

582.922:581.4(6)
MEDEDELINGEN LANDBOUWHOGESCHOOL
WAGENINGEN • NEDERLAND • 77-20 (1977)

**SEEDLING MORPHOLOGY OF
SOME AFRICAN SAPOTACEAE
AND ITS TAXONOMICAL
SIGNIFICANCE**

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(Received 26-VII-1977)

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313739

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1. INTRODUCTION

Seedlings are studied for two reasons mainly. First of all there is an urgent need amongst plant ecologists to identify seedlings from a certain region or habitat. To enable this, seedlings have been described and figured, and identification keys have been composed, in temperate regions (LUBBOCK, 1892; KING, 1966; CSAPODY, 1968; MULLER, in prep.) as well as in the tropics (TROUP, 1921; DUKE, 1965; DE LA MENSBRUGE, 1966; BURGER, 1972; DE KONING, in prep.; DE VOGEL, in prep.). Moreover, morphological characters may have ecological significance. TROUP (1921), RIZZINI (1965) and JACKSON (1968) emphasized that seedling morphology should be thoroughly investigated for a better comprehension of germination, establishment and juvenile growth during the natural regeneration of vegetation.

In the second place seedlings are studied because they provide additional information to our knowledge of the life cycle of plants. It is generally accepted today, that taxonomical research should not be based exclusively on morphological characters of the mature specimens, but also on characters of the juvenile stages of the plant. Critical examination of correlations between both groups of characters has resulted repeatedly in a better understanding of taxonomically difficult taxa. DE CANDOLLE (1825) was the first botanist to use seedling characters for the delimitation of tribes and genera in *Leguminosae*. Unfortunately, very few botanists followed his example (e.g. GUILLAUMIN, 1910). In the past two decades however, the interest in using seedling characters for taxonomical purposes has revived (VASSILCZENKO, 1936; DE FERRÉ, 1952; LÉONARD, 1957; CERCEAU-LARRIVAL 1962; JACOBS, 1966; WEBERLING and LEENHOUTS, 1966; BRETELER, 1973; BAUDET, 1974). More details about the history of blastogeny (study of the development of the seedling) are given by JACOBS (1966) and BAUDET (1974).

In *Sapotaceae*, as in *Leguminosae*, the delimitation of subfamilies, tribes and genera is rather complicated. Recent monographs and revisions of African *Sapotaceae* show wide differences in opinion: MEEUSE, 1960, 1963; HEINE, 1963; AUBRÉVILLE, 1964, 1974; BAEHNI, 1965; HEMSLEY, 1968. A common concept seems to be absent and confusion about the proper classification and nomenclature reigns. For this reason an investigation of the seedling morphology of the African *Sapotaceae* seems opportune.

In this paper, 46 species out of 25 genera have been studied. Most species are from West and Central Africa. The seedlings were either directly collected in the field or obtained after sowing in a nursery in Kisangani (Zaire) or in the conservatory at Wageningen (Netherlands). Specimens have been conserved as herbarium or in spirit at the Herbarium Vadense (WAG). Other seedlings have been studied at the Herbarium of the National Institute for Agricultural Sciences at Yangambi, Zaire (YBI), or have been kindly made available by the Herbarium of the National Botanical Gardens of Belgium (BR). My observa-

tions have been supplemented by information from literature, studied mainly in the Wageningen Laboratory for Plant Taxonomy, where I found working facilities during my temporary assignment on the Staff and thereafter.

Collection and subsequent description took place when the seedlings had developed 2–3 green herbaceous leaves. Dimensions and colours refer to dry material, unless stated otherwise. The organs of the seedlings have been described according to S.A.C.D.B.T. (ANON., 1962). As regards the nervation of cotyledons and leaves, the terminology of HICKEY (1973) was used. Fine details were observed by 40 × magnification, while translucent dots, lactiferous ducts and minute nervation patterns have been observed in transmitted light. Joined cytological research has been carried out by ARENDS (1976).

2. SEEDLING CHARACTERS

2.1. GERMINATION

Germination starts with the absorption of water, followed by swelling and growth of the embryo. The increasing volume of the seed content causes the testa to rupture at the micropylar end. Two linear cracks are formed on the ventral side of the seed, one on each side of the scar. The zone between these two cracks, consisting mainly of the scar, is pushed outwards by the growing embryo as a variably-shaped valve (see fig. 4:2). The first organ which emerges from the testa is the radicle; this enters the soil, anchoring the embryo. Next the hypocotyl is produced, at first in the shape of a bent knee, but soon it stretches and becomes erect, pulling the cotyledons out of the surrounding endosperm and testa, or, if adherent, lifting both. During liberation from the testa, the foliaceous cotyledons expand strongly, fleshy cotyledons hardly or not at all. In some species the hypocotyl does not develop. The fleshy cotyledons of such species either simply unfold or they remain enclosed within the testa. The seedling is considered to be in the cotyledon stage when the cotyledons have been expanded (vs. remain in the testa), but the first leaves have not yet developed. The eophyll stage is reached, when the first leaves (eophylls) have developed.

Germination starts between eight and a hundred days after fruit shedding (DE LA MENSBRUGE, 1966). The cotyledon stage may last from several weeks to some years. RIZZINI (1965) observed a 2 year-long cotyledon stage in *Pouteria torta* MART., a species of periodically burned savannas, with the cotyledons persistent within the testa.

2.2. ROOT SYSTEM

All the observed seedlings have a well developed taproot. In *Argania spinosa**, a species from the Northern Sahara, the taproot is very long (up to 45 cm in the eophyll stage) and slender. *Butyrospermum paradoxum* from the Sudan savana has an extremely stout and woody taproot. The colour of the roots is always whitish, turning brown after drying.

2.3. HYPOCOTYL

The rootcrown, i.e. the transition between the taproot and the hypocotyl, is not always clearly recognizable, but normally it is well marked by changes in

* For authors names the reader is referred to tabel 2 which is mainly based on the classification of AUBRÉVILLE, 1964. In some aberrant cases these names are mentioned in the text.

structure and colour of the epidermis or by a change in shape. In seedlings with a long hypocotyl the rootcrown is usually straight, while in species with a short or absent hypocotyl, it is often geniculate (see fig. 7:3, resp. fig. 20:1, 6).

The length of the hypocotyl varies considerably. In *Omphalocarpum* and *Auranella* it may exceed 20 cm, while in *Butyrospermum* and *Synsepalum* it is quite or nearly absent. During germination it is cylindrical and green, but in the cotyledon stage it may become woody, brown and quadrangular, as is the case in a.o. *Omphalocarpum*, *Donella* and *Gambeya*. In these genera only the extreme apex of the hypocotyl remains green and herbaceous, showing two lateral longitudinal slits. This apical portion may be considered as the prolongation of the petioles of the cotyledons, which have become coalescent with the base of the epicotyl. For practical purposes however, I treat it here as the apex of the hypocotyl. In fresh material it is inflated, in dry material it is narrower than the rest of the hypocotyl. During the eophyll stage or later, the entire hypocotyl becomes woody and once more cylindrical. It is always glabrous.

2.4. COTYLEDONS

The main criteria used for the description of the cotyledons are their position in relation to the testa and their texture.

Seedlings with free cotyledons are called phanerocotylar. The position of their cotyledons may be horizontal or slightly erect. In cryptocotylar seedlings the cotyledons remain enclosed in the testa (DUKE, 1965).

According to their texture the cotyledons of the studied taxa can be classified as follows:

A. Cotyledons foliaceous, nervation acro-brochidodromous.

1. Cotyledons papyraceous, dark green, much enlarging during and after liberation from the testa and the endosperm, long persistent, asymmetrical, base abruptly narrowed into a petiole; venation system conspicuous.
2. Cotyledons coriaceous, dark to light green, enlarging during and after liberation from the testa and the endosperm, less persistent, slightly or not asymmetrical, base abruptly narrowed into a petiole; venation system inconspicuous.

B. Cotyledons fleshy, nervation indistinct, hyphodromous.

Cotyledons thick, plano-convex, light to dark green in phanerocotylar seedlings, pale yellowish green to brown in cryptocotylar seedlings, symmetrical or asymmetrical, caducous to rather persistent (in cryptocotylar seedlings).

The asymmetrical shape of the cotyledons is caused by the shape of the seed and it is expressed in the following features (see fig. 4: 3, 4):

- the blade halves on either side of the midrib are unequal;
- the margin of the broadest blade half is either concave or straight, instead of convex between the middle and the apex of the cotyledon;

- the midrib terminates in the margin beside the apex of the cotyledon. The surface is glabrous but on both faces of foliaceous cotyledons minute, colourless papillae can be observed with strong magnification. In some species lactiferous ducts are visible in transmitted light. Stipules are never present.

2.5. ENDOSPERM

According to BOLD (1973, p. 593), presence and quantity of endosperm in germinating seeds depends rather more on the degree to which it has not been absorbed by the embryo during its development, than on the degree in which it has been produced. In the studied taxa of African *Sapotaceae*, the quantity of endosperm varies from abundant (*Omphalocarpum*, *Tridesmostemon*, *Manilkara*) to deficient (*Tieghemella*, *Afrosersalisia*), while endosperm is lacking completely in *Baillonella*, *Synsepalum* and some other genera. Even in seeds from young, green, developing fruits of *Synsepalum dulcificum* no endosperm could be found.

The texture of the white endosperm is soft and fleshy in fresh seeds, it becomes coriaceous in dry seeds. During the liberation of the cotyledons from the testa, the endosperm may remain adherent for some time on their surface near the apex. It soon shrivels and becomes pale brown and membranaceous.

2.6. EPICOTYL

In nearly all species the epicotyl is distinct, straight, slender and either cylindrical or compressed. It may be long (> 4 cm) or short (< 4 cm). This limit at 4 cm was chosen after epicotyl length of seedlings with foliaceous cotyledons was compared with that of seedlings with fleshy ones. Usually an indumentum of variably developed medifixed hairs covers the epicotyl. Lateral buds may be observed in the axils of the cotyledons and also in the axils of cataphylls, brown scale-like rudimentary leaves which are present in some species. From both types of buds new shoots may develop after destruction of the apical bud.

2.7. EOPHYLLS

The first well developed green leaves are called eophylls (DUKE, 1965). They may be opposite or alternate, provided with stipules or not, while their texture is either papyraceous or coriaceous. The petioles are short to rather long, e.g. up to 1.5 cm in *Tieghemella africana*. They are variably shaped and rarely glabrous. Translucent dots have been observed in *Aningeria*, *Malacantha*, *Chrysophyllum giganteum* and *Chrysophyllum muerense*. Lactiferous ducts are visible in transmitted light in many species. The nervation may be eucampto-

dromous or brochidodromous with or without formation of an intramarginal vein. Only in *Malacantha* and *Butyrospermum* the venation is craspedodromous.

As the nervation pattern in foliaceous cotyledons is (acro)brochidodromous, the difference in nervation between the cotyledons and the eophylls is considerable when the eophylls have craspedodromous nervation or brochidodromous nervation with an intramarginal vein.

