Geo-Eco-Trop, 1982, 6 (2) 139-160

ON THE LEAF ANATOMY OF TREES AND SHRUBS OF THE MONTANE EVERGREEN FOREST OF MALAŴI AND ZIMBABWE

A propos de l'anatomie foliaire des essences de la forêt montagnarde sempervirente du Malaŵi et du Zimbabwe

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ABSTRACT

After having establish a preliminary list of 83 trees and shrubs of the montane evergreen forest of Malawi and Zimbabwe, the authors study the leaf anatomy of 19 of them. These present a mean blade thickness of 250 µm, the abundance of crystals (84 %), the frequence of a complete ring of woody support tissue surrounding the libero-ligneous cluster of the main nerve (58 %) and of a hypodermis (42 %). Pachyphylly, noted for montane rain forests, is here no more than a tendency, as well as light differences appear with regard to the Shabo-Zambian dense dry forests, sometimes considered as "laurisilvae".

RESUME

Après voir établi une liste préliminaire de 83 espèces ligneuses de la forêt montagnarde sempervirente du Malawi et du Zimbabwe, les auteurs étudient l'anatomie foliaire de 19 d'entre elles. Celles-ci montrent une épaisseur moyenne du limbe de 250 µm, l'abondance de cristaux (84 %), la fréquence d'un anneau complet de tissu de soutien entourant le faisceau libéro-ligneux de la nervure principale (58 %) et d'un hypoderme (42 %). La pachyphyllie signalée pour les forêts denses équatoriales montagnardes ne constitue ici qu'une tendance, de même qu'apparaissent de légères différences avec les forêts denses sèches shabo-zambiennes, parfois considérées comme "laurisilves".

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INTRODUCTION

The leaf illustrates multiple ecological factors by its periodicity, its morphology, its anatomy and its chemical composition. It reacts both to climate and soil characteristics.

The leaf periodicity and the deciduous or evergreen nature of the vegetation cover are basic features in the varying plant formations' systems of classification, both on a world scale and on that of tropical regions (BROCKMANN-JEROSCH & RUBEL, 1912; ELLENBERG & MUELLER-DOMBOIS, 1974; KEAY, 1959).

The raw spectrum of leaf surface classes (RAUNKIAER, 1934; TAYLOR, 1975) has also been used to characterize vegetation types. In tropical Africa the spectra of different dry forests (THOMASSON, 1971, 1977; MALAISSE & COLONVAL-ELENKOV, 1981), of sclerophyllous formations (LEBRUN in DE SLOOVER *et al.*, 1965; MALAISSE & COLONVAL-ELENKOV, 1981) and of flooded, swamp, fringing and riparian forests of the Zaïrean basin (EVRARD, 1968) have been specified in particular. In connection with this has been noted the reduction in leaf size when considering the succession of vegetation types, from those of the equator to the desert (DUVIGNEAUD, 1974), along a climatic gradient (WERGER & ELLENBROEK, 1978) or with an increase in altitude (DOLPH & DILCHER, 1980).

In the Zambezian region, leaf anatomy was studied respectively for three dominant trees in miombo woodland (ERNST & WALKER, 1973), for high termitaria vegetation (COLONVAL-ELENKOV & MALAISSE, 1975), for the plateau dry evergreen forests (MALAISSE & COLONVAL-ELENKOV, 1981) and for various types of woodland (MALAISSE *et al.*, 1982). Perceptible differences became apparent, which permitted us to prove :

- the presence of a particular dominant anatomical type for woodland species, namely the existence of a palissadic parenchyma occupying the whole thickness of the lamina,
- the existence of four main anatomical types for termitaria species indicating the presence within this flora of several ecological groups (MALAISSE, 1976),
- the existence of a sclerophyllous tendancy (relatively thick lamina, frequency of hairiness, relatively small leaf size, various sclerous tissues) for dry evergreen forest species.

This last observation encourages questions as to the similarities of the Zambezian dry evergreen forest with the African montane evergreen forest.

Lastly, for the same Zambezian region, the chemical composition of the leaf, with a view to phytogeochemical prospections was approached, as much for copper (DUVIGNEAU & DENAEYER-DE SMET, 1963; WILD, 1968; BROOKS *et al.*, 1980), as for cobalt (DUVIGNEAUD, 1959), manganese (DUVIGNEAUD & DENAEYER-DE SMET, 1960), nickel (WILD, 1970) and serpentine (WILD, 1974, 1978).

The present study proposes to examine the leaf anatomy of species found in the African montane evergreen forests of Malawi and Zimbabwe in order to lead to an understanding of the adaptive significance of leaf characters and to a comparison with other African evergreen forests, namely the Shabo-Zambian dry evergreen forest.

