F. von Breitenbach

Reports on indigenous forests
Part 1

Introduction and methods

South-eastern Transvaal forests

Kaapsehoop forests

Uitsoek forests

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G.P.-S.

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Contents

Introduction

In 1977, a few years before my retirement from permanent service, the then Secretary for Forestry, Mr D. P. Ackerman, assigned to me a survey of the indigenous forests of Natal and Transvaal. Initially this was very much of a side-line project. Apart from the normal office routine in the forest management section and thereafter at the Forestry Research Institute, I was still occupied with several other matters such as a conservation plan for the Transkei forests, a comprehensive report on protected tree legislation and the publication of the Southern Cape Tree Guide. It was only in the middle of the eighties that I could fully concentrate on the survey. By that time, however, there was no longer an opportunity for continued fieldwork.

Originally a complete inventory of indigenous forests on state and privately owned land was envisaged. The scope was soon reduced to indigenous areas within demarcated state forests. Even this proved unrealistic in view of extremely limited time, facilities and staff, as well as the fuel restrictions that severely curtailed motor travel in those years. What eventually materialised was a series of selective spot investigations.

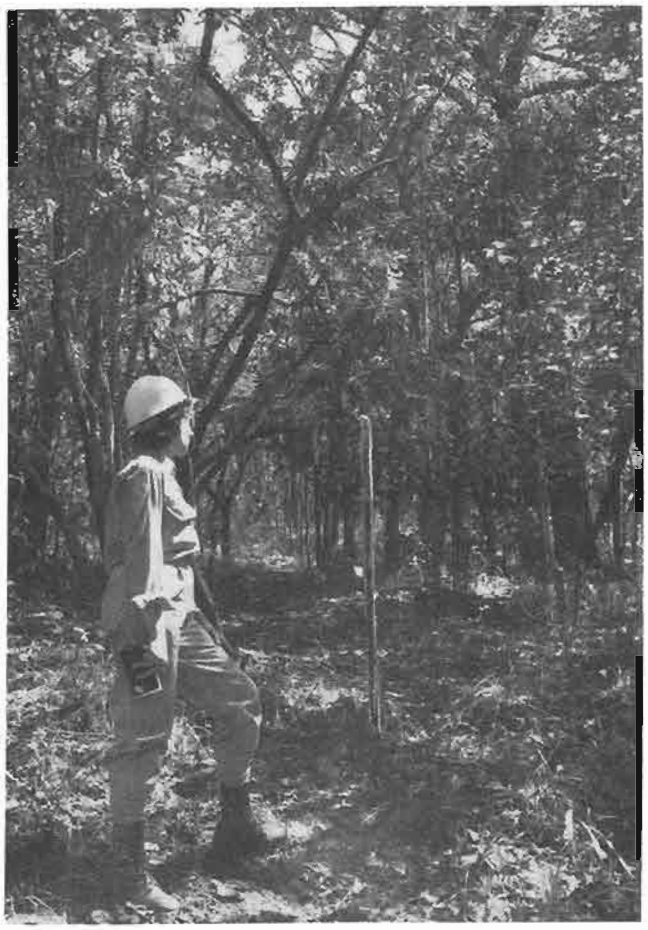
In the main the investigations consisted of strip enumerations for a qualitative/quantitative and structural assessment of main stand, understorey, shrub layer and herb layer.

The work was concentrated in the following areas (see also Fig. 1, Map of the indigenous forests of South Africa):

		Number of sampling strips
1	*Soutpansberg*	
	Entabeni	66
	Ratombo	5
	Roodewal	2
	Hanglip	2
2	*Houtbosberg*	
	De Hoek/Woodbush	28
	Broederstroom	21
3	*Wolkberg*	
	New Agatha	30
	Serala	18
	Steilkop	7
4	*South-eastern Transvaal*	
	Kaapsehoop	10
	Uitsoek	19
5	*East Griqualand*	
	Mpetsheni	36
	Ngele	9
	Total	253

Preparatory work done at Marite, Ceylon and Long Tom (Eastern Transvaal), Ngome (Northern Natal) as well as Sarnia and Nkonzo (Natal Drakensberg) could not be followed up.

Sampling strips already laid out at Goede Hoop (Soutpansberg) could not be used as a result of devastating windfalls over large areas.



Laying out a sampling strip in semi-deciduous forest at New Agatha

The enumeration team consisted of myself and my wife, Jutta. While all the measuring work was done by Jutta, I did the recording. We were usually assisted by two or three labourers from the local forest station who helped us carry the equipment and, under Jutta's supervision, planted the marker poles, cleared the strip boundaries and dug the soil pits.

We worked in spells of two to three weeks, living in temporary quarters at the forest station. We left at day-break, in winter even earlier, and returned at night-fall, staying in the forest the whole day. The fieldwork took us altogether some 600 days. It was the greatest experience of our life.

Data processing was less exciting. I have been labouring on it for several years. While this first report, on the south-eastern Transvaal forests, is being published, those for East Griqualand, Wolkberg, Soutpansberg and Houtbosberg are still in preparation.

The study confirms that the perception of our indigenous forests as an undifferentiated mixture of afromontane elements requires revision in favour of an assemblage of distinct forest types which, however, can only be clearly identified if the conventional species lists are supplemented by quantification (basal area, density and cover/abundance) and structural analysis.

Furthermore, and in spite of its fragmentary nature, the work shows by way of example a practical method of determining forest types for stand classification and planned management.

I would like to thank all those who helped in various ways, in the first place Jutta, but also the foresters and labourers, my colleagues at forest research and in the conservation forestry section, my faithful office assistant, Catherine Sehlata, and last but not the least the untiring staff of the Government Printer.

F. v. B.

Pretoria, June 1989

Methods

The methods used for fieldwork as well as the entire system of data evaluation and presentation have been specially developed for the project in proportion to the particular purpose and the available means.

Sampling strips

The sampling strips were laid out in representative parts of the forests. The sites were selected so as to cover different altitudes, aspects and slope percentages. Abnormal areas such as large, recent windfall openings or rocky outcrops were avoided as far as possible. Slope and surface had to be fairly uniform for the length of the sampling strip. The strips were laid exactly in the direction of the slope.

A sampling strip measured 50 m by 5 m in vertical projection, thus covering an area of 250 m^2 and consisting of ten 5 m by 5 m (= 25 m^2) squares marked by 1,5 m high poles and numbered from 1 at the lower end to 10 at the upper end (Fig. 2).

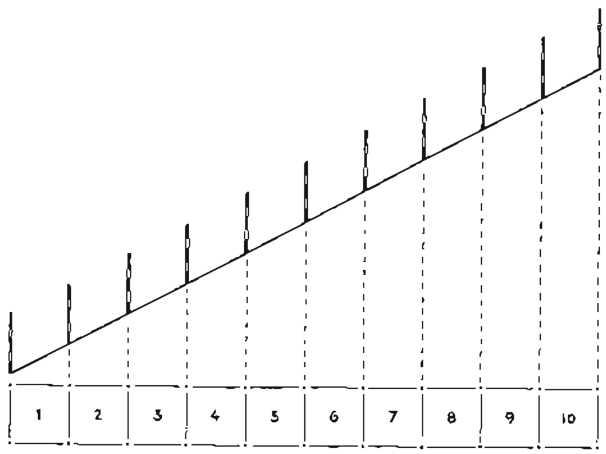


Fig. 2 Profile and basal projection of sampling strip

Slope was measured in percent, using a Haga hypsometer, and compensated for by lengthening the strip and its component squares in accordance with the accompanying table (Fig. 3). This was constructed from the basic degree/percentage compensation table for one 5 m-length (Fig. 4).

When circumstances permitted in high canopy forest areas, two or three sampling strips, or sometimes more, were laid out next to each other. They were numbered a, b, c etc. and the whole block was called a 'battery' or, more precisely, a double strip or a triple strip (Fig. 5).

When several sampling strips were joined lengthwise, this was called a transect (Fig. 6).

15%		5,05
	10°	5,07
20%		5,10
25%		5,15
	15°	5,20
30%		5,23
35%		5,30
	20°	5,33
40%		5,40
45%		5,50
	25°	5,55
50%		5,60
55%		5,70
	30°	5,82
60%		5,85
65%		5,95
70%		6,10
	35°	6,17
75%		6,25
80%		6,40
85%	40°	6,55
90%		6,72
95%		6,90
100%	45°	7,10

Fig. 4 Basic degree/percentage compensation table (m)

15%	20%	25%	30%	35%
0,00	0,00	0,00	0,00	0,00
5,05	5,10	5,15	5,23	5,30
10,10	10,20	10,30	10,46	10,60
15,15	15,30	15,45	15,69	15,90
20,20	20,40	20,60	20,92	21,20
25,25	25,50	25,75	26,15	26,50
30,30	30,60	30,90	31,38	31,80
35,35	35,70	[illegible]	36,61	37,10
40,40	40,80	41,20	41,84	42,40
45,45	45,90	46,35	47,07	47,70
50,50	51,00	51,50	52,30	53,00

40%	45%	50%	55%	60%
0,00	0,00	0,00	0,00	0,00
5,40	5,50	5,60	5,70	5,85
10,80	11,00	[illegible]	11,40	11,70
16,20	16,50	[illegible]	17,10	17,55
21,60	22,00	[illegible]	22,80	23,40
27,00	27,50	[illegible]	28,50	29,25
32,40	33,00	33,60	34,20	35,10
37,80	38,50	39,20	39,90	40,95
43,20	44,00	44,80	45,60	46,80
48,60	49,50	50,10	51,30	52,65
54,00	55,00	56,00	57,00	58,50

65%	70%	75%	80%	85%
0,00	0,00	0,00	0,00	0,00
5,95	6,10	6,25	6,40	6,55
11,90	12,20	12,50	12,80	13,10
17,85	18,30	18,75	19,20	19,65
23,80	24,40	25,00	25,60	26,20
29,75	30,50	31,25	32,00	32,75
35,70	36,60	37,50	38,40	39,30
41,65	42,70	43,75	44,80	45,85
47,60	48,80	50,00	51,20	52,40
53,55	54,90	56,25	57,60	58,95
59,50	61,00	62,50	64,00	65,50

Fig. 3 Strip length compensation table (m)

Fig. 5 Triple strip

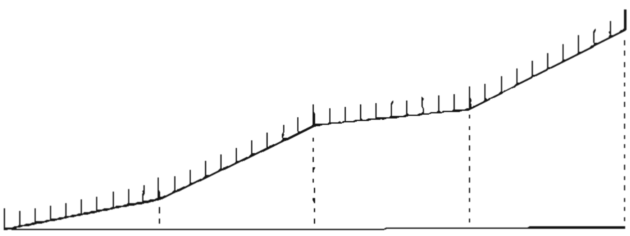


Fig. 6 Transect

Data recording

The enumeration data for each sampling strip were recorded on a set of specially designed forms (the original forms with Afrikaans lettering):

Form No. 1 Stand profile and basal diagram / Standprofiel- en basisdiagram (Fig. 7.)

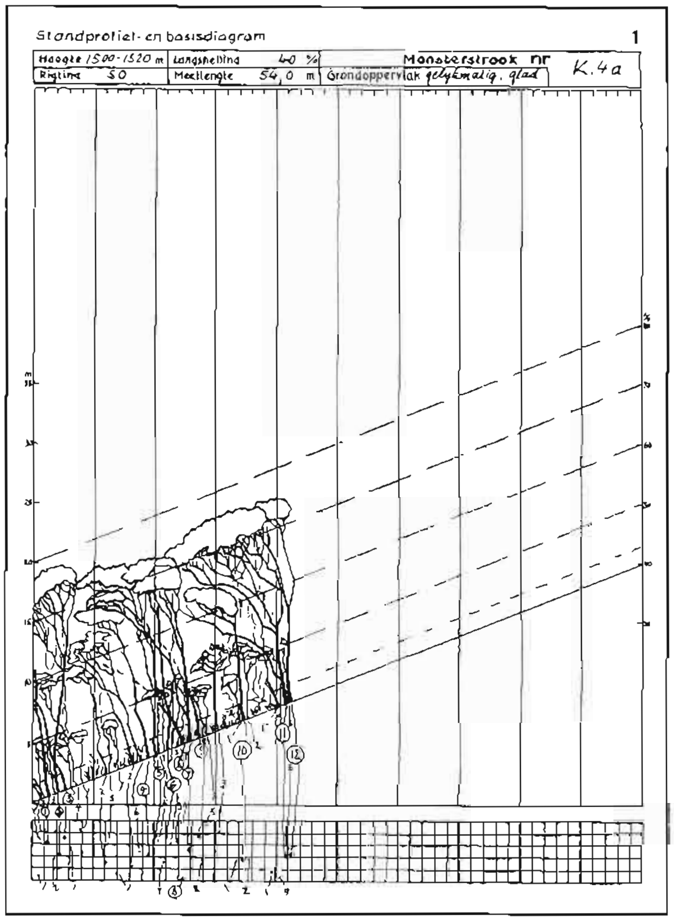
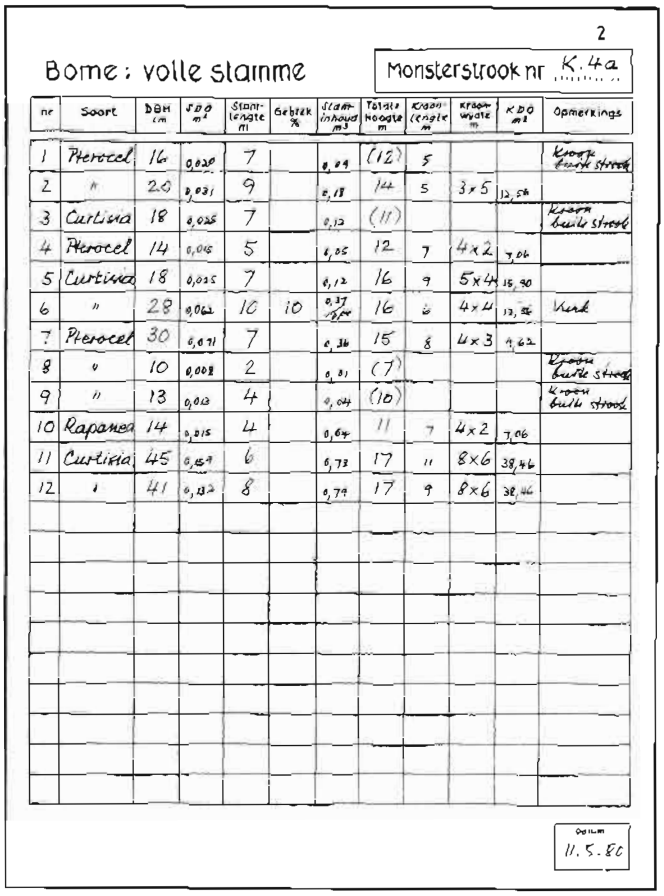


Fig. 7 Form No. 1 — Stand profile and basal diagram



2

Bome : volle stamme — Monsterstrook nr K.4a

nr	Soort	DBH cm	SDO m²	Stamlengte m	Gebrek %	Staminhoud m³	Totale hoogte m	Kroonlengte m	Kroonwydte m	KDO m²	Opmerkings
1	Pterocel	16	0,020	7		0,09	(12)	5			Kroon buite strook
2	"	20	0,031	9		0,18	14	5	3×5	12,56	
3	Curtisia	18	0,025	7		0,13	(11)				Kroon buite strook
4	Pterocel	14	0,015	5		0,05	12	7	4×2	7,06	
5	Curtisia	18	0,025	7		0,12	16	9	5×4	15,90	
6	"	28	0,062	10	10	0,37	16	6	4×4	12,56	Vurk
7	Pterocel	30	0,071	7		0,36	15	8	4×3	9,62	
8	"	10	0,008	2		0,01	(7)				Kroon buite strook
9	"	13	0,013	4		0,04	(10)				Kroon buite strook
10	Rapanea	14	0,015	4		0,64	11	7	4×2	7,06	
11	Curtisia	45	0,159	6		0,73	17	11	8×6	38,46	
12	"	41	0,132	8		0,79	17	9	8×6	38,46	

Datum 11.5.80

Fig. 9 Form No. 2 — Trees: full stems

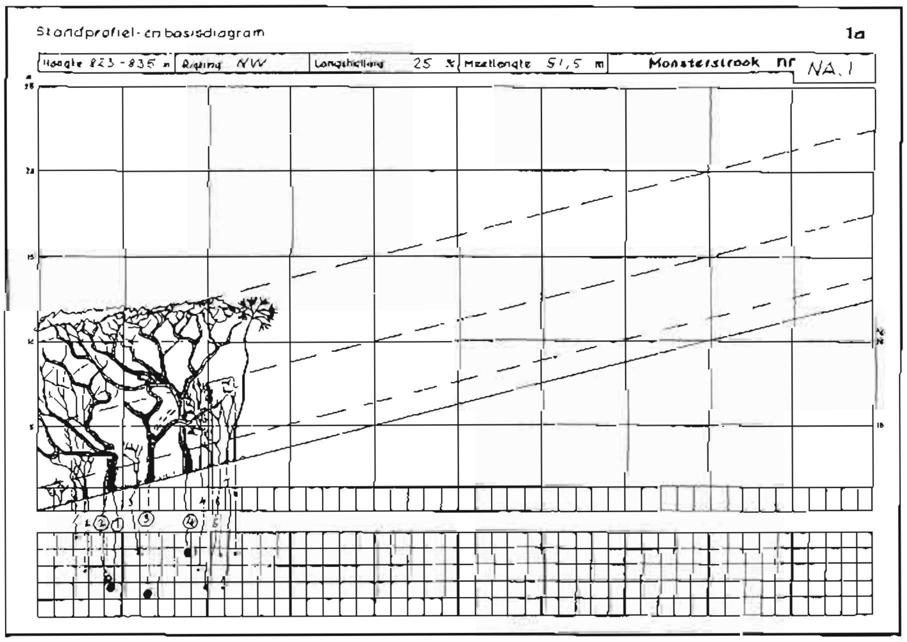


Fig. 8 Form No. 1a — Low canopy variation of Form No. 1

Form No. 1a Low-canopy variation of Form No. 1 (Fig. 8).

Form No. 2 Trees: full stems / Bome: volle stamme (Fig. 9).

Form No. 3 Trees: undersize stems / Bome: ondermaatstamme (Fig. 10).

Form No. 4 Shrubs and herbs / Struike en kruidagtige plante (Fig. 11).

Form No. 5 Dependents / Afhanklikes (Fig. 12).

Form No. 6 Additionals in same-type environment / Addisionele in tipegelyke omgewing (Fig. 13).

Form No. 7 Soil profile / Grondprofiel (Fig. 17).

The forms were printed with an ink-type copier on standard impregnated paper which turned out to be

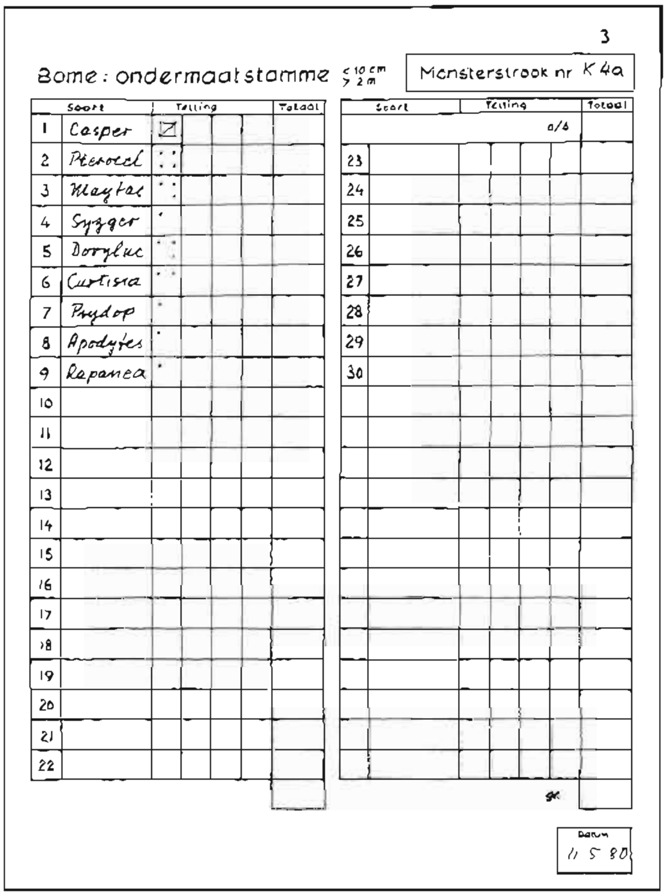


Fig. 10 Form No. 3 — Trees: undersize stems

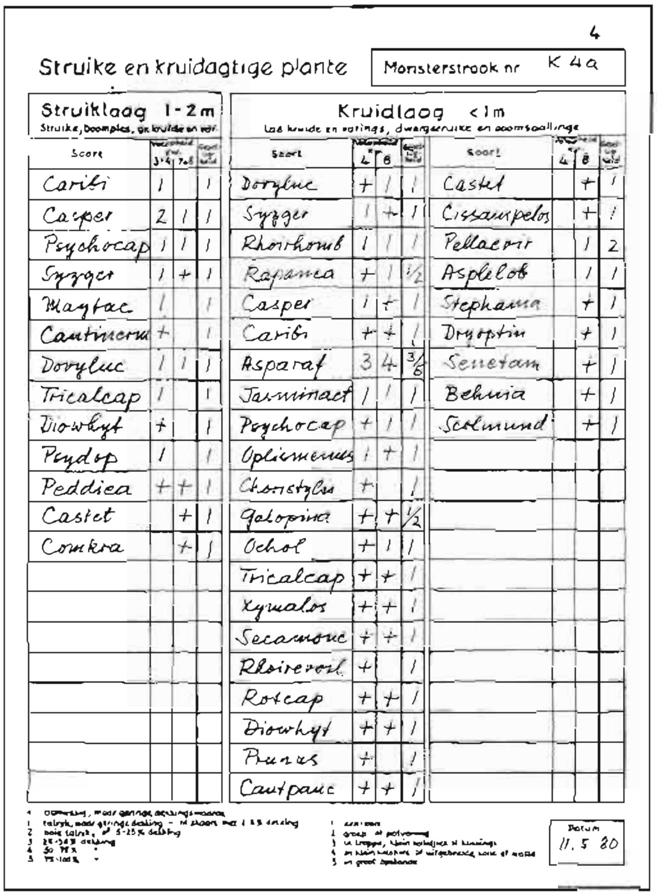


Fig. 11 Form No. 4 — Shrubs and herbs

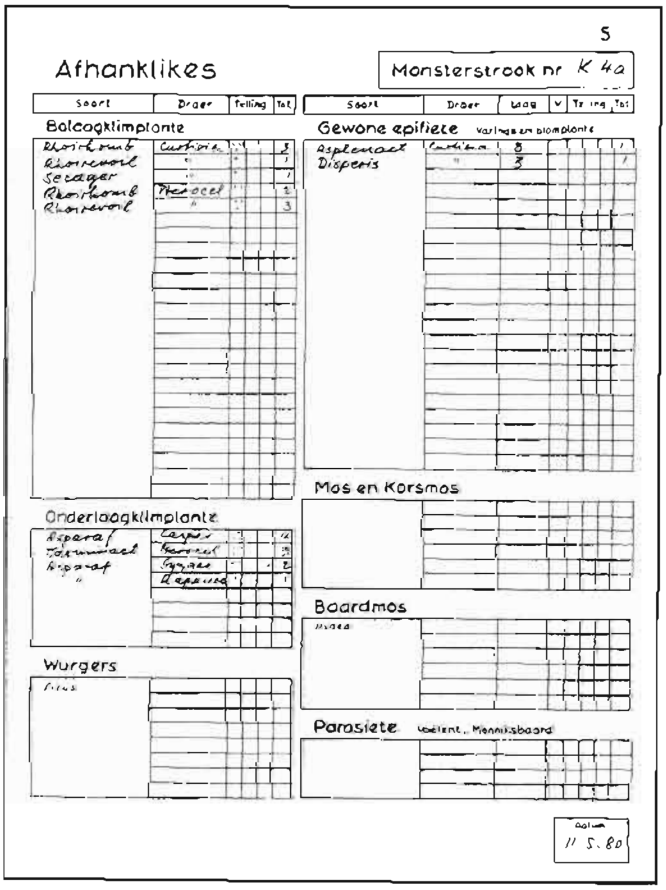


Fig. 12 Form No. 5 — Dependents

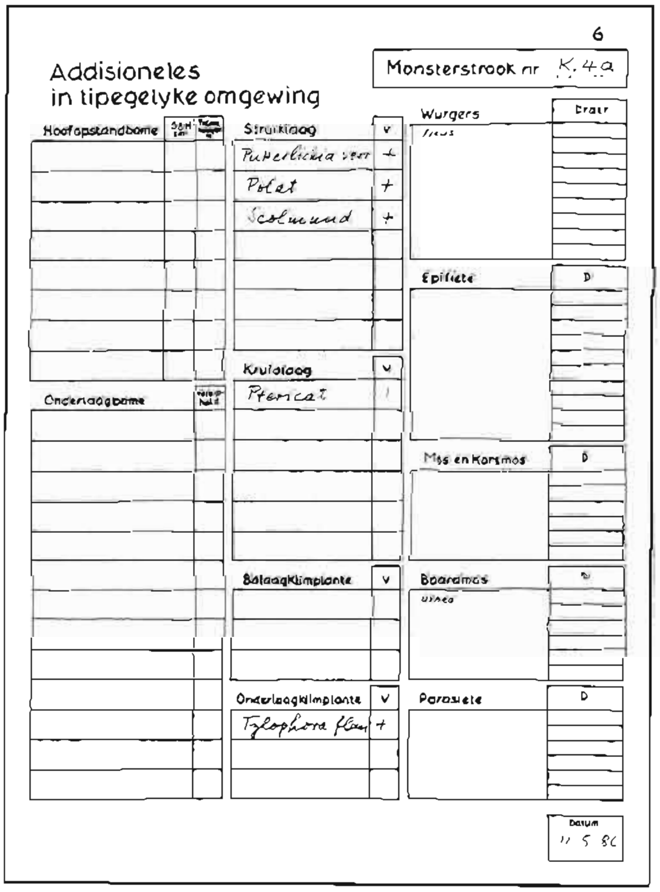


Fig. 13 Form No. 6 — Additionals in same-type environment

reasonably waterproof. Besides, all notes were made with lead pencil. This, together with the use of a surveyor's umbrella, made it possible to work also during morning mist or light mist rains provided the tree crowns were visible, as well as immediately after rains when the foliage was still dripping.

Species were referred to and recorded by "short names", that is contractions of genus name and specific epithet. Examples are 'Pofalc' for *Podocarpus falcatus*, 'Polat' for *Podocarpus latifolius*, 'Ocobul' for *Ocotea bullata*, 'Cuspic' for *Cussonia spicata*, 'Cryplieb' for *Cryptocarya liebertiana*, 'Syzger' for *Syzygium gerrardii*, 'Nucong' for *Nuxia congesta* and 'Nuflor' for *Nuxia floribunda*. Where only one species of a genus was involved, the genus name alone was used, such as 'Curtisia' for *Curtisia dentata*, 'Halleria' for *Halleria lucida* and 'Prunus' for *Prunus africana*.

The use of short names for recording as well as in oral communication between measurer and recorder proved an extremely efficient method.

Species identification

Field enumerations of the type employed in the present project require close familiarity with the trees and other plants. One must know the trees intimately, at least by bark and leaves including the juvenile state. As all the work must be done in winter and spring to avoid the summer rains, one must also be able to recognise the plants of the forest floor in the sterile state. There is no time for "identification" as far as the more common species are concerned. Sometimes, however, there may be some doubt about a small fern, a dry grass, a buckweed or an asparagus. For such an event we always carried with us a large suitcase containing a reference collection for matching on the spot.

It also happened from time to time that a tall tree caused uncertainty. In such cases a zoom binocular was used to study the crown foliage. Double-checks had of course to be made by means of fallen leaves on the ground and sucker shoots. In one instance it became necessary to shoot down branchlets with a telescopic rifle.

Stand profile and basal diagram

When a sampling strip was laid out, the basic information including altitude, slope direction and percentage, as well as the actual length of the strip, was entered on Form No. 1 (Fig. 7). The altitude above sea-level was read from a pocket barometer and verified by marking the strip position on the topographic map (1:50 000). The nature of the slope surface (e.g. even or uneven, rocky-stony etc.) was also recorded.

The ground surface of the sampling strip was then indicated in the stand profile section of the form as a straight line in accordance with the slope percentage. A number of parallel lines were drawn above it so as to indicate 5 m-strata.

While each tree was measured, its outline was sketched in as accurately as possible. In the basal section the basal area projection of each tree stem was marked according to its true position. Each tree was numbered identically with the number of its measurement record on Forms No. 2 or 3 (Figs. 9 and 10).

Trees leaning or branching from outside into the sampling strip as well as lianes, shrubs and herbs, windfalls, large stones and rocky outcrops were also shown.

Trees

A tree was defined as a woody stem originating below breast height (1.3 m) and belonging to a recognised tree species (according to the National List of Indigenous Trees or, in the case of weeds i.e. exotic invaders, the National List of Introduced Trees). Apart from single-stemmed trees this included also the individual shoots of multi-stemmed or low-forking trees.

A distinction was made between "full stems" and "undersize stems". Stems of and above 10 cm diameter at breast height (DBH) were considered full stems and were fully measured. Stems under 10 cm DBH but taller than 2 m were considered undersize stems and were merely tallied.

The full measuring of stems above 10 cm DBH together with the mere tallying of the smaller stems, a well-proven device of classical forest enumeration, is based mainly on the diminishing significance of basal area and volume as well as the increasing significance of the number of stems from the mentioned limit downwards.

Besides, undersize stems are usually confined to the understorey while full stems mostly participate in the higher stories.

Dead trees, if at least the trunk was still standing and the species identifiable, were also recorded but with the affix "d". They were not included in the stand data but shown separately as mortality.

Full stems

Each full stem was recorded on Form No. 2 (Fig. 9) by species, DBH, stem length, defect percentage, total tree height and mean crown spread.

DBH was measured with a tape to the last full centimetre. Stem length (from ground level to crown base) was measured or estimated in full metres. Defect was estimated as a percentage of trunk volume. Total tree height (from ground level to highest point of crown) was measured in full metres using a range meter, supported and controlled by a Haga hypsometer. Mean crown spread, i.e. the mean of the crown diameters along and across sampling strip direction, was measured or estimated in full metres.

Basal area, bole volume and crown cover were read from standard tables. Crown length was determined as the difference between total tree height and stem length.

Undersize stems

To qualify as a tree a stem under 10 cm DBH had to be taller than the shrub layer, i.e. normally more than 2 m; otherwise it counted as a shrub only.

Undersize stems were recorded on Form No. 3 (Fig. 10) by species and numbers.

Undersize stems are either young individuals of canopy species, or they are understorey species such as *Dovyalis lucida, Diospyros whyteana, Canthium pauciflorum, Cassipourea malosana, Peddiea africana, Eugenia natalitia, Tricalysia capensis, Psychotria capensis* var. *capensis* and *Pavetta inandensis,* which usually remain undersize stems throughout their life.

Shrub layer

The space between the heights of 1 m and 2 m was considered the shrub layer. All plants (young trees, shrubs, tall herbs and ferns) found within this layer in squares 3+4 and 7+8 (Fig. 14) were recorded on Form No. 4 (Fig. 11) by species as well as cover/abundance and sociability.

1	2	3	4	5	6	7	8	9	10

Fig. 14 Shrub layer relevé area (squares 3+4 and 7+8)

The total relevé area for the shrub layer thus amounted to 100 m^2 per sampling strip, or 40 percent of the tree enumeration area.

In some cases where a compact shrub layer was higher, reaching 2,5 m or even 3 m, the height limit was adjusted accordingly.

Herb layer

The space between ground level and a height of 1 m was considered the herb layer. All plants (tree seedlings, dwarf shrubs, low herbs and ferns) found within that layer in squares 4 and 8 (Fig. 15) were recorded on Form No. 4 (Fig. 11) in the same manner as the plants of the shrub layer.

1	2	3	4	5	6	7	8	9	10

Fig. 15 Herb layer relevé area (squares 4 and 8)

The total relevé area for the herb layer thus amounted to 50 m^2 per sampling strip or 20 percent of the tree enumeration area.

Rating scales

Cover/abundance and sociability in the shrub and herb layers were estimated in accordance with the following, slightly adapted Braun-Blanquet scales.

Cover/abundance

+ present, but poor cover
1 numerous, but poor cover; or scarce with 1 % to 5 % cover
2 very numerous, or 5 % to 20 % cover
3 25 % to 50 % cover
4 50 % to 75 % cover
5 75 % to 100 % cover

Sociability

1 single
2 groups or tufts
3 troups, small patches or cushions
4 small colonies or extensive patches and mats
5 large stands

Although sociability was recorded throughout, it was found to have little significance. The values corresponded practically always with those for cover/abundance.

Dependents and additionals

Provision was made by means of Forms No. 5 (Fig. 12) and No. 6 (Fig. 13) for a quantified record of dependent species not otherwise recorded in the sampling strip, as well as for additional species outside the strip but within the same type of forest.

Originally a quantification of these two parameters was envisaged but proved disproportionately difficult and time-consuming. Unquantified observation records were then considered sufficient.

Dependents included canopy as well as understorey lianes, stranglers, common epiphytes (ferns and flowering plants), mosses and crustaceous lichens, beard lichens as well as parasites (mistletoe and dodder).

Additionals in same-type environment, that is in the immediate vicinity of the sampling strip, included trees (full as well as undersize stems), shrubs and herbs, canopy and understorey lianes, epiphytes, moss and crustaceous lichens, beard lichens and parasites.

Soil profiles

In the centre of squares 4 and 8 of each sampling strip (Fig. 16) or, in the case of a battery, every second strip, a soil pit 1 m by 1 m was dug, usually 0,8 m to 1,2 m deep down to bedrock. The profile was prepared on the upper side against the slope. Thickness, colour, texture, structure and roots of each horizon were recorded on Form No. 7 (Fig. 17).

Chemical and physical analysis was not possible due to a lack of laboratory facilities and funds. Acidity tests using a simple colorimetric field kit were abandoned when the results, usually around pH 4.0, showed little significant variation.

Occasionally, if there was a tree, a big root, a rock or another obstacle in the centre of the square, the pit site had to be moved a little.

1	2	3	■	5	6	7	■	9	10

Fig 16 Soil pits squares 4 and 8

The soil pits were closed after inspection. Care was taken to restore the different soil layers and the surface material to their previous positions.

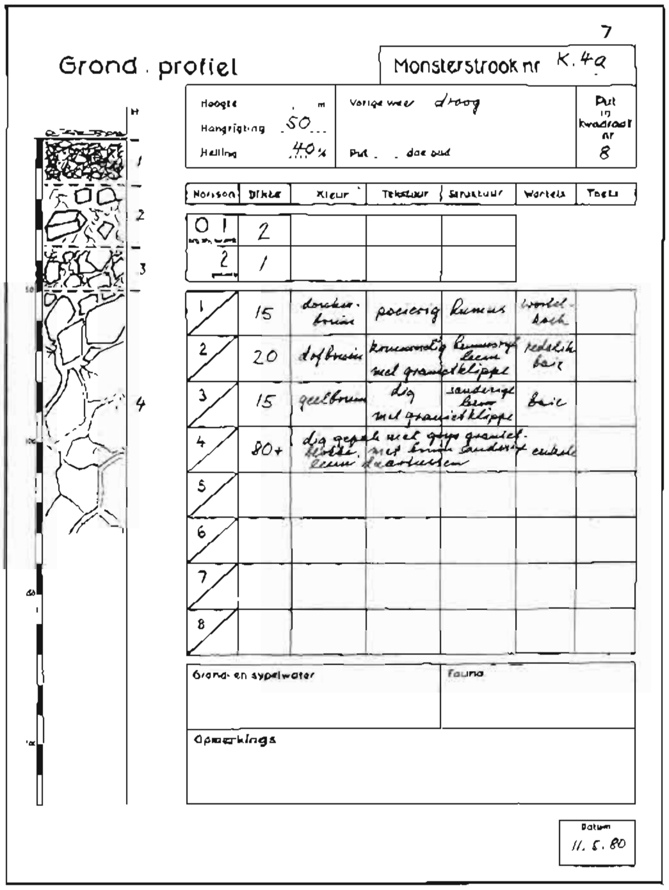


Fig. 17 Form No. 7 — Soil profile

Data processing

The data recorded for every sampling strip and battery were further processed to analyse the quantitative composition of the principal forest strata, viz. tree layer, shrub layer and herb layer. The forms used for the purpose were the following:

Form No. 8 Tree layer (Fig. 18).
Form No. 9 DBH classes (Fig. 19).
Form No. 10a/b Shrub layer (Fig. 20a/b).
Form No. 11a/b/c Herb layer (Fig. 21a/b/c).

An additional analysis was conducted for the crown layer, using Form No. 12 (Fig. 22).

Tree layer analysis

The number of stems in respect of full stems (S), undersize stems (s) and all stems (S+s), as well as the basal area (BA: m^2) and utilisable trunk volume (Vol: m^3) of full stems, were calculated per one hectare (ha) for each species and every sampling strip, battery and group, using Form No. 8 (Fig. 18).

The basal areas for 10 cm DBH classes were compiled on Form No. 9 (Fig. 19).

Shrub layer analysis

The means of the cover/abundance ratings of all tree and other plant species recorded in the shrub layer were determined on Form 10 a/b (Fig. 20a/b) for every battery or contypical group of sampling strips.

The species were broken up into—

(a) canopy tree species, i.e. tree species represented above the shrub layer as full stems;
(b) understorey tree species, i.e. tree species represented above the shrub layer as undersize stems only;
(c) additional tree species, i.e. tree species not represented above the shrub layer;
(d) true shrubs, i.e. woody species not forming trees (including tree species non-arborescent in the area);
(e) other plants such as exceptionally tall herbs or ferns;
(f) lianes;
(g) weeds, i.e. exotics.

Mean cover/abundance ratings were also determined for the above categories.

Species with "present" (+) ratings were left out but were included in the total number of species.