3. SEEDLING TYPES

In the available seedling classifications the major criteria are the position of the cotyledons in relation to the soil surface after germination and their liberation from the testa. The corresponding terminology, derived from agricultural practices, distinguishes epigeal and hypogeal germination, resulting in seedlings with the cotyledons above and below the soil surface respectively. Among the taxa studied I never found seedlings with the cotyledons below soil surface in the field. The germinating seeds were invariably lying on top of the soil, often still enclosed in the mouldering fruit or in dung of monkeys and elephants. However, when seeds of taxa with a short or undeveloped hypocotyl, are sown at considerable depth, the cotyledons may remain buried irrespective of their liberation from the testa. Examples of the latter are *Pachystela*, *Wildemaniodoxa* and *Baillonella*: their seedlings are epigeal in the field, but may be hypogeal when sown at considerable depth. Because of this, I prefer the criterion and the terminology of DUKE (1965), who distinguishes crypto- and phanerocotylar seedlings (see 2.4), but this criterion should be applied with care as well. Taxa, which have phanerocotylar seedlings with a short or undeveloped hypocotyl in the field may produce seedlings with slightly expanded cotyledons if their seeds are sown in a solid heavy soil, which hampers the unfolding of the cotyledons. LÉONARD (1957) arranged the seedlings of some tribes of *Caesalpinaceae* into four types, which may be reduced to two, following the considerations above. His type B (cryptocotylar, hypogeal) is identical to type D (cryptocotylar, epigeal), but the seeds of B have been sown at considerable depth. His type C (phanerocotylar, epigeal, hypocotyl not developed) is but a variant of A (phanerocotylar, epigeal, hypocotyl developed).

The taxonomical value of the length of the hypocotyl may be very limited in certain groups. It has been demonstrated by LAMPRECHT (1945, 1948, quoted by BAUDET, 1974) that the difference between the well developed hypocotyl of the phanerocotylar seedling of *Phaseolus vulgaris* L. and the undeveloped hypocotyl of the cryptocotylar seedling of *Phaseolus coccineus* L. was based on one allele only. Hybridization of the two species was easy and it produced heterozygotic phanerocotylar F₁ seedlings with short hypocotyls, i.e. intermediate between the parents.

This shows that the difference between the phanerocotylar and the cryptocotylar seedling as well as its taxonomical significance may be less fundamental than is pointed out by LÉONARD, l.c., when he concludes: 'Les plantules de toutes les espèces d'un même "bon" genre présentent le même type de structure, ou, en d'autres termes, au sein de chaque "bon" genre domine un seul type de plantule'. The validity of this rule has been criticized already by JACOBS (1966) on the assumption that characters may have different taxonomical weight in different taxa.

The delimitation of major seedling types should be based preferably on

characters with phylogenetic significance. It appears from this study (4), that in *Sapotaceae* the texture of the cotyledons is such a character. It is closely related to the reduction of endosperm, a reputed phenomenon of evolutionary advancement in Dicotyledons (TAKHTAJAN, 1969; CRONQUIST, 1968). The seedlings of *Sapotaceae* can be classified in this way into two basic types:

A: Seedlings with foliaceous cotyledons, developing from seeds with abundant endosperm.

B: Seedlings with fleshy cotyledons, developing from seeds with scanty or no endosperm.

These two types may be further divided in view of the escape of the cotyledons from the testa and the development of the nervation, both characters being closely related to the function of the cotyledons:

A1. Omphalocarpum type: phanerocotylar; hypocotyl long; cotyledons papyraceous, strongly enlarged, dark green, persistent with a conspicuous nervation, dominant functions absorption and assimilation.

A2. Argania type: phanerocotylar; hypocotyl long to short; cotyledons coriaceous, enlarged, dark to light green, persistent to rather caducous, nervation conspicuous to inconspicuous, dominant functions absorption, storage and assimilation.

B1. Tieghemella type: phanerocotylar; hypocotyl long to short; cotyledons fleshy, not enlarged, caducous, dark green to pale yellowish-green or brown, nervation inconspicuous, dominant functions storage and assimilation.

B2. Butyrospermum type: cryptocotylar; hypocotyl not developed; cotyledons fleshy, persistent, pale yellowish to white, dominant function storage.

Some less important characters are correlated with the seedling type:

a: the quadrangular shape of the hypocotyl in the cotyledon stage is found only in A type seedlings;

b: the epicotyl in the B type, particularly in the B2 type, is considerably longer than the epicotyl in the A type, which has a long hypocotyl. In both types the assimilating parts, i.e. the cotyledons resp. the eophylls are elevated;

c: cataphylls are predominantly found in B2 type seedlings;

d: opposite eophylls are only found in B1 seedlings.

By using characters such as phyllotaxis of the eophylls, presence of cataphylls and the length of the first internode, further subdivision of the four types is possible. This, however, does not seem opportune for this study.

A preliminary survey of the seedlings of dicotyledonous taxa other than *Sapotaceae* shows that different seedling types are met in the primitive *Magnoliales* and the more advanced *Asterales*. In the *Magnoliales* 3 different types should be mentioned here:

- **Pycnanthus type:** cryptocotylar; hypocotyl not developed; from seeds with abundant ruminant endosperm and with a minute embryo; cotyledons papyraceous, dominant function absorption. Occurs in *Pycnanthus angolensis* (WELW.) WARB.
- **Monodora type:** like *Pycnanthus*, but with developed hypocotyl; occurring in *Monodora brevipes* BTH., *Monodora crispata* ENGL. et DIELS, *Annona muricata* L. and in *Annona reticulata* L. The cotyledons may be liberated sometimes, but usually they are torn off, being unable to escape from the ruminant endosperm and the testa, leaving two opposite scars on the seedling stem.
- **Cananga type:** phanerocotylar; hypocotyl developed; cotyledons papyraceous, strongly enlarged, dark green, persistent, nervation conspicuous, dominant function absorption and assimilation. Differs from the *Omphalocarpum* type by the minute embryo in the seed. Occurring in *Cananga odorata* (LMK.) HOOK. F. et THOMS., (BURGER, 1972), and in *Annona squamosa* L., (DUKE, 1965 and GILBERT, 1939).

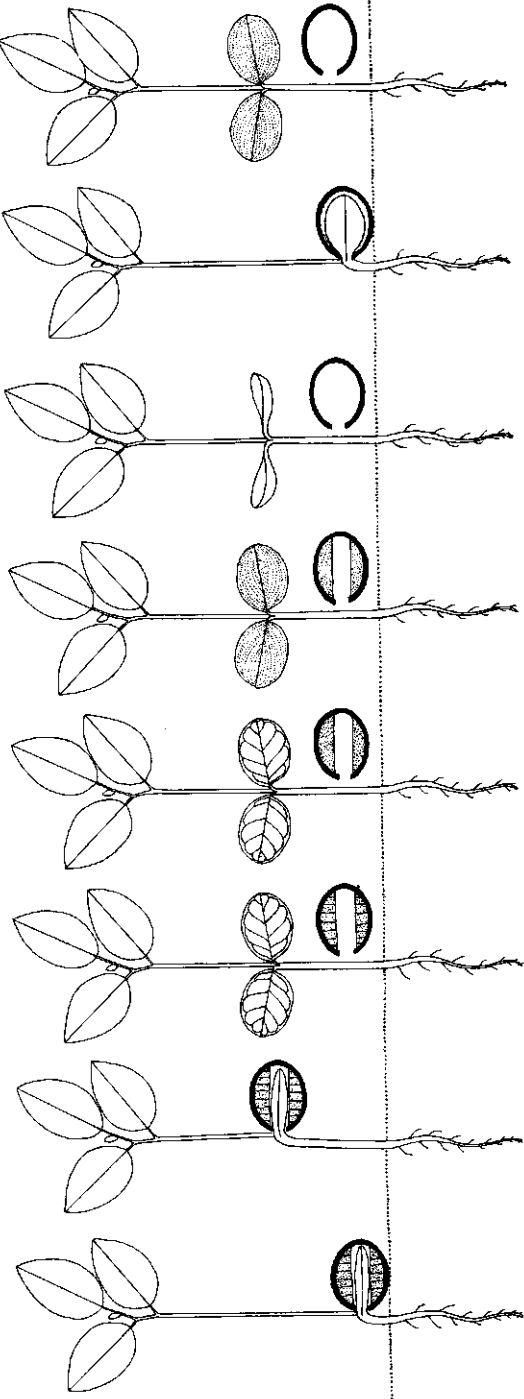
In the *Asterales* the following type has been found:

- **Asterales type:** phanerocotylar; hypocotyl developed; cotyledons foliaceous, enlarged, green, with inconspicuous nervation, dominant functions storage and assimilation.

In table 1 the seedling types mentioned here are summarized; the figures are schematic.

TABLE 1. Seedling types in Sapotaceae, compared with some types occurring in Magnoliales and Asterales.

Characters	Seedling types							
	A ₀	A ₁	A ₂	B ₁	B ₂	C		
	Pycnanthus	Monodora	Cananga	Omphalocarpum	Argania	Tieghemella	Butyrospermum	Asterales
embryo	+	+	+	++	++	++	++	++
hypocotyl	0	l-s	l-s	1	s-1	s-1	0	s-1
cotyledons	encl	encl	fr	fr	fr	fr	encl	fr
position	fo	fo	papyr	papyr	cor	fl	fl	fo
texture	++	++	++	++	+	0	0	+
enlargement								
functions								
absorption	+	+	+	+	+	0	0	0
assimilation	0	0, +	+	+	+	+	0	+
storage	0	0	0	0	+	+	+	+
endosperm	++ (ruminant)	++ (ruminant)	++ (ruminant)	++	++	0, +	0	0



Abbreviations and symbols:

4. CORRELATION BETWEEN SEEDLING TYPE AND SOME IMPORTANT TAXONOMICAL CHARACTERS IN SAPOTACEAE

The authors of the available classifications in *Sapotaceae* (see Introduction) used more or less the same set of characters. However, dissimilar opinions about the taxonomical weight of the characters used led to different applications and resulted in widely different systems. A better knowledge of the variation pattern of the characters in question and understanding of their mutual correlation may help to obtain a consensus of opinion. Therefore a comparison has been made between the variation of the seedling and of other characters used for the classification of *Sapotaceae* (see Table 2).

No correlation seems to exist between seedling type and the following characters:

2. habit;
3. venation pattern of the eophylls;
4. place of the inflorescences;
5. presence of unisexual flowers;
6. number of calyx whorls;
7. coalescence of the sepals;
8. presence of bracts under the calyx;
9. relative length of the corolla tube;
10. presence of dorsal appendages on the petals;
11. number of corolla lobes;
12. number of stamens;
13. number of staminodes.

- ad 3. No difference has been observed between the venation pattern of the eophylls and the venation of leaves from adult specimens. Brochidodromous venation with numerous parallel secondary veins, divergent from the midrib at widely acute or right angles, and uniting in an intramarginal vein, is a striking feature of several species. It may be considered as a more advanced character, while a brochidodromous pattern without an intramarginal vein and few looping secondary veins, divergent at an acute angle should be considered as more primitive (TAKHTAJAN, 1969). The first type with an intramarginal vein has been found in taxa with both seedling types: *Wildemaniodoxa*, B-type; *Englerophytum*, probably also B-type; *Donella*, *Autranella* and *Manilkara*, all A-type.
- ad 4. Cauliflory occurs in taxa with A-type seedlings as well as in taxa with B-type seedlings: *Omphalocarpum*, A-type; *Englerophytum*, (probably) B-type.

TABLE 2. Variation of seedling type and some important taxonomical characters in the studied taxa, classified according to AUBRÉVILLE (1964).