MATERIAL AND METHODS

The flora of the Afro-montane evergreen forests has been the subject of several studies (LEBRUN, 1958; LIBEN, 1962; LEWALLE, 1972). We explored the dense forests on two sites : the Zomba Mountain (1480 m alt., 35° 09' E, 15° 26' S) of Malawi and the Bunga Forest of the Vumba Mountains (1690 m alt., 32° 48' E, 19° 08' S) of Zimbabwe. The work of CHAPMAN & WHITE (1970) provides precious information on the evergreen forests of Malawi in general and the montane forests in particular. For Zimbabwe, the observations of MULLER (in litt.) and CHASE's inventory (1982) provided us with documentation on the flora of montane forests in the Umtali region. These studies enabled us to establish a preliminary list of the flora of the two forests visited, comprising 83 species (see Appendix). Only 26 species are found in the two sites. Our study of the leaf anatomy concerned 19 woody species or 23 % of the flora. These are noted in table I which indicates the voucher number as well as the figure references. The reference collection is deposited at the Herbarium of the University of Lubumbashi and a double at the Jardin botanique national de Belgique at Meise-lez-Brussels (BR). Three mature leaves of each species listed were collected either in February or in April. After collection, the specimens were immersed in a conserving liquid (1/3 water, 1/3 glycerine, 1/3 95° alcohol). Transverse sections including the midrib were cut by an anatomical razor or on a rotary microtome. The main colouring agents used were iodine green and ruthenium red (3 minutes) after immersion in desinfectant and acetic acid at 40 % (10 minutes).

Reference figure	Reference voucher specimen (M*; L.M.S.**)	Family	Taxon
1 D, 4 O	M 6032	Aquifoliaceae	*Ilex mitis*
3 I	M 12726	Araliaceae	*Cussonia spicata*
-	M 12741	Chrysobalanaceae	*Parinari excelsa*
2 E	M 12185	Cornaceae	*Curtisia dentata*
-	M 4191	Ericaceae	*Agauria salicifolia*
3 H, 4 N	M 4228	Hypericaceae	*Garcinia volkensii*
3 K	M 12740	Icacinaceae	*Apodytes dimidiata*
-	M 12176	Loganiaceae	*Tabernaemontana angolensis*
-	M 12737	Meliaceae	*Ekebergia capensis*
3 L, 4 Q	M 12738	Myrsinaceae	*Maesa lanceolata*
-	M 12739	Ochnaceae	*Ochna holstii*
4 R	M 12179	Podocarpaceae	*Podocarpus latifolius*
-	M 4227	Podocarpaceae	*Podocarpus milanjianus*
2 G	M 12196	Rubiaceae	*Psychotria zombamontana*
1 D, 4 P	M 12194	Rutaceae	*Clausena anisata*
3 J, 4 M	M 12736	Sapindaceae	*Dodonaea viscosa*
1 C	L.M.S. 1048	Theaceae	*Ficalhoa laurifolia*
2 F	L.M.S. 6219	Thymeleaceae	*Gnidia glauca*
1 A	M 12180	Thymeleaceae	*Peddiea africana*

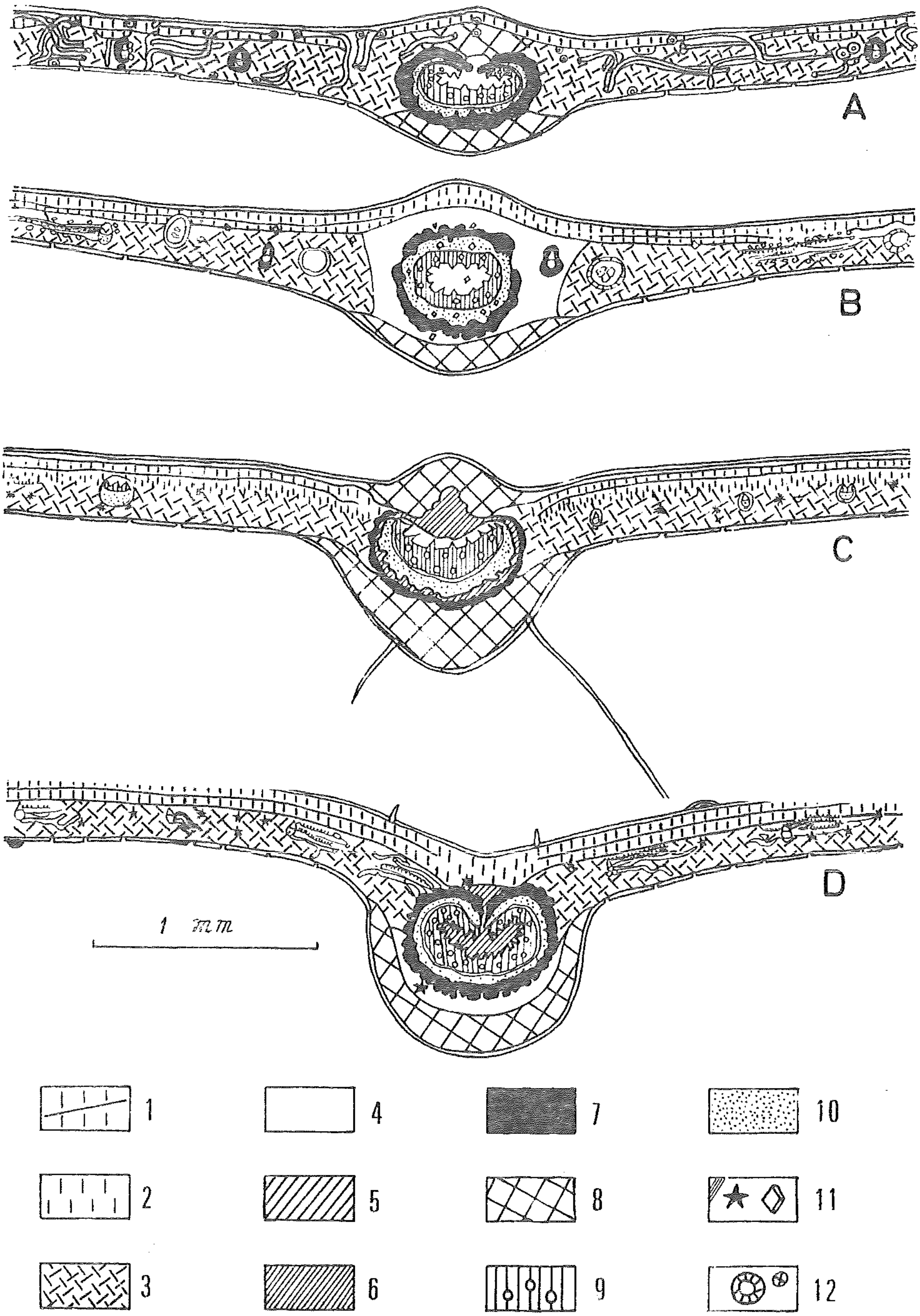
Tab. I : List of studied taxa. * MALAISSE; ** LISOWSKI, MALAISSE & SYMOENS.