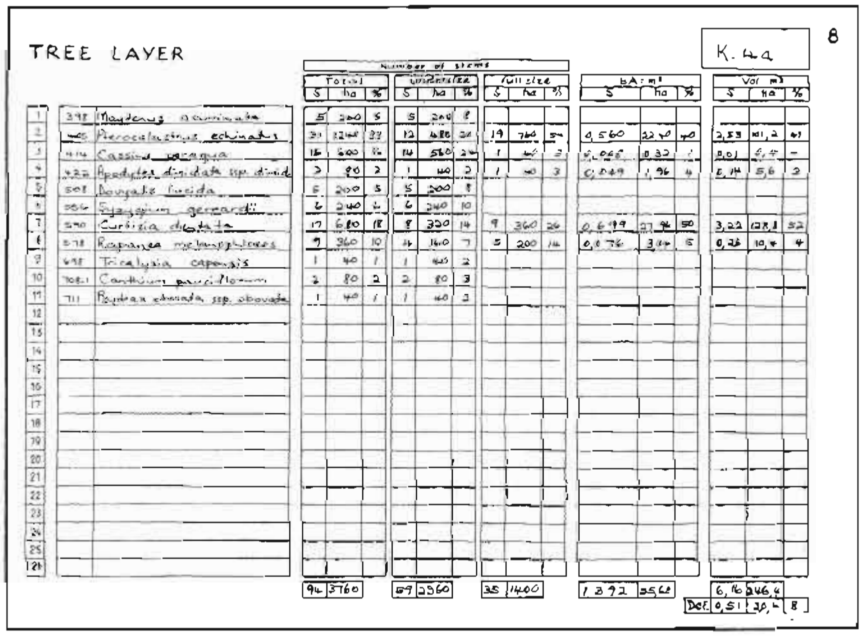
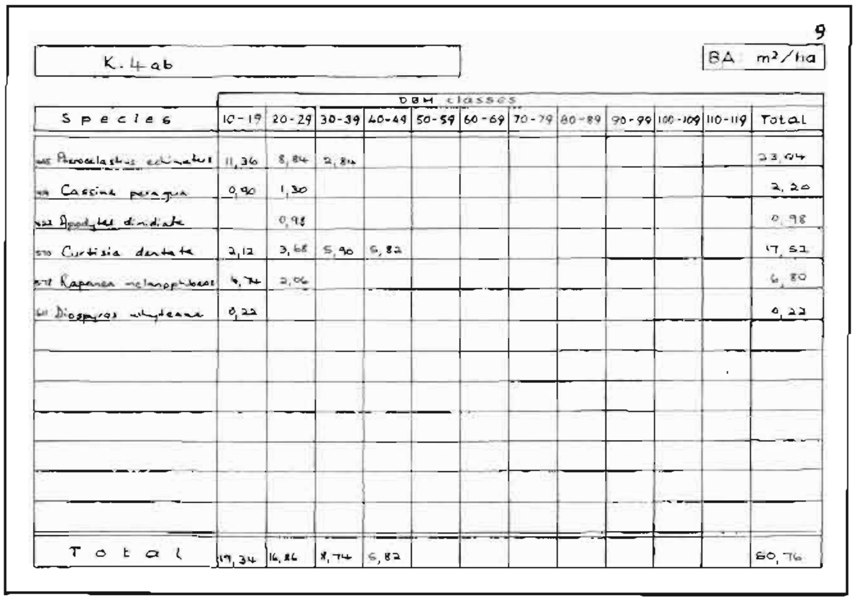


Fig. 18 Form No. 8 — Tree layer



9

K. 4ab

BA m²/ha

Species	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	Total
Pterocelastrus echinatus	11,36	8,84	2,84									23,04
Cassine peragua	0,90	1,30										2,20
Apodytes dimidiata		0,98										0,98
Curtisia dentata	2,12	3,68	5,90	5,82								17,52
Rapanea melanophloeos	4,74	2,06										6,80
Diospyros whyteana	0,22											0,22
Total	19,34	16,86	8,74	5,82								50,76

Fig. 19 Form No. 9 — DBH classes

Herb layer analysis

The means of the cover/abundance ratings of all species recorded in the herb layer were determined on Form 11 a/b/c (Fig. 21a/b/c) in the same manner as for the shrub layer, except that the true non-tree species were further broken up into ferns, monocots and dicots.

Stand data graphs

In respect of every sampling strip or battery, or con-typical group of strips or batteries, a stand analysis was compiled and graphically expressed. The values shown against species are basal area (m²/ha) and numbers (i.e. densities) of full stems (S/ha) and undersize stems (s/ha), as well as cover/abundance in shrub layer and herb layer.

Shrub and herb layer species were subdivided into trees, shrubs, monocots, dicots, ferns (incl. fern allies) and lianes.

Description of sampling areas

All information relating to a particular sampling area has been put together in a comprehensive description

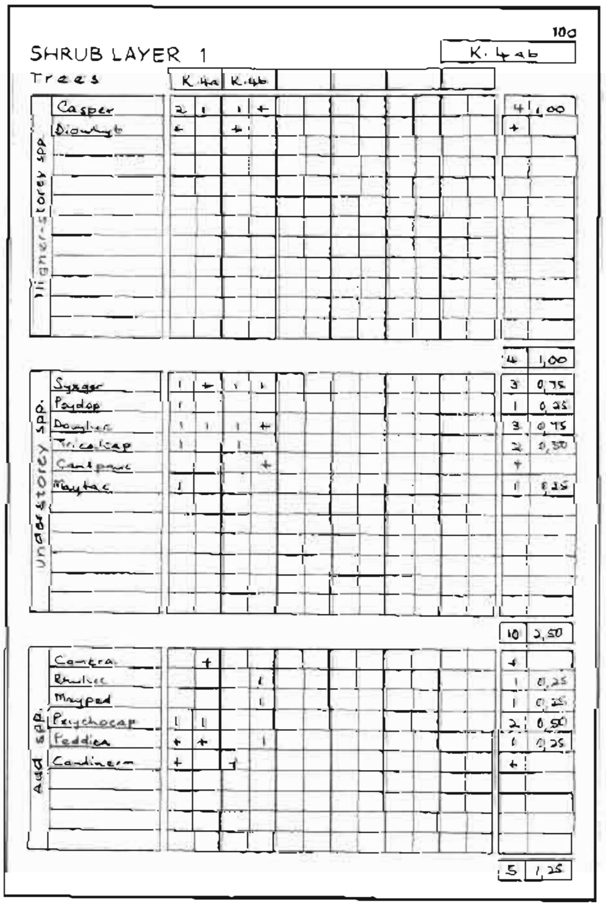


Fig. 20a Form No. 10a — Shrub layer

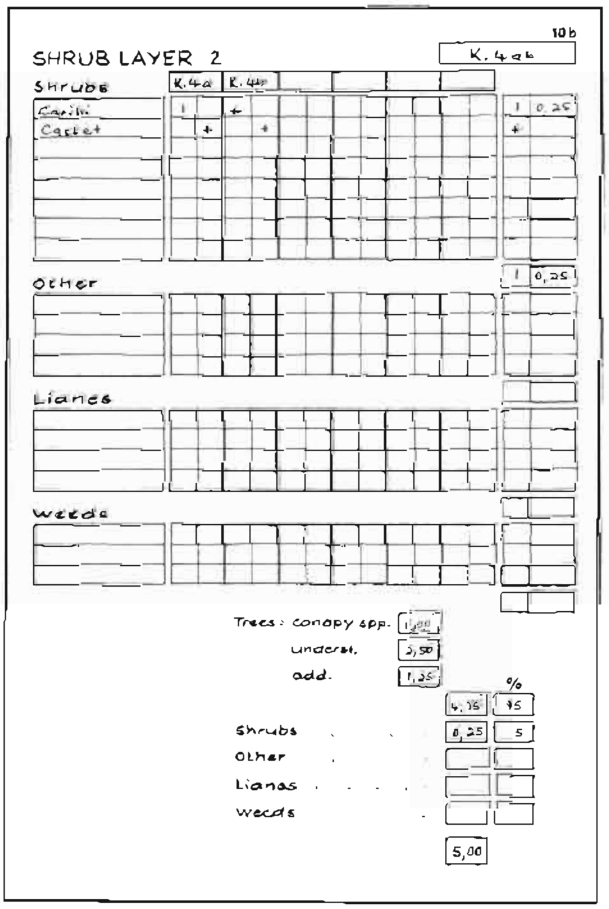
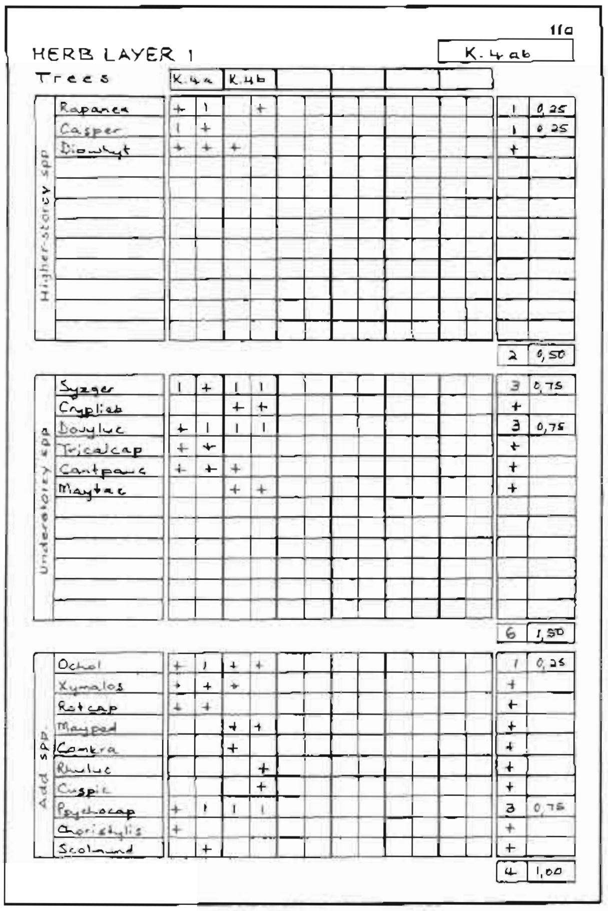


Fig. 20b Form No. 10b — Shrub layer



HERB LAYER 1 — 11a — K. 4 ab

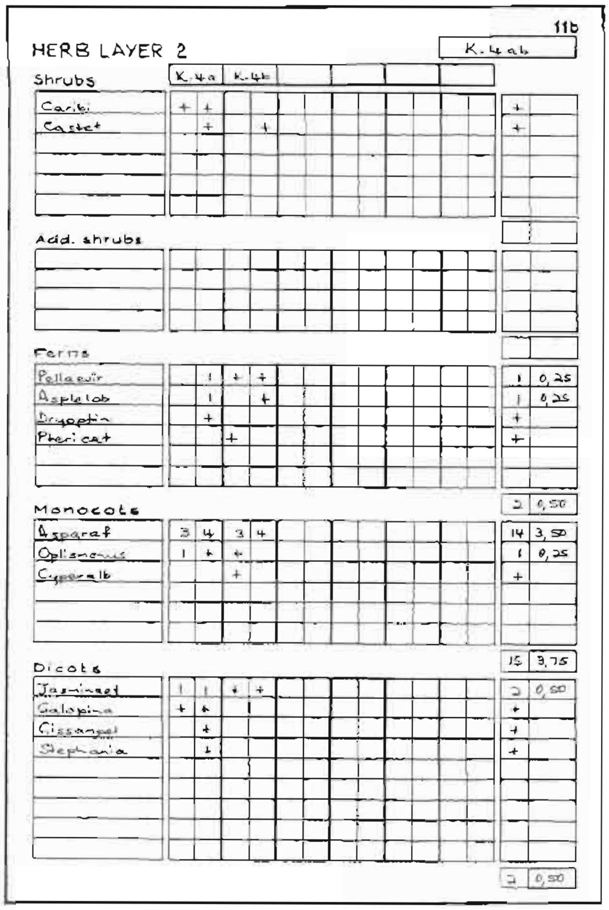
Trees — K.4a, K.4b

Higher-storey spp: Rapanea + 1 + (1, 0,25); Casper 1 + (1, 0,25); Diowhyt + + + (+) — 2, 0,50

Understorey spp: Syzger 1 + 1 1 (3, 0,75); Cryplieb + + (+); Dovyluc + 1 1 1 (3, 0,75); Tricalcap + + (+); Cantpauc + + + (+); Maytac + + (+) — 6, 1,50

Add spp.: Ochol + 1 + + (1, 0,25); Xymalos + + + (+); Rotcap + + (+); Maypod + + (+); Combra + (+); Rhuluc + (+); Cuspic + (+); Psychocap + 1 1 1 (3, 0,75); Chorietylis + (+); Scolmund + (+) — 4, 1,00

Fig. 21a Form No. 11a – Herb layer



HERB LAYER 2 — 11b — K. 4 ab

Shrubs — K.4a, K.4b: Caribi + + (+); Castet + + (+)

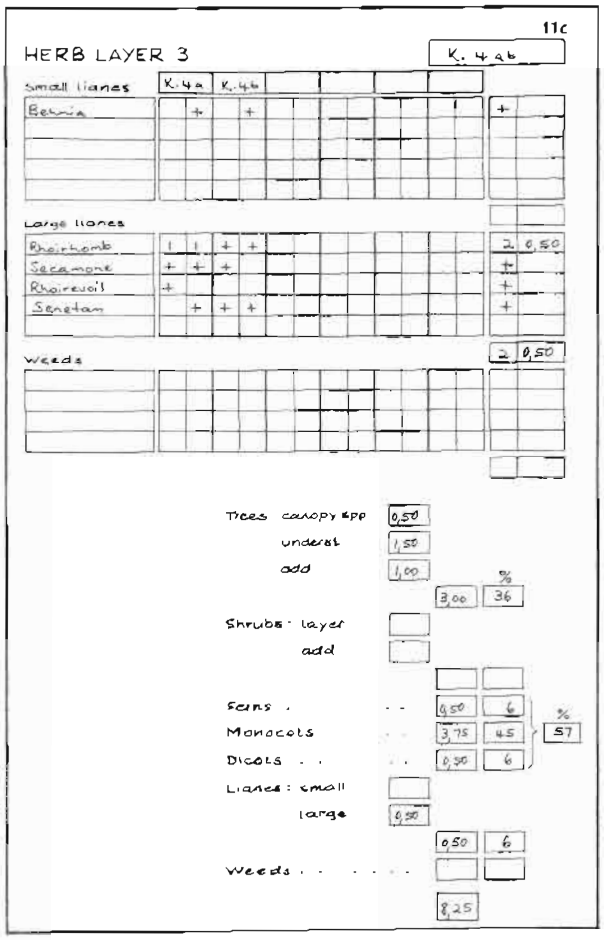
Add. shrubs

Ferns: Pellaeuir 1 + + (1, 0,25); Asplelob 1 + (1, 0,25); Dryopt + (+); Pteri cat + (+) — 2, 0,50

Monocots: Asparaf 3 4 3 4 (14, 3,50); Oplismenus 1 + + (1, 0,25); Cyperalb + (+) — 15, 3,75

Dicots: Jasminaet 1 1 + + (2, 0,50); Galopina + + (+); Cissampel + (+); Stephania + (+) — 2, 0,50

Fig. 21b Form No. 11b – Herb layer



HERB LAYER 3 — 11c — K. 4 ab

Small lianes — K.4a, K.4b: Behnia + + (+)

Large lianes: Rhoirhomb 1 1 + + (2, 0,50); Secamone + + + (+); Rhoirevoil + (+); Senetam + + + (+) — 2, 0,50

Weeds

Trees canopy spp 0,50; underst 1,50; add 1,00 — 3,00, 36 %

Shrubs layer; add

Ferns 0,50, 6; Monocots 3,75, 45; Dicots 0,50, 6 — 57 %

Lianes: small; large 0,50 — 0,50, 6

Weeds

8,25

Fig 21c Form No. 11c – Herb layer

including situation, soil, tree layer (the whole as well as upper storey, intermediate storey and understorey), shrub layer, herb layer and dependents. Structural and successional interpretations as well as a tentative classification by presumed forest types have been added.

Stand profile and basal diagrams, soil profiles, DBH-class graphs and stand data graphs have been included.

In the stand profile diagrams the tree species are indicated by the national tree numbers: bold figures in the crowns designating full-stem trees, small figures below the ground line undersize stems.

As regards terminology and nomenclature the following should be noted:

(a) Slope has been described in accordance with the scale below:

Up to 8%	almost level
9%–16%	gentle
17%–32%	moderate
33%–48%	steep
49%–70%	very steep
71% and more..........	precipitous

(b) Cover/abundance in shrub layer and herb layer has been described using the scale below:

1–2	poor
3–4	moderate
5–6	fair
7–8	rich
9–10.......................	very rich

(c) Scientific names of tree species and tree numbers follow the National List of Indigenous Trees (1986) and the National List of Introduced Trees (1984). As regards all other plants the nomenclature of the List of Species of Southern African Plants (1984) was used.

Most of the stand data graphs had been completed before the new editions of the above reference works became available. As the name changes that had occurred, were relatively insignificant (for example, *Asparagus* to *Protasparagus*), updating was considered unnecessary.

Layer analysis and type models

The species values for the different parameters of tree, shrub and herb layers of all sampling areas in a particular region were graphically correlated so as to arrive at configurations reflecting "forest types". In respect of these, climax models were then developed.

Supplementary notes

While the principal object of the study was attained with the description of forest types for the classification of the forests, all residual information such as utilisable timber volumes, crown layer (crown area, volume and density) and tree growth forms as well as bryophytes, was appended in separate chapters of "supplementary notes".

Timber volume

The utilisable timber volume, i.e. trunk volume less defect per species per hectare, was calculated for the sampled growing stock of each forest type and, by means of the volume/basal area ratio, extrapolated to the type models.

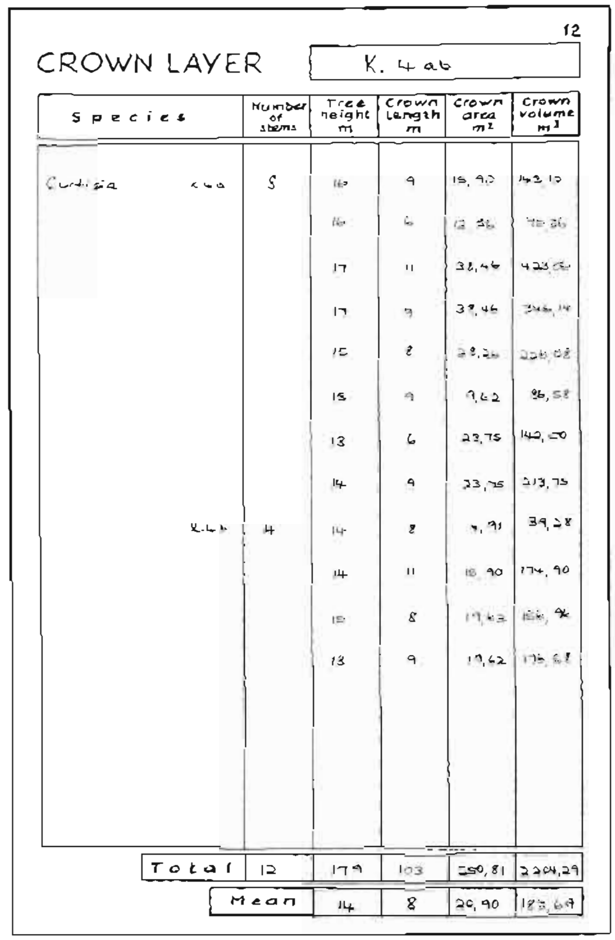
Although the timber-productive management of indigenous forests, except possibly those with a high Yellowwood/Stinkwood component, is widely regarded as an outdated and at any rate economically unrealistic concept, the relevant implications are discussed in terms of actual volumes, if only for reference purposes.

Crown layer analysis

The remaining set of full-stem data, namely tree height and crown length, was processed on Form No. 12 (Fig. 22) to obtain their means, as well as the means and totals of crown area and crown volume for the various species and forest types, and eventually to calculate the crown density which was expected to be different for each forest type and development phase.

The crown area of a tree was taken to be that of a circular area with the mean crown spread as diameter. The crown volume was taken as that of an ellipsoid equal to a paraboloid with the circular crown area as base and the crown length as height, which in turn is equal to half the cylindrical volume.

Crown density in terms of area (Fig. 23) has been expressed by the crown area index (CAI) which was obtained by dividing the total crown area by the unit area (1 ha = 10 000 m^2). In dense stands with interlocking crowns and few or small canopy gaps, i.e. where the total crown overlap is larger than the total gap area, the crown area index is larger than 1, while it is smaller in open stands.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CROWN LAYER — K. 4 ab

Species	Number of stems	Tree height m	Crown length m	Crown area m^2	Crown volume m^3
Curtisia kaa	5	16	9	15,90	143,10
		16	6	12,56	75,36
		17	11	38,46	423,06
		17	9	38,46	346,14
		15	8	28,26	226,08
		15	9	9,62	86,58
		13	6	23,75	142,50
		14	9	23,75	213,75
[illegible]	4	14	8	4,91	39,28
		14	11	15,90	174,90
		15	8	19,63	[illegible]
		13	9	19,62	[illegible]
Total	12	179	103	250,81	2204,29
Mean		14	8	20,90	183,69

Fig. 22 Form No. 12 — Crown layer

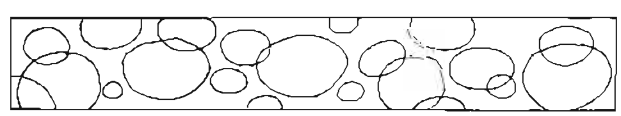


Fig. 23 Crown area

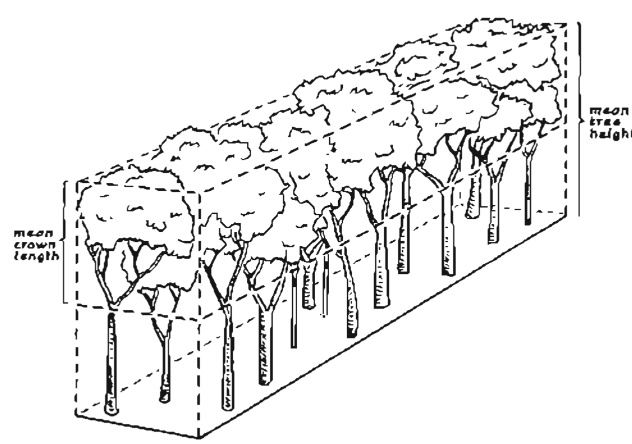


Fig. 24 Crown volume

Crown density in terms of volume (Fig. 24) has been expressed by two crown volume indices (CVI), one for the crown layer itself (CVI_c) and another for the whole stand (CVI_S). The crown volume indices were calculated in a similar manner as the crown area index, namely by dividing the total crown volume by the mean crown layer volume and the mean stand volume respectively. Each of the two last-named volumes was taken to be a rectangular space with the unit area as base, but with the mean crown length as height in the case of the mean crown layer volume, and with the mean tree height as height in the case of the mean stand volume.

The crown area, volume and density data have been tabulated for each forest type, with the sampled species means extrapolated to the type models. (Figures in brackets were not used in subsequent calculations. The rounded off species means for tree height and crown length, as well as the species means for crown area and crown volume, are based independently from each other on the sampling data, as are the total means. The mean tree height and mean crown length employed for the calculation of the mean stand volume and the mean crown volume are derived from the sampled overall totals.)

Growth form

To elucidate elementary growth form tendencies of the different tree species in response to habitat, the mean tree heights together with the means of crown length, crown area and crown volume (as extracted from the crown layer analysis) were tabulated under forest types.

Bryophytes

The fieldwork for the present project coincided with the compilation of the bryophyte volumes (mosses and liverworts) of the Flora of Southern Africa at the Botanical Research Institute, Pretoria. To augment the existing herbarium material we were requested to collect specimens in the forests. As the work on the Flora seemed to assure us of prompt identification of our specimens, we welcomed the idea as an opportunity to obtain data on the bryophyte flora of our sampling areas for possible use as a complementary parameter in the classification of forest types, hoping the humidity differences brought about by altitude, aspect and stand composition would be reflected by the bryophyte assembly. There might even be direct habitat preferences of certain bryophyte species for particular tree species or other substrates like boulders, dead bark, decaying wood or the forest floor, which would add to their indicator value, if any.

Whenever circumstances permitted at the end of the enumeration of a sampling area, Jutta therefore made a moss and liverwort collection, usually from growths spotted during enumeration. Locality and substrate information was recorded on the specimen bags.

The identifications were done by Robert E. Magill, a visiting bryologist from Missouri Botanical Garden, and J. van Rooy at the Botanical Research Institute. The "J. von Breitenbach" specimens are filed in the Cryptogam herbarium of the Institute and many of them have been used as vouchers for the description of species in the bryophyte volumes of the Flora.

A synopsis of the bryophyte species collected and identified for each sampling area, together with a discussion of recognisable patterns and trends, has been added under Supplementary Notes for each forest area.

Circumstances did not always permit full collection, and the actual collections were of necessity limited to a single time, mainly the dry season when a number of species are not easily visible or have no sporophytes. Moreover, quite a few of our specimens have not been identified up to now.

South-eastern Transvaal forests

At its southern end the Eastern Transvaal escarpment forms an L-shaped bend around a broad foothill terrace above the lowveld. This semi-circular mountain gallery is the home of a multitude of small to medium-sized forests of both the evergreen and semi-deciduous types. The evergreen forests are confined to the 1 200 – 1 800 m altitudinal belt and can roughly be classified into the upper montane forests of the higher mistbelt slopes above 1 500 m and the lower montane forests of sheltered slopes and large ravines between 1 200 m and 1 500 m. The remnants of semi-deciduous forest occur on lower valley slopes and along streambanks between 900 m and 1 200 m.

Covering a total area of nearly 5 600 ha, the forests are situated in the catchments of river systems and can be grouped accordingly (Fig. 25).

1 **Dullstroom.** Eight forest patches of the upper montane type on the eastern flank of the Dullstroom plateau which forms the hindmost escarpment section and is the source of the Crocodile River; on the farms Welgedacht, Waterval, Rietfontein and Knapdaar (total c. 80 ha).

2 **Western Schoemanskloof.** Three groups of forests in the second Crocodile River catchment, the kloof area between Badfontein and Sterkspruit.

Group one comprising some five forest patches of the lower montane type on the northern side of the Crocodile, on the farms Doornhoek and Sterkstroom (total c. 60 ha).

Group two consisting of four patches, also of lower montane forest, on the western side of the

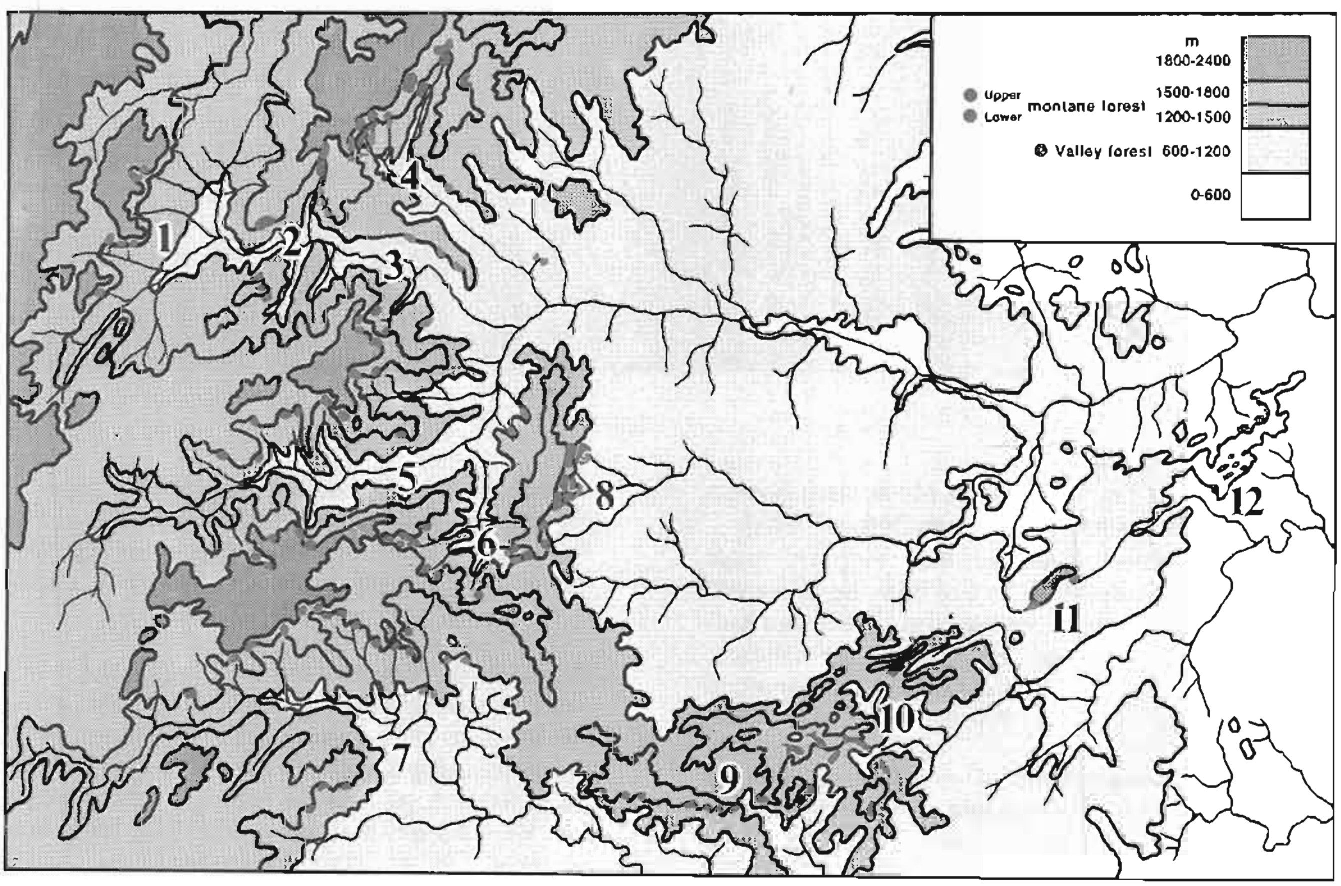
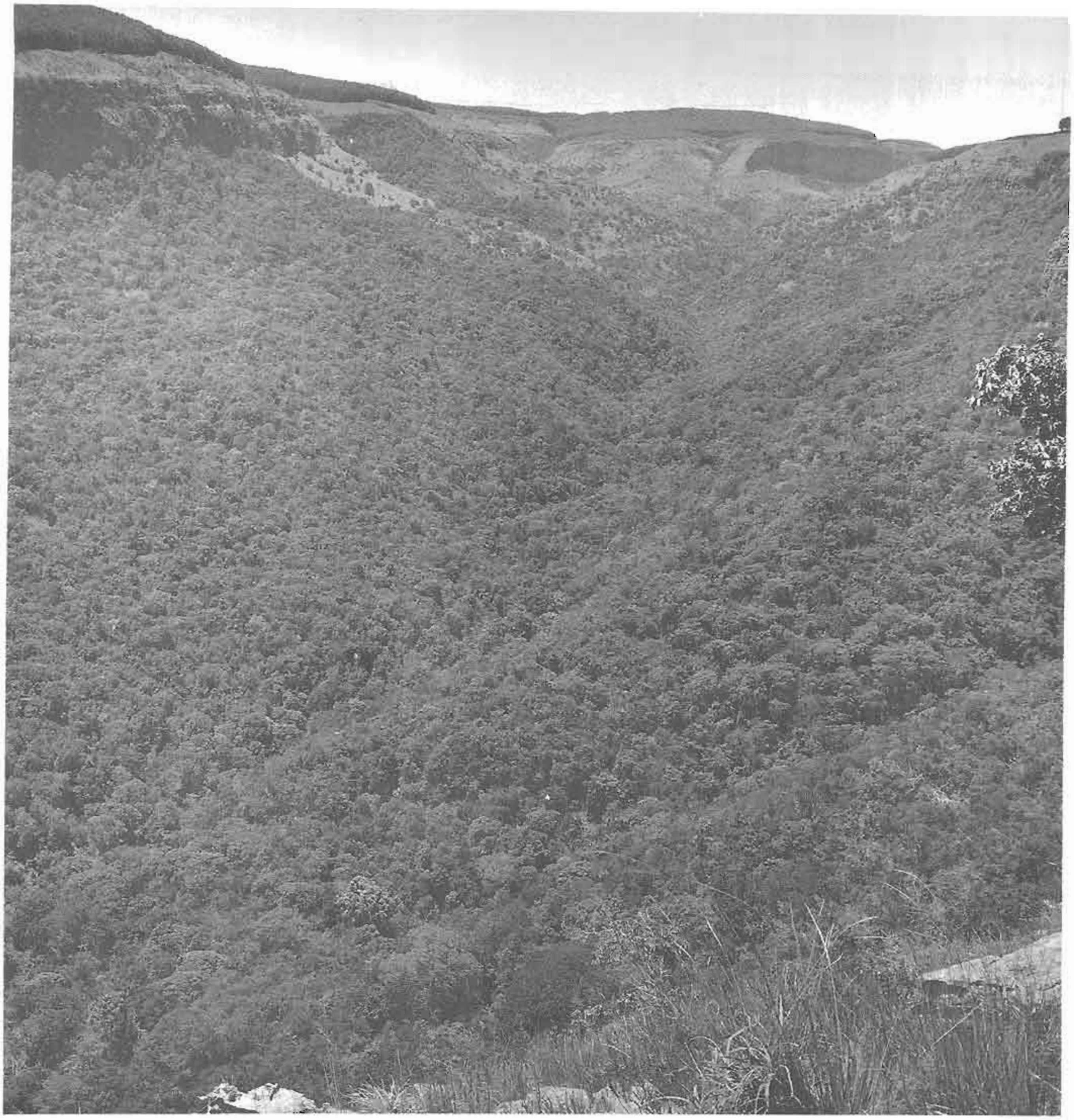


Fig. 25 South-eastern Transvaal forest areas



Buffelskloof forest from the south

Sterkspruit kloof on the farms Mooiplaats, Somerset, Doornhoek and Sterkstroom (total c. 50 ha).

Group three including the relatively large Buffelskloof forest (700 ha), of both the upper and lower montane types, on the farm Uitkyk and Kalmoesfontein, as well as four smaller patches, mostly valley bush, on the farms Kalmoesfontein and Sterkspruit (total c. 60 ha).

3 **Eastern Schoemanskloof.** Two groups of forests in the catchments of Crocodile tributaries on both sides of the eastern Schoemanskloof.

Group one in the north comprising three patches of valley forest on the farms Rietvlei, Mooiland and In die Middel (total c. 100 ha).

Group two in the south consisting of a patch of valley forest on the farm Elandshoek (c. 20 ha) and five patches of lower and upper montane type forest on the farms Mooiplaats (c. 200 ha), Geluk (c. 90 ha) and Koedoeshoek (c. 140 ha).

4 **Houtbosloop.** A large number of upper and lower montane type forests as well as valley forests in the Houtbosloop catchment, mainly on Uitsoek State Forest including Kantoorbos and Wonderkloof (total c. 500 ha), and on the farms Blyfstaanhoogte and Klipbankspruit (total c. 150 ha), Blyfstaanboschspruit (c. 80 ha) and Boschkom (c. 60 ha).

A lower montane type forest (c. 60 ha) on the farm Renosterhoek in the uppermost catchment of the Nelspruit may be included here.

5 **Elandskloof.** Three groups of small forests in the catchments of Elands River tributaries.

Group one to the north of Elandskloof consisting of twelve aggregate patches of upper and lower montane forest in the Elandshoogte complex including the farms Houtboshoek and Houtbosfontein (total c. 1 000 ha).

Group two to the south of Elandskloof comprising five patches of upper montane forest in the Waterval Onder area on the farms Weltevreden, Schoonspruit and Rietspruit (total c. 190 ha).

Group three to the east of Elandskloof including two aggregate valley forest patches in Battery Creek and Starvation Gully on Berlin State Forest (total c. 30 ha).

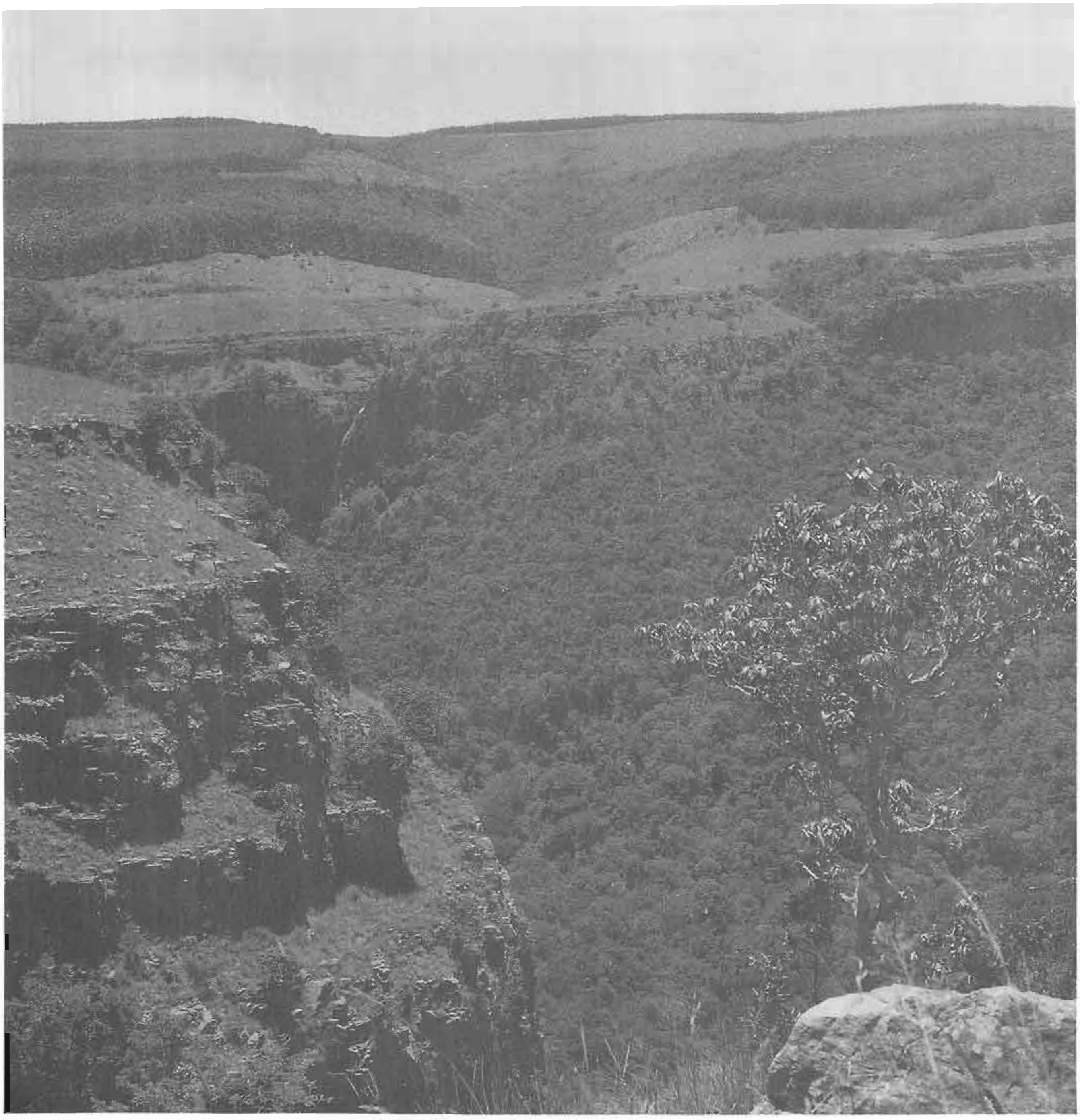
6 **Ngodwanekloof.** Three groups of small forests in the catchment of the Ngodwane River and its main tributaries (the Ngodwane itself being a principal tributary of the Elands River).