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	seedling type	habit	venation of adult leaf	inflorescence	sexuality	calyx lobes	coalescence of calyx lobes	calyx bracts	corolla shape	appendages of corolla lobes	corolla lobes	stamens	staminodes	level of insertion of stamen	locules	developed seeds	scar position	shape and dimension of scar	endosperm	cotyledons
I. SIDEROXYLOIDEAE H. J. Lam																				
A. Sideroxyloae Dub. emend. H. J. Lam																				
Sideroxylon inerme L.		s		a	2	5	u	0	t	0	5	5	5	g	5	1	b	c	++	fo
Argania spinosa (L.) Skeels	A2	t	b	a	5	5	f			0			5	g	-5	b-v	ell	+++	fo	
Spinulima oxycantha (Baillon) Aubrév.		s		a	5	5				0				g		b	c	+++	fo	
B. Pouteriaceae H. J. Lam emend. Aubrév.																				
Vincentella Pierre		s		a	5	5	f	0	c	0	5	5	5	g		b	c	0	fl	
Aningeria altissima (A. Chev.) Aubrév. et Pellegr.	B1	t	e-b	a	5	5	f			0	5	5	5	s.p.	5	v	ell	0	fl	
Aningeria adolfi-friederici (Engl.) Robyns et Gilbert																				
Aningeria robusta (A. Chev.) Aubrév. et Pellegr.	B1	t	b	a	5	5	f	0	t	0	5	5	5	s.p.	5	v	ell	0	fl	
Tulstea serotii (De Wild.) Aubrév. et Pellegr.	B1	t	a	a	5	5	f	0	t	0	5	5	5	s.p.	5	v	ell	0	fl	
Synsepalum dulcificum (Schum.) Baillon	B2	t	a	a	5	5	f	0	s.t.	0	5	5	5	s.p.	5	v	ell	0	fl	
Synsepalum stipulatum (Radlk.) Engl.	B2	s	b	a	2	5	t	0	t	0	5	5	5	g	5	v	la	0	fl	
Synsepalum subcordatum De Wild.	B2	t	b	r	2	5	t	0	t	0	5	5	5	g	5	v	la	0	fl	
Afrosersalisia affzelii (Engl.) Aubrév.	B1	t	b	r	2	5	t	0	t	0	5	5	5	g	5	v	la	0	fl	
Afrosersalisia cerasifera (Welw.) Aubrév.	B1	t	e-b	r-a	2	5	u	0	s.t.	0	5	5	5	g	5	v	la	+	fl	
Pachystela bequaertii De Wild.	B1	t	e-b	r	2	5	su	0	s.t.	0	5	5	5	g	5	v	la	0	fl	
Pachystela brevipes (Bak.) Engl.	B1	t	e-b	r	2	5	su	0	s.t.	0	5	5	5	g	5	v	la	0	fl	
Pseudobovinnella oblanceolata (S. Moore) Aubrév. et Pellegr.		s	b	a	2	5	u	0	s.t.	0	5	5	5	g	5	v	la	0	fl	
C. Planchonelleae Aubrév.																				
Brevicia leptosperma (Baehni) Heine	A1	t	b	a	2	5	f	0	t	0	5	5	5	s.p.	8	v	li	++	fo	
Aubregmia taiensis (Aubrév. et Pellegr.) Heine	A1	t		a	1	5	f	0	t	0	5	5	5	b	8	v	li	++	fo	
D. Malacanthaceae Aubrév.																				
Wildemaniodoxa laurentii (De Wild.) Aubrév. et Pellegr.	B1	t	b+i	r	2	5	f	0	t	0	10	10	10	g	10	1	v	ell	0	fl
Malacantha alnifolia (Bak.) Pierre	B1	t	c	a	2	5	f	+	t	0	5	5	0	s.p.	5	1	v	ell	0	fl
Delpyodora macrophylla Pierre	s			a	2	5	f	+	+	0	5	5	0	b	5	5	v	li	0	fl
Englerophytum Krause	t			c	2	5	f	0	t	0	5	5	0	g	5	1	v	ell	0	fl
E. Chrysophyllae Aubrév.																				
Chrysophyllum azaguiense Miège	B1	t	e-b	a	2	5	f	0	t	0	5	5	0	b	5	4-5	v	li	0	fl
Chrysophyllum giganteum A. Chev.	B1	t	c	r-a	2	5	f	0	s.t.	0	5	5	0	b	5	5	v	ell	+	fl
Chrysophyllum mucronense Engl.	B1	t	e	r-a	5	5	f	0	s.t.	0	5	5	0	s.p.	5	4-5	v	ell	+	fl
Zeyherella longepedunculata (De Wild.) Aubrév. et Pellegr.	t	b+i	r-c	a	2	5	f	0	s.t.	0	5	5	0	g	5	1	v	li	0	fl
Donella ogowensis (A. Chev.) Aubrév. et Pellegr.	A2	t	b+i	a	2	5	su	0	u	0	5	5	0	b	5	-5	v	li	++	fo

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- ad 5. Unisexual flowers are uncommon in African *Sapotaceae*.
- ad 6. All the three subfamilies, distinguished by means of the number of calyx whorls, include A- as well as B-type seedlings.
- ad 10. Dorsal appendages are rare in *Sideroxyloideae* (*Kantou*, B-type) and absent in *Omphalocarpoideae* (predominantly A-type) but common in *Mimusopoideae* (A- and B-type).
- ad 13. Staminodes occur in taxa of each seedling type. In some taxa staminodes are strongly reduced or lack completely: *Pachystela*, *Zeyherella*, *Wildemaniodoxa*, all with B-type seedlings. This might indicate a correlation with the advanced seedling type in *Sideroxyloideae* only, but *Gambeya subnuda* contradicts this view (reduced staminodes and A-type seedling). Moreover several taxa with B-type seedlings have well developed staminodes (*Synsepalum*, *Kantou*, *Gluema*, *Butyrospermum*). Hence AUBRÉVILLE's opinion that reduction of staminodes is an advanced character in *Sapotaceae* is not supported by this evidence.

On the other hand more or less well marked correlations seem to exist between seedling type and the following characters:

- 14. level of insertion of the stamen on the corolla tube;
- 15. number of locules in the ovary;
- 16. number of developed seeds in the ripe fruit;
- 17. scar position on the seed;
- 18. shape and dimension of the scar;
- 19. endosperm development in ripe seeds;
- 20. cotyledon development in ripe seeds.

- ad 14. In the *Sideroxyloideae* other than *Sideroxyleae*, stamens are inserted predominantly between the gorge and the base of the corolla tube in taxa with A-type seedlings. In taxa with B-type seedlings the insertion is located at the gorge, except in *Aningeria*, *Malacantha*, *Chrysophyllum giganteum*, *Chrysophyllum azaguieanum* and *Chrysophyllum muerense* where the insertion is situated below the throat.
- ad 15. In *Sideroxyloideae* and *Omphalocarpoideae* a correlation exists between seedling type and the number of locules in the ovary. Numerous (more than 5) locules, to be considered as a primitive character, is concomitant with the A-type. *Wildemaniodoxa* with 10 locules and a B-type seedling forms an exception. Taxa with 5 locules have either A-type or B-type seedlings, in *Mimusopoideae* with 6–8 locules both A- and B-type seedlings occur as well.
- ad 16. Taxa with (3–)5 or more well developed seeds in the fruit nearly always have A-type seedlings. Only *Delpydora*, *Chrysophyllum giganteum*, *Chrysophyllum azaguieanum* and *Chrysophyllum muerense* combine the presence of 3–5 developed seeds with B-type seedlings. Monospermy always is concomitant with B-type seedlings, except in *Sideroxyleae* and in *Mimusopoideae* (A-type in *Mimusops*, *Manilkara* and *Autranella*).

ad 17. The scar is the remarkable ventral or basal area on the testa, with which the seed has been coalescent with the placenta. This area has a dull, rough, greyish-brown surface which is contrasting with the glossy smooth brown appearance of the lateral and dorsal part of the testa. Dimension, shape and position of the scar depend on the manner of coalescence of the ovule or seed with the placenta. Not only the hilum and the immediate region around it but also the raphe and the area above the raphe may become adherent to the placenta, thus participating in the scar formation. The omphalodium, often erroneously called hilum, is the place on the scar where the vascular strand of the funicle passes through the testa towards the chalaza. Below the omphalodium the vascular strand remains visible on the scar surface, indicating the transformed raphe. The end of the vascular strand forms the real hilum (the place where the funicle was attached in the ovule stage). According to CHESNAIS (1943) the place of the omphalodium and the scar are not always in the same way related to placentation and hilum position. Basal placentation may lead to a basal scar (a.o. *Mimusops*), but also to a basi-ventral scar as in *Austranella congolensis* or even to a ventral scar, as is the case in *Tieghemella*. Axillary placentation however leads always to a ventral scar, which may be either wide or narrow. Consequently placentation can not be deduced 'a priori' from scar position or vice versa.

Shape and dimension of the scar are correlated with the shape of the seed and the number of seeds in the fruit. Flat seeds from fruits with numerous developed seeds tend to have linear scars, while seeds from monospermous fruits usually have elliptic or large scars.

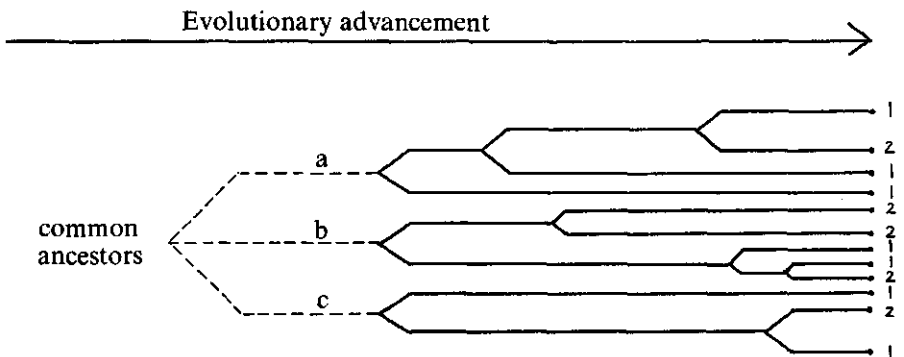
Table 2 shows that basal and basi-ventral scar position is correlated with the A-type seedling. Ventral scar position is found in taxa with A- and B-type seedlings. In *Mimusopoideae* extension of the scar from basi-ventral towards ventral leads from A-type towards B-type seedlings. In taxa with ventral scar position (*Sideroxyloideae* except *Sideroxyleae*, *Omphalocarpoideae*) linear scars are correlated with the A-type seedling. Exceptions to this rule are *Delpydera macrophylla* and *Chrysophyllum azaguieanum*, which have B-type seedlings. Taxa with wide ventral scars (elliptic to large) covering nearly the entire surface of the testa, have B-type seedlings. These taxa normally have monospermous fruits and more or less elliptic seeds.

ad 19, Taxa with abundant endosperm have A-type seedlings, B-type seedlings
20. develop from seeds with deficient endosperm or none at all. In the first group the cotyledons are foliaceous in the seed, in the second group they are fleshy.

5. SOME REMARKS ON THE CLASSIFICATION OF THE SAPOTACEAE

A natural classification system reflects the phylogenetic relationships of the taxa concerned. In such a system, taxa of higher order such as orders, families and subfamilies may be considered as evolutionary lines, which develop independently.

A certain character may show the same evolutionary trend, e.g. 1 → 2, in different taxa of higher order. If such a character is used for the delimitation of subfamilies, stages of the same evolutionary advancement but originating from different evolutionary lines are taken together, composing new, artificial units as may be shown in the following scheme:



a, b and c represent independent evolutionary lines (orders, families or subfamilies).

1 and 2 represent stages of evolutionary advancement of a certain character.

In *Sapotaceae* the loss of endosperm seems to be such a character with the same evolutionary trend in different independent lines. For this reason it should not be used for the delimitation of subfamilies, nor characters closely correlated with it.