Blade thickness, thickness of the outer walls of the upper and lower epidermis (including cuticles), the thickness of palisade and non palisade mesophyll were measured, avoiding exceptionnaly wide (midrib) or narrow (leaf edge) portions of the sections. The presence of a hypodermis, sclerenchyma, crystals and hairs was noted. All observations were made by light microsopy. The non-palisade/palisade mesophyll ratio was calculated, being the ratio most commonly found in the literature (TANNER & KAPOS, 1982). Stomatal density was obtained by a count made on four sq mm of regular sections of the leaves surfaces. The stomata density cannot be counted for *Agauria salicifolia* and *Parinari excelsa* due to the abundance of monocellular hairs. The abundance of papillae did not allow the measurement of the height of the guard cell of *Ekebergia capensis*.

RESULTS

Figure 1 show schemas of the leaf anatomic structure of most of the species studied (for *Parinari excelsa* and *Tabernaemontana angolensis* see MALAISSE & COLONVAL-ELENKOV, 1981). Table II gives their main characteristics. Considering all species, blade thickness ranged from 129 to 360 µm, mean thickness being 250 µm. The thickness of the outer wall of the upper epidermis ranged from 3.6 to 14.0 µm (mean 7.3 µm), and that of the outer wall of the lower epidermis from 2.4 to 12.0 µm (mean 5.6 µm). The height of the guard cell ranged from 15.0 to 30.0 µm (mean 21.0 µm).The ratio of the non-palisade to the palisade mesophyll ranged from 0.36 to 8.67 (mean 2.70). Only *Gnidia glauca* has stomata on the upper surface of the lamina, and the density of stomata on the lower surface ranged from 81 mm^{-2} to 452 mm^{-2} (mean 221 mm^{-2}). One to two layers of palisade parenchyma may generally be observed ; only *Agauria salicifolia* possesses 5 to 6. The hypodermis is only present in 8 species or 42 %. Crystals are frequent (84 %), resin channels rarer (26 %). The trichome, mainly formed of unicellular hairs, may be seen in 6 species, or 32 %. *Ekebergia capensis* shows numerous papillae. Lastly the two *Podocarpus* studied showed on both leaf surfaces the presence of one to two layers of wooded fibres parallel to the main nerve (Fig. 2 R).