Group one in the western part consisting of seven lower montane type forests on the farms Uitzicht, Houtboschloop and Doornkloof (total c. 150 ha).

Group two in the south consisting of a single lower montane type forest on the farm Mooifontein (c. 50 ha).

Group three in the east comprising some six

Buffelskloof forest from the east, with *Bequaertiodendron magalismontanum* on the krantz in the foreground



patches of lower montane as well as valley type forest on the farms De Goede Hoop and The Narrows (total c. 100 ha), and on Coetzeestroom State Forest (c. 160 ha).

7 **Badplaas.** Two groups of small forests in the catchment of the Komati River.

Group one in the north consisting of about 18 patches of upper and lower montane forest as well as valley forest in south-facing kloofs of the Slaaihoekberge on the farms Bloemfontein, Boshoek, Goedgelegen, Treurfontein, Doornhoek, Engelsedraai, Uitkomst, Vaalkop and Onverwacht (total c. 370 ha).

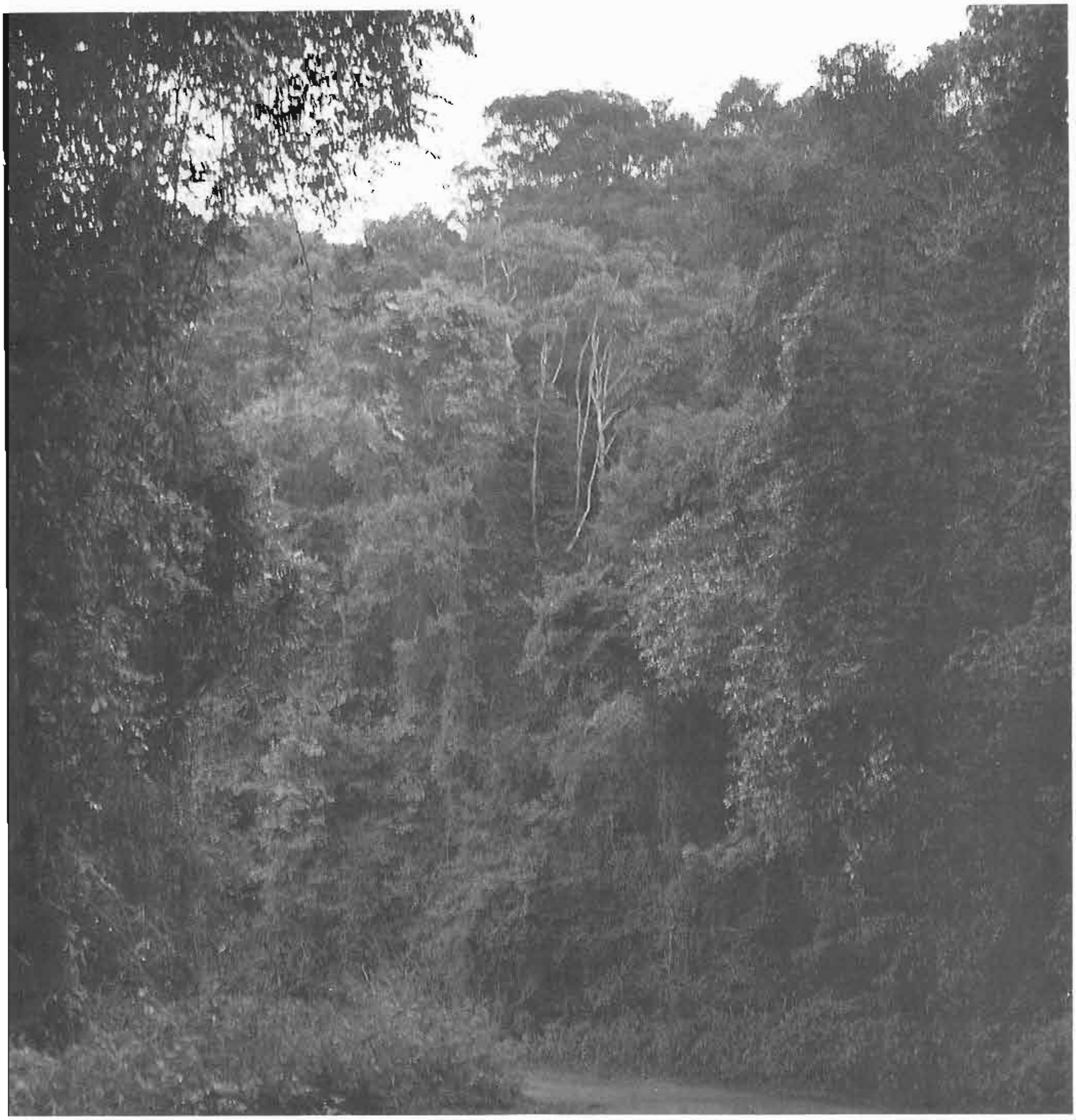
Group two in the south consisting of three lower montane forest patches on the farms Kalkkloof, Alexandria and Avontuur (total c. 50 ha).

8 **Kaapsehoop.** A group of forests and forest remnants in the Noordkaap River catchment on the escarpment south and south-east of the village of Kaapsehoop.

Consisting of a chain of about 10 patches of upper and lower montane forest together with a series of valley forest appendages on Kaapsche Hoop state land, which has recently been incorporated with Berlin State Forest, and the farm Bradley (total c. 285 ha).

9 **Kangubane.** Two groups of small forests at the sources of tributaries of the Komati River in south-facing kloofs of the Kangubane mountain ranges between Nelsberg and the Swaziland border.

Pedlar's Bush; *Combretum kraussii* forming an archway



Pedlar's Bush; note the high canopy

Group one in the west consisting of six patches of lower montane forest and one of valley forest on the farms Stolzburg, Avontuur, Hooggenoeg, Geluk and Onverwacht (total c. 160 ha).

Group two in the east comprising three aggregate patches of upper montane forest on the farms Schultzenhorst, Mendon and Josefsdal (total c. 100 ha), and four patches of lower montane forest on the farms Noisy, Dunbar and Loenen (total c. 120 ha).

10 **Makhonjwa.** Two groups of forests in the catchments of the Lomati River.

Group one in the south consisting of two patches of upper and lower montane type forest on the farm Schoonoord (c. 120 ha).

Group two in the north consisting of the fairly large Pedlar's Bush (c. 140 ha) in the Twello forestry area, in the catchment of the Hlatikula River, a tributary of the Lomati.

11 **Louw's Creek.** Two forests of the valley type on opposite sides of the Mistland mountains, a lowveld watershed between the Crocodile and Lomati rivers.

The forest in the west (c. 80 ha) being situated on the farm Waaiheuvel and in the adjacent native reserve, at the source of the Louw's Creek, a tributary of theCrocodile River; the forest in the east (c. 50 ha) on the farm Rhineland, at the source of the Mhlambanyati, a major tributary of the Lomati River.

12 **Malelane.** Two groups of small valley type forests in the Big Buffalo range, a major lowveld watershed.

Group one in the south consisting of some seven forest patches at the sources of Lomati tributaries on the farms Singerton, Kaalrug, Sherlock, Minnehaha, Laughing Waters and Letubi (total c. 50 ha).

Group two in the north comprising four forest patches at the sources of the Buffalo Creek and the Malelane, tributaries of the Crocodile River, mainly on the farm Coulter (total c. 20 ha).

The largest single units of forest are found at Buffelskloof, Pedlar's Bush, Kaapsehoop and Uitsoek. Only the two last-named forests have been investigated for the present project.

History of the region

Several hundred years ago, when the Mswati people entered the area of present-day Swaziland, the original Basuto occupants of the area gave way and moved to the north. There they became the bakaNaqonane (alternative spellings being bakaNgomane, bakaNgonane and bakaNgwane) and occupied the lowveld between the Sabi River in the north and the Lomati River in the south. Through the centuries they were exposed to several massive infusions by Shangaan refugees from the east, the present Mozambique, and gradually lost their own language which was supplanted by Tsonga and siSwati. Their tribal identity became further eroded under the strong influence of an increasingly numerous Mswati settler population all along the Swaziland border. A third element in the area was the Mbayi people who inhabited the foothills and mountains of the great escarpment in the west. They belong to the Basuto-Bapedi group, speak a Sotho dialect and were originally vassals of the bakaNaqonane.

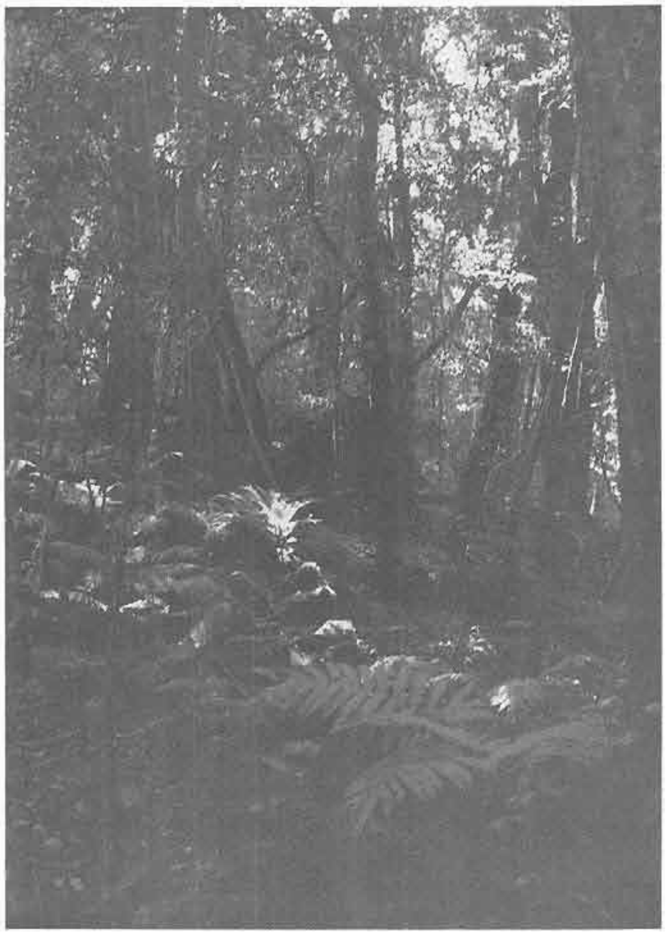
The Mbayi would appear to be the people who inhabited the area of the south-eastern Transvaal forests for two or three centuries. They were probably responsible for extensive shifting cultivation and mining operations resulting not only in temporary disturbance but possibly also the destruction of parts of the forests.

When the Dutch East India Company established a fort and trading station at Delagoa Bay in 1721, natives came from the interior, bearing gold dust in ostrich feather quills. The gold is thought by Webb (1954) to have come from the Kaapsehoop area where old workings were found by the first white diggers one and a half centuries later. There appears to be no direct connection with the Zimbabwean gold mining activities which occurred much earlier, around 1500, but legend has it that at some stage a Karanga tribe had mined alluvial gold in the De Kaap area as well as iron at Malelane and that their activities had been brought to a halt by the arrival of the bakaNaqonane (Bulpin, 1965), which must have taken place at least one century before 1700. Incidentally the natives also brought articles of iron to Fort Lagoa and said it came from a mountain not very far inland, which no doubt was the Ironstone Kop at Malelane, a rich deposit of haematite and iron oxide, where ancient workings are evident too. All this suggests that the bakaNaqonane as well as the Mbayi continued, to some extent at least, the mining activities of earlier inhabitants.

Interesting in this context are the stone mounds that were found on many gravel slopes along the foothills of the Makhonjwa range between Barberton and Hectorspruit. All loose surface stones had been gathered and stacked in neat piles, 1,5 m in diameter and 1 m high. Studded with hundreds or even thousands of such stone heaps, some areas looked like giant cemeteries. The stone heaps may well have resulted from a kind of massive prospecting operation. The explanation offered according to Webb (1954) by older natives, namely that the tremendously labour-intensive collecting operation had been undertaken by order of the Mbayi chief "on the pretext that it would enable the cattle to walk and graze more freely, but actually to keep the young men occupied and restrain their fighting vigour", sounds like a cover story. Stone heaps have also been found in forests, particularly under krantzes where the Black Reef outcrops.

Of interest also is a statement by Zeederberg (1971) that in 1898, more than ten years after the gold rush, a 52 oz. gold nugget was picked up on the road between Kaapsehoop and Barberton. Zeederberg relates that in those days many travellers preferred to leave the coaches and walk the section between Kaapsehoop and Barberton in the hope of finding a nugget or two, and that in fact hundreds of nuggets were picked up in that manner. Those nuggets had hardly been left behind by the white diggers.

In the first half of the 19th century the bakaNaqonane and Mbayi were overrun by the Swazis who.



Above and below right: Remnants of stone walls at a Mbayi forest refuge in Kantoorbos, Uitsoek

under King Somhlolo, also named Sobhuza I, conquered the entire lowveld and escarpment areas between the Crocodile and Olifants rivers. The Swazi reign over the territory consisted mainly of periodic raids of the existing settlements.

The Swazi conquest forced the Mbayi to seek refuge in the forests during the raiding season, probably winter. Remnants of the hiding places in remote parts of the forests are still evident.

The periodic inhabitation of the forest retreats probably came to an end with the cession in 1846 of the conquered areas by Sobhuza to the "Dutch South-African Nation", that is the Voortrekker republic of Ohrigstad which had been established in the previous year. Occasional Swazi raids still took place up to the Olifants River in the years thereafter, but the white settlers on the highveld rapidly consolidated their protectorate over the lowveld. By experience they learned of the climatic incidence of malaria and used the winter months to explore the lowveld on extensive hunting expeditions. After also getting acquainted with the tsetse-fly belts, they soon were in full control of the area as far as their immediate aims were concerned, namely exploitation of game products and a safe transport route to the port of Lourenço Marques.

Soon the settlers also invaded the kloof areas of the escarpment. The well-watered and wooded valleys, which were given appropriate names like Bosfontein, Boshoek and Bosoord, were cleared for pastures and ploughland. One of the first to arrive was P. A. Schoeman who in 1848 chose a farm, Mooiplaats, in the valley of the upper Crocodile River. The valley was then named Schoemanskloof.

Schoeman was not long alone. In the following year the Volksraad transferred to Lydenburg and the valleys of the Uitkyk, Elandshoogte and Ngodwane plateaus were sectioned up into farms.

The patches of evergreen forest in the higher-lying kloofs were an important feature. There the settlers found the urgently needed supplies of wagon and construction timber, especially assegaai and some yellowwood, as reflected in names like Houtbos, Houtboshoek, Houtbosfontein and Houtbosloop.

The area with the most accessible and richest forests, the north-western part of the Houtbosloop valley, was reserved by the "Kantoor", the government at Lydenburg, as a public timber resource and became thus known as Kantoorbos. It was the first state forest in Transvaal. (The second area to be reserved in that manner appears to have been the Grootbos in the Houtbosberg or Woodbush mountains.)

The farming boom on the escarpment was of short duration, however. After the initial enthusiasm many of the settlers found out that they had moved too far into the malaria danger zone. When children died in increasing numbers, the farmers retreated onto the highveld one by one. The exodus gathered further momentum with the transfer of the government to Pretoria in 1860. In the seventies very few of the escarpment farms were still occupied. Most of them were lying vacant for decades, being used only for emergency grazing from time to time.

The farm Beestekraal, in a remote valley of the Houtbosloop area, was put to an extraordinary use: the breeding and training of zebras as disease-resistant draught animals for farmwork and the coach services in

Entrance to the small living quarters

Clay pot in the kitchen building

Fig. 12

Ruins of what is thought to have been the Kantoorbos forest station. Situated in the heart of Kantoorbos (meaning "Government forest"), the station controlled the access to about twelve different kloof forests on both sides of the upper Houtbosloop where constructional timber is said to have been felled in the middle of the 19th century for use at Lydenburg. Only the western and northern parts of the complex seem to have served as forest station. The unfinished buildings including the open stable were probably added twenty to thirty years later when the timber extraction road east of the Houtbosloop was extended to Kwaggaskraal for the zebra breeding scheme. The complex may then have been used as a relay station. It may have been taken into temporary use once more in the early 20th century as a supply base-
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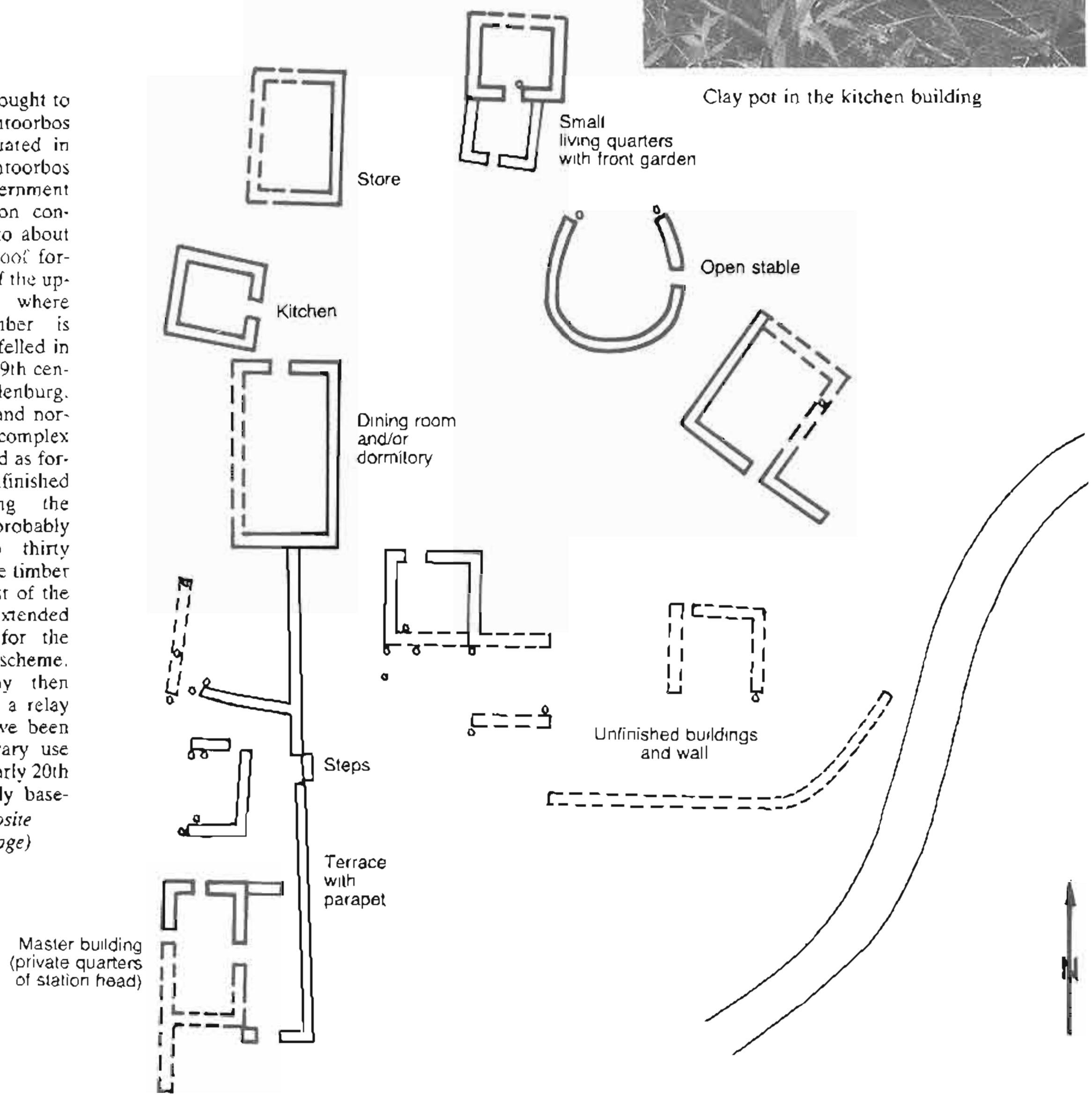

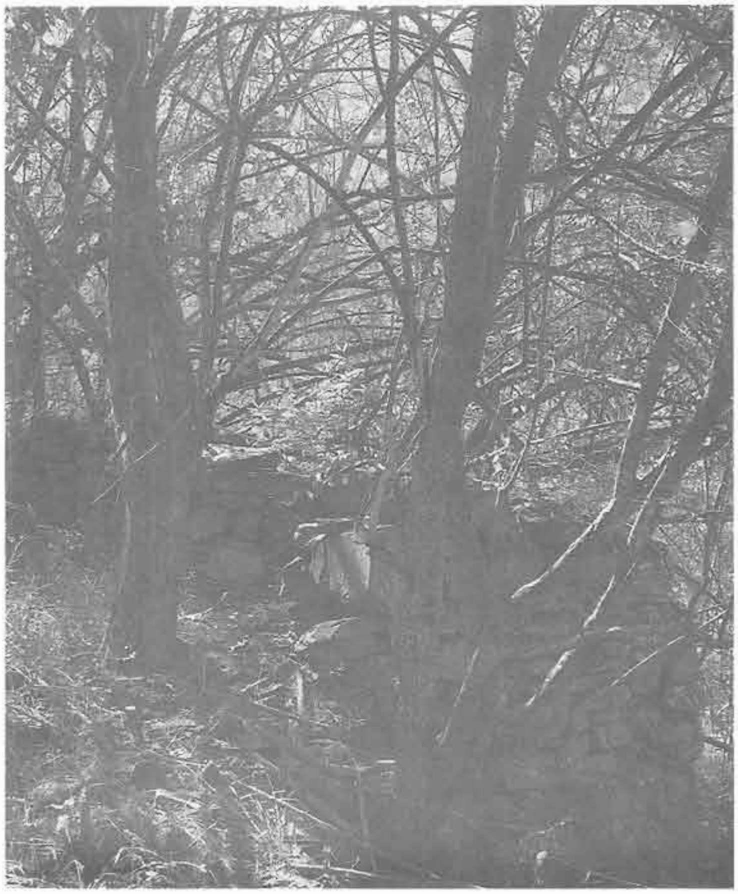

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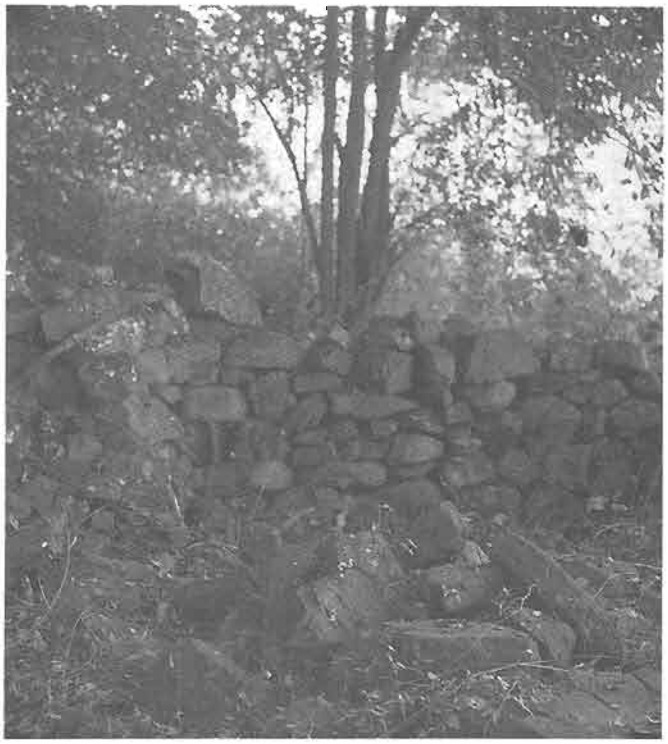
cum-farm centre for the Uitzoek gold mine at Klipbankspruit which was reached via the Kantoorbos/Kwaggaskraal route before the Blyfstaanspruit road was built.

In contrast to the well-constructed older buildings, particularly the master building (above left) and the so-called small living quarters (opposite page, above left) both of which have plastered walls, the more recent and partly unfinished additions are crude stone structures. The trees have obviously grown up after the complex was finally vacated, probably in the first half of the 20th century.



Above, below and right: Ruins of zebra stables constructed of massive stone walls, at Beestekraal

the late eighteen seventies and early eighties. Domesticated zebras were then much in demand due to a severe shortage of horses and mules. Remnants of box-like structures where the zebras were kept in isolation, can be found at Beestekraal and local blacks are still telling tales about the 'kwaggas'.

Another interlude was the gold rush of the early seventies in the Sabie area and, ten years later on the Ngodwane or Kaap plateau and in the De Kaap valley. The northern fields, all alluvial, were soon exhausted. The southern fields were started in a similar manner, with an alluvial find on the farm Berlyn, today's Berlin State Forest, amidst remnants of old African workings. Gold-bearing reefs were soon discovered and the entire

Kaap plateau became the scene of tremendous activity. A town sprung up at a place near the highest cliff, called Duiwelskantoor, and was renamed Kaapsehoop in allusion to the great expectations.

In August 1882 there were 250 diggers at Kaapsehoop, a month later their numbers had increased to nearly 1 000. The population, including diggers, traders, store keepers, inn keepers and a multitude of hangers-on, was swelling daily and reached a total of 8 000 in the beginning of 1884 (Don McDermid, pers. comm.). Shortly thereafter it shrunk rapidly when most of the diggers removed to the newly discovered Pioneer Reef near the present town of Barberton. The exodus became almost complete with the discovery of Barber's Reef and the Sheba Reef in 1885.

In addition to the founding of Barberton, a number of short-lived towns and villages came into being in the new area, such as Eureka City, Joe's Luck and Fairview, to accommodate the thousands of prospectors, miners and businessmen. The boom activities reached a peak in 1886 and came to a sudden end early in the following year. Most of the diggers left for the newly discovered goldfields at the Witwatersrand. Both at Barberton and Kaapsehoop the mining operations

were stabilised by being concentrated in the hands of a few companies.

In spite of having been short-lived, the gold rush had opened up the south-eastern lowveld. Not only several major gold mines and a number of smaller ones continued to operate, but many other mineral deposits were discovered and their exploitation initiated, such as asbestos, talc, barite and magnesite. The transport riders, bringing up supplies from Lourenço Marques, had developed a rudimentary road system which was soon backed up by a railway (1895). The rail access to the market of the Witwatersrand stimulated local farming development which was favoured by the sudden disappearance of the tsetse fly (in connection with the rinderpest) and the discovery of the nature of malaria.

While the lowveld thus became a scene of steady development, the escarpment continued to be exposed to erratic impulses between periods of near-dormancy. During the Anglo-Boer War the escarpment attracted attention as a major zone of resistance to the invasion forces and, subsequently, an area of guerilla strongholds. The repopulation of the escarpment farms was promoted by the economic depression of the nineteen thirties which stimulated marginal gold mining, slate mining and similar activities. Eventually, stabilisation was achieved by massive afforestation with pine and gum plantations which, since the nineteen forties and fifties, have given the escarpment its final and most appropriate role as one of South Africa's foremost timber producing regions.

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Forest history

In the absence of direct evidence one can reconstruct the history of the forests only in a very generalised manner, largely by conjecture.

There is little doubt that some 140 years ago, when the Trekkers took possession of the area, the extent of the forests was about the same as today. An exception were the valley grounds which the white farmers cleared for agriculture. Most of the hillsides and lower mountain slopes were inhabited by black tribes and any semi-deciduous forest and bushveld vegetation that may have been there, had been removed long ago. In some parts, like the lower slopes and foothills of the Kaapsehoop escarpment, the high population and lifestock pressure had not only led to complete denudation of the soil but also to large-scale erosion as shown by the deep dongas one still can see today.

The evergreen forests of the higher slopes which may originally have covered areas between 50 and 100 per cent larger than today, were then already confined to their present borders as a result of centuries if not millenia of veld fires and heavy grazing. In a few areas, especially at Kaapsehoop, sections of the forests appear to have been destroyed during an early reef mining period.

Contrary to popular notion, neither the gold rush at the end of last century nor the subsequent development of the area up to present days seemed to have had any noticeable impact on the forests.

The digger populations of Kaapsehoop and Barberton no doubt consumed large quantities of fuelwood. This resulted in the denudation of the surrounding bushveld areas but hardly affected the forests. The tent and shack towns springing up during the gold rush did not create a demand for construction timber. Whatever "building" materials were required were brought along by the prospectors and businessmen on their wagons, with the transport riders taking care of what was needed in addition. Even if there had been a substantial demand for timber, none of the Whites then in the area would possibly have wasted his time on timber felling during that frenzied period.

It was apparently only after the collapse of the boom, when permanent companies took over and organised orthodox underground mining operations, that mining timber, mainly assegai (*Curtisia dentata*), was extracted from the forests, usually by the mine personnel themselves as at Kaapsehoop (Don McDermid, pers. comm.).

The relatively large quantities of roof and floor timbers as well as of door and window frames needed in the late eighteen eighties and the nineties for house building, particularly at Barberton (much of which burnt down in 1891), were initially brought up by wagon from the Cape and later, after the opening of the eastern railway in 1895, supplied from Lourenço Marques in the form of imported spruce and fir.

The south-eastern Transvaal forests never contained yellowwoods in quantities that could have provided construction timber on a scale required for urban development. For that reason they were spared invasion by the hordes of pitsawyers who scoured the northern Transvaal forests during the seventeen years between the founding of Johannesburg and Pietersburg in 1886 and the completion of the link-up with the Cape railway in 1903, i.e. until the cheaper imported timber became freely available.

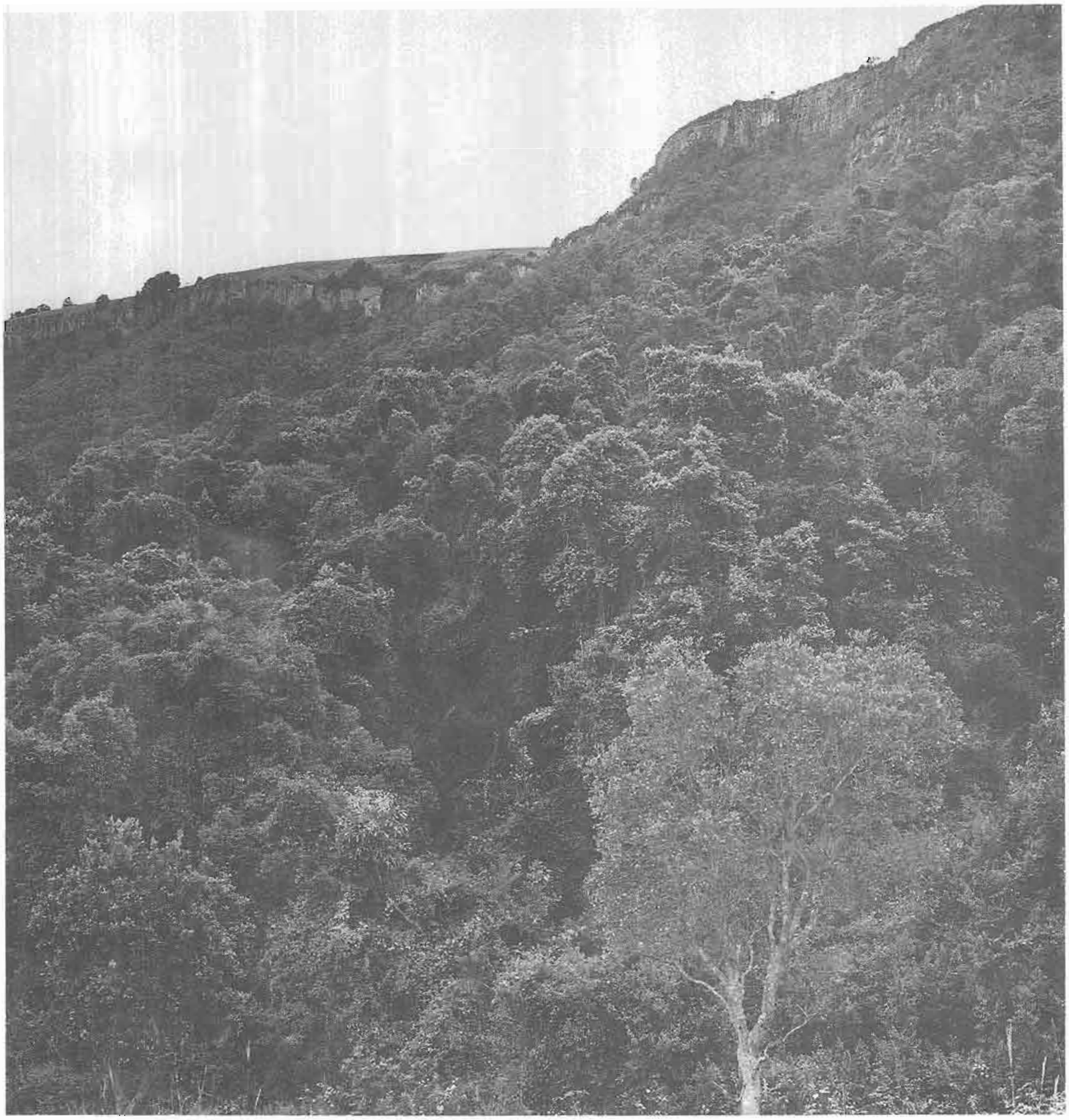
There is no evidence of an indigenous, evergreen forest having been effectively reduced in size or having been altogether removed in the area since the arrival of the Whites. The only forest clearing that took place, concerned the valley bottom vegetation as already mentioned. This includes the semi-deciduous forest remnants in the Kaalrug area in the east, that have more recently made way for mango plantations.

Moreover, there is no substance to the claim that the commercial timber plantations were established at the expense of the natural forests. Tree planting was started early in this century. At first eucalypts and black wattles were planted for the reclamation of mining sites. Soon some of the mining companies also began to establish plantations of eucalypts and pines for their own requirements. Large-scale afforestation of the mistbelt areas with pines and of the foothills with eucalypts, both by the State and private companies, started in the nineteen thirties and forties, climaxing in the fifties. Of course, not all this afforestation took place in open grassland. For many plantings it was necessary to clear bushveld and mountain scrub, but no case is known of forest clearing for a commercial timber plantation.

Kaapsehoop forests

The Kaapsehoop forests are situated to the south and south-east of the village of Kaapsehoop, in a shallow recess of the escarpment on the eastern flank of the Ngodwane plateau. The several blocks of forest occupy the south-east facing slopes and ravines constituting the catchment of the Noordkaap River (Fig. 27).

The forests of the upper montane type extend from just under the krantzes at an altitude of about 1 650 m, in a broad front down the steep slopes to a terrace at about 1 500 m, dividing there into a number of wide wedges of lower montane forest which, at about 1 200 m, taper into narrow ravine galleries of scrubby



Kaapsehoop forests from the south

valley forest.

The upper, main portions of the forest are on state land, while the extensions below the intermediate terrace are on land owned by a private timber company and afforested with pine and eucalypt plantations.

Minor patches of ravine forests occur also in the deep kloofs on the western side of the Ngodwane plateau, especially in Starvation Gully, Battery Creek and Coetzeestroom Creek.

Climate

H. C. von Christen, in an unpublished report of 1961 on the soils and the ecology of the pine plantations of the "Kaapsehoop plateau", differentiated three distinct climatic zones in the area of the Ngodwane plateau:

1. The temperate perhumid zone or mistbelt proper, occupying the altitudinal range between 1 500 m and the highest plateau elevation at 1 675 m;
2. the temperate humid zone between 1 250 m and 1 500 m;
3. the subtropical subhumid zone below 1 250 m.

Von Christen assigned the evergreen, or montane, forest to the two temperate zones and the bushveld to the subtropical zone. Although he addressed only the conditions on the plateau and to the west, his classification fits also the escarpment on the eastern side. The interzonal division lines at about 1 500 m and 1 250 m are well reflected by the floristic data.

During fieldwork in winter 1979 the 1 450 m contour was emphasised by two phenomena: heavy frost and road ice above that line and mosquitos below it.