5.1. THE CLASSIFICATION OF BAEHNI

By using scar width as criterion for the delimitation of subfamilies in *Sapotaceae*, BAEHNI (1965) proposed *Croixioideae* and *Madhucoideae*. However, scar width is closely correlated with the quantity of endosperm present (and by consequence with the seedling type). The chosen delimitation of scar width = $\frac{1}{2}$ circumference of the seed between the two subfamilies is quite arbitrary and does not coincide with the division between seeds with abundant endosperm

and seeds with deficient or no endosperm. As a result *Croixioideae* include only taxa with scanty or no endosperm and B-type seedlings, while in *Madhucoideae* also taxa with abundant endosperm and A-type seedlings occur. Thus closely related species end up in different subfamilies: *Aningeria altissima* (A. CHEV.) AUBRÉV. et PELLEGR. in *Croixioideae*, *Aningeria adolfi-friederici* (ENGL.) ROBYNS et GILBERT in *Madhucoideae*.

Another criticism has to be placed where BAEHNI (l.c.) distinguishes groups of genera based on the presence of staminodes in three possible combinations:

- developed staminodes, always present;
- staminodes absent;
- staminodes variably present in rudimentary form and absent in the same species.

The third possibility requires the examination of numerous specimens while the attribution of a single specimen remains doubtful. Applying the variability of a character in this way as a character in it self, the genus *Pachystela* PIERRE is divided and referred to two separate groups of genera: *Pachystela* and *Amorphospermum*. *Pachystela brevipes* in which staminodes are variably present thus belongs in the first group, while *Pachystela insolo* ENGL., a close relative of *Pachystela bequaertii*, in which staminodes are always absent, is referred to the second.

BAEHNI (l.c.) proposes some genera which are heterogeneous as far as the seedling type is concerned. In *Pouteria* for example, he combines series of genera and species: *Breviea* and *Endotricha* (both with seedling type A) together with *Tulestea* and *Aningeria adolfi-friederici* (both having B-seedlings). In the genus *Chrysophyllum* L., defined as having no staminodes, *Delpydora* (B-type), *Donella* (A-type) and some species of *Gambeya* (A-type) are included. The species of *Gambeya* with rudimental staminodes (a.o. *Gambeya subnuda*) are therefore transferred to the genus *Planchonella*.

5.2. THE CLASSIFICATION OF AUBRÉVILLE

The four subfamilies of AUBRÉVILLE's classification (1964) – which is an elaboration of the system of LAM (1939) – are based on the number of calyx whorls and the number of stamens. Both characters are not correlated with the seedling type (see 4, ad 6 and ad 12). The three subfamilies occurring on the African continent are by consequence variable as far as the seedling type is concerned. For the distinction of tribes AUBRÉVILLE (l.c.) used in *Omphalocarpoideae* and *Sideroxyloideae* the presence of staminodes, the presence of dorsal appendages on the corolla lobes, the dehiscence of fruits, the position of the scar and the development of endosperm. In the *Mimusopoideae* he applied the number of sepals for the tribes and scar position for the sub-tribes. As the endosperm development and scar position (see 4, ad 17) are correlated with the seedling type, it logically follows that in each sub-tribe of the *Mimusopoideae* only one single seedling type is found.

The tribes *Omphalocarpeae* and *Chrysophylleae* need further attention. In *Omphalocarpeae* the genus *Tsebona* R. CAPURON from Madagascar has seeds without endosperm (AUBRÉVILLE, 1974), hence it will have B-type seedlings. The other investigated taxa from the *Omphalocarpeae* have A-type seedlings. In the *Chrysophylleae*, defined by AUBRÉVILLE as having copious endosperm the problem seems more complex. The type genus *Chrysophyllum* L. has as type species *Chrysophyllum cainito* L., a tree from South America with deficient endosperm and fleshy cotyledons (VINK, 1958). It will provide the B-type seedling, as is the case with more American *Chrysophyllum* species. The African species formerly placed in this genus are referred to the genera *Gambeya*, *Donella* and *Zeyherella*. They have copious endosperm, except *Zeyherella longepedicellata*, *Chrysophyllum azagueianum*, *Chrysophyllum giganteum* and *Chrysophyllum muerense*, which have at the utmost deficient endosperm and B-type seedlings.

Chrysophylleae as based on the presence of copious endosperm by AUBRÉVILLE (1964) are in contradiction with the type species. The taxa in this tribe with none or deficient endosperm consequently should be separated from those with copious endosperm. The obvious taxonomical consequences are purposely avoided by me.

The distinction between the genera *Donella* and *Gambeya* based on the nervation of leaves from the adult plant is confirmed by differences in texture and nervation of cotyledons and eophylls.

SUMMARY

The seedling morphology of 46 African species of *Sapotaceae* representing 25 genera, is studied in this paper. Two major seedling types are distinguished, a primitive type with strongly enlarged, foliaceous cotyledons and an advanced type with not enlarged, fleshy cotyledons. Other seedling classifications and their taxonomical value are discussed. The two seedling types are compared with seedling structure in reputedly primitive and advanced taxa such as *Magnoliales* resp. *Asterales*. The texture of the cotyledons seems to be correlated with the level of insertion of the stamen in the corolla tube, with the number of locules in the ovary, with the number of developed seeds in the fruit, with the position, shape and dimension of the scar on the testa and with the quantity of endosperm in the seed. The progressive loss of endosperm and the evolution of fleshy cotyledons from foliaceous ones seems to have taken place in several, quite separate evolutionary lines. When these characters or closely correlated ones are used for the delimitation of sub-families in *Sapotaceae*, unnatural heterogeneous units are created composed by taxa which only share the same stage of evolution concerning cotyledon texture. On a lower level the seedling type can be used for the delimitation of tribes, genera and species.

RÉSUMÉ

La blastogénie de 46 espèces (25 genres) de *Sapotaceae* africaines a été étudiée. Deux types principaux de plantules sont distingués sur la base de la texture cotylédonaire: un type primitif à cotylédons foliaires et un type avancé à cotylédons charnus. D'autres systèmes de classification de plantules et leurs significations taxonomiques ont été examinés. Les deux types principaux de plantules des *Sapotaceae* ont été comparés avec des plantules trouvées dans les *Magnoliales* et avec des plantules trouvées dans les *Asterales*. Il a paru que la texture des cotylédons est corrélée avec la hauteur d'insertion des étamines dans le tube corollaire, avec le nombre de loges ovariennes, avec le nombre de graines développées, avec la position, la forme et la dimension de la cicatrice sur la graine et avec la quantité d'albumen dans la graine. La perte progressive d'albumen et l'évolution de cotylédons charnus sont rencontrées dans des différents embranchements des *Sapotaceae*. Par l'utilisation de ces caractères (ou d'autres qui en sont corrélés) pour la délimitation de sous-familles dans les *Sapotaceae*, on crée des unités artificielles et hétérogènes, composées de taxa qui n'ont en commun que leur stade d'évolution en rapport avec la quantité d'albumen dans la graine. Au niveau plus basse, on peut utiliser ces caractères pour délimiter des genres et des tribus.

ACKNOWLEDGEMENTS

As this investigation was initiated during the period I was working in the Faculty of Agronomy of the National University of Zaire (1970–1974), my thanks are due to the Board of the University and to the Dean of the Faculty of Agronomy for their permission to work on this subject. Cits. YOSWA BOHELE and MASSUDI MANDA KENDA were valuable assistants in the field, Cit. SALUMU MAJANGA BIN ATIBU was very helpful in the Herbarium of the Faculty of Agronomy.

For hospitality and loans, my thanks are due to the Director of the Herbarium of the National Institute for Agricultural Study and Research (I.N.E.R.A.) at Yangambi, Zaire, and to the Director of the National Botanical Gardens of Belgium at Brussels, Dr. J. J. DEMARET. Dr. ir. J. J. F. E. DE WILDE kindly sent me living seeds from Cameroon.

At the Laboratory of Plant Taxonomy and Plant Geography of the Agricultural University of Wageningen, I wish to express my acknowledgements to Prof. dr. H. C. D. DE WIT, Ir. J. C. ARENDS, M.Sc., Ir. J. J. BOS, Dr. ir. F. J. BRETELER and Dr. A. J. M. LEEUWENBERG for their interest in my work and their critical remarks. Mrs. F. N. BATA-GILLOT made the drawings, which are a very essential part of this paper. Miss D. M. WASSINK (typescript), Mr. G. BOELEMA (polishing and correcting manuscript and proofs), Mr. J. DE BRUIJN (Herbarium), Mr. C. T. DE GROOT (Library), Mr. W. H. GROTENBREG and the late Miss M. TEULINGS (handling seedlings in the greenhouse) contributed in a very friendly and valuable way to this paper.

APPENDIX

DESCRIPTIONS AND DRAWINGS OF 46 SPECIES OF
AFRICAN SAPOTACEAE

1. *Afrosersalisia afzelii* (ENGL.) AUBRÉV.

Fig. 1: 1-8

Hypocotyl straight, quadrangular, 2-5 cm long, 1-1.5 mm in diam., smooth, glabrous, brown, rootcrown straight, rarely geniculate.

Cotyledons free, fleshy, rather caducous, horizontally expanded to obliquely erect, symmetrical, plano-convex, elliptic to narrowly elliptic, with the margins slightly curved inwards, sessile, 1-2 cm × 0.3-0.4 cm × 0.2-0.4 cm, glabrous with membranous endosperm persisting on the surface. *Nervation* hyphodromous.

Epicotyl straight, strongly compressed, in older seedlings more cylindrical, (3)4.5-10.5 cm long, 0.5-1 mm in diam., pubescent, puberulous or glabrescent with sessile medifixed appressed silvery grey hairs; sub-axillary buds inserted at ca. 1 mm above the axil of the cotyledons, pubescent, brown; cataphylls absent.

Eophylls mostly opposite, papery, exstipulate; petiole slightly canaliculate, 1-4 mm long, pubescent with silvery grey-ferruginous hairs; blade elliptic to narrowly elliptic, 3.8-12 cm × (0.4) 1.3-3.8 cm, base cuneate to decurrent, apex rounded, obtuse or slightly acuminate (acumen rounded, ca. 4-7 mm long), faintly puberulous to glabrescent with appressed, medifixed, sessile, silvery grey, often unequal-branched hairs on the midrib. *Nervation* eucamptodromous; midrib of moderate size, straight, prominent on both sides; 6-16 pairs of secondary veins, angle of divergence moderately to widely acute, of moderate size to fine, uniformly curved, joining superadjacent secondary veins through tertiary veins; intersecondary veins present, confluent with tertiary veins; tertiary veins with angle of origin moderately acute exmedially, admedially wide to right, percurrent, slightly impressed below, predominantly alternate, rather far apart; quaternary veins resolute in imperfect reticulum; areoles polygonal to oblong, often arranged parallel to the secondary veins; veinlets simple to ramified.

Specimens examined:

IVORY COAST: *Cremers 580* (BR), 3 seedlings; *Cremers 440* (BR), 1 seedling; *De Koning 2522, 2945, 3190, 3363, 3617* (WAG), ca. 30 seedlings, voucher: *De Koning 2249* (WAG).

2. *Afrosersalisia cerasifera* (WELW.) AUBRÉV.

Fig. 1: 9-11

Hypocotyl cylindrical to slightly angular, 0.1-1.2 cm long, 2-3 mm in diam., brown, glabrous; rootcrown straight - slightly geniculate.