Eleven species in our sample, or 58 %, showed a common characteristic, the presence of a complete ring of woody support tissue surrounding the libero-ligneous cluster of the main nerve. The remainig 8 species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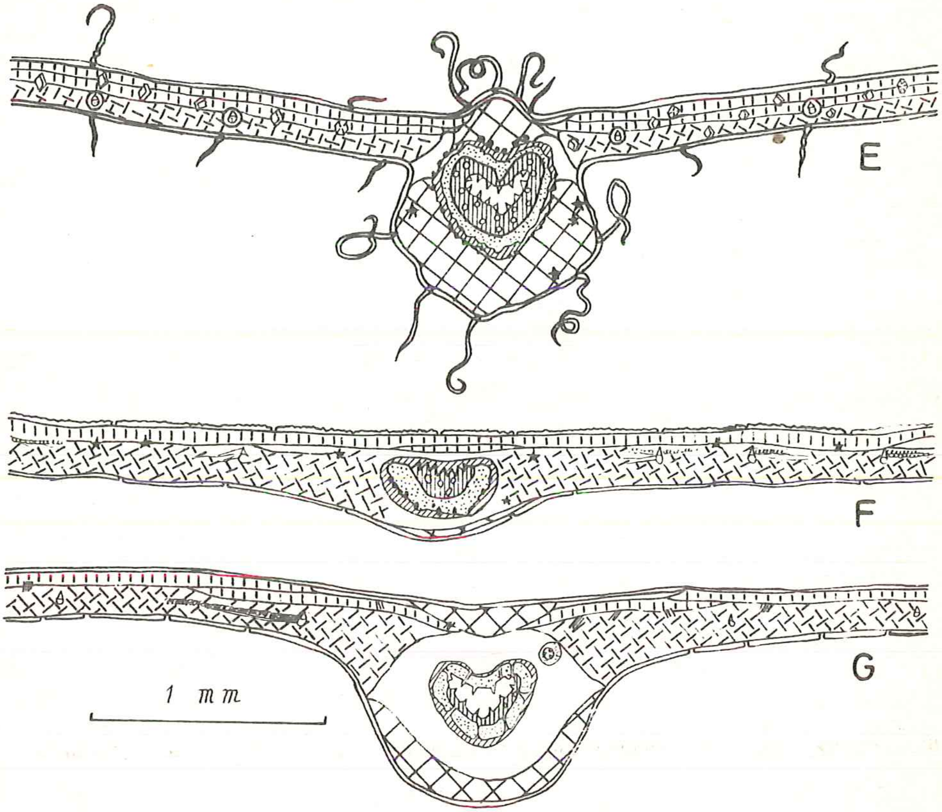
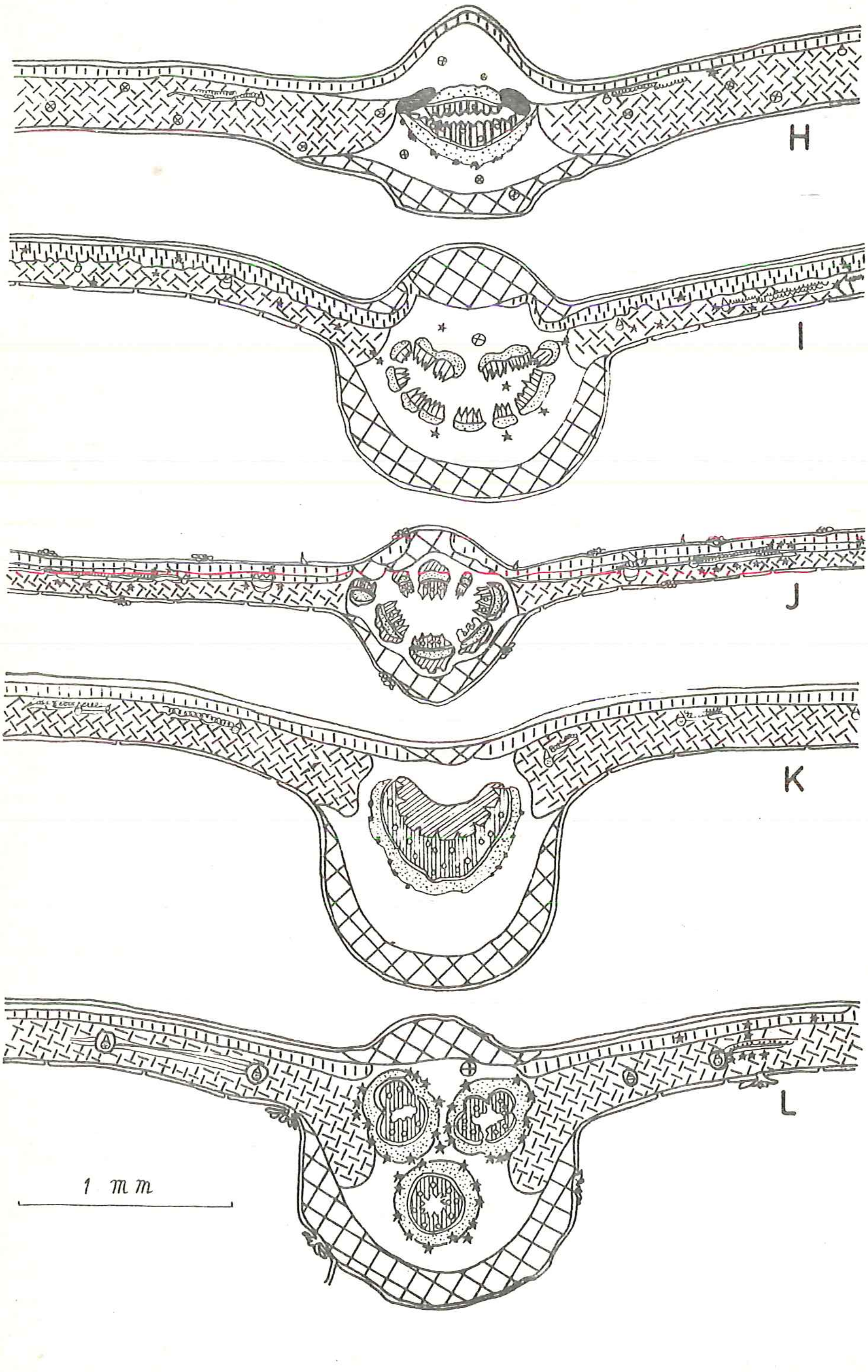