The rainfall figures for Kaapsehoop, representing the upper limit of the mistbelt, show an annual average

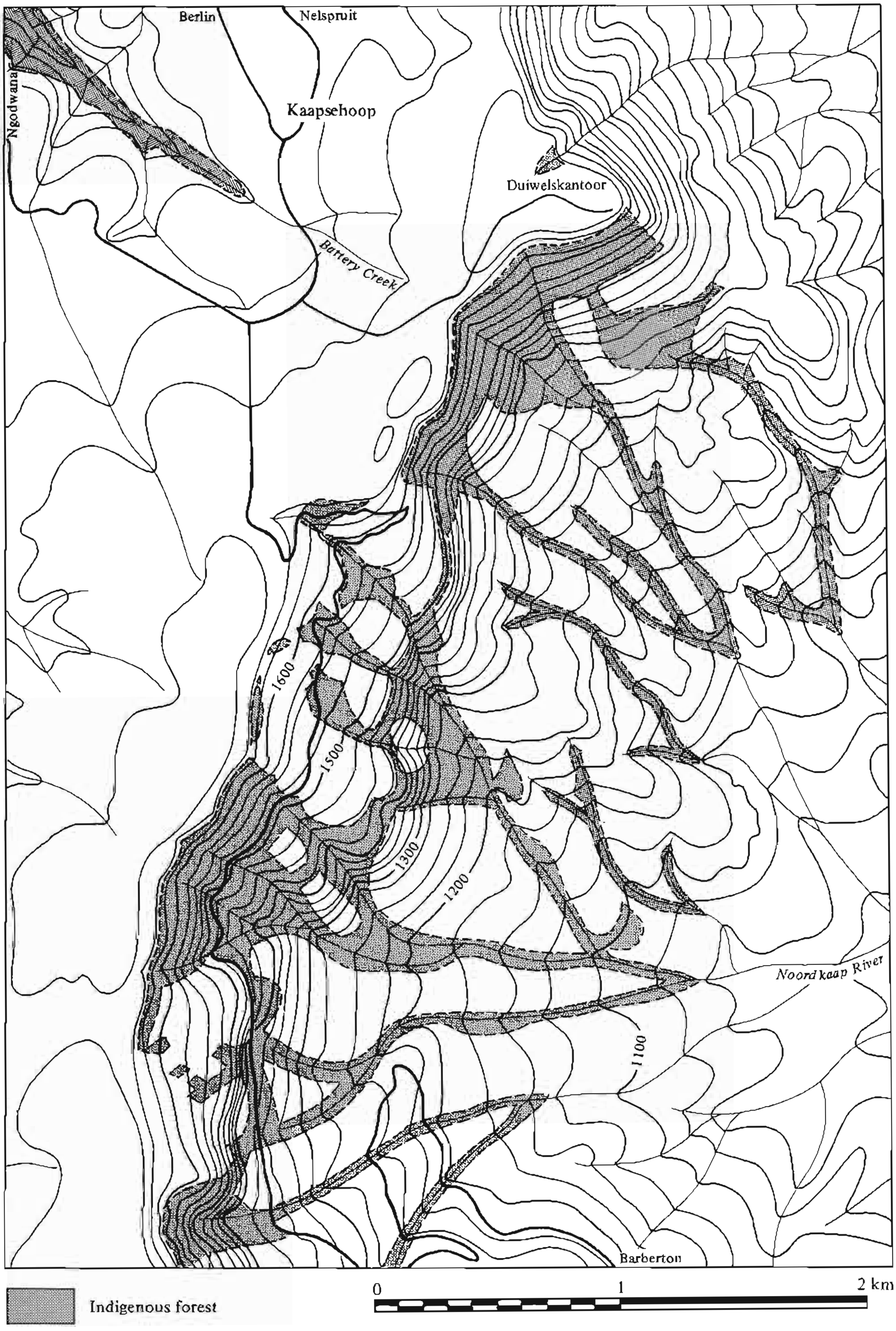
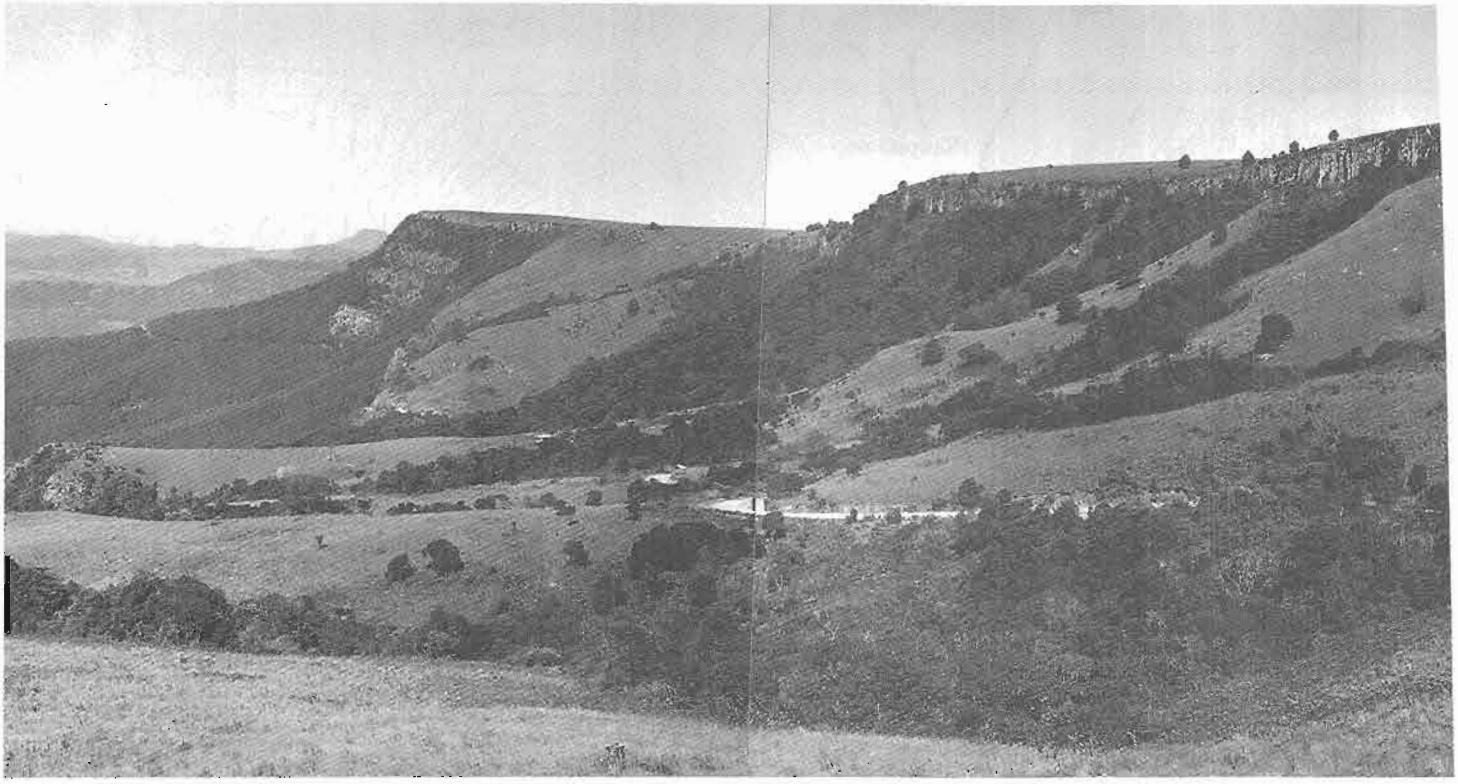


Fig. 27 Kaapsehoop forest map



Kaapsehoop forests from the north

(1903–1984) of 1 502 mm of which 84,4 percent falls during the summer months from October to March.

Geology and soils

The slopes of the eastern escarpment of the Ngodwane plateau, where the actual Kaapsehoop forests are situated, are underlain by Nelspruit Granite. The krantzes on top consist of the hard quartzites of the Black Reef Series.

The soil consists mainly of red-brown to yellow-brown sandy loams derived from the underlying granite rock. The latter is evident in the form of saprolites at a depth of 0,5 m to 1 m. With increasing depth these decaying rock pieces join into solid bedrock.

The soil contains scattered or whole layers of relatively unweathered granite blocks. These are fragments of rock pieces that have fallen down from exposed parts of the escarpment. The granitic debris is sometimes mixed with quartzite blocks which obviously originated from the krantzes. Also the surface of the slopes is in many places strewn with stones and boulders.

In spite of the rock avalanches which appear to occur from time to time, it is clear from the presence of the saprolitic bedrock that the conical ridges running up the escarpment are not true talus slopes but, like the ravines between them, products of erosion. Yet there are occasional pockets of unconsolidated or semi-consolidated talus.

The upper layers of the loam soil are humus-enriched. On top there is usually a shallow subsurface root-mat, i.e. a dense accumulation of feeder roots together with sandy humus. The ground surface is covered by a litter layer of dead, undecomposed and semi-decomposed leaves and other organic debris.

The ravines in the western part of the plateau show similar conditions. However, due to the extreme steepness of the slopes, the soil layer is very shallow and the granite is often exposed under the nearly vertical quartzite krantzes. Lower down the erosion has even eaten into the ancient sediments and volcanic rocks underneath.

Vegetation

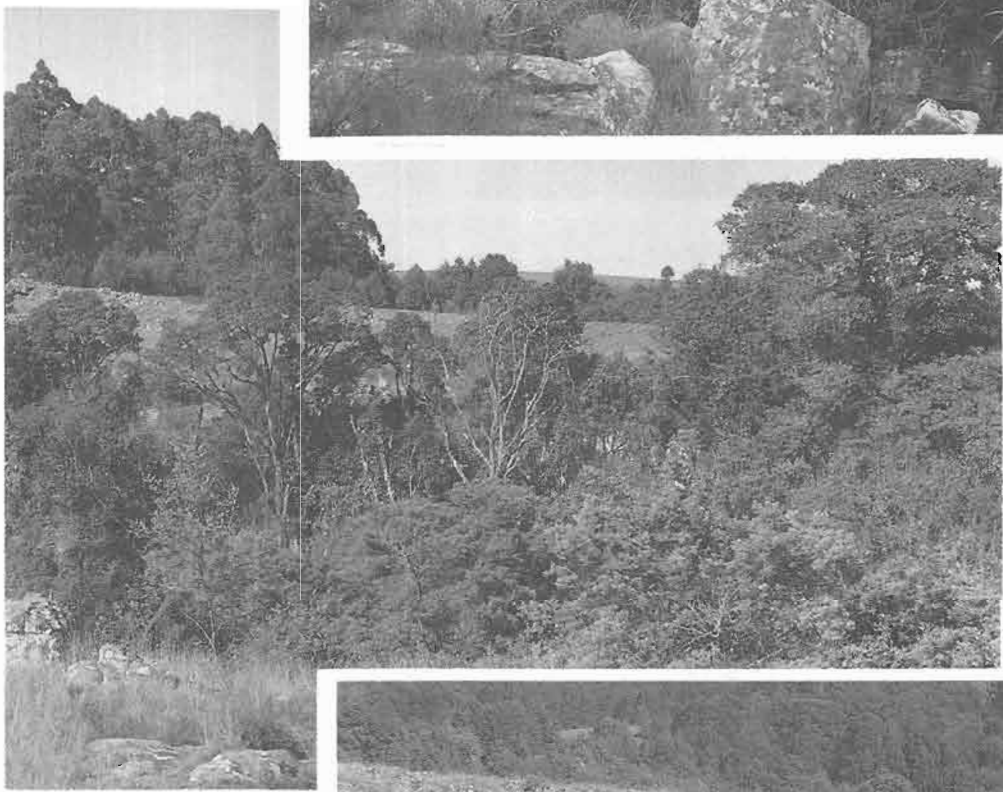
Two veld types (Acocks 1951/1975) are prevalent in the area: the North-eastern Mountain Sourveld which includes forest, scrub and grassveld, and the Lowveld Sour Bushveld.

In the east the bushveld occupies the rolling country above the actual lowveld and ends at the foot of the Kaapsehoop escarpment at about 1 100 m altitude, while in the west, on the westerly inclined Ngodwane plateau, it ascends up to some 1 300 m. The higher plateau portions are occupied by mountain grassveld and occasional scrub groups. The steep slopes of the escarpment in the east, as well as the eastern aspects of the plateau kloofs support forest and scrub.

This altitudinal arrangement of the veld types is well reflected by randomised spot checks of woody species growing outside the closed forests in the area between Ngodwana in the west and the escarpment road in the east.

More than half of the 79 species encountered on western aspects (Fig. 28) are bushveld species and are concentrated at the altitudes between 1 100 m and 1 300 m to the near-exclusion of other species. The only non-bushveld species occurring at and below 1 300 m

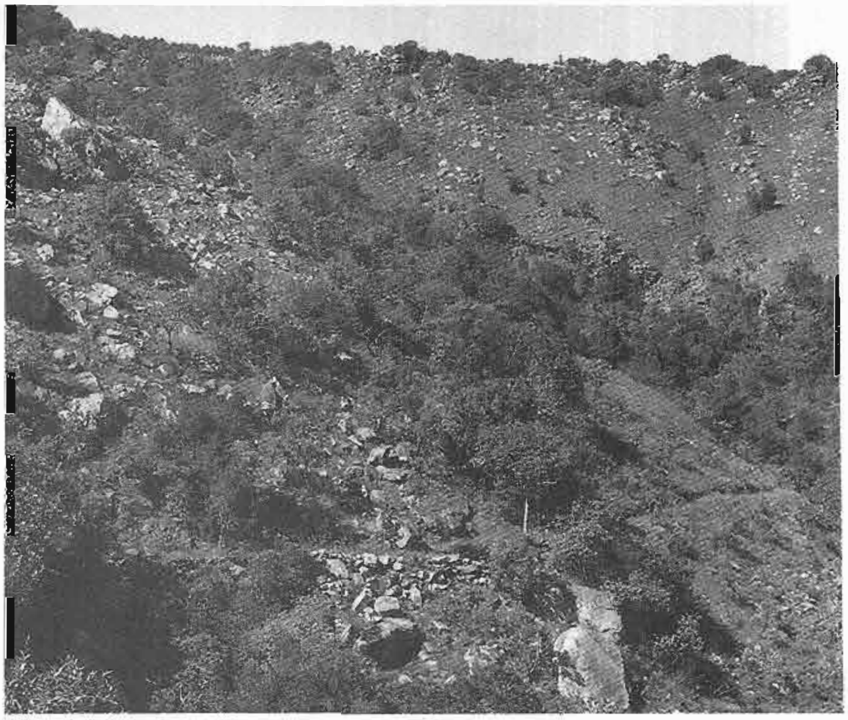
Myrica pilulifera and *Aloe arborescens* on an outcrop in the highest plateau portion at Duiwelskantoor



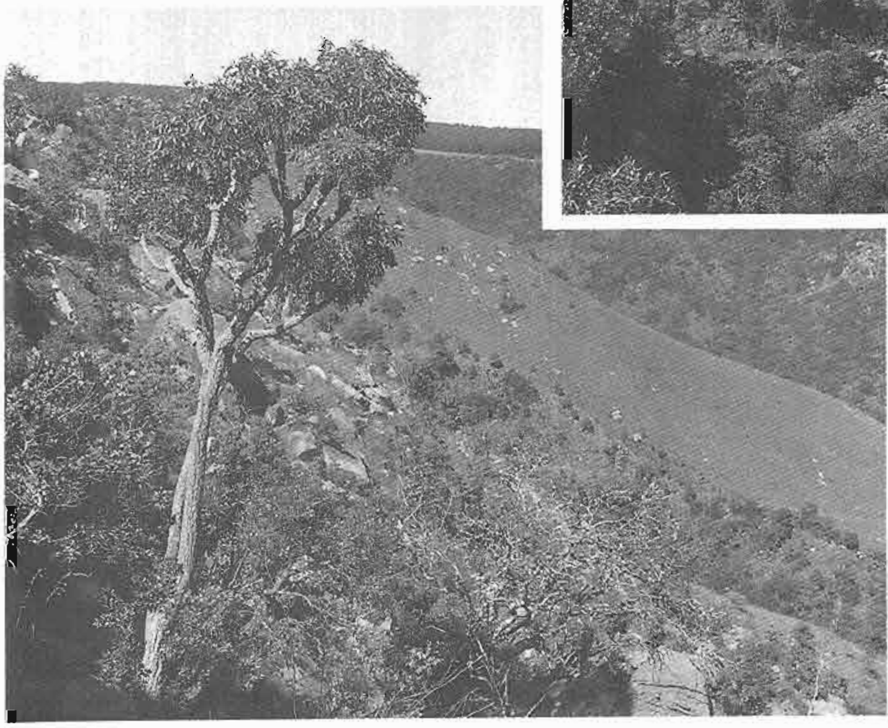
The uppermost section of Battery Creek, with gum and pine plantations in the background

The deep gorge of the upper Battery Creek, with *Podocarpus latifolius, Combretum kraussii, Nuxia congesta, Schefflera umbellifera, Pterocelastrus echinatus, Rapanea melanophloeos, Cussonia spicata* var. *triptera* and *Faurea galpinii*

The upper end of Starvation Gully, with dense scrub forest



Open scrub in the central portion of Starvation Gully



Cussonia spicata var. *triptera* at the krantzes above Starvation Gully are two dry-type forest species, viz. *Rhus chirindensis* and *Ekebergia pterophylla;* two pioneers, *Dombeya burgessiae* and *Solanum mauritianum,* as well as two mountain scrub members, *Bequaertiodendron magalismontanum* and *Faurea speciosa.* There are also a few transgressors like *Dalbergia armata, Cussonia spicata* var. *triptera, Apodytes dimidiata* subsp. *dimidiata, Ficus sur* and *Diospyros whyteana,* as well as the shrub

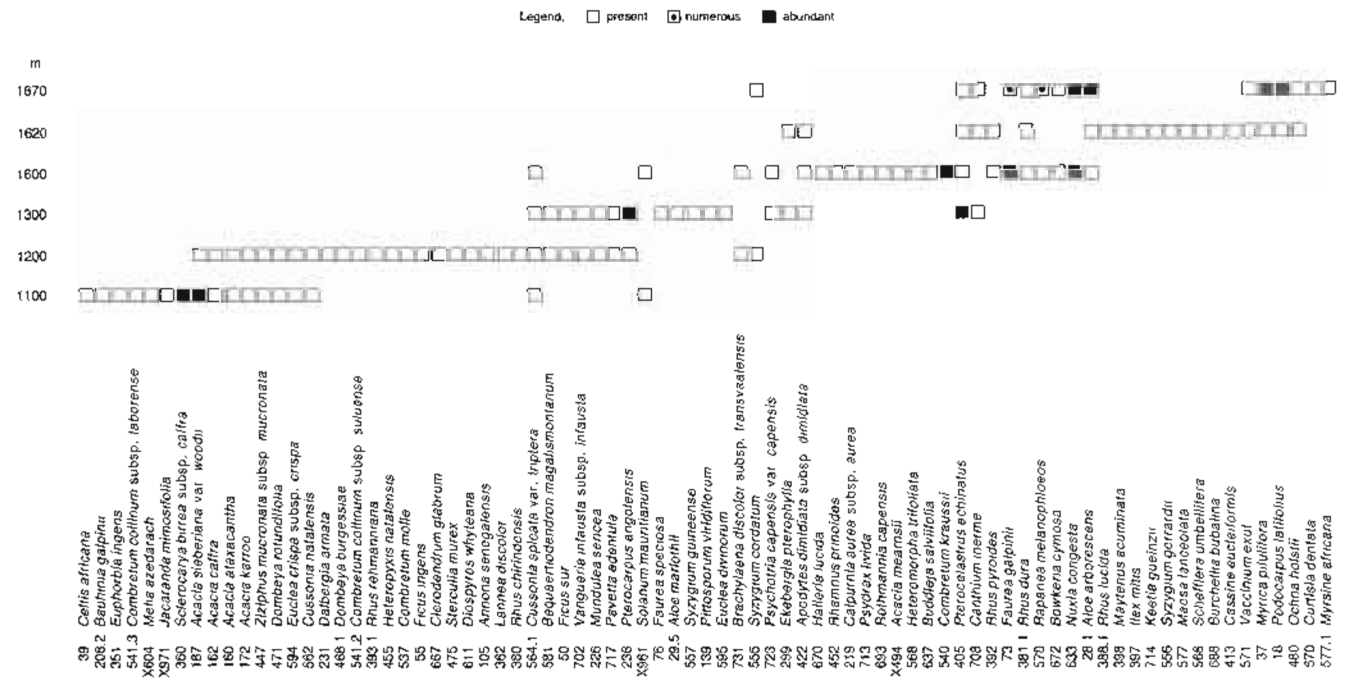


Fig. 28 Woody species on western aspects (at random outside forests)

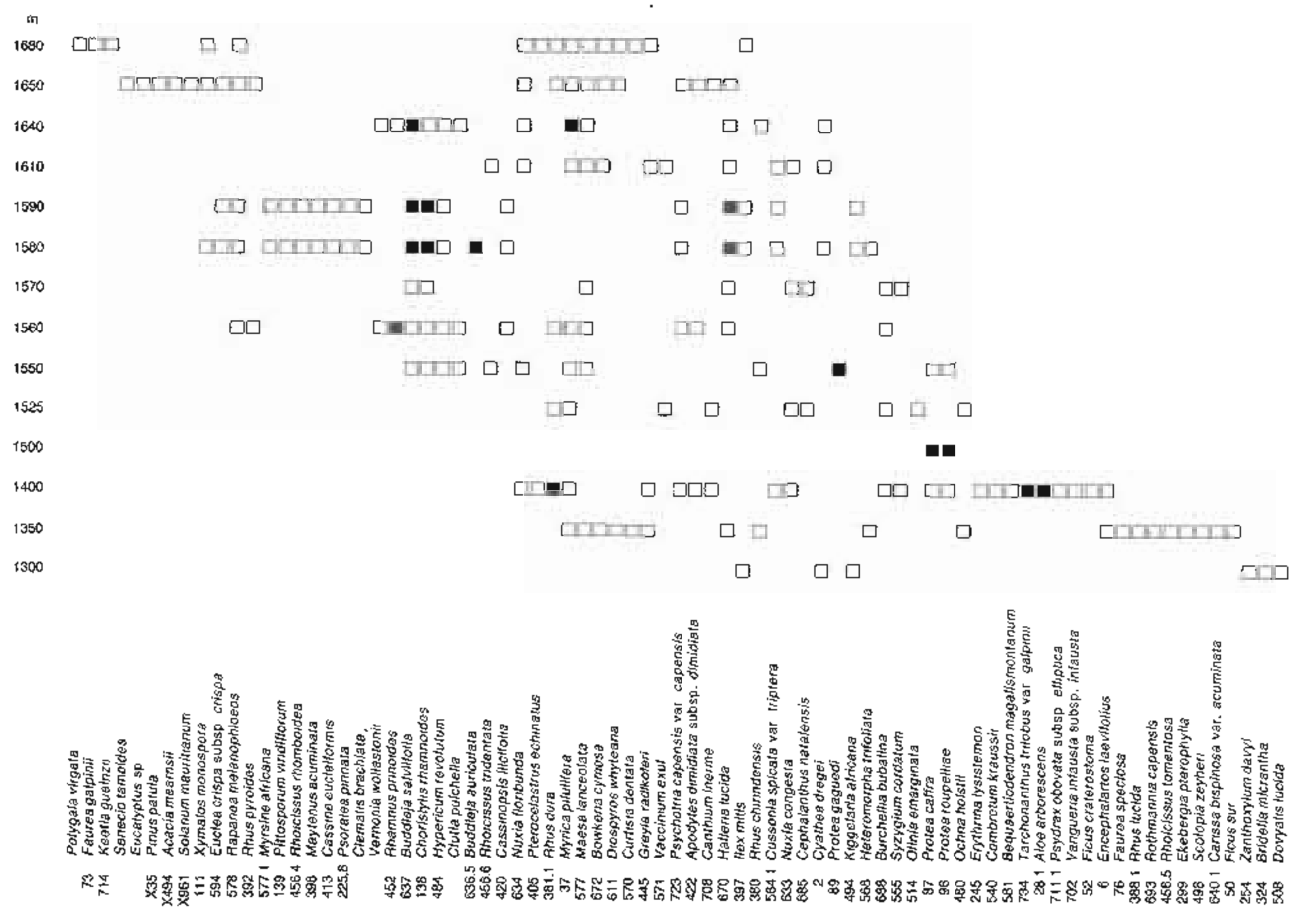
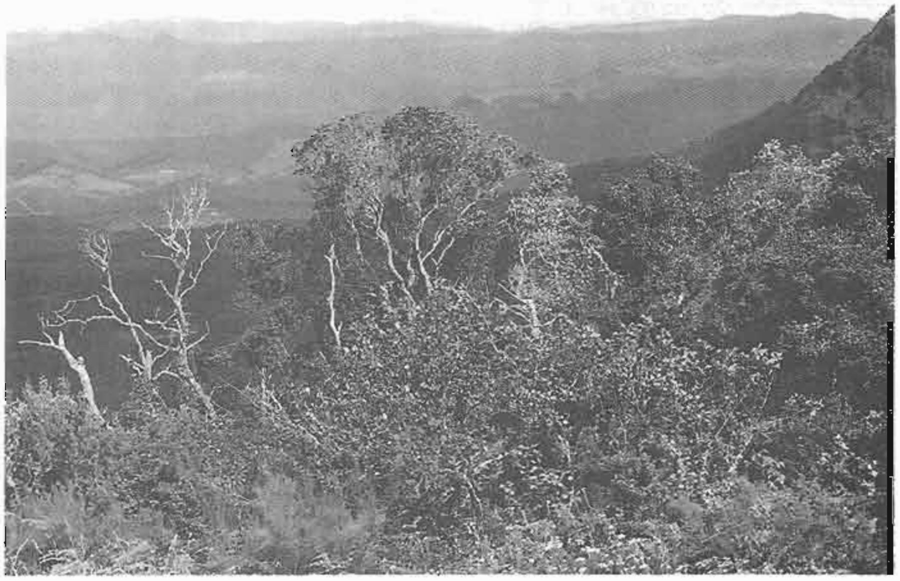
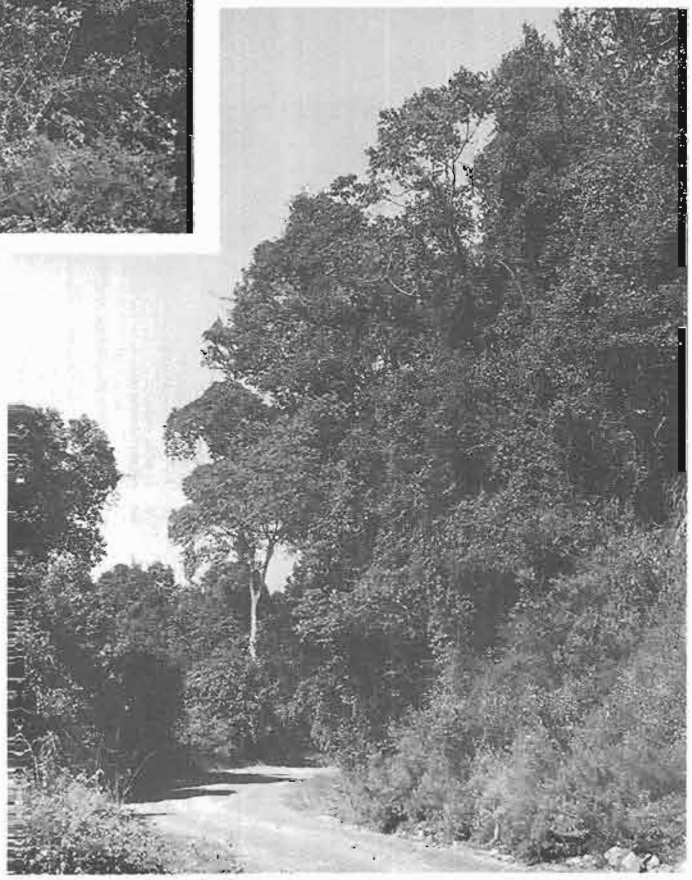


Fig. 29 Woody species on eastern aspects (at random outside forests)



Scrub forest of *Greyia radlkoferi* (foreground), *Rapanea melanophloes* and *Pterocelastrus echinatus* at the upper end of a forested ravine, just under the krantzes.



Above: Escarpment road through central forest block

Middle left: Forest in lower portion of Battery Creek

Southern forest edge with *Nuxia floribunda*, *Halleria lucida* and *Buddleja salviifolia* forms of *Pterocelastrus echinatus* and *Canthium inerme*.

The forest and mountain scrub species, on the other hand, monopolise the higher altitudes, 1 600 m and above, with only a few intruders present such as *Brachylaena discolor* subsp. *transvaalensis*, a transition forest species; *Syzygium cordatum*, a wetland species, and *Heteromorpha trifoliata*, an ubiquitous pioneer.

The altitudes between 1 300 m and 1 600 m, which are occupied by grassveld and pine plantations, are not included in the western aspect spot checks.

On the eastern aspects (Fig. 29), from 1 680 m down to 1 300 m, only true forest and mountain scrub species were encountered, including a few transgressors like *Pittosporum viridiflorum* and *Rhoicissus tridentata*, and the green-leaved scrub forest form of *Euclea crispa* subsp. *crispa*. The only stranger was *Bridelia micrantha*, which in a wooded ravine had made its way from the valley forests up to an altitude of 1 300 m.

Secondary vegetation

In various places along the upper part of the escarpment, that is between the krantzes and the terrace, the forests are replaced by secondary grassveld and scrub, including self-sown pine groups and protea veld. A major area of that kind is in the centre of the forest belt (Fig. 30).

This area is thought to have been deforested in the course of the original reef mining activities that may have started around 1600 and lasted until the beginning of the 19th century when the early mining settlements were razed by the conquering Swazis.

At the time of the Kaapsehoop gold boom the deforested sections of the upper slopes were probably covered by thickets of forest pioneers. These have most certainly fallen victim to fuelwood cutting for the then populous town, with their reconstruction having afterwards been inhibited by grazing and veld fires. Only recently, after all the mining operations had come to an end and state forestry had taken over control of the

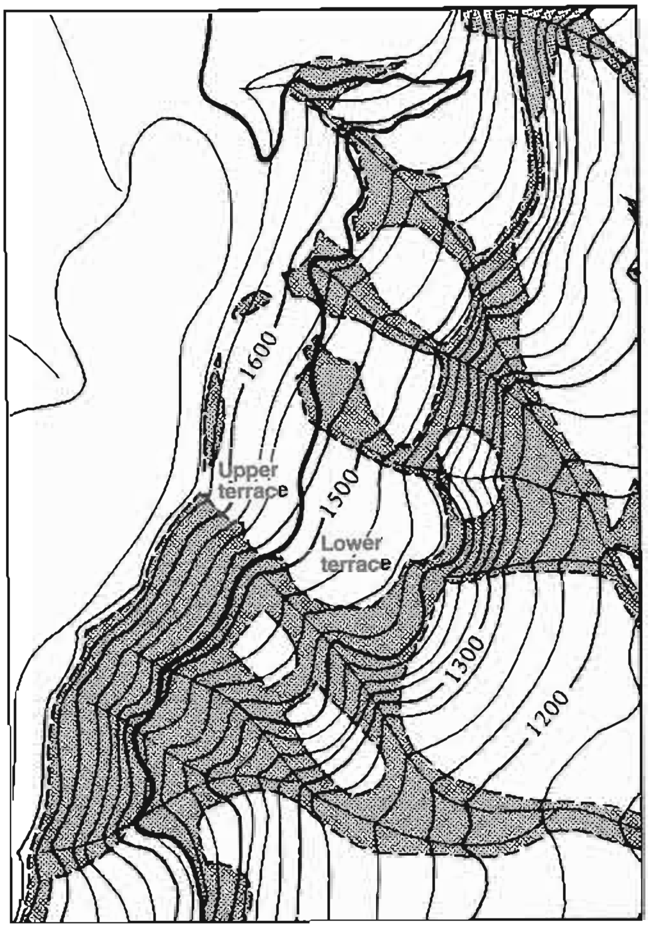
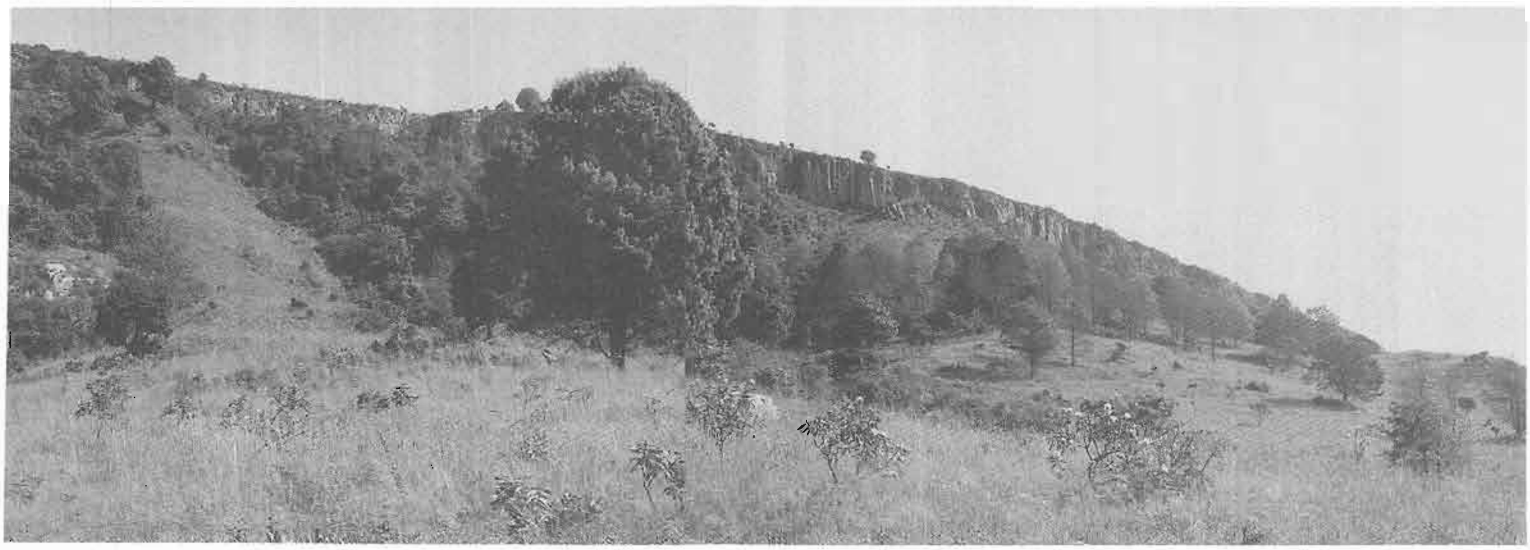


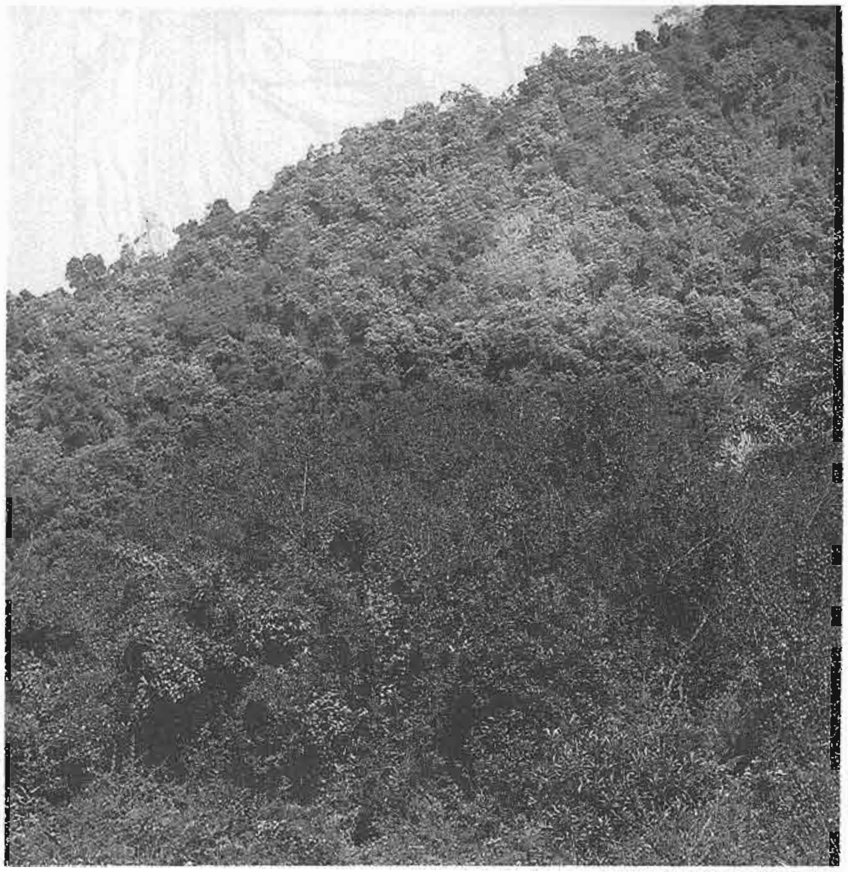
Fig. 30 Area of secondary vegetation (possibly prehistoric reef mining area) in centre of forest belt

area, the veld got another chance to recover, with natural bush clumps springing up once again as forerunners of the forest, but this time interspersed with self-sown pine trees.