Cotyledons free, fleshy, unfolding and borne obliquely erect or remaining together and only slightly diverging to free the epicotyl, sessile, narrowly elliptic to elliptic-ovate, plano-convex, glabrous, smooth, 1.0-1.8 cm × 0.4-0.8 cm × 0.1-0.3 cm, base and apex rounded to truncate, orange brown (in fresh material) to brown. *Nervation* hyphodromous.

Epicotyl straight, cylindrical, angular above the cotyledons and compressed in the upper part, 6-14 cm long, 0.5-1.5 mm in diam., brown, sparsely

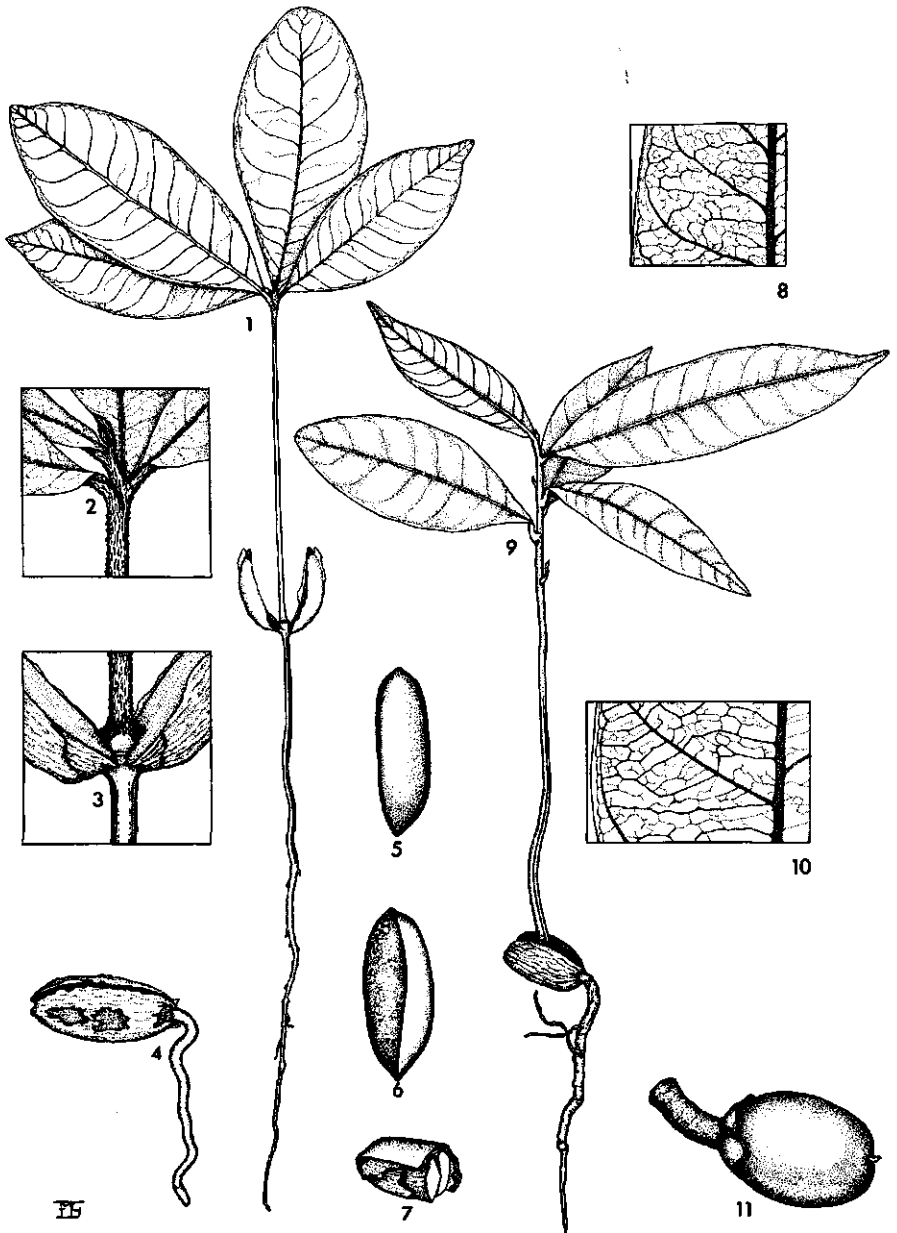


FIG. 1: 1-8. *Afrosersalisia afzelii* (ENGL.) AUBRÉV. - 1. habit, $\frac{2}{3}\times$; 2. base of the eophylls, $\frac{2}{3}\times$; 3. base of the cotyledons, $\frac{2}{3}\times$; 4. germinating seed, testa removed, cotyledons covered by membranous endosperm, $1\times$; 5. seed, ventral, $1\times$; 6. seed, lateral, $1\times$; 7. seed in transversal section, testa partly removed, $1\times$; 8. nervation of eophyll, $2\times$.

9-11. *Afrosersalisia cerasifera* (WELW.) AUBRÉV. - 9. habit, $\frac{2}{3}\times$; 10. nervation of eophyll, $2\times$; 11. fruit, $\frac{2}{3}\times$.

After: De Koning 2945 (1-3, 8), 2522 (4), 2249 (5-7); Bokdam 3969 (9-11).

pubescent; cataphylls often present, inserted on the upper part, densely covered with ferruginous, medifixed hairs.

Eophylls alternate, rarely subopposite, papery, exstipulate, petiole slightly canaliculate, 1–3 mm long, pubescent; blade elliptic to narrowly elliptic, (2.5)4.5–11.5 cm long, (0.8)1–3.2 cm wide, base cuneate, apex acute to rounded or faintly acuminate with an obtuse acumen (up to 8 mm long); midrib puberulous to glabrescent beneath. *Nervation* eucampto-brochidodromous; primary vein of moderate size to weakly developed, straight, prominent on both sides; 6–12(18) pairs of fine secondary veins, angle of divergence wide, uniformly curved, joining superadjacent secondary veins through tertiary veins in the lower part of the leaf, and through loops of secondary veins in the upper part of the leaf; intersecondary veins confluent with tertiary veins; tertiary veins only visible above (without transmitted light), angle or origin exmedially narrowly to moderately acute, admedially obtuse to right; reticulation incomplete, predominantly alternate and close, oblique to the midrib.

Specimens examined:

ZAIRE: *Bokdam 3969* (WAG), 14 seedlings, voucher: *Bokdam 3968* (WAG); *HPLY 7129*, 7094 (YBI), voucher: *B 1016* (BR, YBI); *HPLY 4128* (YBI), voucher: *O 1650* (BR, YBI).

3. *Aningeria adolphi-friederici* (ENGL.) ROBYNS et GILBERT Fig. 2: 1–5

Hypocotyl straight, angular to cylindrical, 0.7–1.4 cm long, 2–3 mm in diam., glabrous, brown; rootcrown straight to slightly geniculate.

Cotyledons free, fleshy, opposite, obliquely erect to horizontally expanded, slightly curved inwards, sessile, elliptic to narrowly elliptic, 1.4–2.5 cm × 0.5–0.9 cm × 0.3–0.7 cm; bases connected by a rim around the node, or, after disruption, with 2 auricles, 2–3 mm long; apex rounded; surface glabrous, wrinkled when dry.

Epicotyl straight, angular at the base, cylindrical in the middle part, and compressed below the eophylls, 9–22 cm long, 1–2 mm in diam., pubescent; cataphylls absent.

Eophylls opposite, papery, exstipulate; petiole slightly grooved, 7–12 mm long, pubescent with medifixed appressed hairs; lamina elliptic to narrowly elliptic, 4.5–9.7 cm × 1.8–4 cm, base cuneate, apex acute to slightly acuminate, midrib pubescent above, with Y-shaped, shortly stalked hairs with about equal, spreading filiform undulate branches on the primary, secondary and tertiary veins below. *Nervation* eucampto-brochidodromous, primary vein straight, prominent below; 10–18 pairs of secondary veins, angle of divergence widely acute, uniformly curved, joining superadjacent secondary veins in the upper part at a right angle; intersecondary veins rare; tertiary veins exmedially and admedially originating at a right angle, alternate, percurrent, straight or sinuous and oblique to the midrib, close together; quaternary veins hairlike, translucent, reticulating; areoles well developed, triangular to polygonal, of medium to small size, at random arranged.

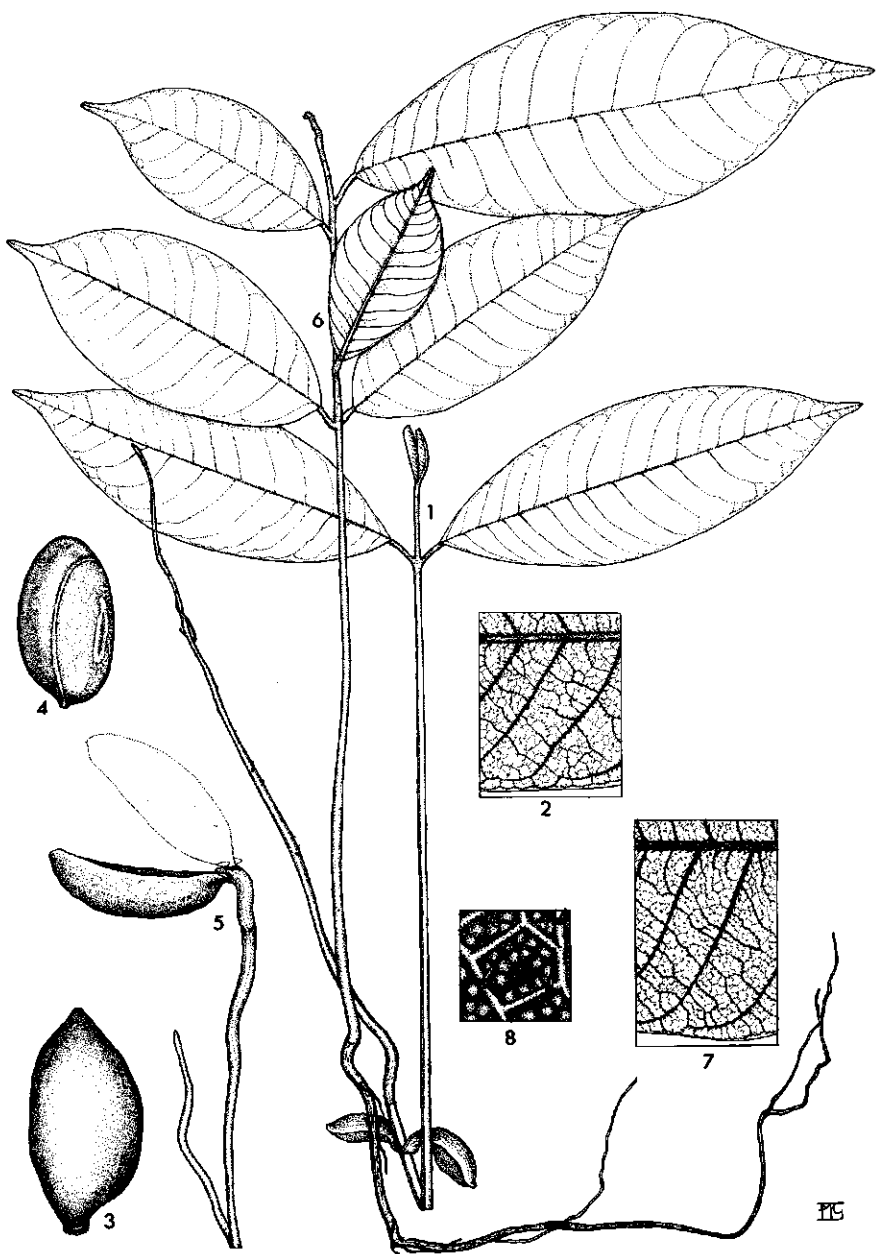


FIG. 2: 1-5. *Aningeria adolfi-friederici* (ENGL.) ROBYNS ET GILBERT - 1. habit, $\frac{2}{3} \times$; 2. underside eophyll, $2 \times$; 3. fruit, $1 \times$; 4. seed, $1 \times$; 5. germinating seed, testa removed, $\frac{2}{3} \times$.