Fig. 1 : Transversal sections in the lamina of afro-montane evergreen forests' plants : A : *Peddiea africana*; B : *Clausena anisata*; C : *Ficalhoa laurifolia*; D : *Ilex mitis*; E : *Curtisia dentata*; F : *Gnidia glauca*; G : *Psychotria zombamontana*; H : *Garcinia volkensii*; I : *Cussonia spicata*; J : *Dodonaea viscosa*; K : *Apodytes dimidiata*; L : *Maesa lanceolata*.
The bar is equivalent to 1 mm.
Key of symbols : 1 : green-leaved palisade parenchyma; 2 : green-leaved palisade lacunose parenchyma; 3 : green-leaved lacunose parenchyma; 4 : colourless parenchyma; 5 : sclerous parenchyma; 6 : sclerenchyma; 7 : sclerous fibres; 8 : collenchyma; 9 : bast; 10 : xylem; 11 : calcium oxalate needles, sea-urchins and plaquettes; 12 : resin channels.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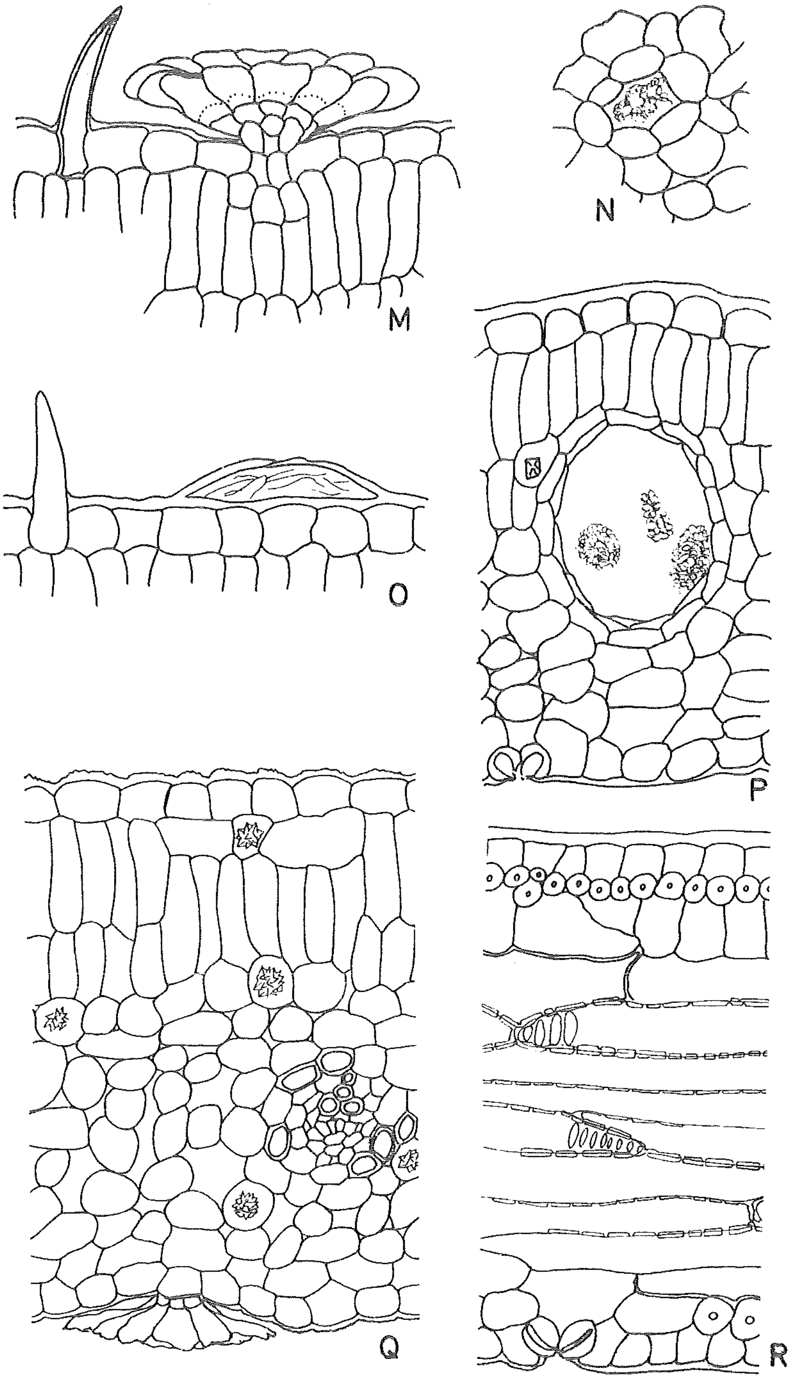

Fig. 2 : Details of the leaf anatomy of afro-montane evergreen forests' plants : M : *Dodonaea viscosa* : upper epidermis; N : *Garcinia volkensii* : secretory pocket; O : *Ilex mitis* : upper epidermis, suberous verruca; P : *Clausena anisata* : resin channel; Q : *Maesa lanceolata* : transversal section; R : *Podocarpus latifolius* : transversal section. Enlargement : 312 x (except M and N, 625 x).

Taxon	Lamina thickness (µm)	Thickness of outer walls of epidermis including cuticle (µm)		Nº of cell layers in palisade	Thickness of the palisade (µm)	Thickness of non-palisade (µm)
		Upper	Lower			
Agauria salicifolia	340-360	9.8	6.5	5-6	126	45*
Apodytes dimidiata	285	6.5	3.0	1	89	136
Clausena anisata	252	6.0	4.8	2	84	132
Curtisia dentata	175	6.5	3.6	1(2)	66(45)	60(75)
Cussonia spicata	240	6.6	8.4	1(2)	56	130
Dodonaea viscosa	187	7.5	6.4	2	73	70
Ekebergia capensis	348	11.9	6.8	2+(1)**	148	131
Ficalhoa laurifolia	260	12.0	7.6	(2-3)	72	120
Garcinia volkensii	336	14.0	12.0	1	30	260
Gnidia glauca	264	5.2	4.5	1(2)	54	156
Ilex mitis	340	11.0	7.5	2(3)	105	178
Maesa lanceolata	264	5.2	7.5	1(2)	40-60	156
Ochna holstii	129	4.8	3.0	1(2)	30(45)	57(42)
Parinari excelsa	99-195	3.6	2.4	2	57	105
Peddiea africana	220	8.2	5.7	1	45	108
Podocarpus latifolius	240	7.7	4.6	1	31	180
Podocarpus milanjianus	230	3.6	3.0	1	28	135
Psychotria zombamontana	186	3.6	2.8	1	39	102
Tabernaemontana angolensis	288	5.7	5.8	1	30	192
Mean value	250	7.3	5.6	2	64	129
S.D.	66	3.1	2.4		34	53