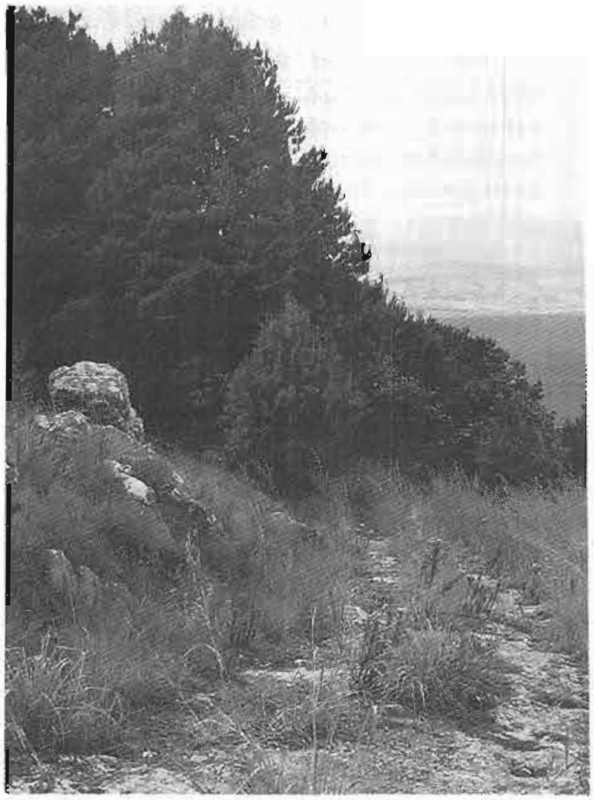
One of these bush clumps, situated in a small and shallow, relatively moist depression near the upper slopes at an altitude of 1 560 m, was enumerated. The dominant species was *Rhamnus prinoides*, a common

Self-sown pines in the *Protea gaguedi* veld of the upper terrace



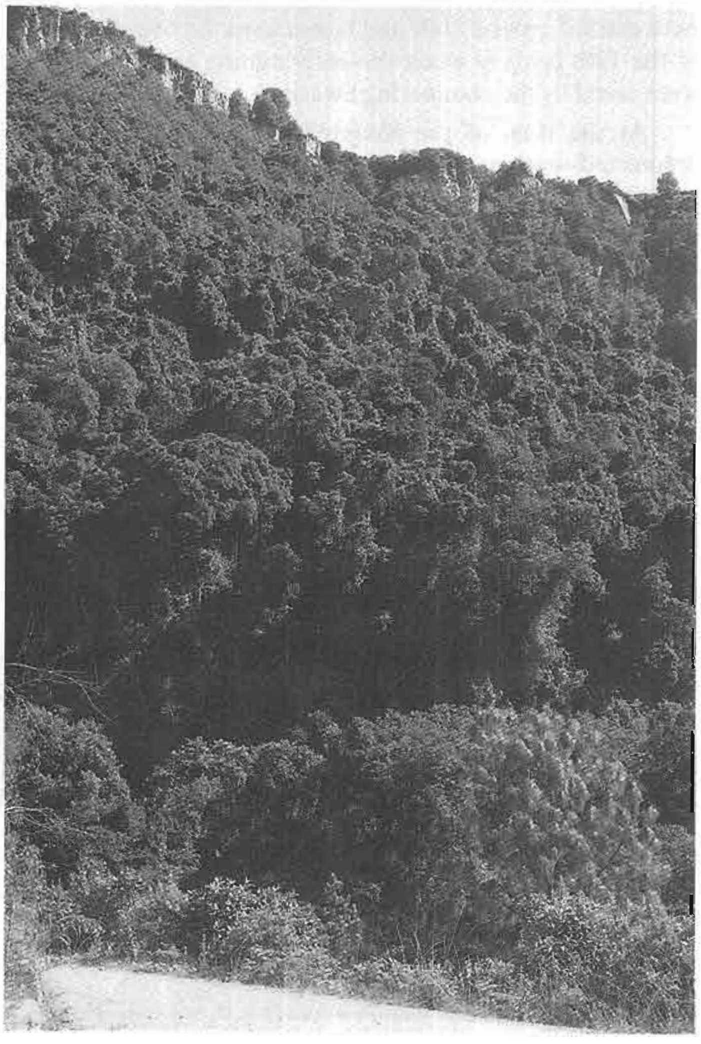


A dense, *Rhamnus prinoides*-dominated bush clump initiating the reconstruction of the forest

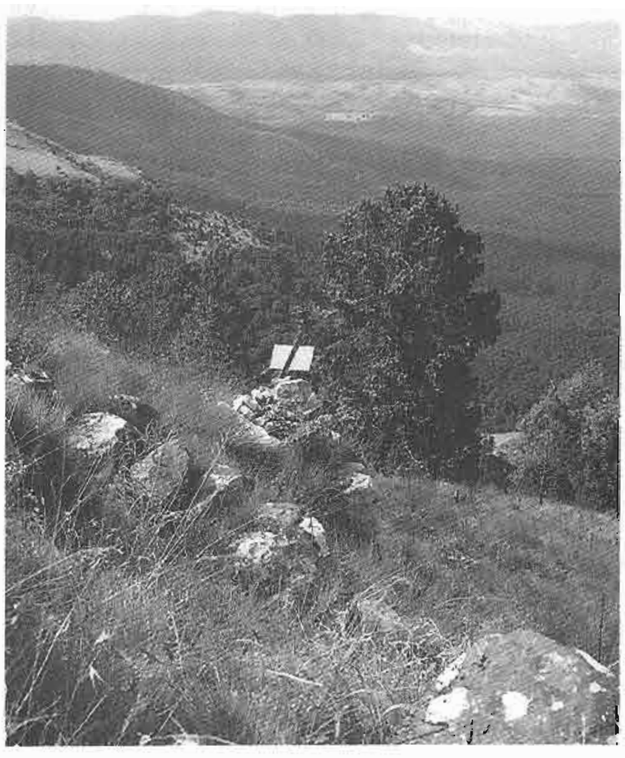


Cart track to pine-covered former mining site

Pinus patula spreading at roadside

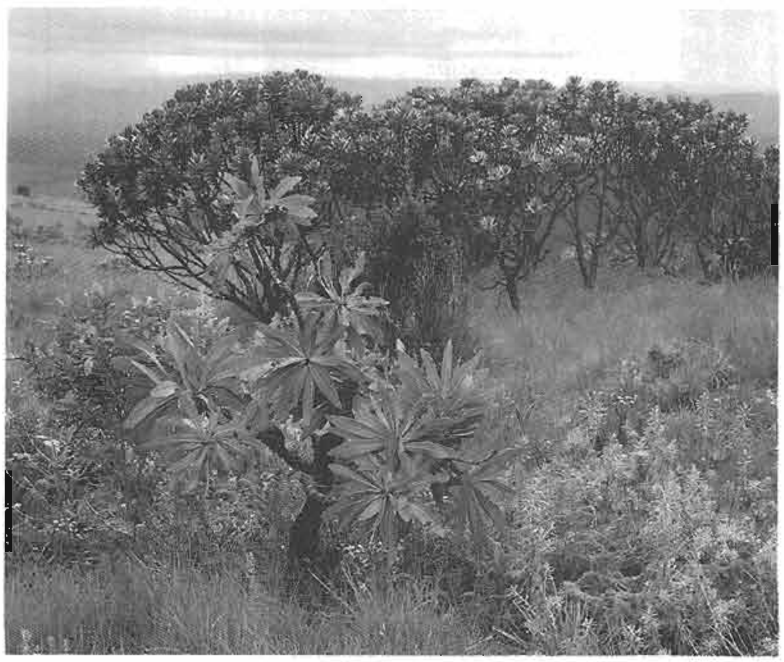


A live claim near the southern edge of the central forest block



Protea gaguedi, flowering

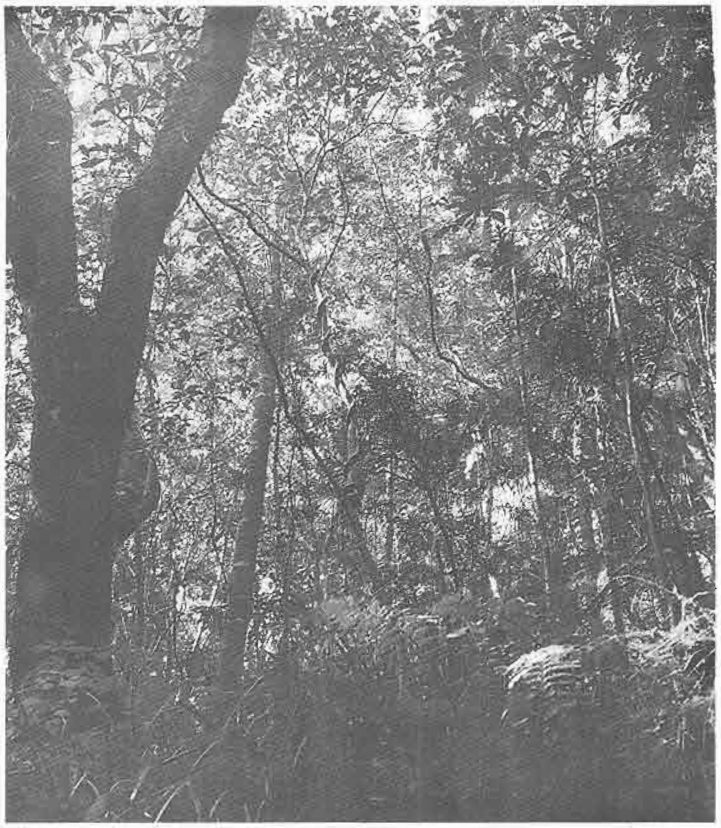
Lower terrace colonised by *Protea caffra* and old stands of *P. roupelliae*



Protea caffra in front of a *P. roupelliae* thicket forest nurse tree. Among the other species were the usual elements of mistbelt forest margins and openings such as *Maesa lanceolata, Buddleja salviifolia, Myrica pilulifera, Clutia pulchella, Hypericum revolutum, Rhus dura, R. pyroides, Halleria lucida* and *Cassinopsis ilicifolia;* understorey trees like *Burchellia bubalina, Psychotria capensis* var. *capensis* and *Vernonia wollastonii,* as well as early climax canopy trees like *Apodytes dimidiata* subsp. *dimidiata, Nuxia floribunda* and *Rapanea melanophloeos.*

The large central terrace which is thought to have been a densely populated mining settlement for several centuries, is occupied by protea veld as an apparent fire climax. In the upper part, west of the road at an altitude of about 1 500 m and on rocky-stony ground, there are scattered groups of *Protea gaguedi* together with a few individuals of *P. roupelliae* and *P. caffra,* as well as occasional self-sown pines.

The lower part of the terrace, a semi-circular area with shallow soil at an average altitude of 1 500 m, is covered by a population of low and seemingly young *P. caffra.* Near the southern edge of the terrace there is a group of tall and old *P. roupelliae.*

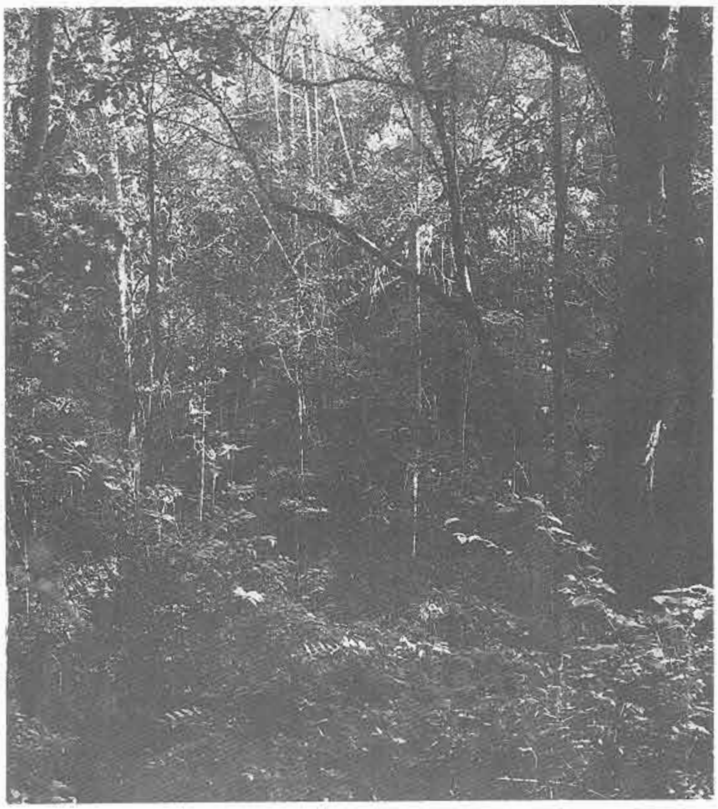


An *Ocotea kenyensis* tree in the sink-hole forest

Sink-hole forest

On the eastern edge of the Ngodwane plateau there are areas where the quartzitic sandstones of the Black Reef Series are exposed and have partly decayed, leaving behind grotesquely shaped hard-core formations as well as deeply eroded holes and caves. One of these areas is a large shallow trough just south of Spitskop and The Wattles at an altitude of 1 600 m. There are a number of smaller and bigger erosion holes and most of them are partly or wholly colonised by shrub and tree groups.

The luxuriant shrub layer and lower storey of the sink-hole forest



The biggest and deepest of these holes is an almost quadrangular "sink-hole", about 25 m by 25 m and some 20 m deep with vertical walls. The sloping ground of the bottom, which is drained by a streamlet that disappears into an underground cave, is occupied by an entire forest.

The forest is dominated by huge specimens of *Ocotea kenyensis* and *Cussonia spicata* var. *triptera.* Other canopy trees are *Ilex mitis, Xymalos monospora, Rapanea melanophloeos, Schefflera umbellifera* and *Syzygium gerrardii.*

The lower storey is made up of *Podocarpus latifolius* which is particularly plentiful, as well as *Maesa lanceolata, Ochna holstii, Canthium pauciflorum, Dovyalis lucida, Pterocelastrus echinatus, Rothmannia capensis, Psychotria capensis* var. *capensis, Keetia gueinzii, Halleria lucida, Peddiea africana, Ficus craterostoma, Apodytes dimidiata* subsp. *dimidiata, Tricalysia capensis* and *Micrococca capensis.*

The shrub layer consists of *Plectranthus fruticosus,* the herb layer of *Asparagus africanus, Carex spicatopaniculata, Streptocarpus cyaneus, Asplenium boltonii, Blechnum giganteum, Dryopteris inaequalis* as well as abundant *Impatiens sylvicola* and *Isoglossa* sp.

Gleichenia umbraculifera is draping the wet walls of the hole.

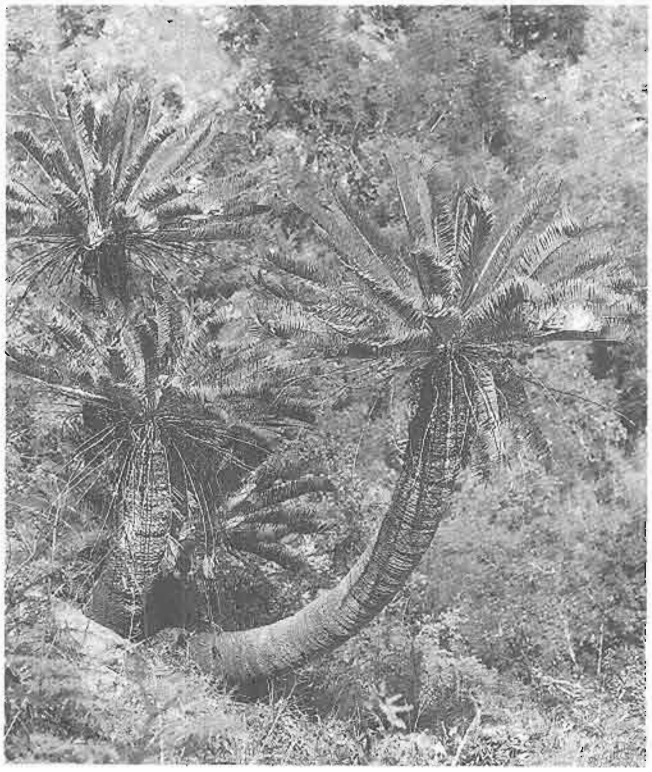
The upper rim of the hole is densely stocked with shrubs and shrubby trees of *Aloe arborescens, Vacci-*

nium exul, Maytenus undata, M. acuminata, Myrica pilulifera, Cassine eucleiformis, Nuxia congesta, Rhus lucida, R. pyroides, R. dura, Burchellia bubalina and *Ekebergia pterophylla,* as well as some of the species that occur also inside the sink-hole, such as *Apodytes dimidiata* subsp. *dimidiata, Ochna holstii, Keetia gueinzii, Ilex mitis, Syzygium gerrardii, Pterocelastrus echinatus, Podocarpus latifolius, Maesa lanceolata* and *Schefflera umbellifera.*

The presence of *Ocotea kenyensis* suggests that the sink-hole acts as a vegetation trap, which may at least partly be responsible for the relatively high species diversity. The obvious maturity and the well-balanced functioning of this isolated forest system is significant, however.

Noteworthy species

In addition to the afore-mentioned presence of *Ocotea kenyensis* in the sink-hole forest, there are several other



Above: *Combretum collinum* subsp. *taborense at Ngodwana*

Left: *Encephalartos laevifolius* in Starvation Gully

species with a limited or otherwise noteworthy occurrence in the area.

The escarpment forests in the east as well as some of the western kloofs house small pockets of *Cassine peragua,* marking the most northern distribution of the species.

An endemic cycad, *Encephalartos laevifolius,* is based with its main population in Starvation Creek.

Acacia natalitia, a white-barked member of the *A. karroo* complex (and presently sunk under the latter species), occurs with a few individuals on the western slopes of the Ngodwane plateau, from near Ngodwana up to the high ridges above Coetzeestroom kloof.

On the lower western slopes there are also scattered specimens of *Combretum collinum* subsp. *taborense*, a species of the northern Kalahari sand regions and rare in South Africa.

Postscript. The grassveld, scrub and protea veld areas referred to in the section on secondary vegetation and illustrated on pages 33 and 35, have meanwhile been planted up with pines.

Sampling areas

Access to the Kaapsehoop forests is difficult due to the steep slopes, averaging from 40% to 70%, and the deep ravines between the mountain buttresses. There are also other obstacles such as huge rocky outcrops, densely overgrown windfall openings, low-hanging lianes and impenetrable undershrub thickets.

In 1967 a road connecting the Twello plantations with the Kaapsehoop/Ngodwana road was constructed through the central and southern forest blocks. It follows an old elephant trail (Don McDermid, pers. comm.) which, no doubt, served also as an access route to the prehistoric mining settlements. The road — though a nerve-racking experience because of its

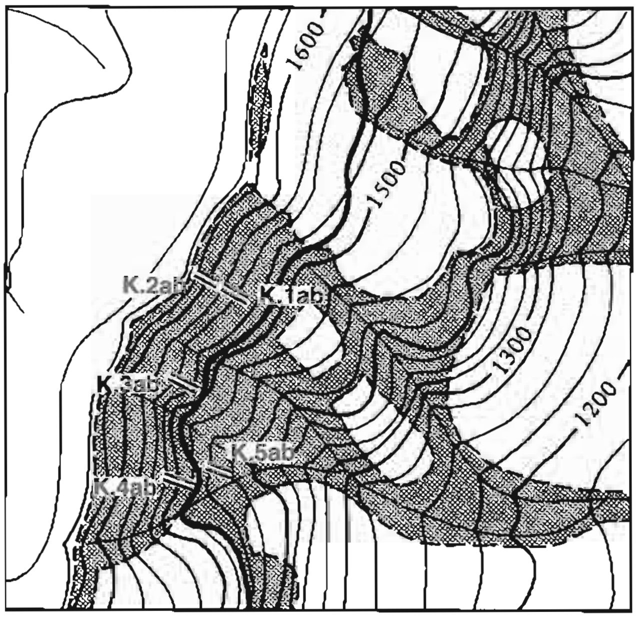
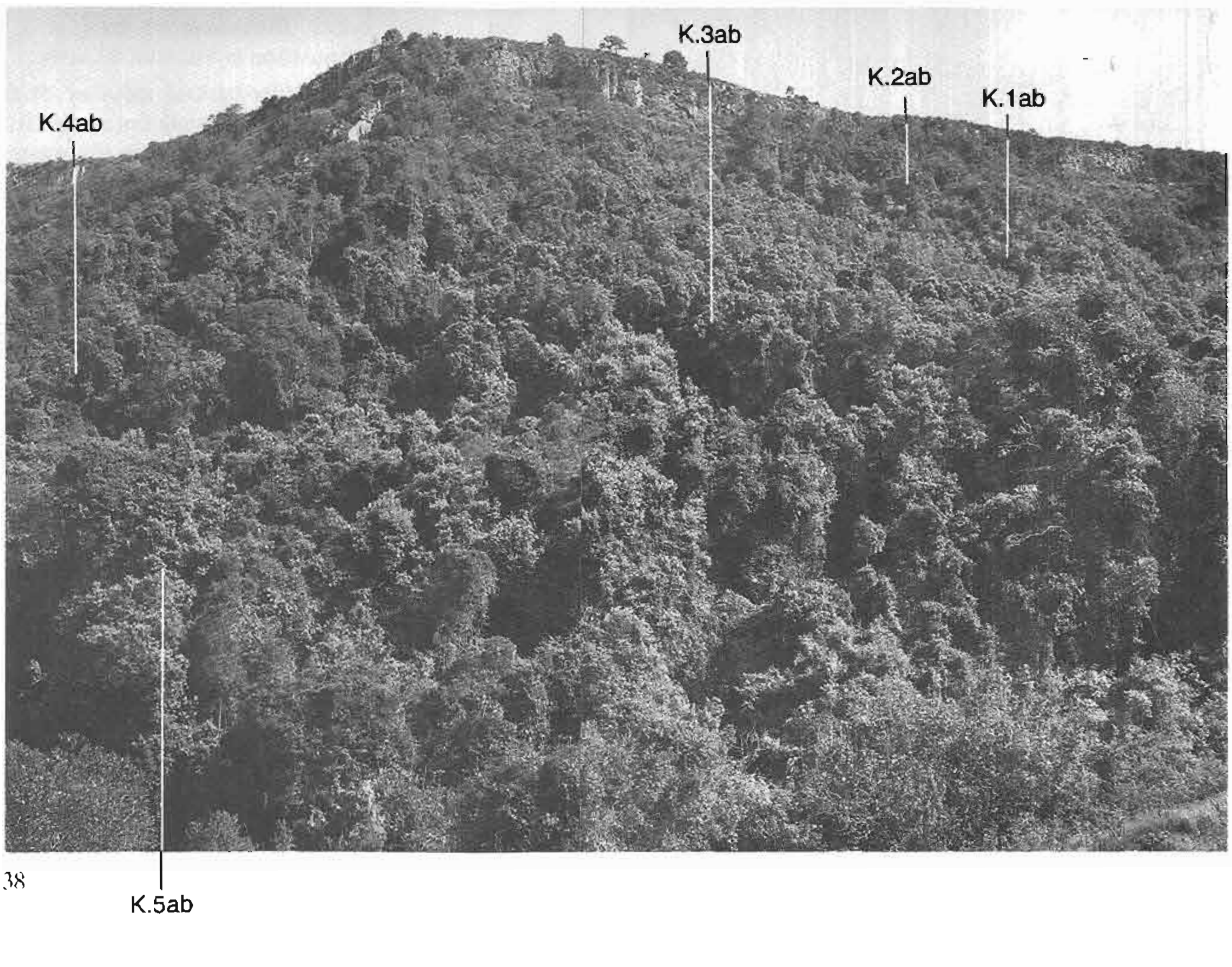


Fig. 31 Locality map of Kaapsehoop sampling areas

Below: Panorama of central forest block with sites of sampling areas



extreme narrowness, the hairpin bends and the suicidal travelling speed of the timber lorries — presented a welcome opportunity to investigate the forest.

Therefore, immediately after completion of the enumerations at Uitsoek in July 1979, work was started at Kaapsehoop. Four single sampling strips, viz. K.1a, K.2a, K.3a and K.4a, as well as a double strip, K.5ab, covering a portion of the central forest block between the altitudes of 1 430 m and 1 610 m were laid out. The last-mentioned sampling area was also enumerated at that time. While the second half of 1979 was spent in the East Griqualand forests, work at Kaapsehoop was resumed in May 1980. The sampling areas K.1 to K.4 were enlarged to double strips and the enumerations completed in the same month. (See Fig. 31)

Even for winter conditions, the Kaapsehoop forests proved to be a very cold place. In the morning strong winds were blowing from the lower bench up the escarpment. After it became calm between 9 and 10 a.m. the sun brought some relief in spite of the dense canopy. However, this was of short duration because by noon the shadow of the mountain fell over the forests and the temperatures dropped again.

The silence and solitude one usually experiences in the forests, was pleasantly broken during enumerations in K.3ab when we had the company of two pairs of Purple-crested Loerie excitedly watching our activities from the crowns of *Curtisia dentata* trees for several days.

A less welcome interruption of the tranquil life in the forests was a whole week of gale force wind when laying out strips in 1979. It nevertheless was very instructive: the howling storm together with the sounds of the tormented forest: the groaning tree trunks bending over and chafing against each other: the violently smashing crowns and splintering branches: the blinding bark-dust filling the air: and pieces of wood, dislodged epiphytes, bird's nests and even stones flying past or hitting you unexpectedly.

The subsequent descriptions of the Kaapsehoop sampling areas are arranged in altitudinal order: K.2ab (1 580 — 1 610 m), K.1ab (1 550 — 1 580 m), K.3ab (1 515 — 1 540 m), K.4ab (1 500 — 1 520 m) and K.5.ab (1 430 — 1 455 m).

K.2ab

Double strip; enumerated in May 1980.

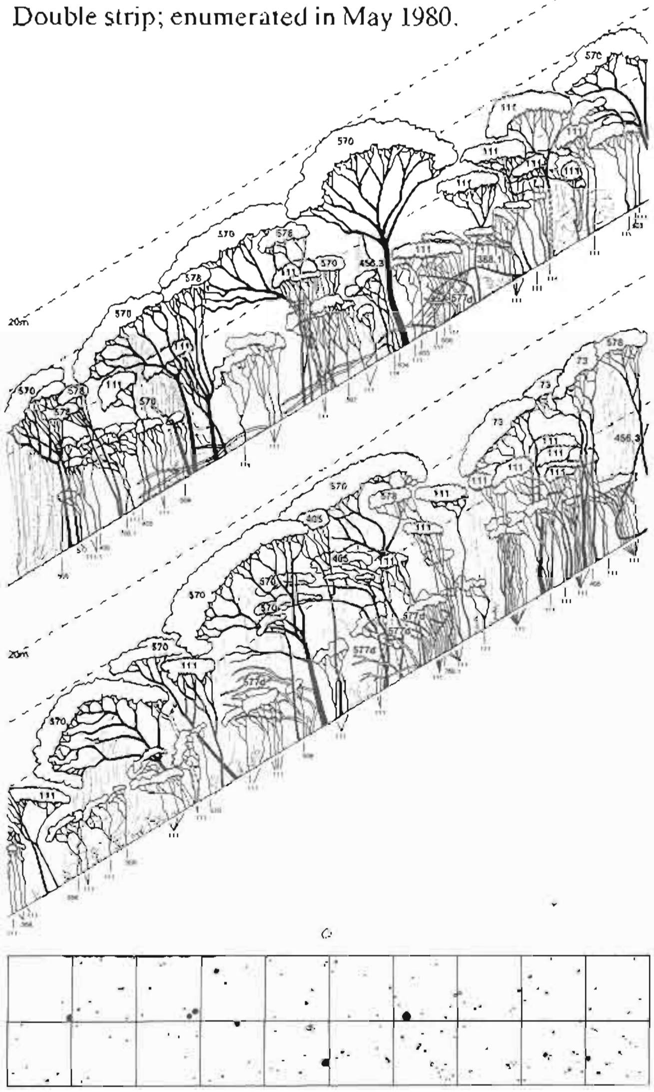


Fig. 32 Combined stand profiles and basal diagrammes of K.2a (below) and K.2b (above)

Situation: South-eastern slope, very steep (60%), even; at an altitude of 1 580 – 1 610 m, just under the krantzes south of Kaapsehoop in the central forest block.

Soil: Both profiles suggest optimum conditions by showing an exceptionally thick (20 cm) subsurface humus layer without a distinctly condensed root-mat, over a very thick (50 to 70 cm) dark-brown, humus-enriched and root-penetrated loam layer with granite blocks (old rock falls), and underlain by yellow to reddish brown sandy loam containing saprolites and solidifying into bedrock at a total depth of 1,5 m.

The ground surface is covered by the usual, 2 to 3 cm thick leaf-litter layer.

Tree layer: Three-storied, the strata broken and partly merged as a result of previous severe disturbance. Assegai *(Curtisia dentata)* timber was extracted in the first half of the century for use in the mines. The logs were winched up to the plateau.

The present basal area of between 35 m^2/ha (strip *b*) and 40 m^2/ha (strip *a*) is probably still depressed, with the full potential of the site thought to be in the region of 45 to 50 m^2/ha.

Although the dominant species, *Curtisia dentata*, occupies 51% of the basal area, it holds only a 20%

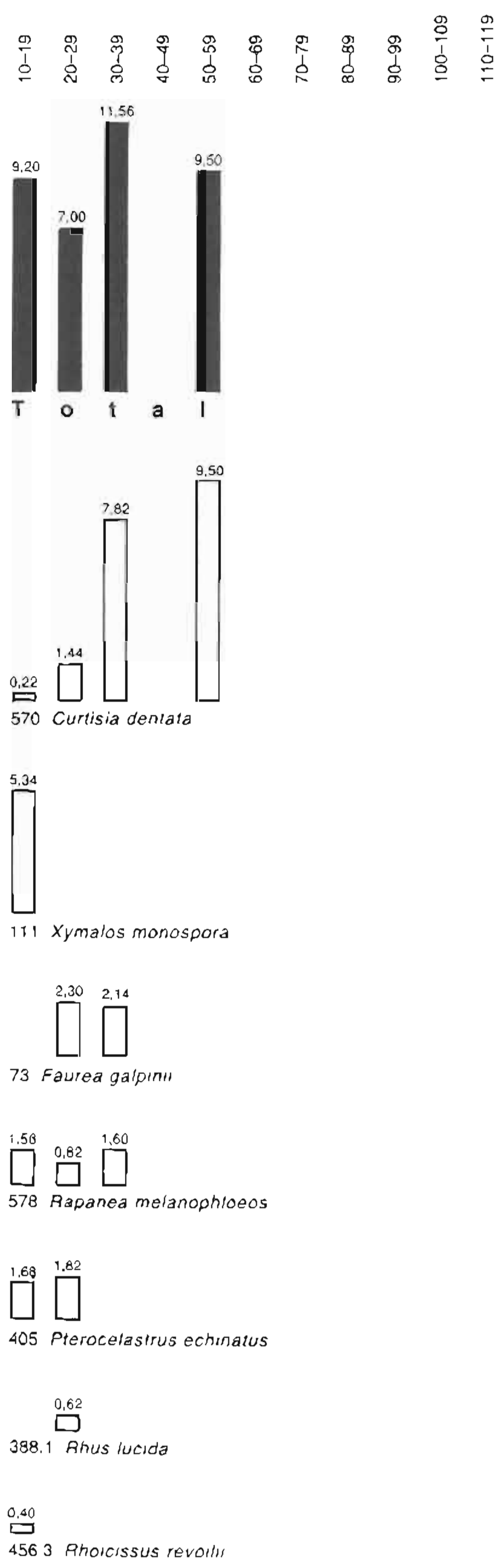


Fig. 33 DBH class distribution (m^2/ha) in K.2ab

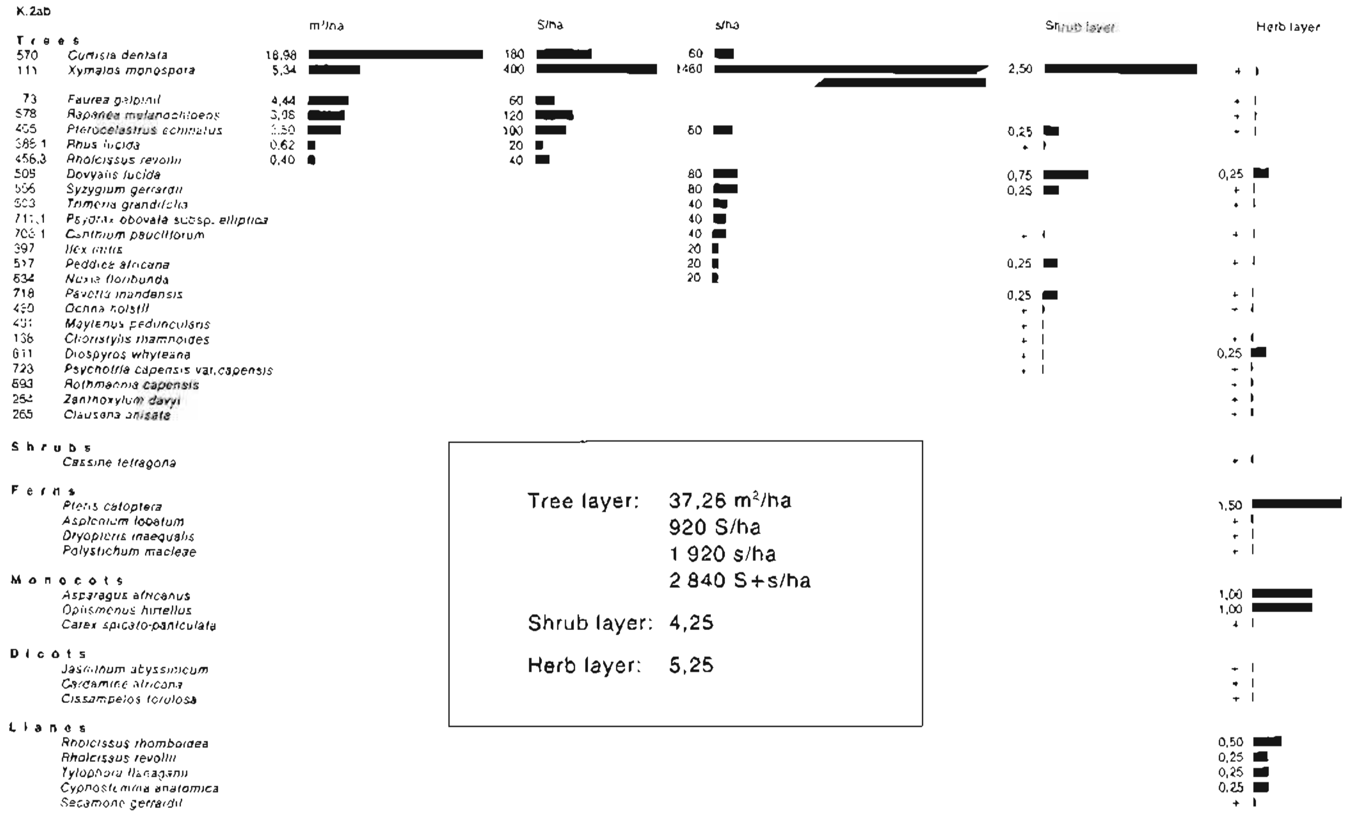


Fig. 34 Stand data graph of K.2ab, with data summary

share of the full stems and as little as 3 % of the undersize stems. Its stock is concentrated in the larger DBH classes while the smaller size classes are still overloaded with successional species and gap opportunists such as *Rhus lucida, Rapanea melanophloeos, Faurea galpinii* and, especially, the "forest devastation weed" *Xymalos monospora** which supplies 43% of the full stems, but only in the smallest DBH class (10 – 19 cm), in addition to 76% of the undersize stems.

Pterocelastrus echinatus, a supportive climax co-dominant in this forest type, is limited to 9% of the basal area and 6% of all stems, being possibly still retarded through the massive *Xymalos monospora* invasion.

Upper storey: The original, 18 to 20 m high canopy of large-crowned *Curtisia dentata* is preserved only in the median portion of both strips. In the lower portion and in strip *b* also in the upper one, the canopy function has been taken over by intermediate-storey trees. In the upper portion of strip *a* several trees of *Faurea galpinii* and *Rapanea melanophloeos* have established a canopy over the once large opening there.

Intermediate storey: Between 8 m and 15 m high, with the medium-sized crowns of mainly *Xymalos monospora* as well as some *Rapanea melanophloeos, Pterocelastrus echinatus* and suppressed *Curtisia dentata* scattered in light-shaft positions.

* In the old days *Xymalos monospora* was often denounced as a forest pest which after invading worked-out portions and proliferating by vigorous coppicing, casts a dense shade and prevents the reproduction of other species.

It may be more correct to say that *X. monospora*, being very rare in undisturbed forests, appears in large numbers in severely disturbed montane forests, establishing itself during the early reconstruction phase in windfall and/or felling openings and sealing the existing gaps in the upper storey by rapidly forming subsidiary canopies at understorey and intermediate-storey levels.

Continued disruptions of the upper storey, especially if accompanied by soil compaction and root damage as a result of log slipping, trampling by draught oxen as well as by browsers congregating in the overgrown openings, and also encampments of tribes people and their animals, may cause a multiplication of the invasive *X. monospora* population by means of root-suckering.

Although remaining relatively thin-stemmed and confined to the lower and intermediate stories, *X. monospora* is in the process quite capable of taking over a substantial or sometimes even the largest part of the basal area and thus becoming a false dominant.

In advanced stages of reconstruction of the climax upper storey the *X. monospora* population is ageing, deteriorating and eventually dying out. Where the death of bigger specimens would leave a gap in the canopy, ground exposure is prevented by the prior development of a dense cluster of coppice shoots. These will wither as the canopy closes up.

Only in very exceptional circumstances single stems of *X. monospora* live to grow and join the upper storey.

X. monospora appears to be intolerant to recurrent fires and is absent from secondary bush clumps (see pp. 33–36) as well as fire-climax stands such as U.8abc and U.9abc (pp. 98–109).

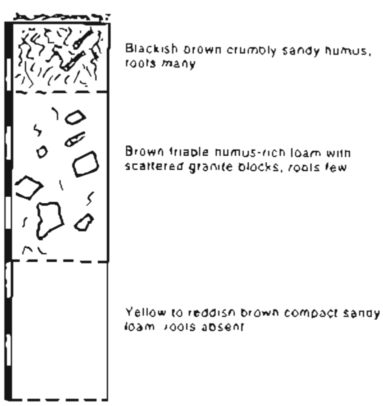
K.2a

SE 60%
1 580 – 1 610 m

Tree layer: 39,12 m^2/ha
1 000 S/ha
2 400 s/ha
3 400 S+s/ha

Shrub layer: 4,00

Herb layer: 6,50



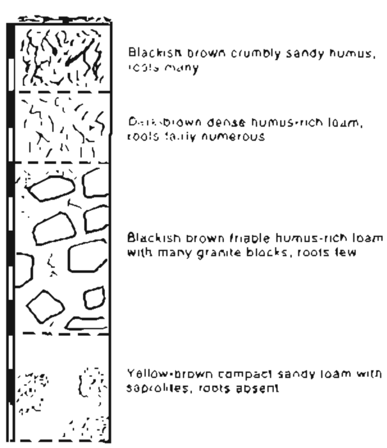


Fig. 35 Stand profile and basal diagram of K.2a. with data summary and soil profiles

K.2b

SE 60%
1 580 — 1 610 m

Tree layer: 35,40 m²/ha
840 S/ha
1 440 s/ha
2 280 S+s/ha

Shrub layer: 4,50

Herb layer: 4,00

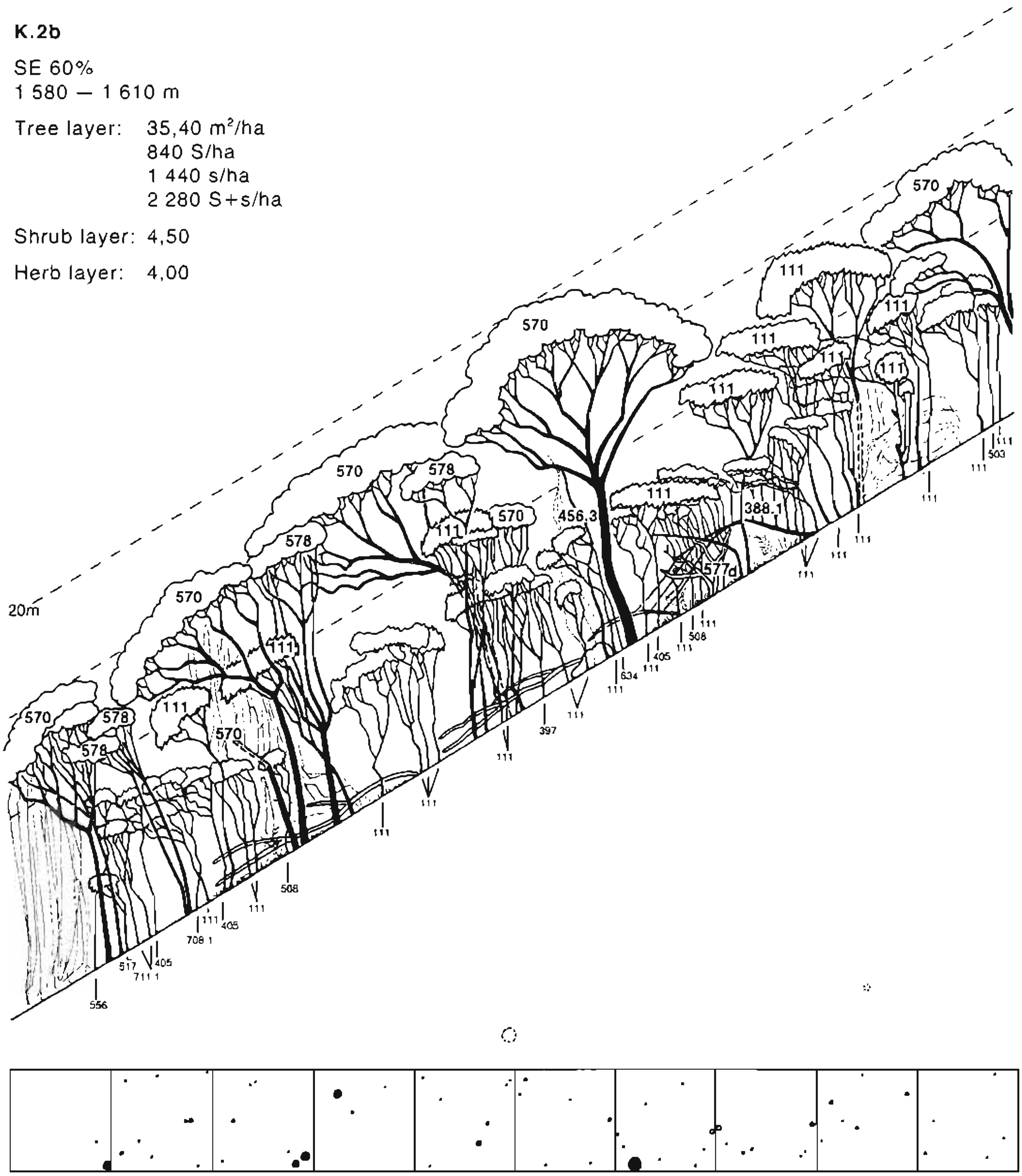


Fig. 36 Stand profile and basal diagram of K.2b, with data summary

A single medium-sized *Cassine peragua* was found in the close vicinity, quite distant from the main population of this localized species some 100 m lower down.

Understorey: 3 to 5 m tall, in old gaps sometimes elevated to 6 or 7 m; broken up into groups. Dominated by sucker clumps and shrubby trees of *Xymalos monospora*. A few young specimens of *Curtisia dentata* and *Pterocelastrus echinatus* are present in addition to permanent understorey inhabitants such as *Diospyros whyteana*, *Canthium pauciflorum* and *Peddiea africana*.