6-8. *Aningeria altissima* (A. CHEV.) AUBRÉV. ET PELLEGR. - 6. habit, $\frac{2}{3} \times$; 7. underside eophyll, $2 \times$; 8. detail nervation with translucent dots, $40 \times$.

After: Bokdam 4228B (1, 2); Gilbert 631 (3-5); Bokdam 4376 (6-8).

Specimens examined:

ZAIRE: *Bokdam 4228B* (WAG), 5 seedlings, voucher: *Bokdam 4228A* (WAG); *Gilbert 631* (BR), 1 seedling, voucher: *Gilbert 631* (BR).

4. *Aningeria altissima* (A. CHEV.) AUBRÉV. et PELLEGR.

Fig. 2: 6-8

Hypocotyl cylindrical, straight, glabrous, 0.5-2.5(3) cm long; rootcrown straight to geniculate.

Cotyledons free, fleshy, caducous, sessile, up to 1.5 cm long (in seed).

Epicotyl straight, cylindrical, (4)5-15 cm long, pubescent with medifixed, grey or yellowish-brown, sessile, very unequal-branched hairs; cataphylls sometimes present, densely pubescent.

Eophylls opposite to subopposite, rarely alternate, papery, exstipulate; petiole slightly flattened above, 4-7 mm long, densely pubescent with grey-brown hairs; lamina narrowly elliptic to elliptic, 5.5-7.5 cm × 2.2-3.2 cm, base obtuse, apex acute to acuminate, acumen up to 7 mm long, acute; mesophyll with minute, inconspicuous, translucent dots; midrib glabrescent above, all veins pubescent beneath with unequal-branched Y-shaped hairs, branches erect. (Some of these hairs appear to be simple if one of the two branches remains rudimentary.) *Nervation* eucampto-brochidodromous; primary vein of moderate size, straight, impressed above, prominent beneath; secondary veins prominent beneath, angle of divergence widely acute, joining superadjacent secondary veins through brochidodromous loops in the upper part of the blade, and through tertiary veins in the lower part; tertiary veins originating exmedially at right to wide angles, admedially at right to obtuse angles, percurrent, oblique to nearly parallel to the midrib; quaternary veins hairlike, translucent, reticulating; areoles at random arranged, well developed quadrangular to polygonal, small, without veinlets.

Specimens examined:

IVORY COAST: *Cremers 618* (BR), 1 seedling.

ZAIRE: *Bokdam 4376* (WAG), 2 seedlings, voucher: *Bokdam 4375* (WAG); *Dubois 526bis* (BR), 4 seedlings, voucher: *Dubois 526* (BR).

5. *Aningeria robusta* (A. CHEV.) AUBRÉV. et PELLEGR.

Hypocotyl 0.5-1 cm long.

Cotyledons fleshy, 1.3 cm long, 0.6 cm wide, horizontally expanded to slightly erect.

Epicotyl 7-9 cm long, pubescent with ferruginous hairs.

Eophylls opposite, often unequal in size, elliptic, 4-5.5 cm × 2.8-3.2 cm; midrib densely pubescent on both faces, secondary and tertiary veins only so on the lower face. *Nervation* with 10-14 pairs of secondary veins; tertiary veins parallel, reticulating.

References:

DE LA MENSBRUGE, 1966.

6. *Argania spinosa* (L.) SKEELS

Fig. 3

Rootsystem with taproot more than 45 cm long; secondary roots mainly in lower part of the taproot.

Hypocotyl straight, cylindrical, ca. 4 cm long and 3 mm in diam., glabrous, smooth, rootcrown geniculate.

Cotyledons free, thickly coriaceous, persistent; petiole ca. 5 mm long, flattened, glabrous; lamina elliptic to narrowly elliptic, ca. 3.5 cm × 1.5 cm, base obtuse to shortly attenuate, apex obtuse, glabrous, minutely papillate above, smooth beneath. *Nervation* hypho-brochidodromous, visible in transmitted light; primary vein stout at base, straight, not prominent; 1(-2) pair(s) of secondary veins arching from the base joining the superadjacent 1-2 secondary veins at a widely acute angle; intersecondary veins absent; tertiary veins developed mainly exmedially of the basal secondary veins, uniformly looped, joining superadjacent tertiary veins; quaternary veins reticulate, areoles well developed, of medium size, polygonal to oblong, parallel to the nearest vein of higher order; veinlets absent.

Epicotyl straight, cylindrical, ca. 2.4 cm long, sparsely pubescent, hairs medifixed, sessile, ± equal-branched; cataphylls absent.

Eophylls alternate, papery, exstipulate, axillary spines 5-6 mm long; petiole semi-terete, 1-4 mm long, pubescent; blade narrowly elliptic, 2.0-2.3 cm × 0.4-0.6 cm, base decurrent, apex obtuse, glabrous above, glabrescent beneath. *Nervation* brochidodromous; primary vein straight, prominent beneath; 5-9 pairs of secondary veins, angle of divergence narrowly acute in the lower half, moderately to widely acute in the upper half of the eophylls; tertiary veins originating at variable angles, reticulating; areoles imperfectly developed, ± angular.

Specimens examined:

ALGERIA: *De Wit* s.n. (cult. WAG), 1 seedling, voucher: seeds no. 615/65 (2/7/65).

7. *Aubreginia taiensis* (AUBRÉV. et PELLEGR.) HEINE

Hypocotyl stout, 17-20 cm long.

Cotyledons free, foliaceous; petiole flattened; lamina elliptic, ca. 11 cm × 6.5 cm, apex acuminate, base attenuate in petiole.

Epicotyl ca. 7 cm long, tomentose.

Eophylls alternate, coriaceous, blade elliptic to ovate, 10 cm × 6 cm, decurrent at base, glabrous; petiole 1-1.5 cm long, appressed pubescent.

References:

DE LA MENSBRUGE, 1966.

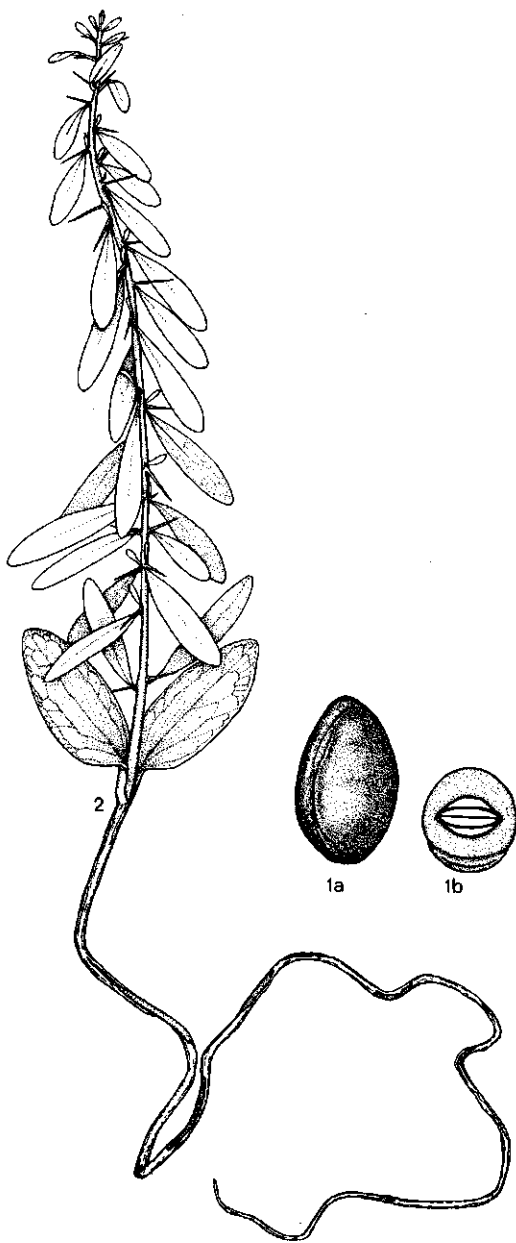


FIG. 3. *Argania spinosa* (L.) SKEELS - 1. two coalescent seeds; 1a. lateral, 1 \times ; 1b. transverse section, showing 1 fertile seed (with 2 cotyledons, accompanied by endosperm) and one empty, compressed seed; 2. habit, $\frac{2}{3}\times$.

After: J. J. de Wilde 1790 (1); De Wit s.n. (2).

Hypocotyl straight, angular to cylindrical, sometimes with an oblique annular swelling on the transition from a thinner upper part to a thicker basal part, 14–22 cm long, 1.5–3 mm in diam., minutely pustulate when young, later glabrous, smooth or sparsely lenticellate; rootcrown straight to slightly geniculate, 3–5 mm in diam.

Cotyledons free, coriaceous, persistent; petiole formed by the abruptly attenuate base of the lamina, flattened, 4–10 mm long, glabrous; lamina asymmetrical, elliptic to broadly elliptic, 6–10 cm × 5–7 cm, base obtuse to rounded, apex rounded, glabrous, smooth above, minutely papillate below, inconspicuous in old specimens. *Nervation* acro-brochidodromous; primary vein straight to slightly zig-zag; 3–7 pairs of secondary veins (2 of which originating at the base, the other originating in the upper part of the primary vein); tertiary veins mainly developed on the exmedial side of the basal secondary veins; quaternary veins visible in transmitted light, reticulating, areoles well developed, triangular to polygonal, of medium size, at random arranged, veinlets simple or once forked; a system of parallel hairlike lactiferous ducts, radiating from the base and the midrib is visible under strong magnification on both faces of the cotyledons.

Epicotyl straight, cylindrical, 0.8–4.5 cm long, pubescent with medifixed, appressed, equal-branched grey-brown hairs; cataphylls sometimes present.

Eophylls alternate, papery; stipulae subulate, caducous, 1–2 mm long, densely pubescent, grey-brown; petiole slightly canaliculate, 4–9 mm long, pubescent; lamina narrowly obovate, 5–18 cm × 2–4 cm, base cuneate, apex abruptly acuminate, acumen slender rounded, 4–9 mm long; glabrous above, but pubescent on the veins, lamina minutely papillate (hardly visible at 20 × magnification). *Nervation* brochidodromous with a tendency to the development of an intramarginal vein; primary vein straight, of moderate size, impressed to prominent above, prominent beneath, 8–13 pairs of secondary veins, angle of divergence widely acute to moderately acute towards the apex, hairlike, straight, abruptly looped and joining superadjacent secondary veins, these loops forming intramarginal vein; intersecondary veins numerous; tertiary veins originating exmedially and admedially at right angles, ramifying and confluent with intersecondary veins; quaternary veins resolute in imperfect reticulum; areoles polygonal or irregularly shaped, of medium size, at random arranged; hairlike sinuous lactiferous ducts, parallel to the primary vein, are sometimes visible, mainly in young eophylls.

Specimens examined:

ZAIRE: *Bokdam 4401* (WAG), 3 seedlings, voucher: *Bokdam 4400* (WAG); *Bokdam 4490* (WAG), 3 seedlings, voucher: *Bokdam 4489* (WAG); *Bokdam 4579* (WAG), 2 seedlings; *Bokdam 4619* (WAG), 2 seedlings, voucher: *Bokdam 4656* (WAG); *Hombert 246* (BR), 1 seedling; *Hombert 295* (BR), 1 seedling, voucher: *Mahieu 156* (BR); *HPLY 3311* (YBI), voucher: *O 728 = B210* (YBI); *Maudoux 109* (BR), 2 seedlings.