Tab. II : Leaf anatomy of species studied. (* green-leaved lacunose pa-

Non palisade/palisade ratio	Nº of cell layer in hypodermis	Presence (+) Absence (-)						Mean guard cell height (µm)	Upper/lower density of stomata mm^{-2}
		Crystals	Circumvascular sclerenchyma	Collenchyma	Rasin channels	Hair			
						Monocel-lular	Pluricel-lular		
0.36	1+(1)	+	+	+	-	+	-	18.0	-
1.53	0	-	-	+	-	-	-	30.0	0/197
1.57	0	+	+	-	+	-	-	21.6	0/221
0.91	0	+	+	+	-	+	-	15.0	0/209
0.30	(1)	+	-	+	-	-	-	21.5	0/264
0.96	0	+	+	+	-	+	+	19.0	0/258
0.89	0	+	+	+	-	papillae		-	0/198
1.67	1	+	+	+	-	+	-	28.8	0/286
8.67	0	+	-	+	+	-	-	24.0	0/373
2.89	0	+	+	-	-	-	-	22.0	61/132
1.69	0	+	+	+	-	-	-	19.5	0/452
3.12	1	+	-	+	+	+	+	25.5	0/211
0.93	0	+	+	+	-	-	-	15.0	0/294
1.84	2	+	+	+	-	+	-	17.0	-
2.40	0	+	-	-	-	-	-	20.4	0/122
2.81	1/1***	-	-	-	+	-	-	19.5	0/178
4.82	1/1	+	-	-	+	-	-	17.0	0/154
2.61	0	-	-	-	-	-	-	15.0	0/121
6.40	1	+	+	+	-	-	-	30.0	0/81
2.70								21.0	4/229
2.21								4.9	15/95

lisade parenchyma; ** (1) locally one layer; *** one layer on each side).

either showed an open vascular chain (*Tabernaemontana angolensis*, *Podocarpus latifolius*, *P. milanjianus* and *Cussonia spicata*) or one that was closed (*Maesa lanceolata*) without sclerification of any kind but with a bifacial collenchyma, either various incomplete sclerifications such as patches of liberian fibres (*Dodonaea viscosa* and *Garcinia volkensii*) or a massive pole of sclerenchyma (*Apodytes dimidiata*). Within the first group of 11 species, it is possible to differentiate several types by the nature of the support ring surrounding the libero-ligneous cluster, namely :

- ring of sclerenchyma,
- ring of sclerenchyma and fibres,
- ring of sclerous fibres.

Moreover the vascular chain may be either open or closed. The combination of these varying structure types allows the establishment of a differentiation table (Tab. III). It illustrates different stages in the leaves adaptation to overcome a tendency of drought which is observed in the montane forests of Malawi and Zimbabwe during the Southern hemisphere winter. The last stage reached by 5 species comprises a closed vascular chain surrounded by a complete ring of sclerous fibres.

Complete ring of	Vascular chain	
	Open	Closed
Sclerenchyma	*Agauria salicifolia*	*Psychotria zombamontana* *Ochna holstii*
Sclerenchyma and sclerous fibres	*Gnidia glauca*	*Curtisia dentata* *Ficalhoa laurifolia*
Sclerous fibres		*Ekebergia capensis* *Clausena anisata* *Ilex mitis* *Parinari excelsa* *Peddiea africana*

Tab. III : Anatomic characteristics of leaves showing a complete ring of woody support tissue and growing in afro-montane evergreen forests.

DISCUSSION

Of the seven regional mountain systems of the Afromontane archipelago recognized by WHITE (1978) our study deals with two, the Uluguru-Mlanje system and the Chimanimani system.

Our sample contains plants from several phytogeographical elements. WHITE (1978) listed 91 species of Afromontane trees which occur in Southern Africa; eight of them appear in our material, while three others are listed as chorological and ecological transgressors. According to CHAPMAN & WHITE (1970) the evergreen forests of Malawi that occur predominantly above 1370 m, such as the forests of Zomba Mountain, belong from a phytogeographical point of view to the archipelago-like Afro-montane Region. The same authors state that most of the members of this group are so similar to their Guineo-Congolian relatives that it is reasonable to assume that they have evolved relatively recently from Guineo-Congolian ancestors. The genetic element to which they belong is the "Afro-montane element of Guineo-Congolian nephews". Examples are *Garcinia volkensii*, *Ochna holstii* among others. Other endemic species belong to genera or families which are absent from the humid lowland tropics of Africa today, *Ficalhoa* and *Ilex* for instance. Two genuine linking elements are also recognized :

- Forest pioneer connecting species, such as *Clausena anisata* and *Maesa lanceolata*,
- Ecological transgressors, such as *Ekebergia capensis* and *Parinari excelsa*.