Several species that elsewhere reach the canopy or at least the intermediate storey, such as *Syzygium gerrardii*, *Ilex mitis* and *Nuxia floribunda*, appear in this forest type to be confined to the understorey.

A most striking feature of the understorey is a number of dead specimens of shrubby *Maesa lanceolata*, obviously remnants from an early post-exploitation phase when the felling gaps were still wide open.

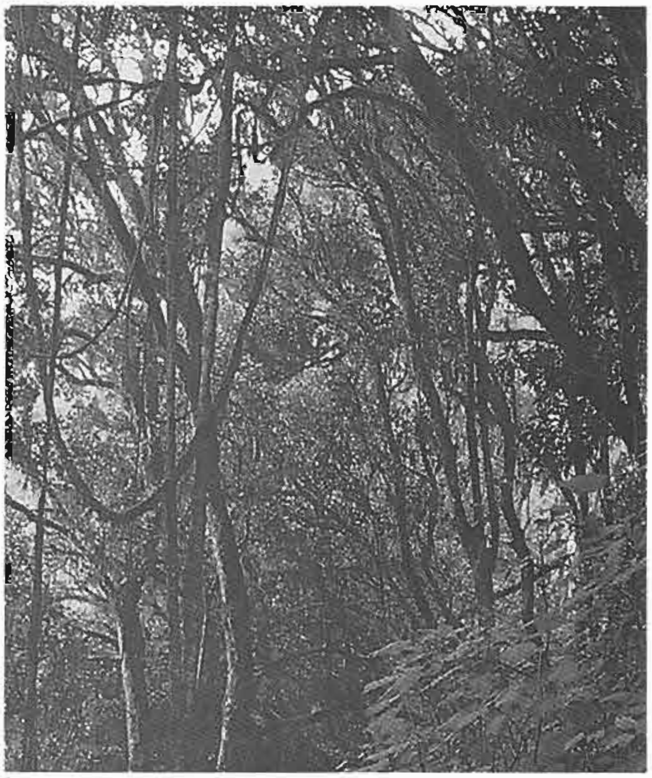
Another remnant from that phase is a fallen but still coppicing tree of *Rhus lucida* in strip *b*.

Shrub layer: Moderately well developed (4,25), it consists by 100% of tree species and reflects largely the understorey including the strong predominance (59%) of *Xymalos monospora* which outcrowds legitimate lower-storey dominants like *Dovyalis lucida*. Saplings of *Pterocelastrus echinatus* are present but none of *Curtisia dentata*.

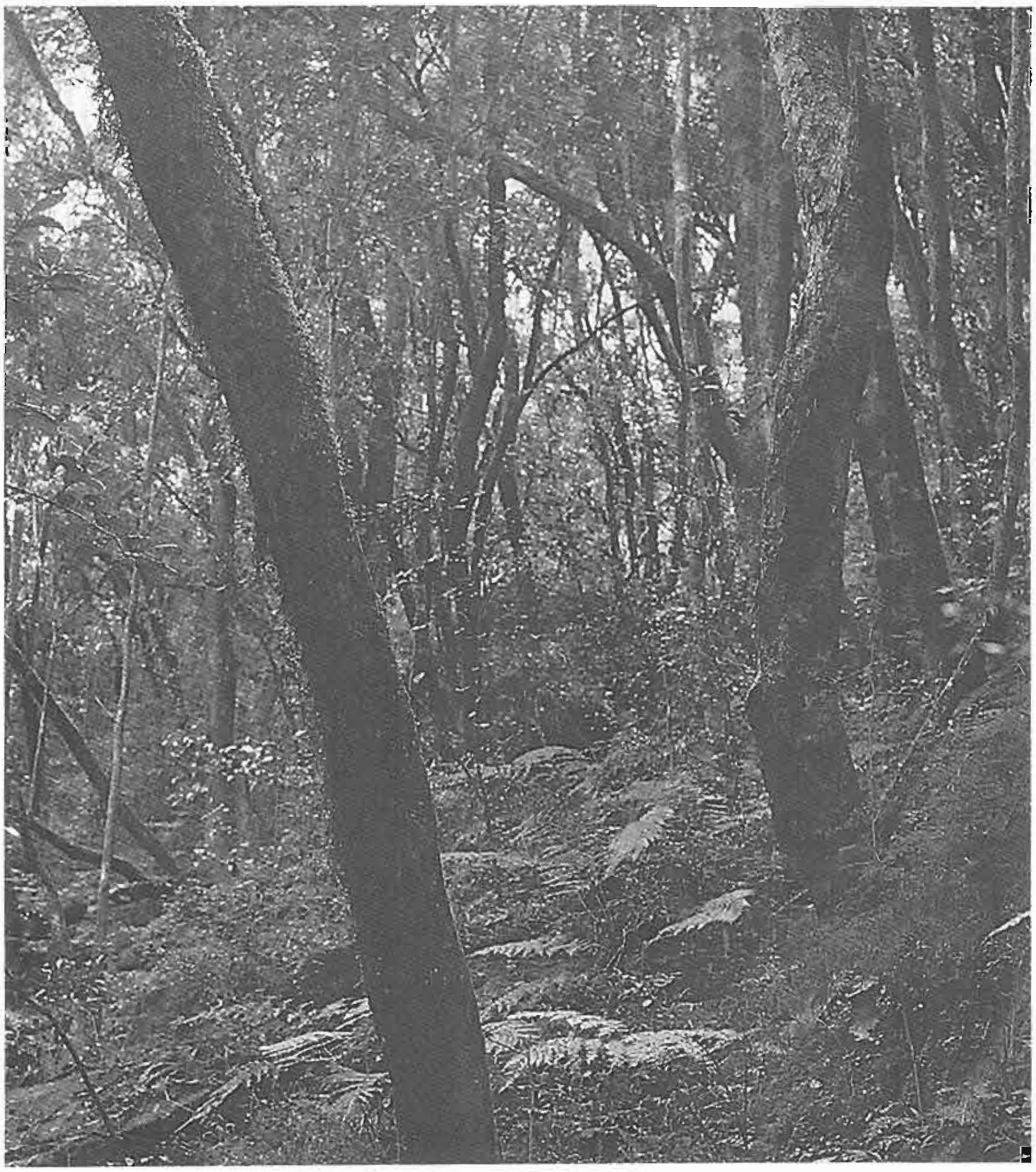
Two species not encountered elsewhere in the area were found in the close vicinity: a clump of *Englerodaphne pilosa* and a young plant of *Bersama tysoniana*.

Herb layer: Fairly well developed (5,25). Seedling regeneration of most tree and shrub layer species is present, but only the two understorey permanents *Dovyalis lucida* and *Diospyros whyteana* reach minimum cover value, altogether not more than 9% of the total. There are no seedlings of *Curtisia dentata*.

The remaining 91% of the existing herb layer cover is provided by 29% ferns, with *Pteris catoptera* being prominent; 38% monocots, mainly *Asparagus*



Above: The drooping loops of canopy lianes



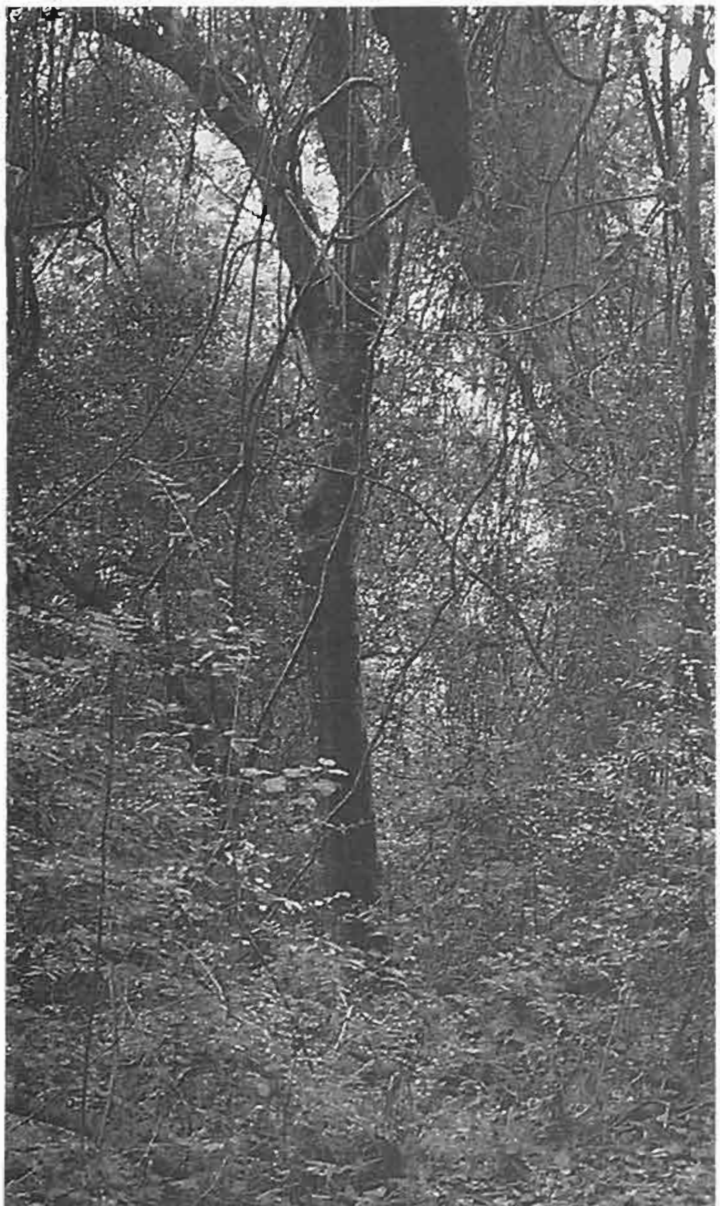
The herb layer is dominated by the fern, *Pteris catoptera*

Coppice growth of *Curtisia dentata* on former exploitation site

africanus and *Oplismenus hirtellus*, and for the rest by dicots and lianes.

Dependents: Canopy lianes, mainly *Rhoicissus rhomboidea* and *Rhoicissus revoilii*, are plentiful. *R. revoilii* was even found with a tree-size stem (in strip *a*), a remnant from pre-exploitation days.

Classification: A median reconstruction stage of a *Curtisia dentata* climax forest, after severe disturbance due to prolonged timber exploitation.



Tree regeneration in old windfall gap

K.1ab

Double strip; enumerated in May 1980.

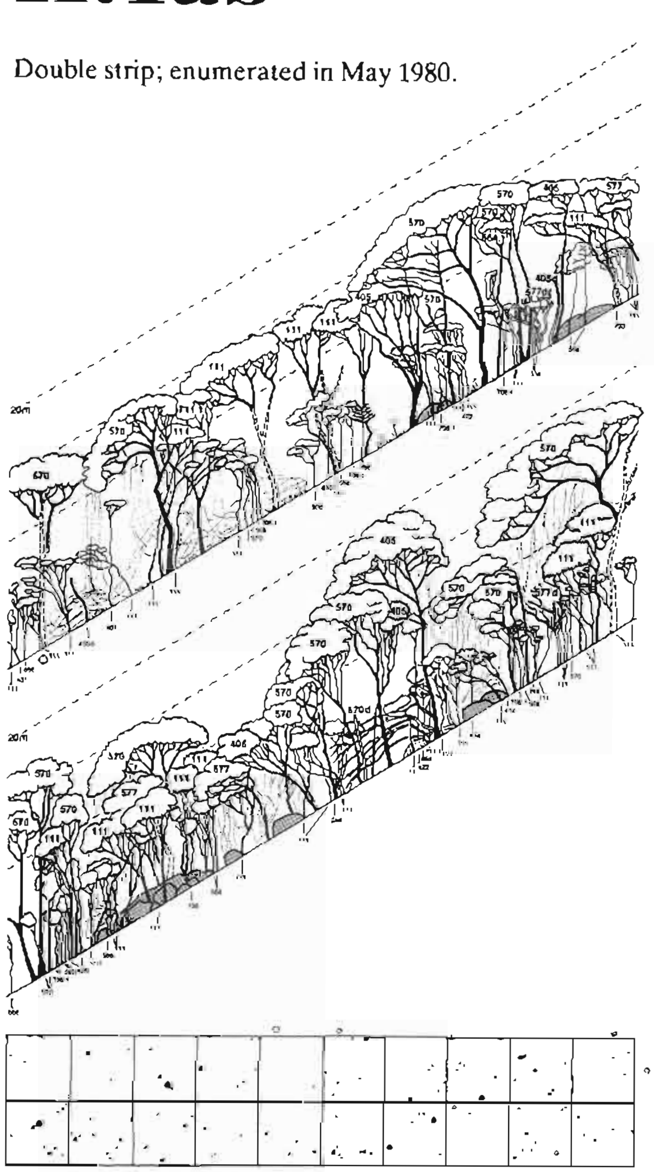


Fig. 37 Combined stand profiles and basal diagrammes of K.1a (below) and K.1b (above)

Situation: South-eastern slope, very steep (60%), even; at an altitude of 1 550 – 1 580 m, in the central forest block south of Kaapsehoop; a downward extension of K.2ab but for terrain reasons horizontally shifted by one strip width so that 1b joins on 2a. (K.1ab was laid out and enumerated before K.2ab, the latter therefore being actually an upward extension of the former.) There are granite outcrops and boulders.

Soil: The profiles differ very little from those in K.2ab, but there is a distinct, 5 cm thick subsurface root-mat on top of the 20 cm thick, dark brown, humus-enriched loam layer. The underlying sandy loam is brown to red-brown, i.e. slightly less leached than in K.2ab and in the upper part even humus-enriched. Rock-fall stones, and few at that, are only found in the upper, quadrat 8 profile. Although their absence could marginally affect the drainage, there is nothing that would indicate the soil conditions to be essentially less optimal than in K.2ab. The profile in quadrat 4, just above a rock bank and boulder concentration, shows no obstruction or other deviation from the pattern higher up. The surface litter layer is also normal.

Tree layer: Three-storied but the strata broken and partly merged as in the upper double strip (K.2ab).

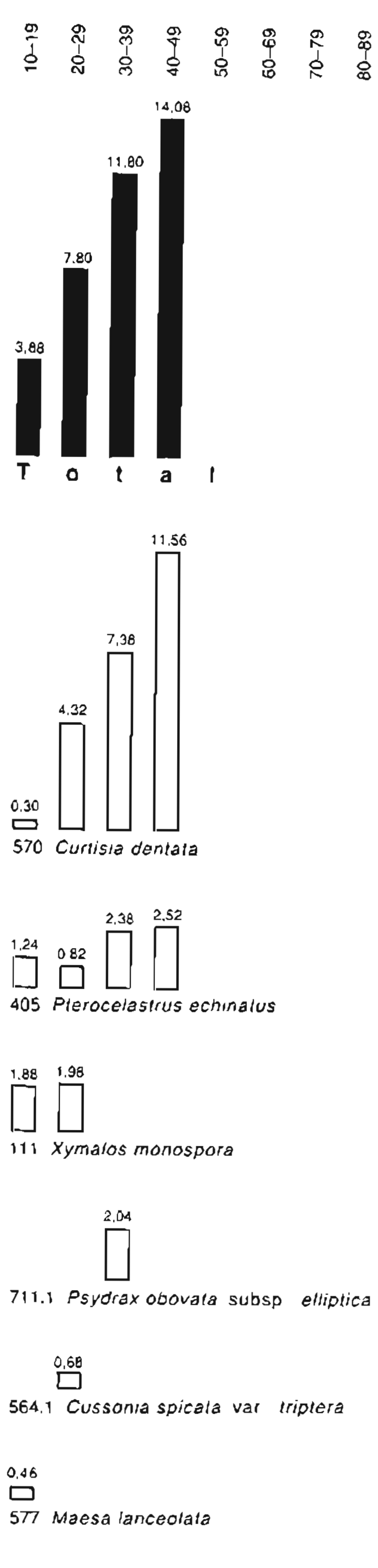


Fig. 38 DBH class distribution (m²/ha) in K.1ab

Former exploitation had obviously extended over the entire slope.

The basal area shows also striking similarities to that of the upper strip. The total of 37,56 m^2/ha for K.1ab is practically identical to that of K.2ab (37,26 m^2/ha). The dominant *Curtisia dentata* holds an even larger share, 62%, than in K.2ab (51%), with the growing stock being also on the side of the larger DBH classes, although not as extremely as in K.2ab: it is made up by double the number of full stems, i.e. 41% (as against 20% in K.2ab). However, the *C. dentata* share of the undersize stems is with 5% almost as small as higher up (3%).

On the other hand, *Pterocelastrus echinatus*, though with 2% similarly under-represented in the undersize class, fulfils its role as a co-dominant much better than in K.2ab: it holds 21% (as against 11%) of the full stems and 18% (9%) of the basal area which, moreover, is well distributed over all DBH classes.

Xymalos monospora holds "only" 46% of the undersize stems (as compared to 76% in K.2ab) and 24% (43%) of the full stems, and its 10% (instead of 14%) share of the basal area includes two DBH classes instead of only the smallest one as in K.2ab. This suggests the invasive *X. monospora* stock to be older than that higher up, which is also demonstrated by larger-size, even canopy trees in the close vicinity, some of them leaning into the sampling strip.

It must be noted that a higher age applies also to the *Pterocelastrus echinatus* population, and that there is an obviously reciprocal interrelationship between the doubling of its stock and the halving of the *Xymalos monospora* stock.

In addition the total lower stand density must be taken into account: the number of all stems is 20% smaller than in K.2ab, with the full stems being 17% less and the undersize stems 26% less.

In spite of the higher ages of the *Pterocelastrus echinatus* and *Xymalos monospora* populations, perhaps by 20 to 30 years and implying an accordingly earlier cessation of exploitation, the lower stand density cannot adequately be explained by natural mortality alone, i.e. self-thinning that may have taken place since then. There must also have been a less severe degree of disturbance, resulting in less vigour and lower densities of the reconstructive and invasive post-disturbance populations and thus, by comparison, a state of slight impoverishment.

This interpretation appears to be supported by the absence of large-gap colonisers such as *Faurea galpinii* and *Rapanea melanophloeos*, and the presence of a late stage, small-gap opportunist, viz. *Cussonia spicata* var. *triptera*.

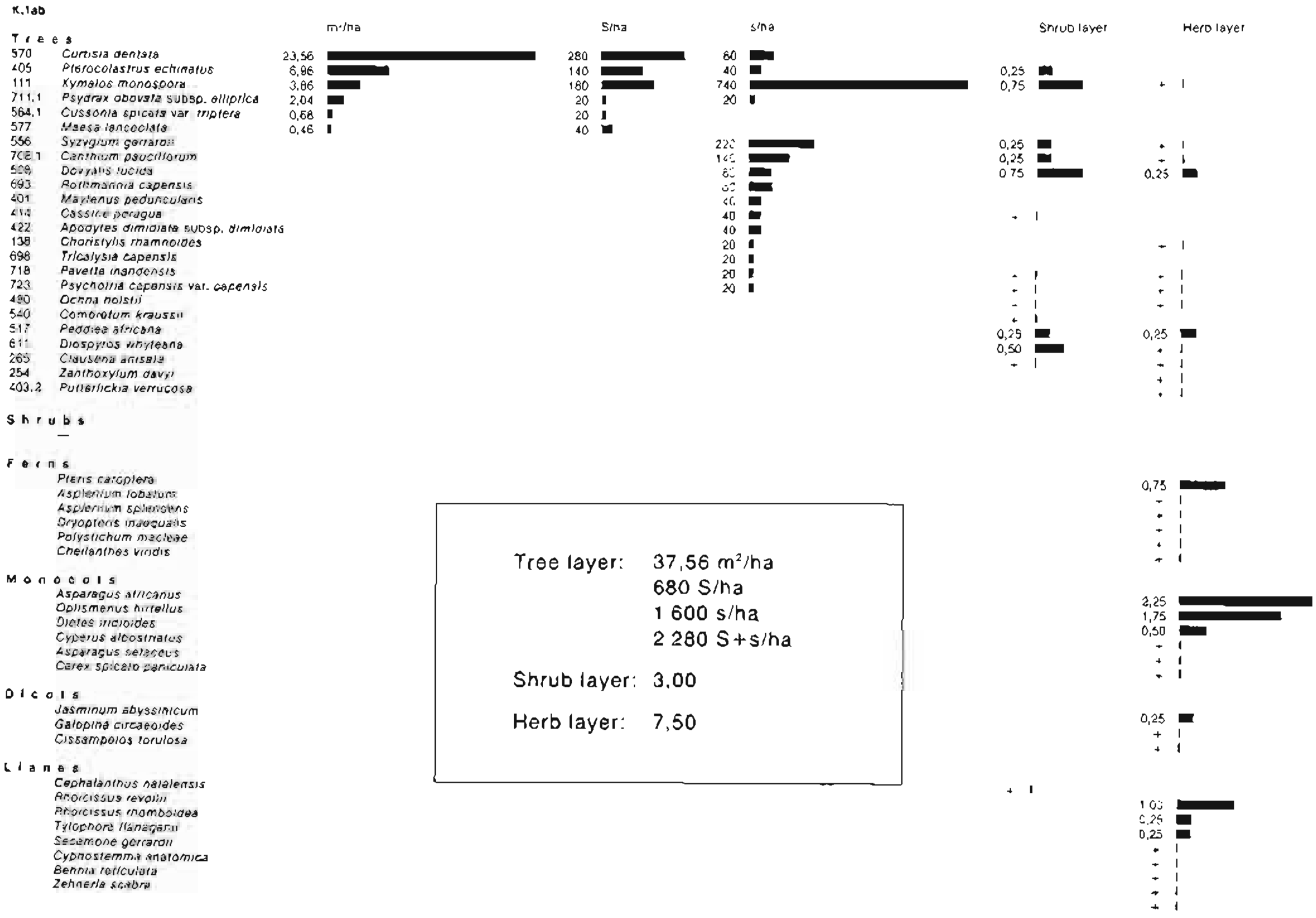


Fig. 39 Stand data graph of K.1ab, with data summary

K.1a

SE 60%
1 550 – 1 580 m

Tree layer: 36,40 m^2/ha
880 S/ha
1 720 s/ha
2 600 S+s/ha

Shrub layer: 3,50

Herb layer: 8,00

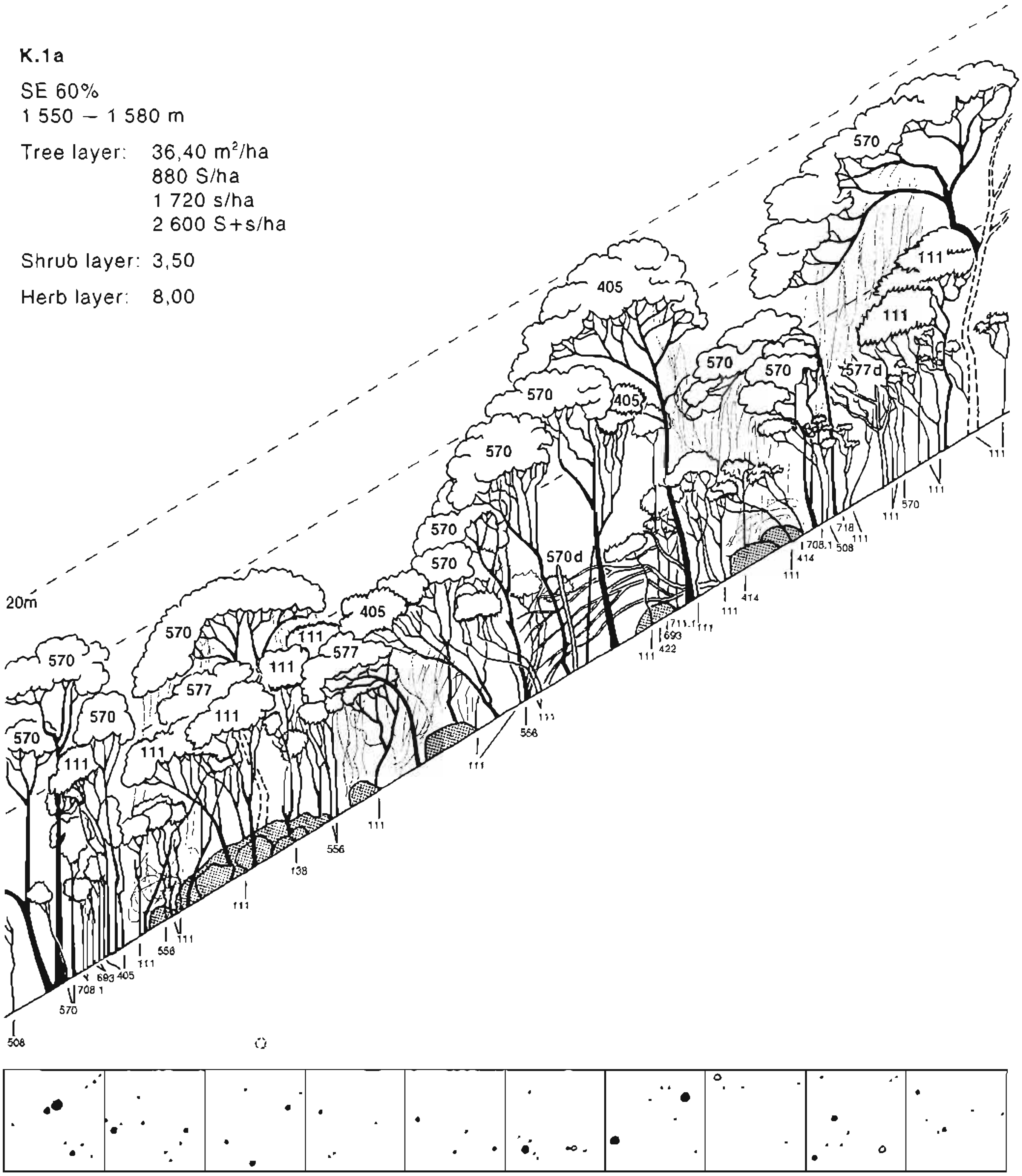
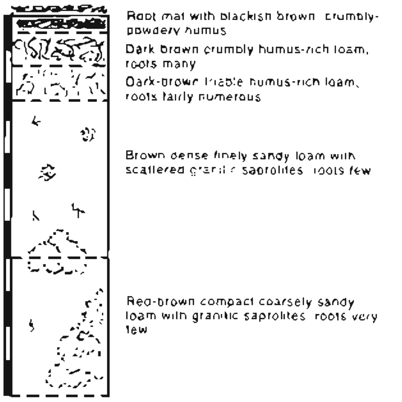
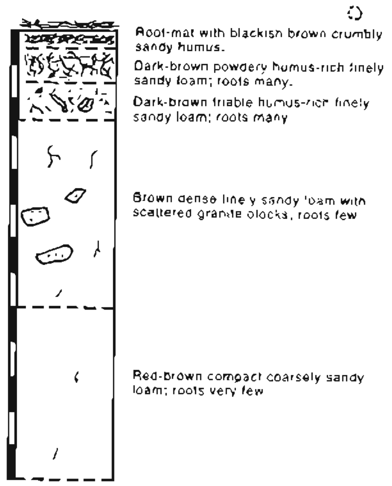


Fig. 40 Stand profile and basal diagram of K.1a, with data summary and soil profiles





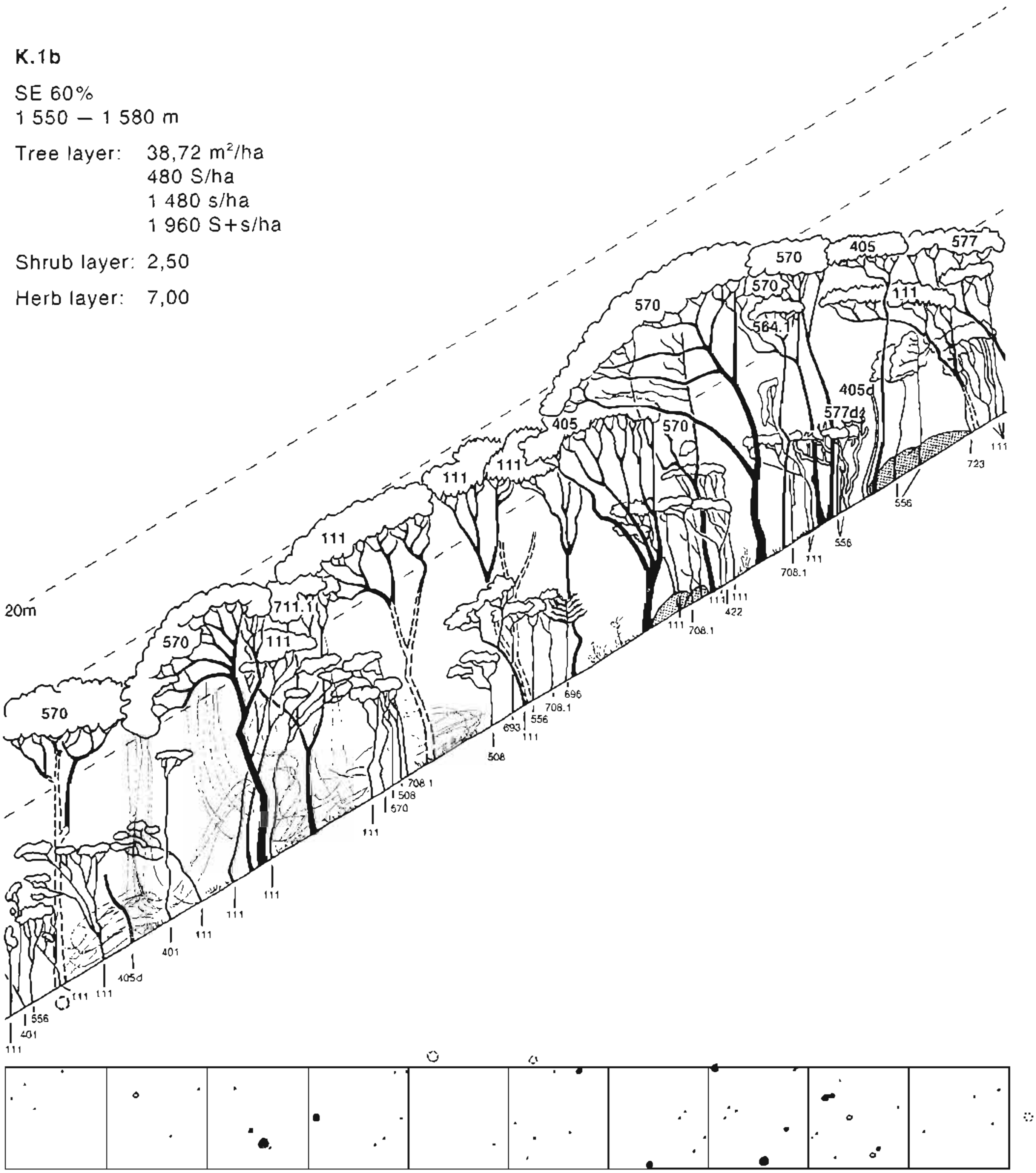


Fig. 41 Stand profile and basal diagram of K.1b, with data summary

Upper storey: Fragmentary evidence of an original canopy height of 18 to 20 m exists in the upper portion of strip *a*, but otherwise a lower, makeshift canopy has been formed at the 15 to 17 m level by old intermediate-storey trees, mainly *Curtisia dentata*, by means of expanded crowns, with a few young trees of *Pterocelastrus echinatus* and *Xymalos monospora* filling in between.

Intermediate storey: With much of it commandeered for substitute canopy function, little has remained of the intermediate storey proper, except in strip *a* under the taller *Curtisia* and *Pterocelastrus* trees, and a few subcanopy trees in strip *b*. Over the old opening in the lower, rocky portion of strip a, the intermediate-storey crowns of *Curtisia dentata*, *Pterocelastrus echinatus* and *Xymalos monospora*, as well as a few surviving tree-like *Maesa lanceolata*, have closed up to form an emergency canopy at the 10 to 12 m level.

Understorey: Broken up into small groups 3 to 5 m tall, but individual members are sometimes elevated to 6 or

8 m where the intermediate storey functions as canopy. The *Xymalos monospora* component is large, but nearly 50 % smaller than in K.2ab, with *Syzygium gerrardii* being the principal beneficiary by having been able to treble its number of stems.

As in K.2ab the dead *Maesa lanceolata* shrubs are witnesses to a past open-gap phase.

Shrub layer: Poor to moderately well developed (3,00). Except for lianous *Cephalanthus natalensis*, the shrub layer is composed of tree species only. The *Xymalos monospora* presence is remarkably modest, permitting a stronger attendance by *Diospyros whyteana*, *Peddiea africana* and *Canthium pauciflorum*, as well as more *Pterocelastrus echinatus* saplings than in K.2ab.

However, as in K.2ab, there is no sapling regeneration of *Curtisia dentata*.

Herb layer: Richly developed (7,50), probably so in response to the relatively poor shrub layer and understorey. Although seedlings of all tree and shrub layer members are present, only the lower-storey specialists *Dovyalis lucida* and *Peddiea africana* obtain cover value, adding up to no more than 7% of the whole herb layer. There is no *Curtisia dentata* or *Pterocelastrus echinatus* regeneration at all.

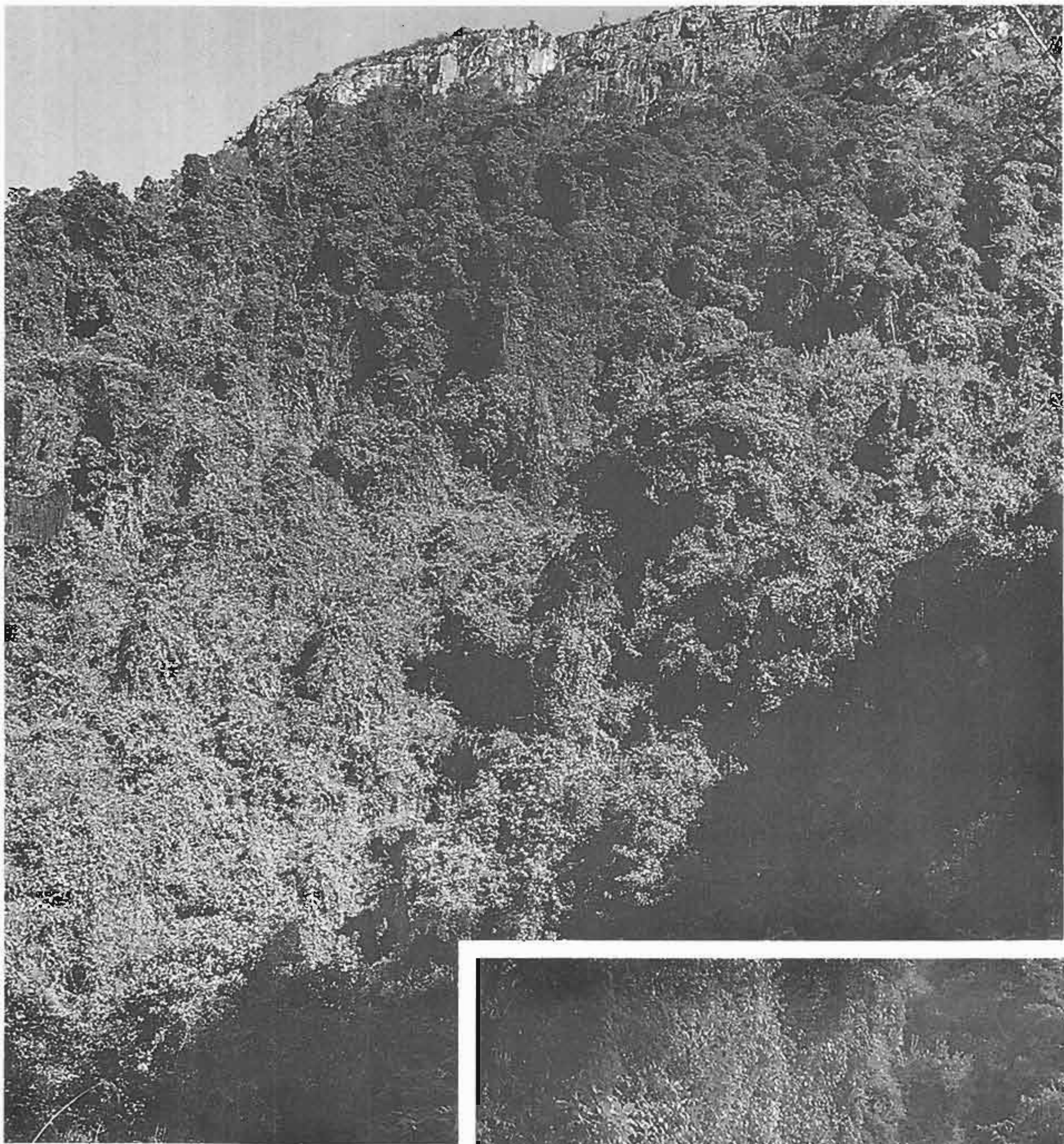
The remaining 93% of the herb layer cover is composed of 10% ferns with prominent *Pteris catoptera;* 60% monocots with a predominance of *Asparagus africanus* and *Oplismenus hirtellus;* 3% dicots and 20% lianes.

The existence of a *Dietes iridioides* colony as well as the presence of *Asparagus setaceus* may be attributed to the lower altitude which is also heralded by an occasional *Combretum kraussii* in the shrub layer and, in the close vicinity, a first appearance of *Keetia gueinzii*.

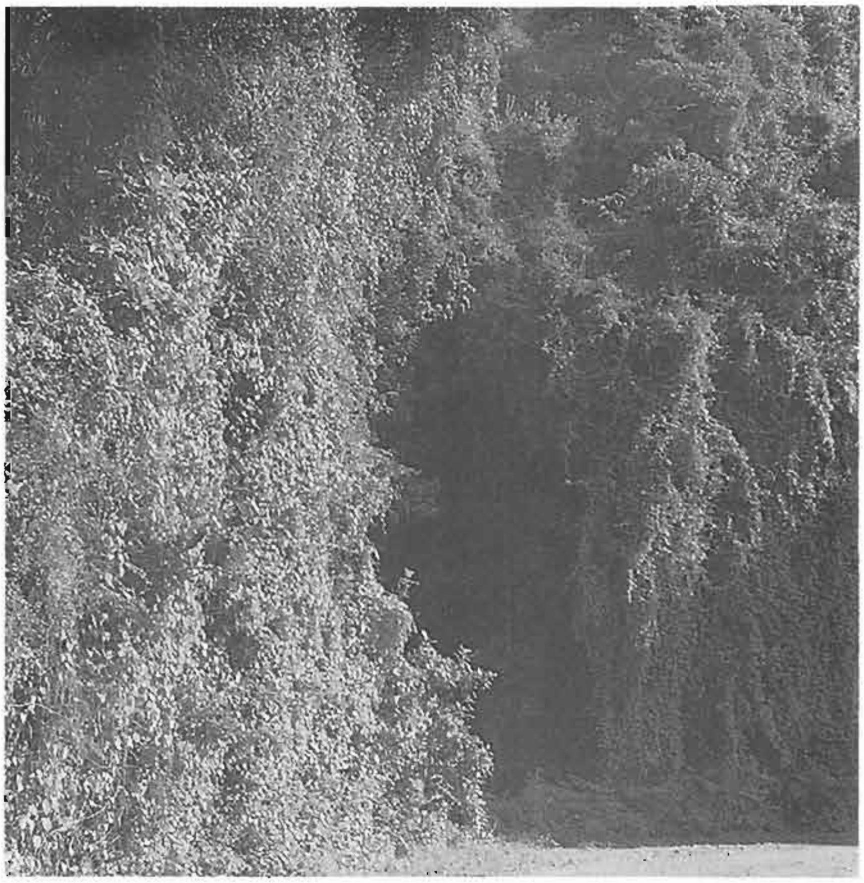
Dependents: The canopy lianes *Rhoicissus rhomboidea* and *R. revoilii* are as plentiful as in K.2ab. Lianoid *Choristylis rhamnoides* is also present.

