	12	7	27	5	2	
s	<i>Maytenus nemorosa</i> (Celastraceae)	130	716	5	29	20	58	12	3	3
t	<i>Scolopia zeyheri</i> (Flacourtiaceae) (2)	56	141		3	10	22	14	5	2
t	<i>Olea woodiana</i> (Oleaceae) (2)	23	65		8	5	5	4	1	
s	<i>Grewia occidentalis</i> (Tiliaceae)	65	231	1	4	9	34	11	1	5
t	<i>Combretum molle</i> (Combretaceae)	23	38		3	6	8	5	1	
s	<i>Maerua cafra</i> (Capparaceae)	5	9		1	2	1	1		
s	<i>Putterlickia verrucosa</i> (Celastraceae)	6	13		1	3	1	1		
s	<i>Rothmannia globosa</i> (Rubiaceae)	98	1398	2	14	13	38	24	5	2
t	<i>Acacia robusta</i> subsp. <i>clavigera</i> (Fabaceae)	21	40		2	1	11	5	2	
s	<i>Bersama lucens</i> (Melianthaceae)	23	83		2		13	7	1	1
t	<i>Clerodendrum glabrum</i> (Verbenaceae)	21	43		2	3	8	4	1	3
t	<i>Croton sylvaticus</i> (Euphorbiaceae) (2)	22	84		1	6	7	7	1	
t	<i>Trichilia dregeana</i> (Meliaceae) (2)	7	28				4	3		
t	<i>Catunaregam spinosa</i> (Rubiaceae)	19	45		1	1	9	4	4	
s	<i>Psychotria capensis</i> (Rubiaceae)	58	264	2	8		32	13	3	
t	<i>Trichilia emetica</i> (Meliaceae) (1)	22	42	1	2		10	6	1	2
s	<i>Allophylus decipiens</i> (Sapindaceae)	15	24	1	2	1	5	4	2	
t	<i>Ekebergia capensis</i> (Meliaceae) (2)	35	61		2	2	13	10	5	3
t	<i>Trimeria grandifolia</i> (Flacourtiaceae) (1)	41	181		5	2	15	9	5	5
t	<i>Vepris lanceolata</i> (Rutaceae) (1)	53	196		2	5	19	15	10	2
t	<i>Albizia adianthifolia</i> (Fabaceae) (1)	81	304		17	2	33	16	11	2
t	<i>Ficus natalensis</i> (Moraceae)	15	16	1	2	2	5	4	1	
s	<i>Peddiea africana</i> (Thymelaeaceae)	70	278	1	8	7	23	18	13	
s	<i>Bridelia cathartica</i> (Euphorbiaceae)	5	5		1	2		1	1	
t	<i>Lannea discolor</i> (Anacardiaceae)	3	9		1		1	1		
t	<i>Teclea gerrardii</i> (Rutaceae)	10	17	2	2	2	1	1	2	
s	<i>Pavetta lanceolata</i> (Rubiaceae)	10	18	1		2	1	2	1	3
t	<i>Sideroxylon inerme</i> (Sapotaceae) (1)	8	19			2		5		1
t	<i>Trema orientalis</i> (Ulmaceae) (2)	16	51			2	2	8	2	2
t	<i>Halleria lucida</i> (Scrophulariaceae)	3	8	1		1		1		
t	<i>Psydrax obovata</i> (Rubiaceae) (1)	57	134	1	16	4	22	7	7	
s	<i>Maerua nervosa</i> (Capparaceae)	6	8					4	2	
t	<i>Dialium schlechteri</i> (Fabaceae)	6	9				3	1	2	
t	<i>Zanthoxylum capense</i> (Rutaceae) (1)	18	43				8	5	5	
t	<i>Acacia burkei</i> (Fabaceae)	4	5				2	1	1	
t	<i>Brachylaena discolor</i> (Asteraceae) (1)	31	95		3	1	12	6	9	
s	<i>Tricalysia sonderiana</i> (Rubiaceae)	4	5				2	1	1	
t	<i>Hymenocardia ulmoides</i> (Euphorbiaceae) (1)	80	1355	2	18		29	18	13	
t	<i>Antidesma venosum</i> (Euphorbiaceae) (1)	26	63		2		8	7	6	3
t	<i>Canthium inerme</i> (Rubiaceae) (1)	58	159		6	1	21	12	13	5
s	<i>Kraussia floribunda</i> (Rubiaceae)	35	174		1	3	11	8	8	4

Appendix 1 Continued

t	<i>Sclerocarya birrea</i> subsp. <i>caffra</i> (Anacardiaceae)	5	6		2		3	
t	<i>Acacia karroo</i> (Fabaceae)	14	112		1	1	3	5
s	<i>Erythroxylum delagoense</i> (Erythroxylaceae)	6	35	1			4	1
s	<i>Margaritaria discoidea</i> (Euphorbiaceae)	5	8	1			3	1
t	<i>Apodytes dimidiata</i> (Icacinaeae) (1)	43	169	3		14	13	12
t	<i>Bridelia micrantha</i> (Euphorbiaceae) (1)	13	27	1		1	4	6
t	<i>Rhus chirindensis</i> (Anacardiaceae) (1)	37	111		4	8	14	8
t	<i>Sapium integerrimum</i> (Euphorbiaceae) (1)	16	37			1	5	10
t	<i>Syzygium cordatum</i> (Myrtaceae) (1)	4	7				1	3
s	<i>Dichrostachys cinerea</i> (Fabaceae)	10	81			2	1	6
s	<i>Strychnos madagascariensis</i> (Loganiaceae)	6	38				1	4
s	<i>Strychnos spinosa</i> (Loganiaceae)	20	102		1	9	3	6
s	<i>Vangueria infausta</i> (Rubiaceae)	3	7					3
t	<i>Cryptocarya woodii</i> (Lauraceae)	3	4				3	
s	<i>Allophylus natalensis</i> (Sapindaceae)	3	7	1			2	