Fringing forest species of the Zambezian Region (MALAISSE, 1975) also occur in Malawi in evergreen forests on well-drained sites (*Agauria salicifolia*), as well as palaeoclimatic relics, such as *Podocarpus milanjianus* (MALAISSE, 1967). Moreover some plants of our sample are still present in the montane rain forest of Burundi (LEWALLE, 1972, 114), others in the plateau dry evergreen forests of the Shabo-Zambian domain.

Such a wide recruitment from various floristic elements favourises a larger variety of leaf anatomical structure as well as a wider spectrum of leaf surfaces. Whereas, according to BUCKLEY *et al.* (1980) most tropical upper montane rain forests are in cloud for prolonged periods and in most years are subject to only moderate drought-stress, montane evergreen forests of Malawi and Zimbabwe on the other hand suffer a marked dry season. This is why the relatively small water deficits that are lethal for most xeromorphic rain montane plants (BUCKLEY *et al.*, 1980) and which are easily surmounted by the sclerophylls of Mediterranean climates, form a constraint to which the flora of montane evergreen forests of Malawi and Zimbabwe responds in different ways. Hence the "pachyphylls", - a term introduced by GRUBB (1974) for leaves with most of the lamina > 300 μm thick, the palisade well developped (generally > 1/2 but < 3/4

Formation type	Upper montane rain forest			Montane evergreen forest	Dense dry evergreen forest
Location	Jamaica	Puerto-Rico	New Guinea	Malawi Zimbabwe	Shaba (Zaïre)
Latitude	18° N	18° N	11° N	15-19° S	12° S
Reference	TANNER & KAPOS (1982)	HOWARD (1969)	GRUBB (1974)	Present study	MALAISSE & COLONVAL (1981)
Altitude (m)	1550	1050	3300	1585	1210
Number of species studied	50	24	61	19	23
Mean lamina thickness (µm)	237	380	376	250	260
Thickness (µm) of the outer wall					
- of the upper epidermis	5.4	6.4	7.4	7.3	-
- of the lower epidermis	4.3	3.3	3.5	5.6	-
Non palisade to palisade mesophyll ratio	2.1	2.0	1.9	2.7	-
Incidence (%) of					
- a hypodermis	28	46	56	42	22
- crystals	76	-	-	84	27
- hairiness	-	-	-	32	61
- sclerenchyma along vascular bundles	92	-	-	58	74
Density of stomata (mm^{-2})	299	-	-	221	-
Specific leaf area ($cm^2.g^{-1}$)	81	-	-	-	113

Tab. IV : Leaf characteristics of tropical montane forests.

of the mesophyll thickness), the outer walls of the epidermis markedly thickened, and a hypodermis frequently present - which easily dominate the Upper rain forests of New Guinea, are no more than a tendency in the evergreen forests of Malawi and Zimbabwe showed by 21 % of the flora.

Leaf characteristics for a series of tropical montane forest formation types are given in table IV. It should be remembered that forests from different geographical areas and therefore of different taxonomic constitution are being considered. As TANNER & KAPOS (1982) suggested, differences in leaf characteristics probably reflect taxonomic differences as well as adaptations to the environment. The leaves of the evergreen montane forests of Malawi and Zimbabwe are thinner than those of the upper montane rain forests of Puerto Rico and New Guinea, but the outer walls are thicker. Occurence of sclerenchyma along vascular bundles is lower as well as the relative importance of palisade mesophyll. The sclerous character is therefore fairly little in evidence on the whole. It is clearly less than in certain equatorial vegetations such as, for example, the "Bana" vegetation of Amazonas (SOBRADO & MEDINA, 1980), ressembling more certain trends noted in the flora of the High Plateau of Itatiaia in Brasil (CAMERIK & WERGER, 1981).

Dense dry evergreen forests of Shaba show light variation in regard with montane evergreen forests of Malawi and Zimbabwe. The main differences are in a lower incidence of hypodermis and crystals but a greater hairiness and a greater occurence of sclerenchyma along vascular bundles. Mean lamina thickness is of the same order. These results express faint differences in regard to DUVIGNEAUD *et al.* (1951) hypothesis of the *laurisilvae* of Upper Shaba.

More informations from Zairean lowland rain forests and upper montane rain forests as well as Zambezian woodlands are necessary in order to establish predictable trends in leaf structure in African tropical regions, a conclusion already underlined for wet tropical mountains by TANNER & KAPOS (1982).

ACKNOWLEDGEMENTS

We are grateful to T. MULLER, Curator of the Zimbabwe national Herbarium and B.W. MORRIS, Curator of the Vumba Botanical Garden for providing lists of trees on the Bunga forest and on the Vumba Mountains respectively. Ir. P. BAMPS and Dr. E. ROBBRECHT of the Jardin Botanique national de Belgique each identified one angiosperm material. NGOY LUNDA

made fair copies of the drawings, whilst UMBA K. typed the paper.

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Appendix : Species of the Zambezian montane evergreen forest (+ = presence; . = absence; * = material studied; ** : Mount Malawi, CHAPMAN & WHITE, 1974; *** : Vumba Mountain, Bunga Forest, CHASE, 1982).