Classification: A median reconstruction stage of a *Curtisia dentata* climax forest, very similar to K.2ab.

Streptocarpus cyaneus between colonies of *Peperomia tetraphylla* on large, moss-covered boulder



The north-eastern flanks of the forest are sealed by lush creeper curtains preventing desiccation



K.3ab

Double strip; enumerated in May 1980.

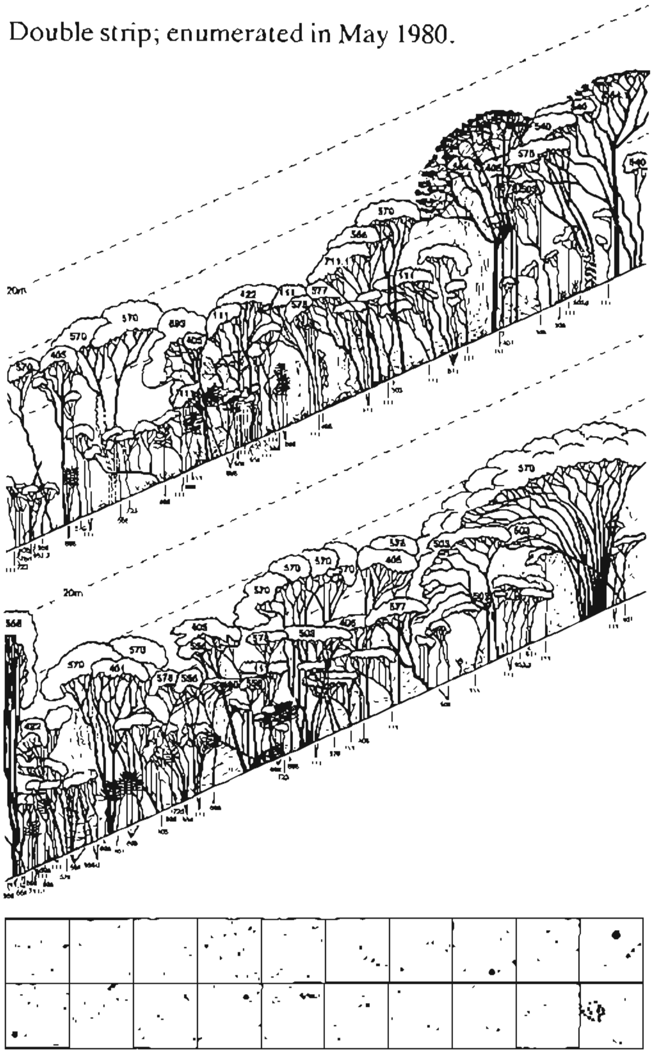


Fig. 42 Combined stand profiles and basal diagrammes of K.3a (below) and K.3b (above)

Situation: South-eastern slope, very steep (50%), even; at an altitude of 1 515 – 1 540 m, in the central forest block south of Kaapsehoop, on the median ridge just above the escarpment road.

Soil: The profiles are very similar to those in K.1ab and K.2ab. Apart from the usual surface leaf-litter layer there is a distinct, 5 cm thick subsurface root-mat over 25 cm dark brown, root-penetrated, humus-enriched loam, underlain by some 30 cm light brown sandy loam with granite blocks and quartzite stones. Thereunder, red-brown coarsely sandy loam rests on saprolitic bedrock at 1 to 1,2 m depth.

Tree layer: Three-storied, the strata broken and partly merged as a result of previous exploitation for assegai timber (*Curtisia dentata*).

If, on edaphic grounds, one accepts the site to be the same as that of K.1ab and K.2ab, the present mean basal area of 51 m²/ha might appear to reflect the full potential. However, when noting that the clearly understocked strip *b*, with five of its canopy trees leaning over from strip *a*, nevertheless carries as much

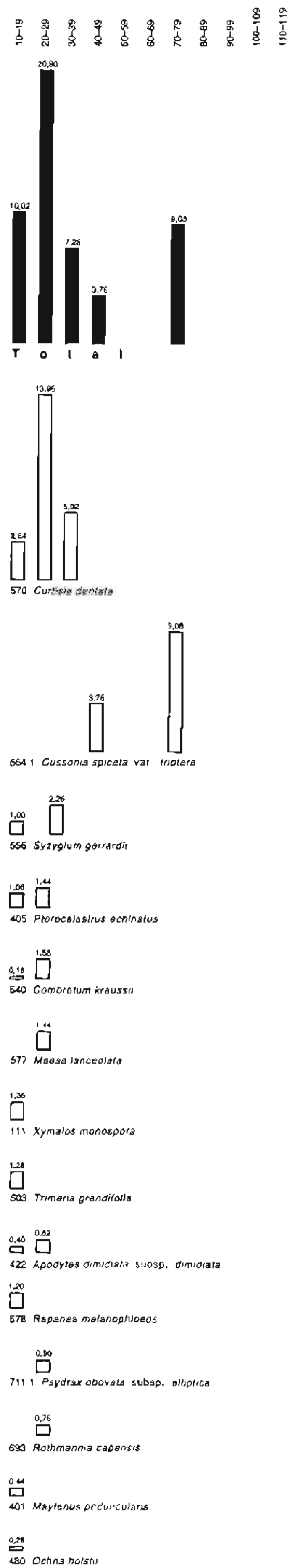


Fig. 43 DBH class distribution (m²/ha) in K.3ab

as 45 m², a higher figure, perhaps 55 to 60 m², would seem to be more adequate.

The high stem density, especially in strip *a* (3 520 S+s/ha), together with the concentration of the full stems in the lower size classes, indicate conditions of juvenile overcrowding typical of a state of vigorous reconstruction of the climax forest. The fact that part of the excessive stems are provided by the large *Curtisia dentata* coppice growth in strip *a* (one of several in the area), does not really make a difference.

The *Curtisia dentata* coppice growth is flanked by two large specimens of *Cussonia spicata* var. *triptera* taking up as much as 25% of the basal area (and even as much as 57% of strip *b* alone). Both the *Curtisia dentata* coppice and the *Cussonia spicata* monsters bear eloquent witness to past exploitation and gap conditions.

With 43% of the basal area and 40% of the full stems, and with the only continuous DBH class structure, *Curtisia dentata* is undisputably the dominant population. It consists of virtually a single generation, with the median one (20 – 29 cm) of the three DBH classes obviously marking the central age group. There is only a single undersize stem in the whole double strip and absolutely no other recruitment. While the upward limitation of the population could possibly be explained as having resulted from the complete removal of all the older stems (although quite a few would probably have been below utilisation size at the time of the last exploitation), the downward limitation, being in effect an isolation, is a peculiarity noted in most *Curtisia dentata*-dominated forests. The reproduction of this and many other species does not seem to be a continuous process but rather a cyclic, primarily climatically controlled event occurring at uncertain, sometimes considerable time intervals. Its principal components — seed years, germination and seedling establishment — are not necessarily integrated nor do they strictly coincide with other relevant processes such as the ageing of stands or the creation of regeneration gaps by windfalls, fire or felling operations. Forest development does appear to follow a specific pattern inherent in the type, but without a predetermined time table or even sequence of events.

In terms of basal area, *Pterocelastrus echinatus* (5%) shares its position as a co-dominant with *Syzygium gerrardii* (6%) which, with decreasing altitude, has moved up into the full-stem class, and has done so together with a number of other species that at higher altitudes are found in smaller sizes only, such as *Combretum kraussii, Trimeria grandifolia, Apodytes dimidiata, Rothmannia capensis, Maytenus peduncularis* and *Ochna holstii*.

The small share of *Xymalos monospora* (3%) is in proportion to the very limited role it was allowed by the main stand species to play in the intermediate storey. Although it still holds 31% of the undersize stems, its

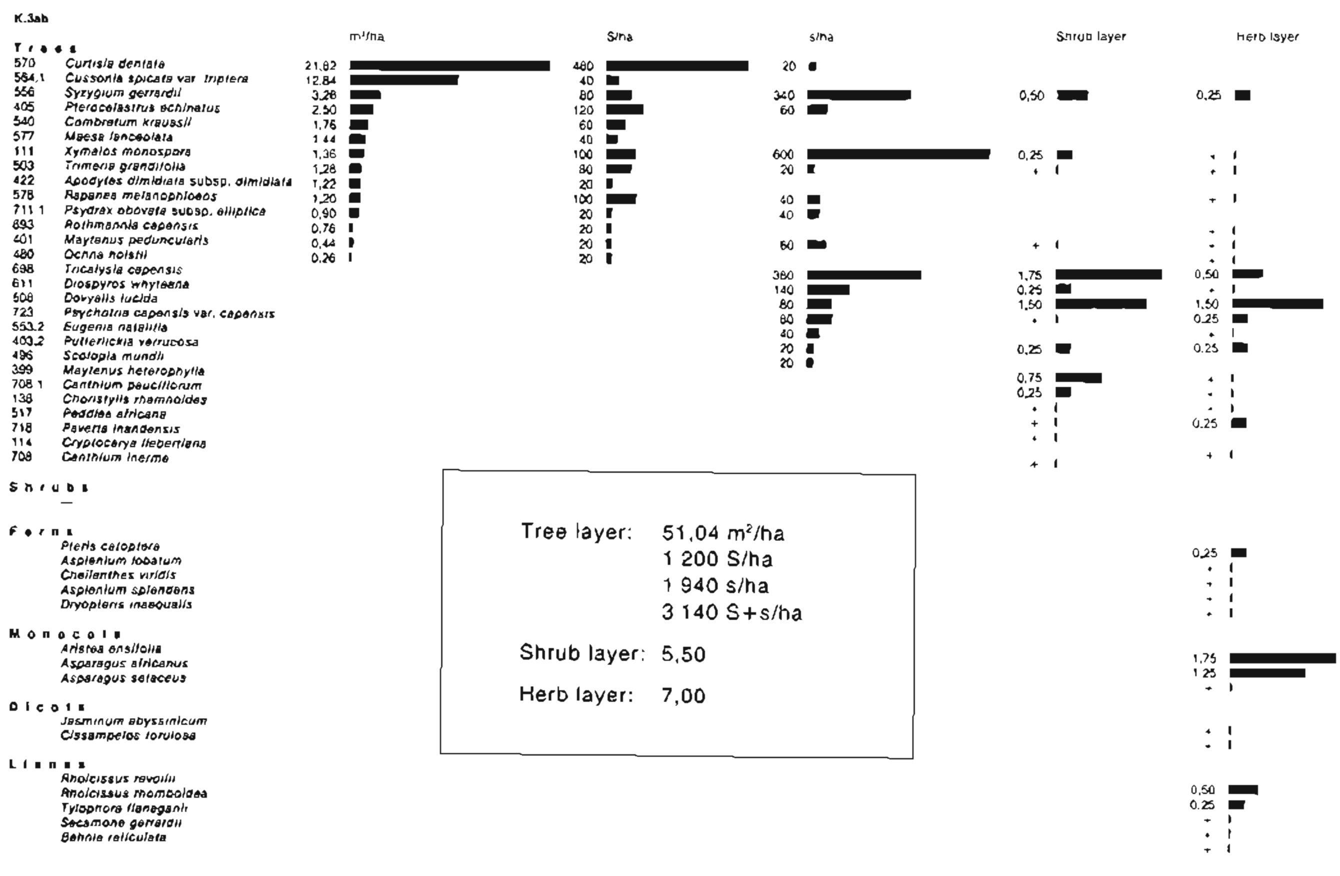


Fig. 44 Stand data graph of K.3ab, with data summary

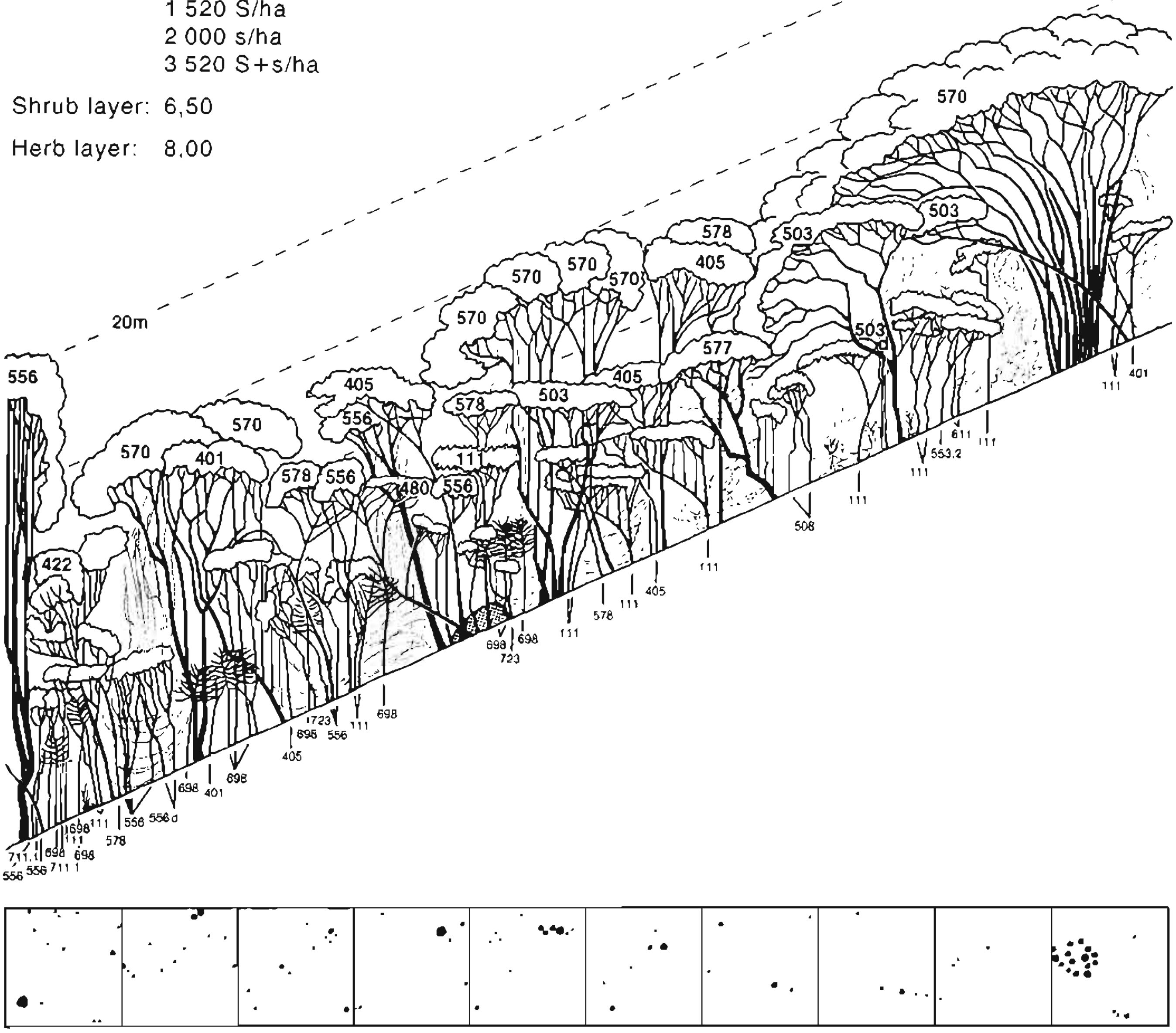
K.3a

SE 50%
1 515 – 1 540 m

Tree layer: 56,68 m²/ha
1 520 S/ha
2 000 s/ha
3 520 S+s/ha

Shrub layer: 6,50

Herb layer: 8,00



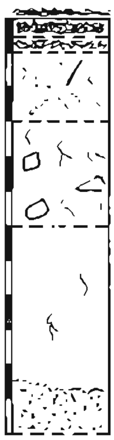


Fig. 45 Stand profile and basal diagram of K.3a, with data summary and soil profiles

K.3b

SE 50%
1 515 — 1 540 m

Tree layer: 45,40 m^2/ha
880 S/ha
1 880 s/ha
2 760 S+s/ha

Shrub layer: 4,50

Herb layer: 6,00

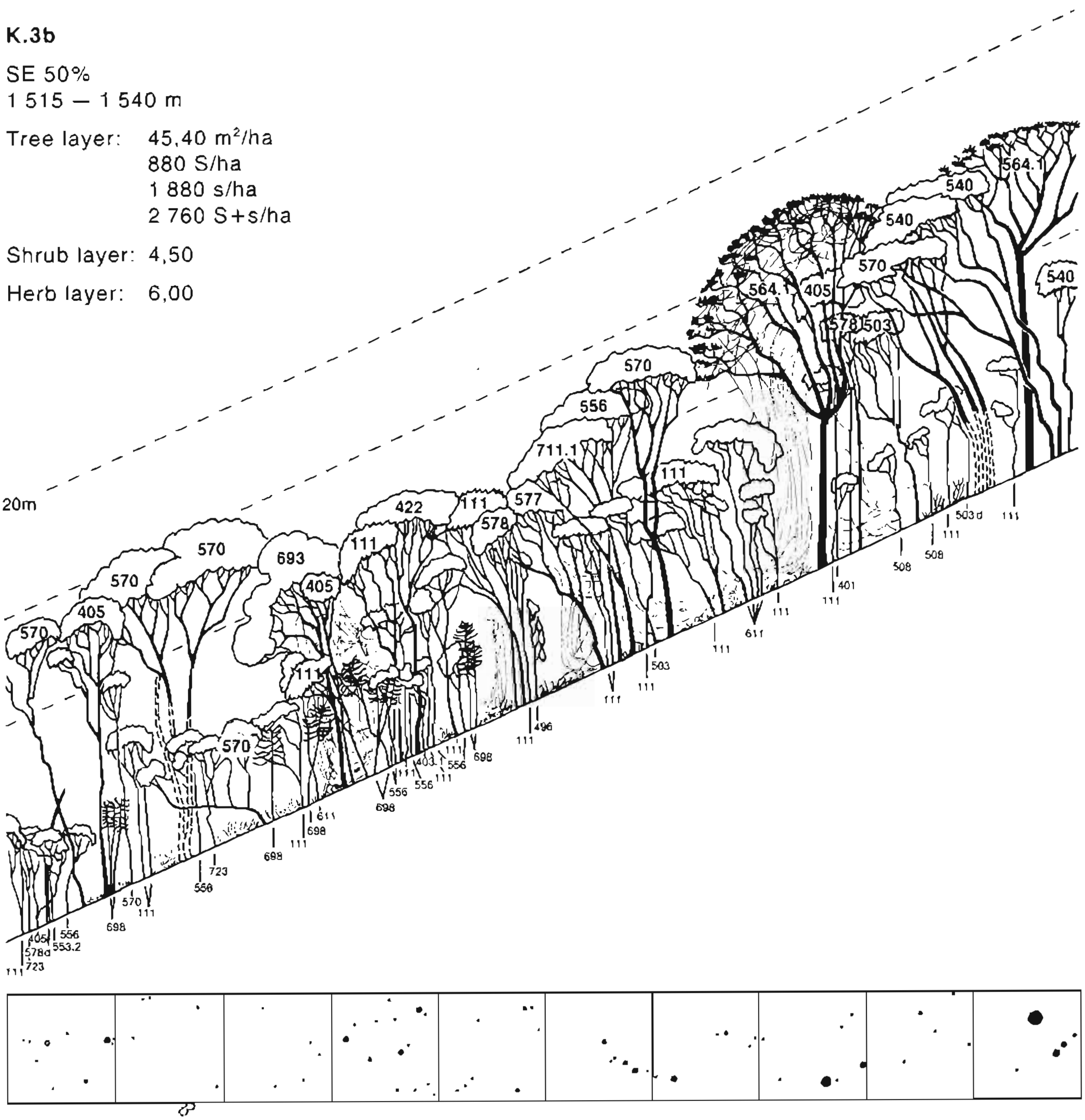


Fig. 46 Stand profile and basal diagram of K.3b, with data summary

massive invasion appears to have been largely arrested in the understorey.

Upper storey: Except for an old broom-crowned *Syzygium gerrardii* towering remnant-like some 5 m over the young forest, and the two *Cussonia spicata* var. *triptera* trees which are also somewhat taller, the present canopy does not exceed the 15 m level and is made up mainly of *Curtisia dentata* crowns. Where the canopy is still broken, *Pterocelastrus echinatus* and *Rapanea melanophloeos* are filling in (as in strip *a*), or the canopy function is taken over by the intermediate storey (as in strip *b*).

An 18 m tall *Cryptocarya liebertiana* was found in the close vicinity as another pointer to the former canopy having been at least 2 to 3 m higher.

Intermediate storey: Between the 7 m and 12 m levels and consisting of scattered crowns of a relatively large variety of species including *Syzygium gerrardii, Trimeria grandifolia, Maesa lanceolata, Pterocelastrus echinatus, Rapanea melanophloeos, Rothmannia capensis, Psydrax obovata* subsp. *elliptica, Maytenus peduncularis, Ochna holstii* and also *Xymalos monospora*, the latter especially in canopy breaks and in the central portion of strip *b* where the intermediate storey substitutes for the canopy.

Understorey: 3 to 5 m tall, broken up into groups; dominated by *Xymalos monospora* (31%), *Syzygium ger-*

rardii (18%) and a comparatively massive *Tricalysia capensis* population (20%) which extends into the shrub layer.

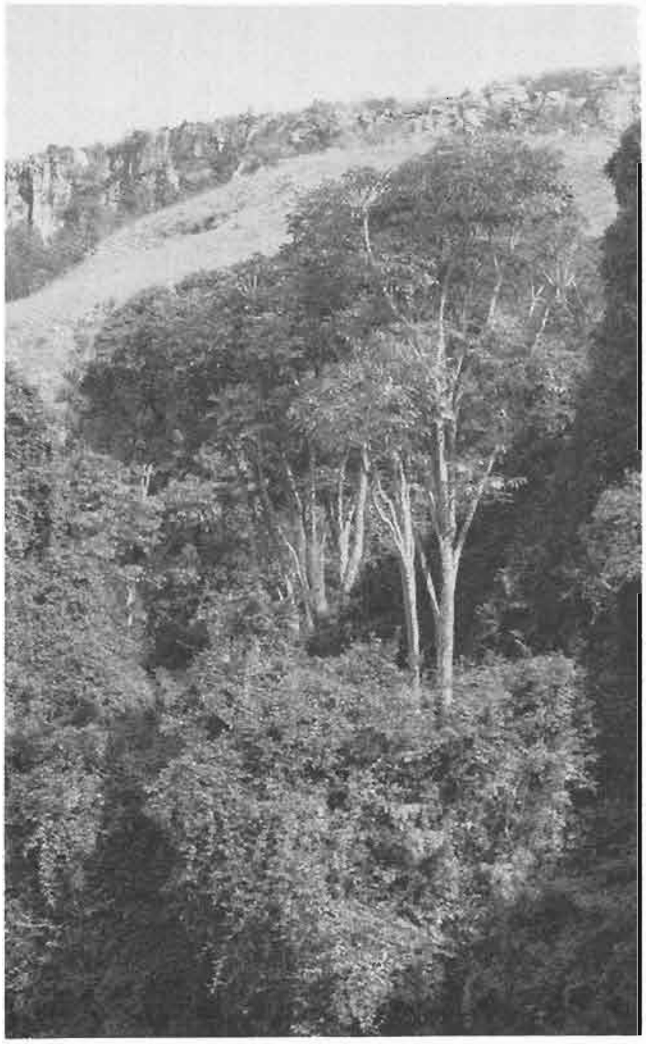
The other lower storey inhabitants, viz. *Diospyros whyteana, Dovyalis lucida* and *Psychotria capensis* var. *capensis,* are also strongly (together 15%) represented.

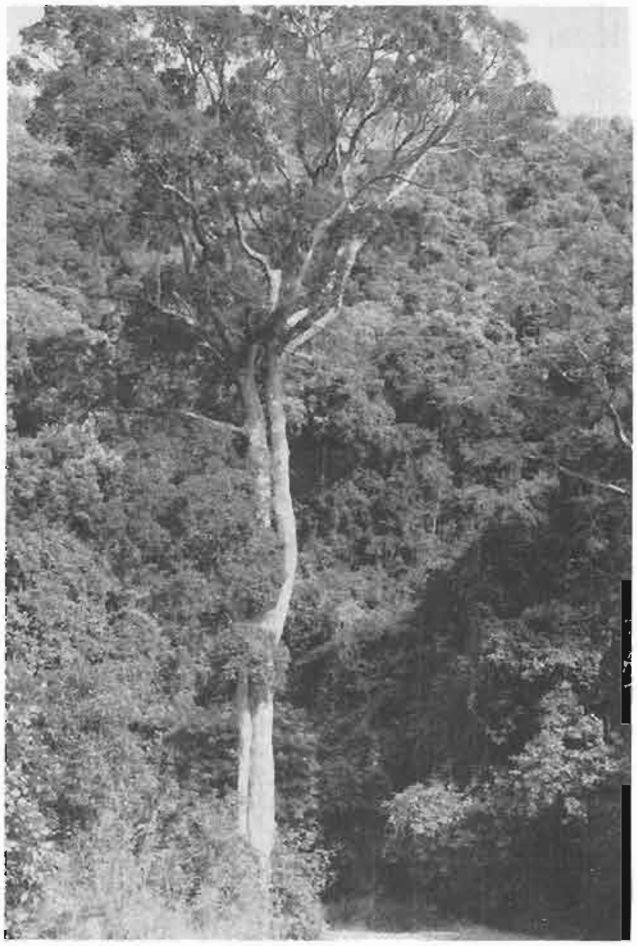
The total absence, also from the shrub and herb layers, of gap-opportunistic upper and intermediate storey species like *Cussonia spicata* var. *triptera, Combretum kraussii* and *Maesa lanceolata,* points to the relatively advanced state of forest reconstruction.

There is an isolated presence, in the sampling strip as well as in the vicinity, of *Scolopia mundii,* a potential upper storey tree but not encountered as such in the area.

Shrub layer: Fairly well developed (5,50) and consisting entirely of tree species. The upper and intermediate storey trees are poorly or not at all reflected, except for a moderate presence of *Syzygium gerrardii* saplings. The near-absence of *Xymalos monospora* recruitment shows that the phase of active invasion is over.

Towering specimens of gap-opportunistic *Cussonia spicata* var. *triptera*





A tall *Syzygium gerrardii* marking the transition from the *Curtisia* forest to the *Syzygium* forest

The layer dominants are *Tricalysia capensis* and *Dovyalis lucida* which together provide almost 60% of the total cover.

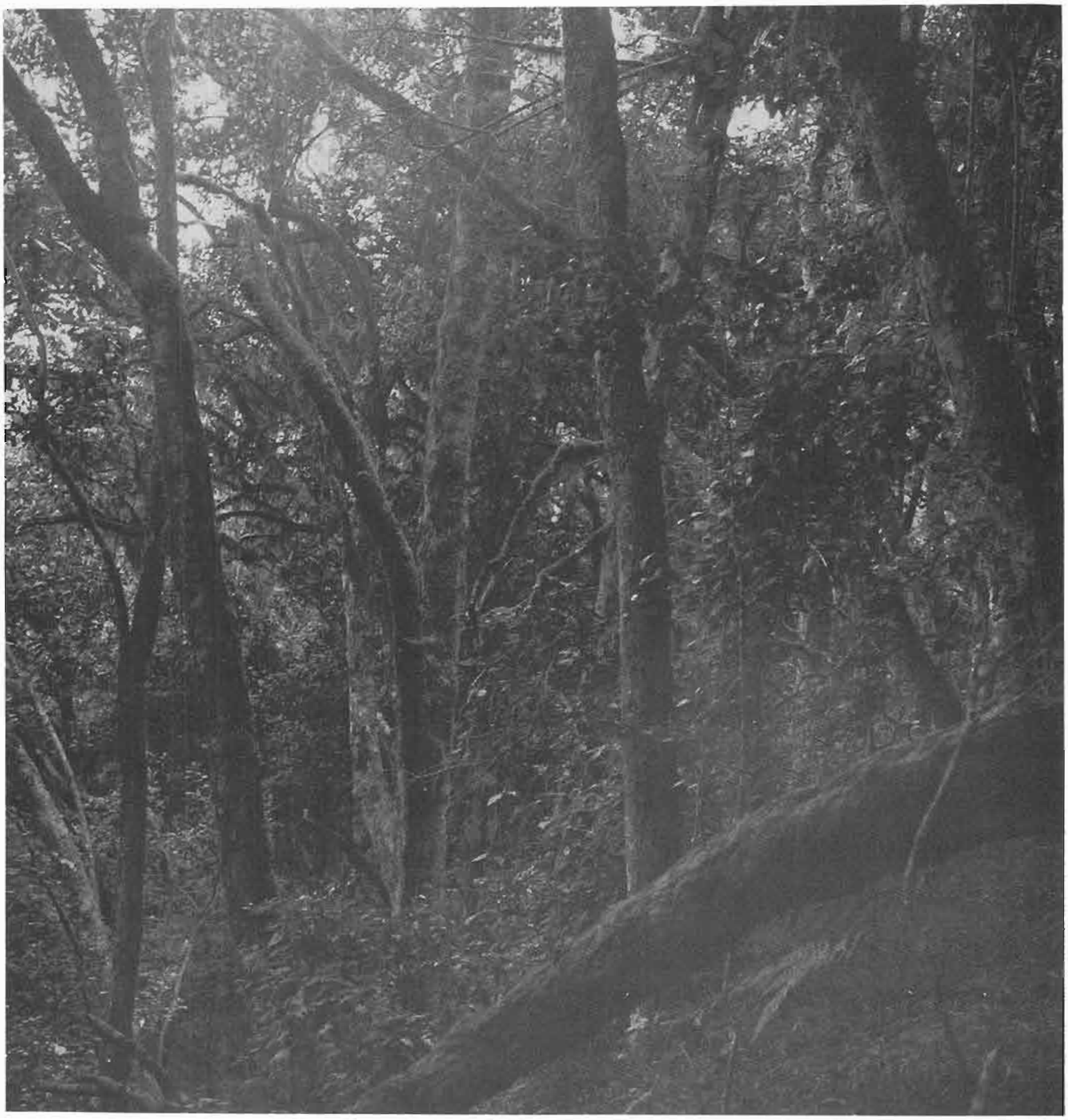
Herb layer: Richly developed (7,00). Some seedling regeneration of most tree and shrub layer species is present but only *Tricalysia capensis* and *Dovyalis lucida* have broad recruitment bases, the latter species even to the extent of layer co-dominance. Together the tree seedlings make up 43% of the total.

The complete absence of *Curtisia dentata,* as in the shrub layer, is noted once again.

The remaining 57% of layer cover is composed of a meagre 3% ferns, concomitant with the sudden near-disappearance of *Pteris catoptera;* 43% monocots with a predominance of *Aristea ensifolia* and *Asparagus africanus,* and 11% lianes.

Dependents: Canopy lianes, exclusively *Rhoicissus rhomboidea* and *R. revoilii,* are abundant and, judging by the host trees, point to the co-emergence of the taller *Curtisia dentata* and the large *Cussonia spicata* var. *triptera* trees.

Classification: An advanced reconstruction stage of a



A climax stand of the *Curtisia* forest with a strong understorey presence of *Syzygium gerrardii*

Curtisia dentata climax forest in the lower part of the upper montane zone and exhibiting distinct features of transition to the lower montane climax, especially in the form of a substantial presence of *Syzygium gerrardii* and *Combretum kraussii* in the higher stories, and of *Tricalysia capensis* in the understorey.

K.4ab

Double strip; enumerated in May 1980.

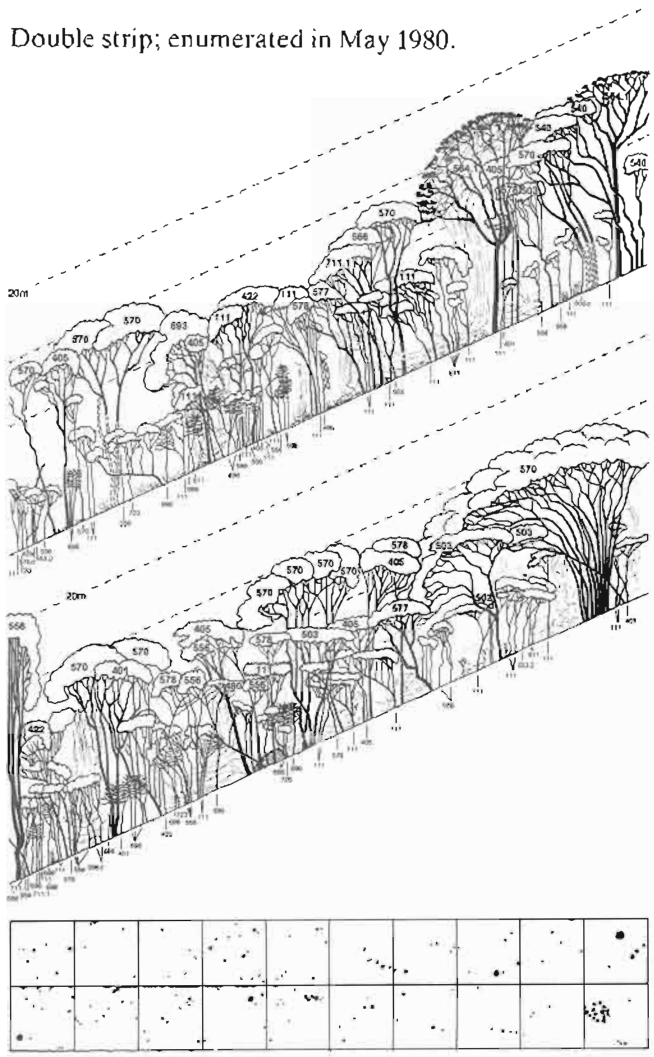


Fig. 47 Combined stand profiles and basal diagrammes of K 4a (below) and K.4b (above)

Situation: South-eastern slope, steep (40%), even, with occasional boulders (strip *b*); at an altitude of 1 500 – 1 520 m in the central forest block south of Kaapsehoop, on the southern ridge just above the escarpment road.

Soil: The two profiles, both of them in strip *a*, have only the surface leaf-litter layer and a 10 to 15 cm thick subsurface root-mat in common, while otherwise they are very different. The profile in the lower portion of the strip (quadrat 4) is underlain by brown loam over saprolitic clay-loam. In the upper portion (quadrat 8), however, the loam contains rock-fall stones and rests on a deep layer of large, unweathered granite blocks with sandy loam between, i.e. on semi-consolidated talus. The talus appears to extend to the whole of strip *b* and suggests not only excessive drainage but also unsteadiness of the substratum.

Tree layer: Basically three-storied but appearing two-storied on the major area, that is the upper half of strip *a* and the entire strip *b*, where the upper and intermediate stories have merged. Situated over talus, these are necessarily sites of chronic instability as clearly shown by recent and old windfalls, as well as by dense stands of seral and pre-climax species, in particular *Rapanea melanophloeos* and *Pterocelastrus echinatus*. The area is also marked by a localised population of *Cassine peragua* which seems to replace *Xymalos mo-*

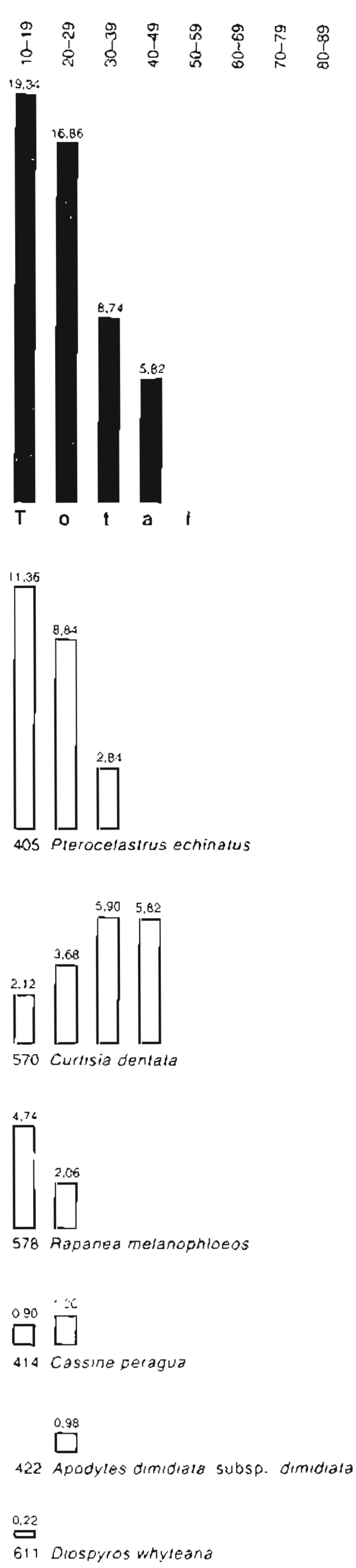


Fig. 48 DBH class distribution (m^2/ha) in K.4ab

nospora to the latter's exclusion.

In the circumstances the mean basal area of 51 m²/ha probably represents the optimum, but the higher figure for strip *a* (56 m²/ha) suggests that the full potential on non-talus sites may be closer to 60 m²/ha. The mean species percentages, namely 45% for *Pterocelastrus echinatus*, 35% for *Curtisia dentata* and 13% for *Rapanea melanophloeos*, are likewise misleading as shown by the figures for the individual strips:

	Strip *a*	Strip *b*
Curtisia dentata	50%	15%
Pterocelastrus echinatus..........	40%	52%
Rapanea melanophloeos	5%	23%

Strip *b*, with its combined high share of 75% for *Pterocelastrus echinatus* and *Rapanea melanophloeos*, together with only 15% for *Curtisia dentata*, appears to be typical for the pro-climax forest on talus slopes, while the climax forest in the lower half of strip *a* shows reverse conditions: 75% for *Curtisia dentata* and a combined 25% for *Pterocelastrus echinatus* and *Rapanea melanophloeos*.

As exploitation for timber apparently never took place in this particular area, the dominance shift from *Curtisia dentata* to *Pterocelastrus echinatus* on talus sites no doubt reflects primarily an edaphic inhibition of the succession towards the climax. However, it may be enhanced by the fact that the position of *Curtisia dentata* as climax dominant is weakened at this transitional altitude between the upper and the lower montane zone, while the complementary role of *Pterocelastrus echinatus* is strongly pronounced: here as well as lower down in the *Syzygium gerrardii* forest.