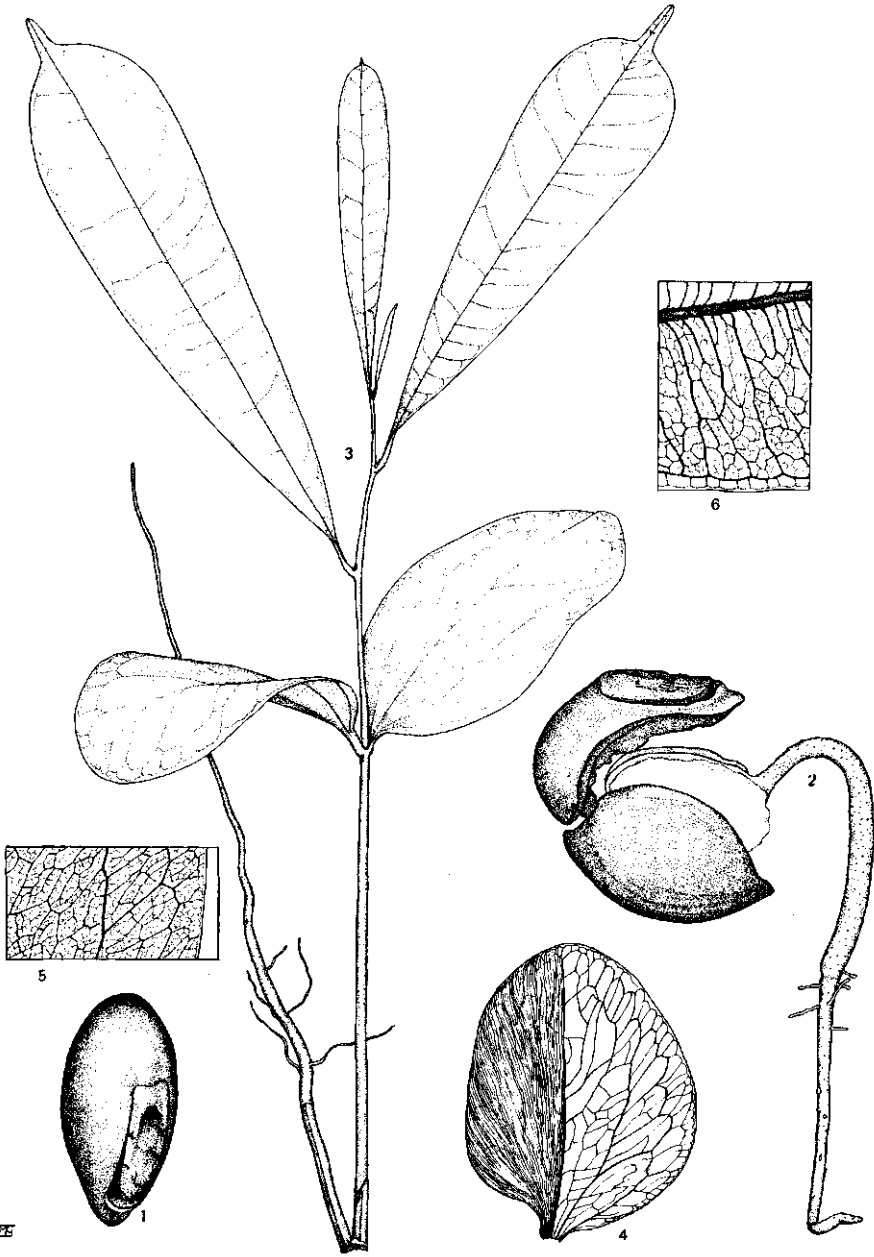


FIG. 4. *Autranella congolensis* (DE WILD.) A. CHEV. - 1. seed, $\frac{1}{2} \times$; 2. germinating seed, $\frac{1}{2} \times$; 3. habit, $\frac{1}{2} \times$; 4. cotyledon, lactiferous ducts in left half and nervation in right half dessinated, $1\frac{1}{2} \times$; 5. nervation cotyledon, $\frac{1}{2} \times$; 6. nervation eophyll, $1\frac{1}{2} \times$.
 After: Bokdam 4656 (1), 4619 (2); Maudoux 109 (3-6).

Hypocotyl straight, cylindrical, ca. 0.5–1.5 cm long, ca. 5 mm in diam., smooth, glabrous; rootcrown straight to geniculate.

Cotyledons free, fleshy, rather persistent, green, sessile, planoconvex, narrowly elliptic, 3.5–4.4 cm × 0.8–1.3 cm × 0.6–0.7 cm, base with a petiole-like attenuation, apex obtuse to rounded, glabrous, wrinkled surface. *Nervation* hyphodromous.

Epicotyl straight, strongly compressed, 15–26 cm long, width up to 3–4 mm, lanate to floccose, with ferrugineous to greyish brown subsessile hairs with filiform equal to subequal sinuous branches; cataphylls absent.

Eophylls opposite, papery; stipules linear to triangular, 6–7 mm long, tomentose; petiole slightly canaliculate, 1–2 cm long, lanate; lamina elliptic to narrowly elliptic, 11–16 cm × 5–6 cm, cuneate at base, apex acuminate, acumen 5–15 mm long, obtuse to acute; veins on both sides tomentose with equal-branched ferrugineous hairs. *Nervation* brochidodromous with a tendency towards an intramarginal vein; primary vein straight, stout to moderate, impressed above, prominent below; secondary veins 16–25 pairs, angle of divergence perpendicular at the base to moderately acute towards the apex of the leaf, straight but abruptly looped near the end, joining the superadjacent secondary vein; some intersecondary veins present, confluent with the tertiary veins; tertiary veins originating at right to widely acute angles exmedially, admedially at right to obtuse angles; percurrent, oblique to the midrib; quaternary veins reticulating; areoles well developed, at random arranged, triangular to polygonal, medium to large, veinlets absent. In young eophylls, sinuous, translucent lactiferous ducts are visible in transmitted light, parallel to the secondary veins, 0.2–0.3 mm apart.

Specimens examined:

CAMEROON: *Bokdam* 4625A, B, 4629 (WAG), 4 seedlings, voucher: J. J. DE WILDE 8373A (WAG).

ZAIRE: *Hombert* 293 (BR), 1 seedling; *Hombert* 431, 434, 452 (BR), 3 seedlings, voucher: *Hombert* 429 (BR).

10. *Brevica leptosperma* (BAEHNI) HEINE

Hypocotyl straight, quadrangular, later on cylindrical, ca. 5–6 cm long, 2–3 mm in diam., glabrous; apex shortly grooved; rootcrown straight.

Cotyledons free, papery, persistent; petiole flattened, 2–3 mm long, glabrous; lamina slightly asymmetrical, ovate to elliptic, ca. 4.5 cm × 2–3 cm, base obtuse to truncate, apex rounded, glabrous, minutely papillate below (30 ×). *Nervation* acro-brochidodromous; primary vein straight, slightly prominent on both sides; 5–7 pairs of secondary veins slightly prominent, 2(–3) pairs ascending from the base; tertiary veins developed on the exmedial side of the basal secondary veins; quaternary veins reticulating; areoles well developed,

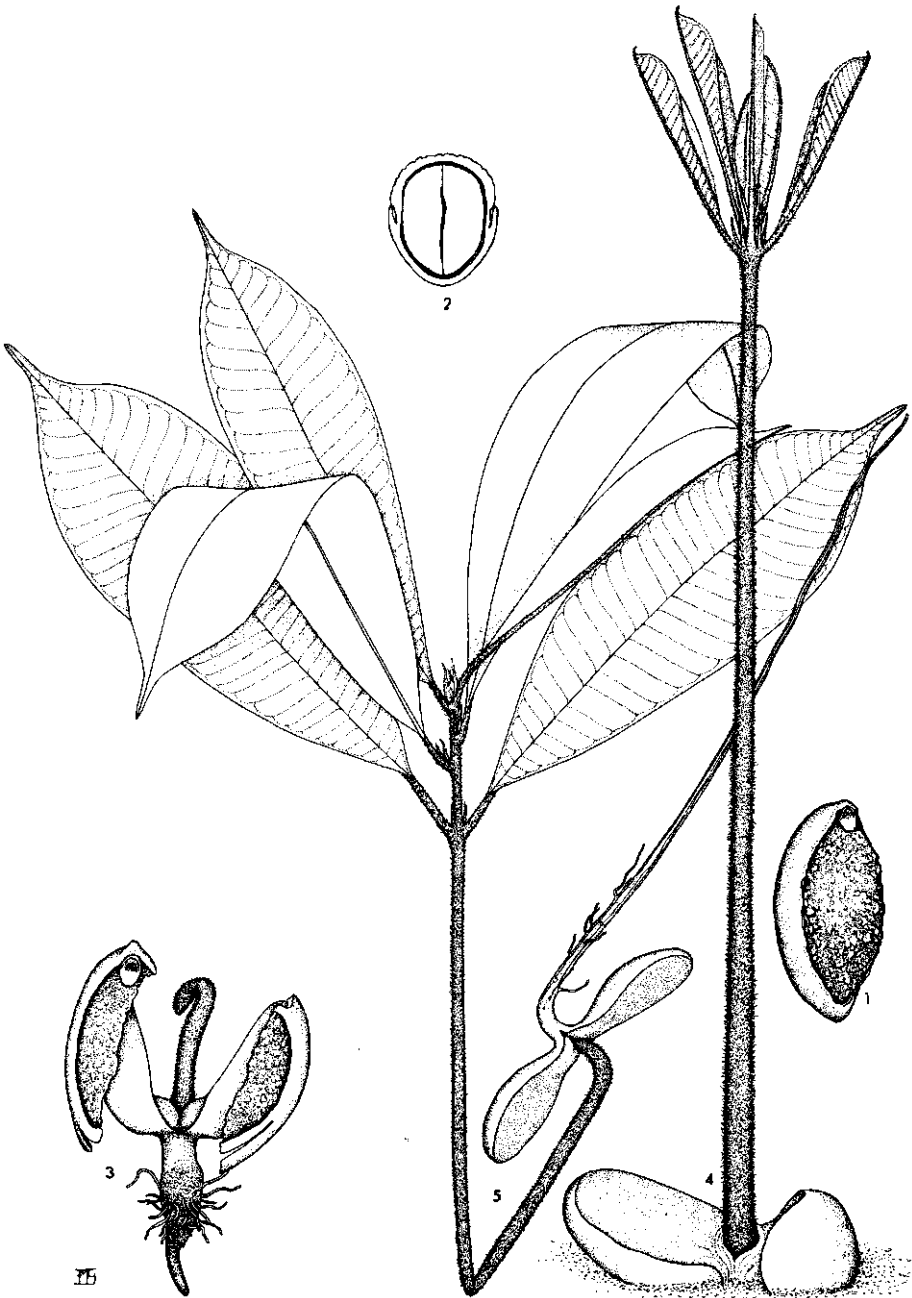


FIG. 5. *Baillonella toxisperma* PIERRE - 1. seed, $\frac{1}{2} \times$; 2. seed, transversal section, $\frac{1}{2} \times$; 3. germinating seed, $\frac{1}{2} \times$; 4. young seedling, habit in situ, $\frac{1}{2} \times$; 5. habit, $\frac{1}{2} \times$.
 After: J. J. de Wilde 8373A (1-2); Bokdam 4625A (3), 4625B (4); Hombert 431 (5).

small (visible in transmitted light), triangular to polygonal or oblong and then parallel to the secondary veins.