	Malawi**	Zimbabwe***
Acanthaceae		
Sclerochiton harveyanus Nees	.	+
Agavaceae		
Dracaena fragans Ker-Gawl.	.	+
Apocynaceae		
Tabernaemontana angolensis Stapf.	*	*
Aquifoliaceae		
Ilex mitis (L.) Radlk.	*	.
Araliaceae		
Cussonia spicata Thunb.	*	.
Cussonia umbellifera Sond.	+	.
Polyscias fulva (Hiern) Harms	+	+
Schefflera umbellifera (Sond.) Baill.	.	+
Celastraceae		
Cassine aethiopica Thunb.	+	.
Cassine papillosa (Hochst.) Kuntze	.	+
Catha edulis (Vahl) Forsk.	+	.
Pterocelastrus echinatus N.E. Br.	+	.
Chrysobalanaceae		
Parinari excelsa Sabine	*	.
Cornaceae		
Afrocrania volkensii (Harms) Hutch.	+	.
Curtisia dentata (N.L. Burm.) C.A. Smith	.	*
Cupressaceae		
Juniperus procera Endl.	+	.
Widdringtonia whytei Rendle	+	.
Ebenaceae		
Diospyros abyssinica (Hiern) F. White	+	+
Diospyros natalensis (Harvey) Brenan subsp. *natalensis*	.	+
Diospyros whyteana (Hiern) F. White	+	+
Ericaceae		
Agauria salicifolia (Lam.) Oliv.	*	.
Erythroxylaceae		
Erythroxylum emarginatum Thonn.	+	+
Euphorbiaceae		
Croton sylvaticus Hochst.	+	+
Macaranga mellifera Prain	+	+
Phyllantus discoideus (Baillon) Muell. Arg.	+	+

	Malawi**	Zimbabwe***
Fabaceae		
Craibia brevicaudata (Vatke) dunn subsp. *baptistarum* (Büttn.) J.B. Gillett	+	+
Flacourtiaceae		
Aphloia theiformis (Vahl) Benn	+	+
Casearia battiscombei R.E. Fr.	+	+
Dasylepis burttdavyi Edlin	+	.
Dovyalis lucida T.R. Sim	.	+
Kiggelaria africana L.	+	+
Rawgonia lucida Harvey & Sond.	*	*
Hamamelidaceae		
Trichocladus ellipticus Walp.	+	.
Hypericaceae		
Garcinia mlanjiensis Dunkley	+	.
Garcinia volkensii Engl.	*	.
Icacinaceae		
Apodytes dimidiata Arn.	*	.
Lauraceae		
Cryptocarya liebertiana Engl.	+	.
Loganiaceae		
Nuxia congesta Fresen	+	+
Nuxia floribunda Benth.	+	.
Meliaceae		
Ekebergia capensis Sparrm.	*	*
Lepidotrichilia volkensii (Gürke) Leroy	+	.
Melianthaceae		
Bersama abyssinica Fresen	+	.
Monimiaceae		
Xymalos monospora (Hark) Warb.	+	+
Myricaceae		
Myrica pilulifera Rendle	+	.
Myrica salicifolia A. Rich.	+	.
Myrsinaceae		
Maesa lanceolata Fask.	*	*
Rapanea melanophloeos (L.) Mez	+	+
Myrtaceae		
Syzygium gerrardii (Harvey ex J.D. Hook) Burrt Davy	.	+
Ochnaceae		
Ochna holstii Engl.	*	*

	Malawi**	Zimbabwe***
Oleaceae		
Jasminum abyssinicum R. Br.	.	+
Linociera battiscombei Hutch.	+	.
Olea africana Mill.	+	.
Olea capensis L.	+	.
Oliniaceae		
Olinia usambarensis Gilg	+	.
Poaceae		
Arundinaria alpina K. Schum.	+	.
Pittosporaceae		
Pittosporum viridiflorum Sims	+	+
Podocarpaceae		
Podocarpus falcatus (Thunb.) Mirb.	+	.
Podocarpus latifolius (Thunb.) Mirb.	.	*
Podocarpus milanjianus Rendle	*	.
Proteaceae		
Faurea forficuliflora Bak.	+	.
Rhizophoraceae		
Cassipourea congoensis DC.	+	+
Cassipourea gummiflua Tul.	.	+
Rosaceae		
Hagenia abyssinica (Bruce) J.F. Gmel.	+	.
Pygeum africanum Hook. f.	+	.
Rubiaceae		
Aulacocalyx diervilloides (K. Schum.) Petit	+	+
Canthium vulgare (K. Schum) Bullock	.	+
Oxyanthus speciosus DC.	+	+
Pavetta umtalensis Bremek.	.	+
Psychotria zombamontana (Kuntze) Petit	.	*
Rothmannia urcelliformis (Schweinf ex. Hiern) Bullock ex Robyns	.	+
Vangueria esculenta S. Moore	.	+
Rutaceae		
Clausens anisata (Willd.) Benth.	*	*
Oricia bachmannii (Engl.) Verdoorn	.	+
Sapindaceae		
Allophylus abyssinicus (Hochst.) Radlk.	+	.
Sapotaceae		
Chrysophyllum gorungosanum Engl.	+	+
Scrophulariaceae		
Halleria liaida L.	+	.

	Malawi**	Zimbabwe***
Sterculiaceae		
Cola greenwayi Brenan	+	+
Dombeya erythroleuca K. Schum.	+	.
Theaceae		
Ficalhoa laurifolia Hiern	*	.
Thymelaeaceae		
Gnidia glauca (Fresen.) Gilg	*	.
Peddiea africana Harv.	*	*
Ulmaceae		
Celtis africana Burm. f.	+	.
Trema orientalis (L.) Bl.	+	.