Upper storey: The canopy of the more climax-like, non-talus portion, mainly the lower half of strip *a*, differs from the rest by being somewhat higher, i.e. 18 – 19 m, as well as larger-crowned and *Curtisia dentata*-dominated. The small-crowned, *Pterocelastrus echinatus*-dominated portion reaches only the 15 – 16 m level. Due to the varying heights of the individual crowns the small-crowned canopy portion is also "deeper". The umbrella-like *Curtisia dentata* crowns around the old and recent windfall areas are partly "borrowed" from outside the strip.

Intermediate storey: In some of the pro-climax areas the intermediate storey cannot clearly be separated from the canopy. The condensed upper part of the intermediate storey as composed mainly of *Pterocelastrus echinatus* and *Rapanea melanophloeos*, actually substitutes for the climax canopy.

The functionally real intermediate storey, between 7 m and 12 m height, is composed in the same manner. In the pro-climax portions it contains much *Cassine peragua*. The presence in this stratum of *Diospyros whyteana*, though blown over, is unusual.

In the pro-climax portions mainly, we have the additional phenomenon of large numbers of undersize stems participating in the intermediate storey, with

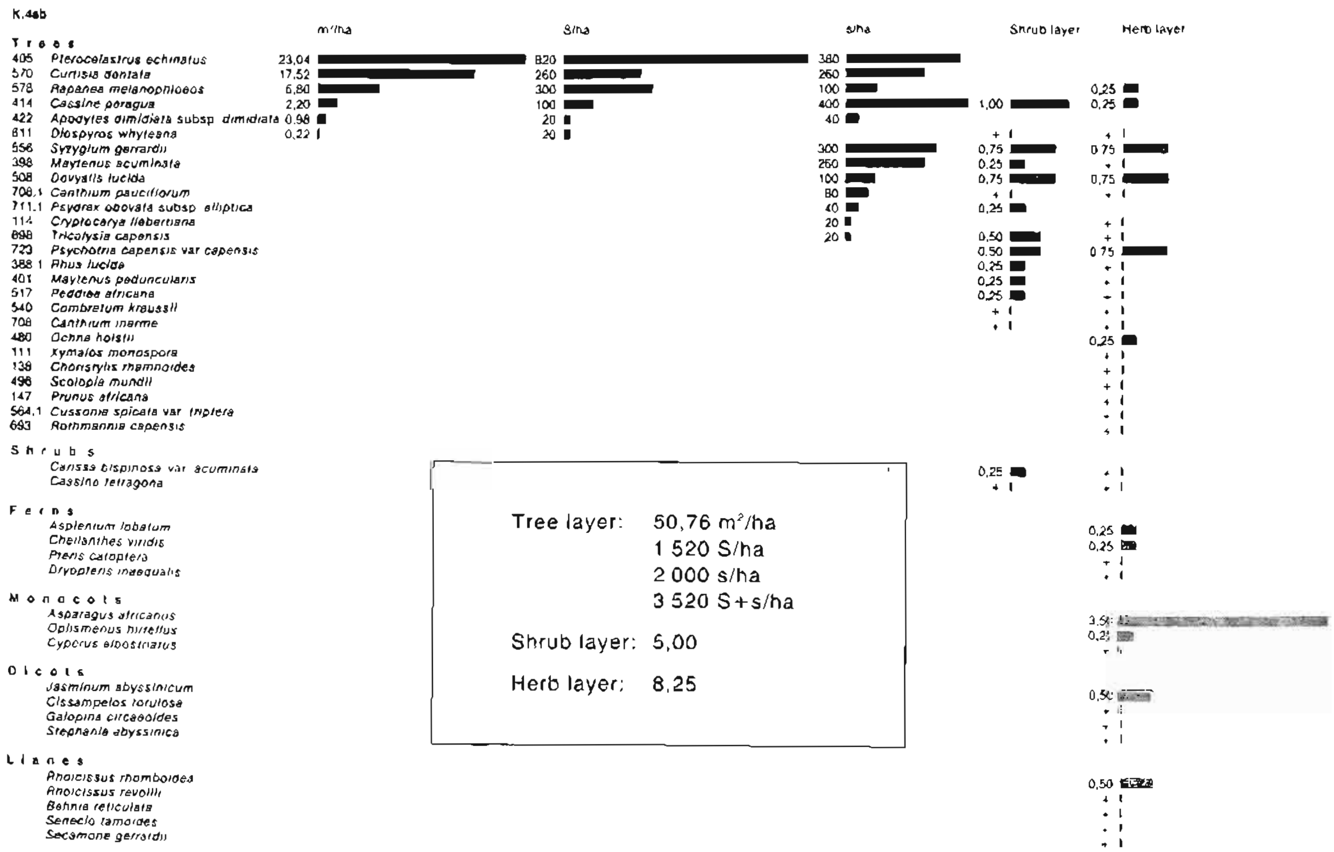
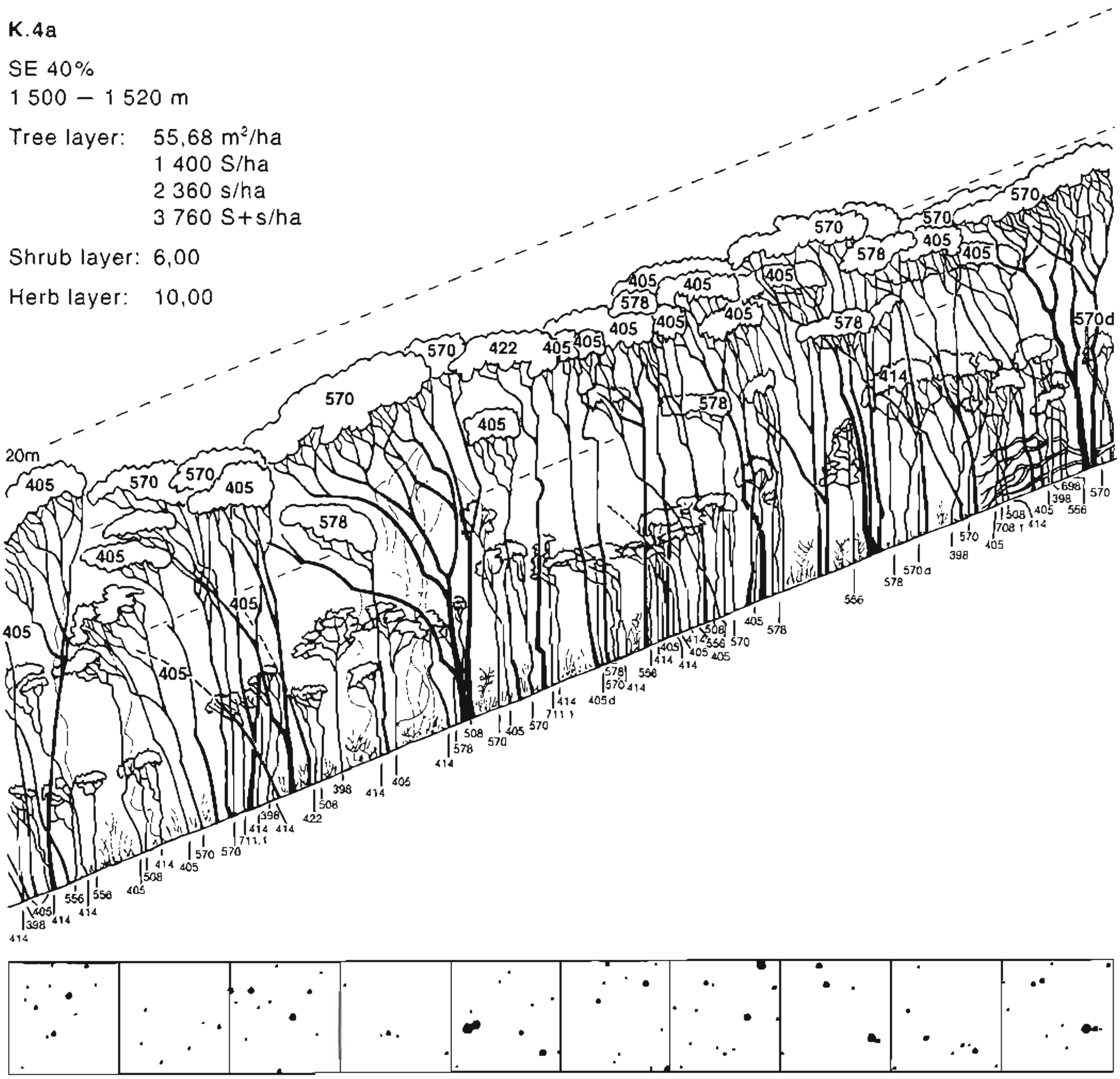


Fig. 49 Stand data graph of K.4ab, with data summary

K.4a

SE 40%
1 500 — 1 520 m

Tree layer:	55,68 m^2/ha
	1 400 S/ha
	2 360 s/ha
	3 760 S+s/ha
Shrub layer:	6,00
Herb layer:	10,00



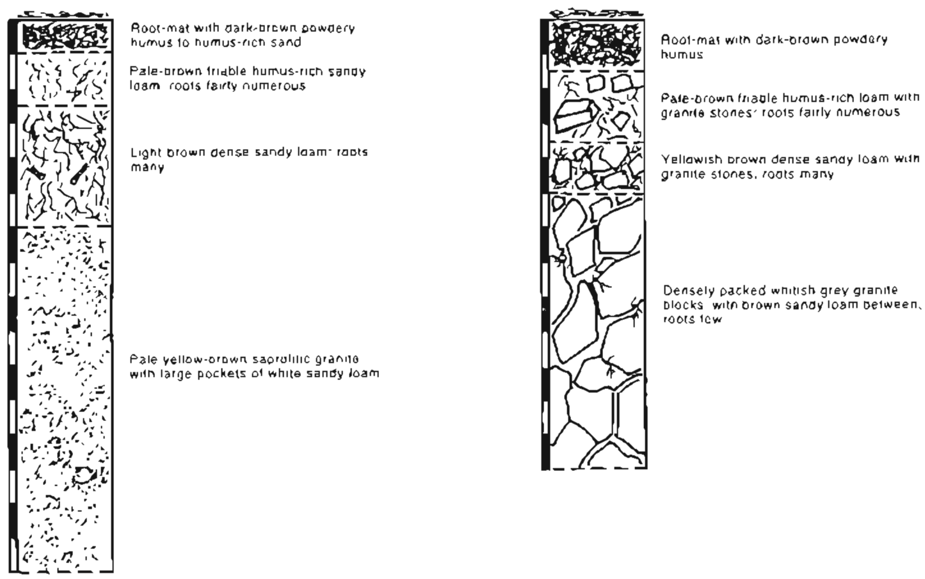


Fig. 50 Stand profile and basal diagram of K.4a, with data summary and soil profiles

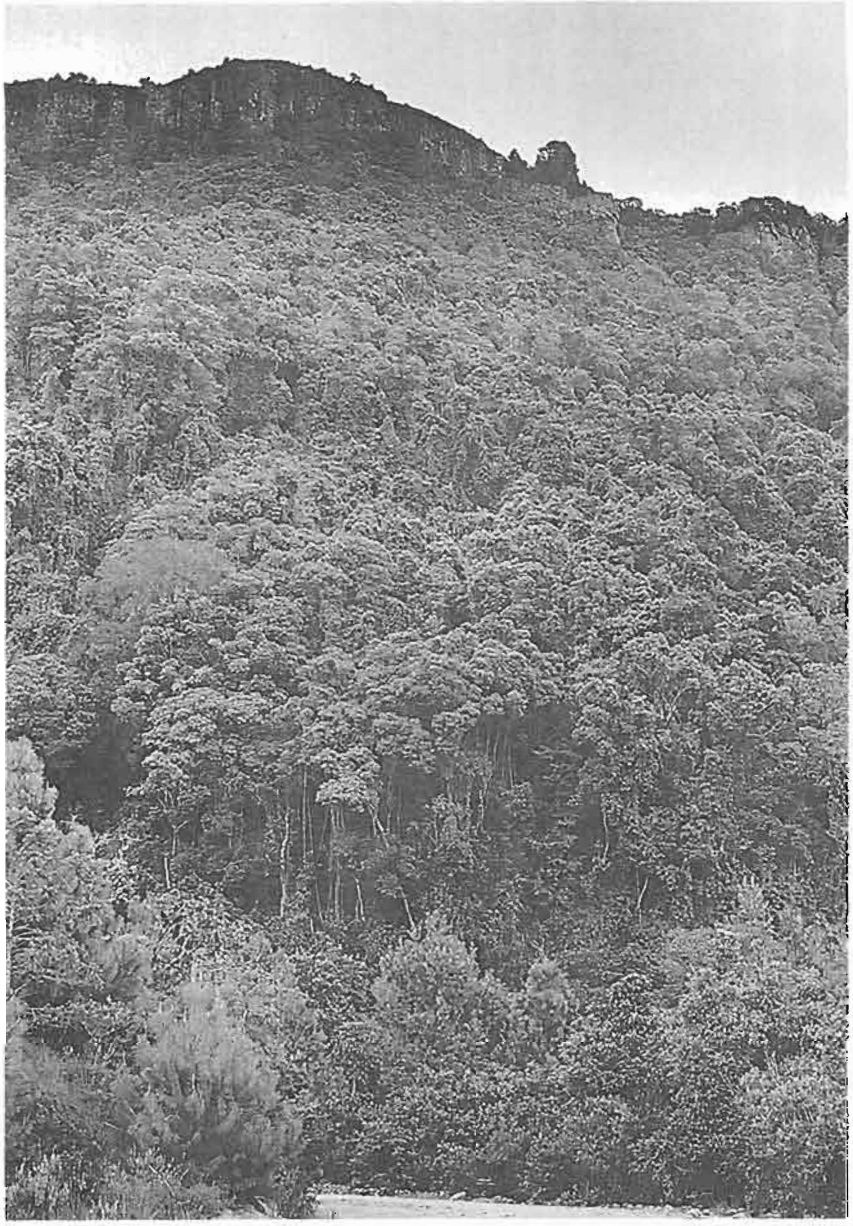
Fig. 51 Stand profile and basal diagram of K.4b, with data summary

some of them even touching the canopy zone. Quite a number of species are involved: *Curtisia dentata*, *Pterocelastrus echinatus*, *Rapanea melanophloeos*, *Syzygium gerrardii*, *Apodytes dimidiata* subsp. *dimidiata*, *Maytenus acuminata*, *Psydrax obovata* subsp. *elliptica* and *Canthium pauciflorum*.

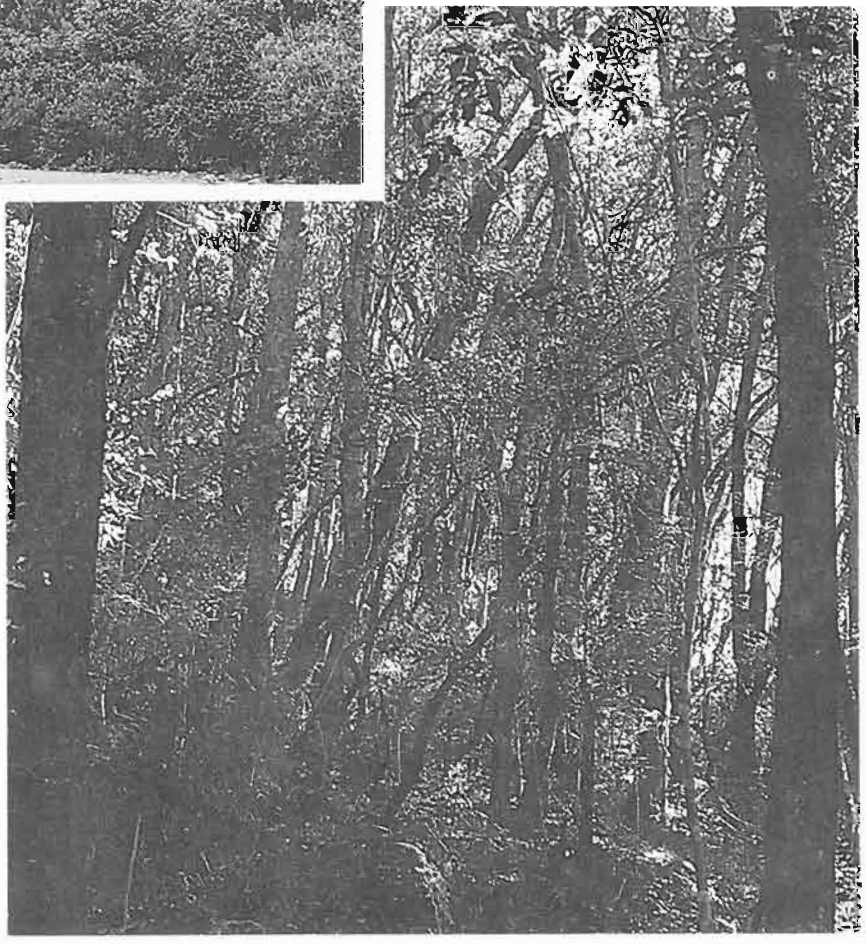
Understorey: With so many undersize stems, including those of true understorey species, elongated into the intermediate storey, one must expect the dividing line to be blurred, which is indeed the case, particularly in the pro-climax portions. Even more significant is the underrepresentation of true understorey species. There is relatively little *Dovyalis lucida* and *Canthium pauciflorum*, and almost no *Tricalysia capensis*, with *Diospyros whyteana* being totally absent. Otherwise the understorey is made up of higher-storey species, which is exceptional. Even more strikingly, this condition is not confined to the pro-climax portions but prevails also in the climax section which, moreover, is no less "infested" with *Cassine peragua* saplings and poles than the other areas. No doubt, this is one of the instances where the understorey demonstrates relative independence.

Shrub layer: Fairly well developed (5,00), it exhibits some of the features one normally finds in the understorey, in particular a stronger presence of true understorey species like *Diospyros whyteana*, *Dovyalis lucida*, *Tricalysia capensis* and *Psychotria capensis* var. *capensis*, but *Syzygium gerrardii* and *Cassine peragua* still supply more than one-third of the total cover. The canopy species, viz. *Curtisia dentata*, *Pterocelastrus echinatus* and *Rapanea melanophloeos*, are absent, however.

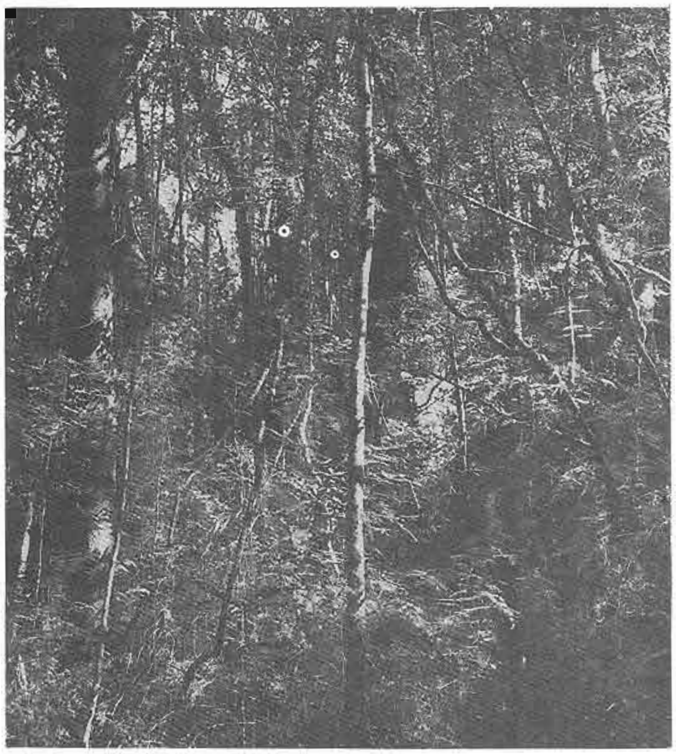
On the other hand, true shrubs such as *Carissa*



In the centre of the picture a *Pterocelastrus echinatus* pro-climax stand (with exposed tree trunks above road cutting)



The same stand from inside; the thin stems are *Cassine peragua.*



Dense *Asparagus africanus* undergrowth

bispinosa and *Cassine tetragona*, put in an appearance.

Herb layer: Richly developed (8,25), surprisingly more so in strip *a* (10,00) than in strip *b* (6,50) in spite of the windfall opening there.

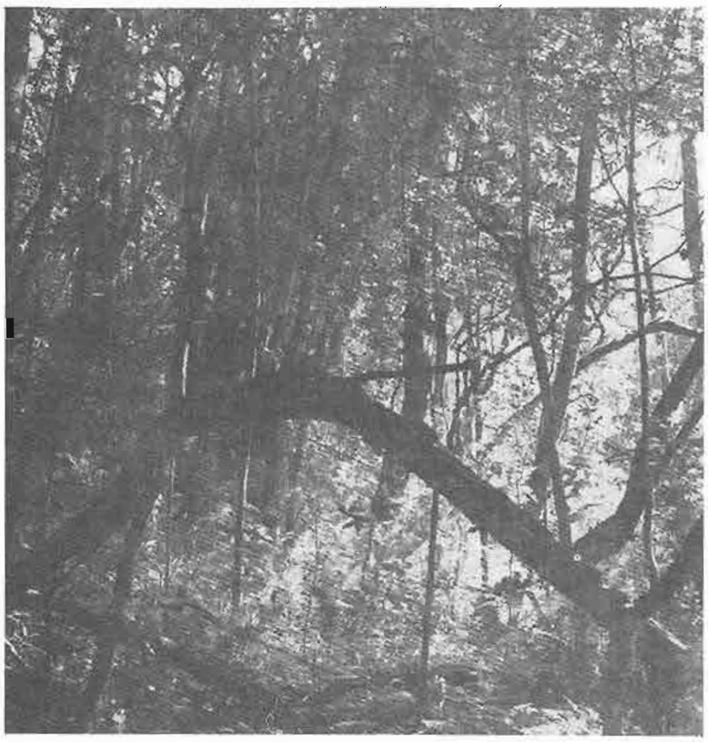
Seedling regeneration of almost all tree and shrub layer species is present, providing as much as 36% of the total cover, with *Syzygium gerrardii*, *Dovyalis lucida* and *Tricalysia capensis* strongly in the lead. *Curtisia dentata* and *Pterocelastrus echinatus* seedlings are completely absent.

The remaining 64% of the herb layer cover is supplied by an insignificant 6% ferns and an equally insignificant 6% dicots, but a massive 45% monocots with *Asparagus africanus* dominating the scene.

Dependents: Canopy lianes, mainly *Rhoicissus rhomboidea*, *R. revoilii* and *Secamone gerrardii*, are present but not abundant. Old specimens of *Curtisia dentata* host epiphytic *Cussonia spicata* var. *triptera*, *Asplenium aethiopicum* and *Disperis lindleyana*.

Classification: A *Curtisia dentata* climax forest (1 part) combined with an edaphically arrested, *Pterocelastrus echinatus*-dominated pro-climax (3 parts) of the former.

High tree mortality as a result of site instability



K.5ab

Double strip; enumerated in July 1979.

Fig. 52 Combined stand profiles and basal diagrammes of K.5a (below) and K.5b (above)

Situation: South-eastern slope, very steep (50%), with a mound in the upper part of strip *a*, otherwise even; at an altitude of 1 430 – 1 455 m, in the central forest block south of Kaapsehoop, on the southern ridge just beneath the escarpment road.

The mound could have originated from the root disk of a fallen giant tree, but it could also be a remnant from a man-made terrace or, even more probably, an old grave. Many tribes bury their chiefs and headmen in the forest.

Soil: The surface leaf-litter layer is present all over the area, but a subsurface root-mat is found only in the upper profile (quadrat 8). Both profiles are very different from those higher up on the escarpment. They reveal a yellowish clay-loam substratum with a shallow, grey-brown clayey, not sandy, loam layer on top. Coarse-grained quartzite blocks are scattered through-

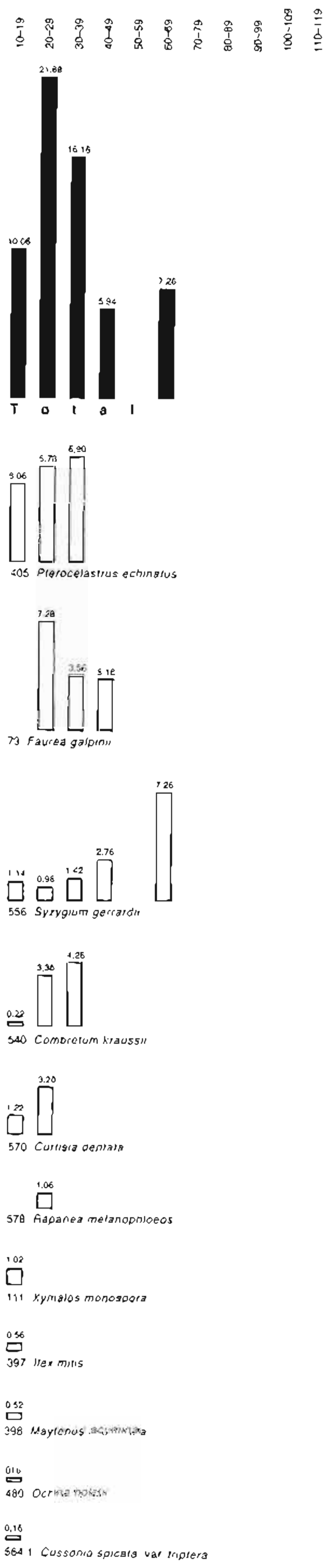


Fig. 53 DBH class distribution (m^2/ha) in K.5ab

out the profiles, suggesting the soil of the median terrace and the lower slopes to be largely of sedimentary origin, having been deposited from erosion material washed down from higher altitudes together with rock falls.

Tree layer: Three-storied, but the upper and intermediate stories broken as a result of previous severe disturbance. Although the area was certainly outside the radius of the McDermid operation, the easy access from the old track (the present escarpment road) leading down to the lowveld obviously invited extraction of assegai (*Curtisia dentata*) timber for use at Barberton. In addition, the forest may have been subject to repeated damage by windstorms and fire.

With the stand structure still being far from the climax stage, the present mean basal area of around 60 m²/ha may be some 15% under the full site potential estimated at 70 m²/ha.

In spite of *Syzygium gerrardii* being with 22% of the total basal area in the third place, its broad DBH class distribution suggests that it has been and will again be the eventual climax dominant. The present predominance of *Pterocelastrus echinatus,* which is taking up 29% of the basal area and 39% of the full stems (but in the lower size classes only), is clearly a temporary reconstruction feature. There are almost no undersize stems, nor is there any sapling or seedling regeneration.

The *Faurea galpinii* stocking, occupying 23% of the basal area, but with full stems only and without any recruitment, is a remnant from a large gap phase, very probably a burn, in the centre. (When the area was revisited seven years later, most of the *Faurea* trees had died.)

Combretum kraussii and *Curtisia dentata*, the only two other species with substantial basal area and full-stem numbers (20% between them) are no doubt long-term climax co-dominants. The share of *Curtisia dentata* will certainly increase in the course of time, mainly at the expense of *Pterocelastrus echinatus* (which in strip *a* shows already 30% basal area mortality) and *Faurea galpinii* (with 8% mortality in strip *b* at the time of enumeration), but hardly to more than 50% of the eventually dominant *Syzygium gerrardii* stocking.

The absence of *Curtisia dentata* regeneration at this present stage does not militate against the expected trend. The cyclic and rather uncorrelated reproduction of the species has already been discussed under K.3ab.

The limited stocking of seral *Rapanea melanophloeos*, of small-gap opportunistic *Cussonia spicata* var. *triptera* and of middle-storey inhabitants like *Ilex mitis, Maytenus acuminata* and *Ochna holstii* is fitting well into the picture.

The actual stem numbers, i.e. more than 1 600 full stems and nearly 5 000 undersize stems per hectare, are multiples of the normal values. The reason for this apparently unreal situation is to be found in a kind of "upward size shift" in the lower strata, with most of the shrub layer occupying the understorey, and most of what normally are undersize stems just making the grade for the full stem class: a rather localised phenomenon.

Upper storey: The group of 20 – 22 m tall *Syzygium gerrardii, Pterocelastrus echinatus* and *Combretum kraussii* in the lower part is no doubt the only canopy remnant from the previous climax forest. The present interim canopy at the 15 – 18 m level is constituted

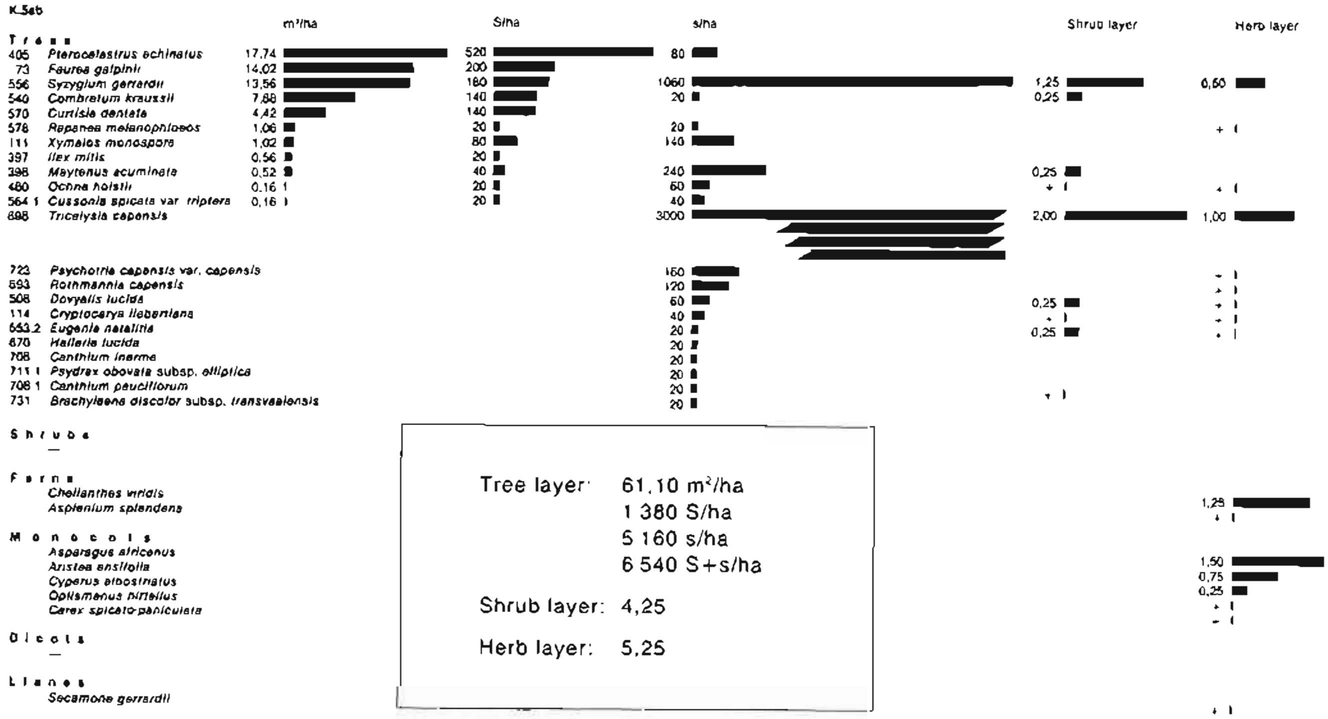


Fig. 54 Stand data graph of K.5ab, with data summary

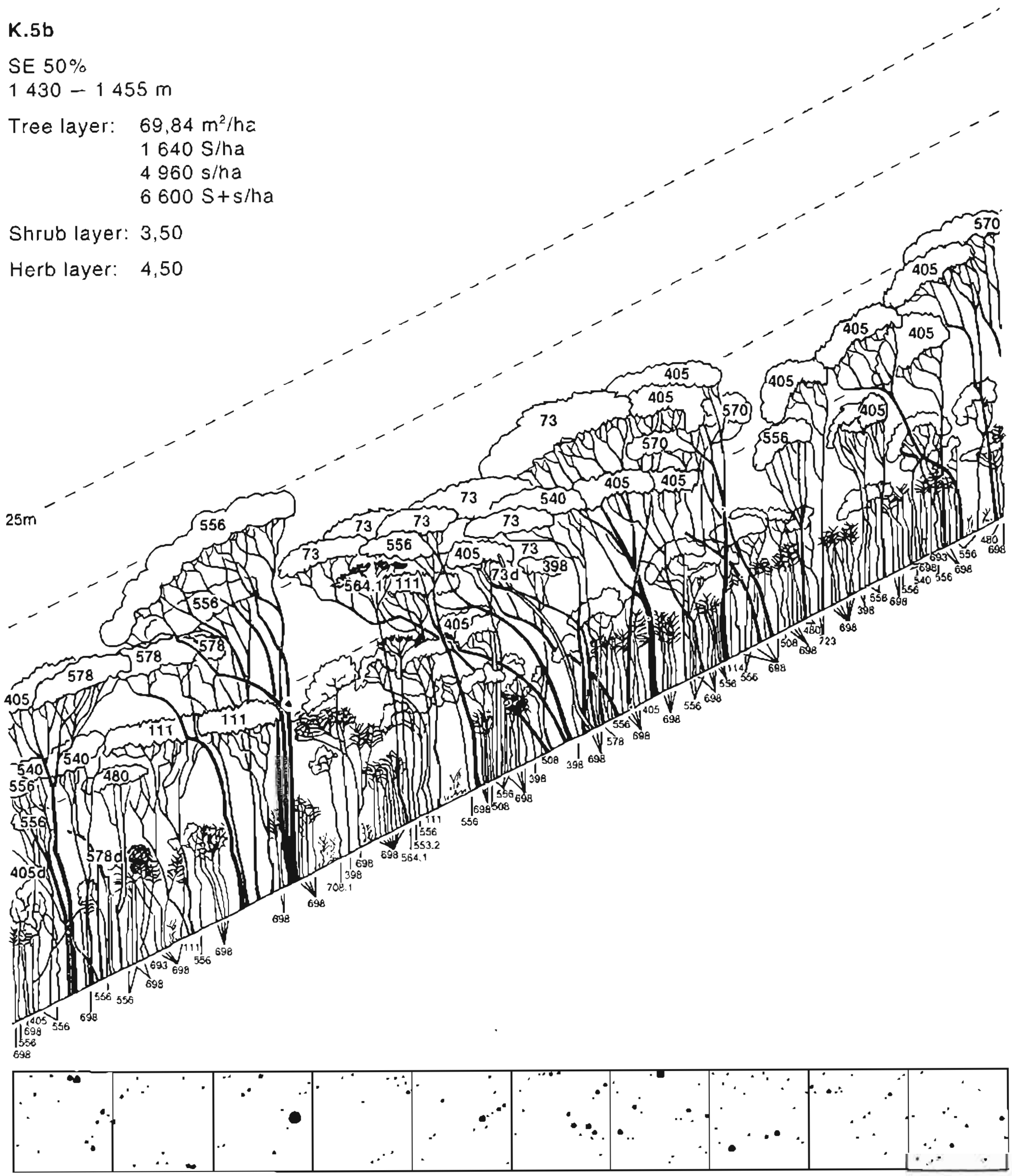


Fig. 56 Stand profile and basal diagram of K.5b, with data summary

almost exclusively by broad crowns of relatively young *Pterocelastrus echinatus* and, in the centre of strip *b*, *Faurea galpinii*. In strip *a* the fragmentation of the canopy is still very much pronounced and the canopy function has partly been taken over by the intermediate storey.

Intermediate storey: Consisting of medium-sized crowns, scattered mostly in gap-stopper positions between 10 m and 15 m height, mainly of *Pterocelastrus echinatus, Curtisia dentata, Rapanea melanophloeos* and *Syzygium gerrardii*. There is also some *Xymalos monospora, Maytenus acuminata, Ochna holstii* and *Ilex mitis* with a few parasol-crowned *Cussonia spicata* var. *triptera* passing through on their way to the upper storey.

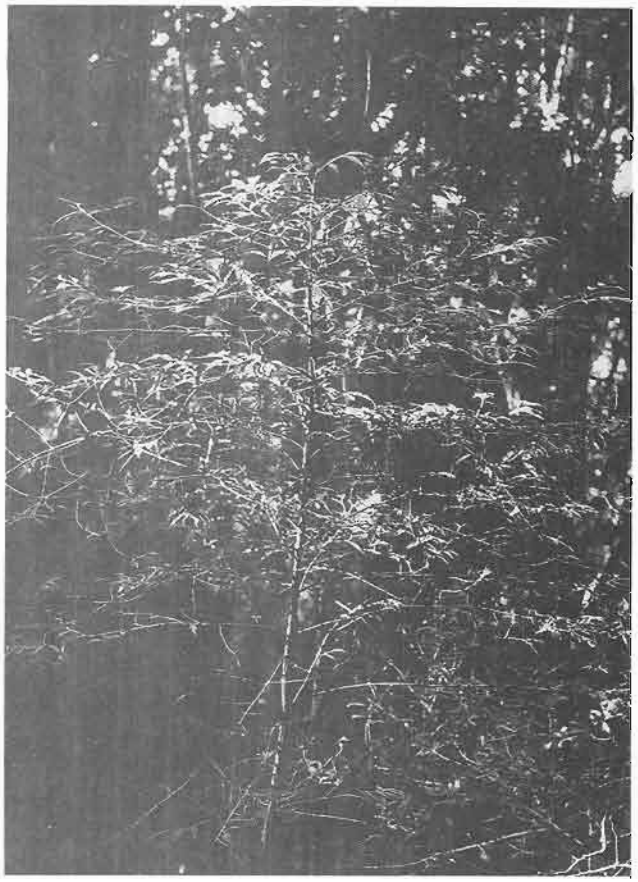
Understorey: A dense and nearly continuous stand of

3 – 4 m tall *Tricalysia capensis*, overtopped by a mass of pole-stage *Syzygium gerrardii* and an admixture of young trees of other upper and intermediate storey species except *Curtisia dentata*, *Faurea galpinii* and *Ilex mitis*, as well as of true understorey species such as *Psychotria capensis* var. *capensis*, *Rothmannia capensis* and *Dovyalis lucida*.

The limited presence of *Eugenia natalitia*, *Halleria lucida*, *Canthium inerme* and *Canthium pauciflorum* is quite legitimate, with some of them, as also *Psydrax obovata* subsp. *elliptica*, destined to move up into the intermediate storey. *Cryptocarya liebertiana* has in this type a real chance of reaching the upper storey.

The only one that does not fit in here, is a single *Brachylaena discolor* subsp. *transvaalensis*, obviously a remnant from the open phase. (It is also found at the roadside.)

The extraordinary prominence of *Tricalysia capensis* is by no means a localised feature but was encountered all along the contour where forest of this type is still preserved. (Even seven years later nothing much had changed.) It links this forest to that of K.3ab where already some *T. capensis* prominence has been observed, suggesting a transitional character of the K.3ab *Curtisia dentata* forest.



Tricalysia capensis in the understorey of K.5ab