Epicotyl straight, cylindrical, 2–3 cm long, glabrescent with grey-brown, equal-branched, sessile, medifixed, appressed hairs.

Eophylls alternate, papery, exstipulate; petiole slightly canaliculate; 1–2(5) mm long, pubescent; lamina narrowly elliptic to obovate or oblong, ca. 6–8 cm × 1.8–2.3 cm, base rounded to truncate, apex acuminate, acumen acute, 0.8–1.5 cm long; young eophylls at first sericeous to floccose above, later glabrescent; densely sericeous below with silver-grey appressed equal-branched hairs, branches spreading and parallel to the secondary veins, and with sparse ferruginous hairs with flattened appressed branches. *Nervation* brochidodromous, primary vein straight, prominent beneath; 8–10 pairs of secondary veins prominent beneath, divergent at a widely acute angle in lower half and at narrowly to moderately acute angles in upper half of the leaf; some intersecondary veins present; tertiary veins originating exmedially at a wide to right angle, admedially at an obtuse to right angle, percurrent to ramified or confluent with intersecondary veins, perpendicular to the midrib; quaternary veins reticulating; areoles imperfectly developed, oblong, ± parallel to the secondary veins.

Specimens examined:

ZAIRE: *Bokdam 4379* (WAG), 1 seedling, voucher: *Bokdam 4377* (WAG); *Bokdam 4399B* (WAG), 2 seedlings, voucher: *Bokdam 4399A* (WAG).

11. *Butyrospermum paradoxum* (GAERTN.F.) HEPPER

Taproot solid and woody; cylindrical to angular at rootcrown level.

Hypocotyl not developed.

Cotyledons remaining enclosed in the testa, fleshy, persistent; the elongated basal parts are fused, forming a tube, enclosing the plumule during germination. This tube splits unilaterally to produce the epicotyl.

Epicotyl straight, cylindrical and slightly ridged, length up to at least 3–4 cm, brown, puberulous, cataphylls present, stipulate.

*Eophylls** alternate, papery to coriaceous, stipules linear, 3–5 mm long, brown, appressedly pubescent; petiole canaliculate, 5–7 mm long, pubescent; lamina elliptic to narrowly elliptic, 4–7 cm × 2–2.5 cm, base cuneate, apex rounded. *Nervation* craspedodromous with a distinct marginal vein; primary vein stout, straight, prominent below; 5–12 pairs of secondary veins prominent beneath, divergent from the midrib at moderately to widely acute angles, uniformly curved, terminating in a marginal vein; intersecondary veins present, confluent with the tertiary veins; tertiary veins few, originating ex- and admedially at right angles, prominent on both sides; quaternary veins reticul-

* In the specimens examined no real eophylls were present. Therefore, the description has been based on the first leaves of the lateral shoots, replacing the damaged eophylls.



FIG. 6. *Chrysophyllum azagueianum* MIEGE - 1. seed, ventral, 1×; 2. seed, transversal section, 1×; 3. habit, 1/2×.

After: Bamps 2037 (1-2); Tolliez 286 (3).

ating, stout, prominent on both sides; well developed areoles, 3-5-angular, at random arranged, small, without veinlets.

Specimens examined:

NIGERIA: *N.N.* (BR), 3 seedlings.

References (+ figure):

JACKSON, 1968.

12. *Chrysophyllum azaguianum* MIEGE

Fig. 6

Hypocotyl 0-3(5) mm long, cylindrical, straight, glabrous.

Cotyledons free, fleshy, caducous, opposite, plano-convex, elliptic, ca. 2 cm \times 0.6-0.8 cm \times 0.5 cm (dimensions taken from dry seed). *Nervation* hypohydromous.

Epicotyl straight, cylindrical, ca. 7.5 cm long, brown-black, pubescent with long appressed very unequal-branched (seemingly 1-branched) hairs, supported by a gland like pustule; cataphylls absent.

Eophylls opposite, papery, exstipulate; petiole ca. 2-4 mm long, flattened, pubescent; lamina elliptic-obovate, 9-14 cm \times 4.5-9 cm, base cuneate, apex acuminate, acumen acute, ca. 1 cm long; sparsely pubescent on primary and secondary veins on both faces, with shortly stalked, very unequal-branched hairs. *Nervation* eucampto-brochidodromous; primary vein straight, impressed to prominent above, prominent beneath; secondary veins 6-9 pairs, divergent at wide angles, uniformly curved, joining superadjacent secondary veins through tertiary veins in the lower half, and through uniformly curved loops in the upper half of the leaf; few intersecondary veins, confluent with tertiary veins; tertiary veins prominent beneath, originating exmedially and admedially at right angles, percurrent, sinuous and oblique to the midrib; quaternary veins reticulating; areoles well developed, triangular to polygonal, at random arranged, without veinlets.

Specimens examined:

IVORY COAST: *Bamps 2037* (BR), fruit and ripe seeds; *Tolliez 286* (BR), 2 seedlings.

13. *Chrysophyllum giganteum* A. CHEV.

Fig. 7

Hypocotyl straight, quadrangular, ca. 3 cm long, 1.5 mm in diam., glabrous.

Cotyledons free, fleshy, plano-convex, ca. (2.2)2.5-3 \times (1.2)1.5-1.8 \times 0.5 cm (dimensions taken from dry seeds), horizontally expanded to obliquely erect, caducous.

Epicotyl straight, cylindrical at the base, strongly compressed under the eophylls, 6-8 cm long, sericeous with grey-white hairs.

Eophylls opposite, papery, exstipulate; petiole slightly grooved, 0.5-1 cm long, appressed puberulous, lamina elliptic, 5-10 cm \times 3-4 cm, base cuneate, apex acuminate, glabrous above, with numerous translucent glandular

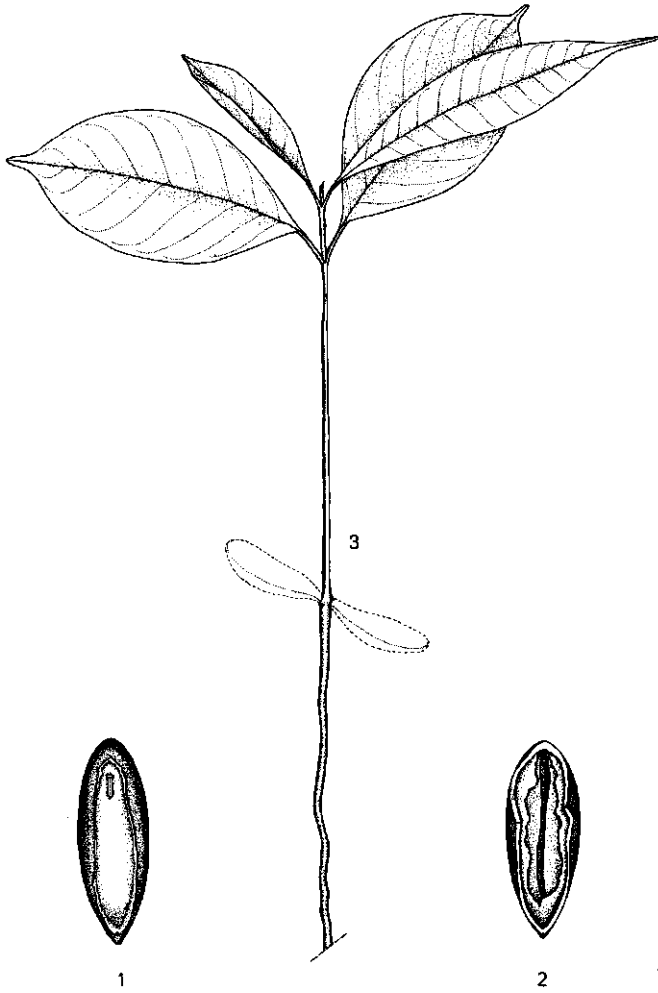


FIG. 7. *Chrysophyllum giganteum* A. CHEV. – 1. seed, ventral, $1\times$; 2. seed, ventral, testa and membranous endosperm partly removed, $1\times$; 3. habit, $\frac{2}{3}\times$.

After: Breteler 2436 (1–2); J. J. de Wilde 258 (3).

dots, sericeous with greyish to silvery hairs below. *Nervation* eucamptodromous; primary vein straight, weakly developed, impressed above, prominent below; 6–9(11) pairs of secondary veins, divergent at widely acute angles at the base and at moderately acute angles near the apex of the leaf, uniformly curved; many intersecondary veins, parallel to the secondary veins; tertiary veins originating exmedially at moderate to narrowly acute angles, admedially at obtuse angles, confluent with the intersecondary veins, ending in the midrib or in the eucamptodromous loop; quaternary veins reticulating together with the

tertiary veins; areoles well developed, large, elongate and parallel to the secondary veins, hairlike veinlets visible in transmitted light.

Specimens examined:

IVORY COAST: *J. J. de Wilde 258* (WAG), 1 seedling.

References:

DE LA MENSBRUGE, 1966.

14. *Chrysophyllum muerense* ENGL.

Fig. 8

Hypocotyl straight, cylindrical to angular, glabrous, ca. 3.5 cm long and 2.5 mm in diam.

Cotyledons free, fleshy, caducous, opposite, plano-convex, elliptic, ca. 2–3 cm × 0.8–1.2 × 0.2–0.4 cm.

Epicotyl straight, strongly compressed, 3.5–9 cm long, densely greyish pubescent, cataphylls absent.

Eophylls opposite, papery, exstipulate; petiole slightly grooved, 3–6 mm long; lamina narrowly elliptic, 4.5–11 cm × 1.5–3.5 cm, base cuneate, apex strongly acuminate, acumen acute, 1–2 cm long, with minute translucent papillae on the upper face, presenting themselves as translucent dots in transmitted light, glabrous above, greyish silvery sericeous below. *Nervation* eucamptodromous; primary vein of moderate size, straight, impressed above, prominent below, 5–11 pairs of secondary veins at moderately acute angles of divergence, uniformly curved; few intersecondary veins, confluent with tertiary veins; tertiary veins exmedially originating at moderately acute angles, admedially at obtuse angles and confluent with intersecondary veins curving backwards, ending perpendicular to the midrib; quaternary veins reticulating, areoles well developed, at random arranged, large to medium sized, triangular to polygonal.

Specimens examined:

ZAIRE: *Bokdam 4349* (WAG), 3 seedlings, voucher: *Bokdam 4348* (WAG); *Bokdam 4576* (WAG), 1 seedling, voucher: *Bokdam 4395* (WAG).

15. *Donella ogowensis* (A. CHEV.) AUBRÉV. et PELLEGR.

Fig. 9: 1

Hypocotyl straight, quadrangular, 4–7.5 cm long, 0.5–1 mm in diam., brown, glabrous; rootcrown straight; apical part 1–3 mm, green, herbaceous.

Cotyledons free, thinly coriaceous, persistent; petiole 0.5–1 mm long, flattened, glabrous; lamina narrowly elliptic to narrowly ovate, 1.9–3.2 × 0.7–1.2 cm, base rounded to obtuse, apex rounded, minutely papillate above. *Nervation* acro-brochidodromous; primary vein straight prominent on both sides, at least at the base of the cotyledon; 3–5 pairs of secondary veins, of which 1–2 are basal pairs originating at narrowly acute angles of divergence; tertiary veins mainly developed at the exmedial side of inner basal pair,

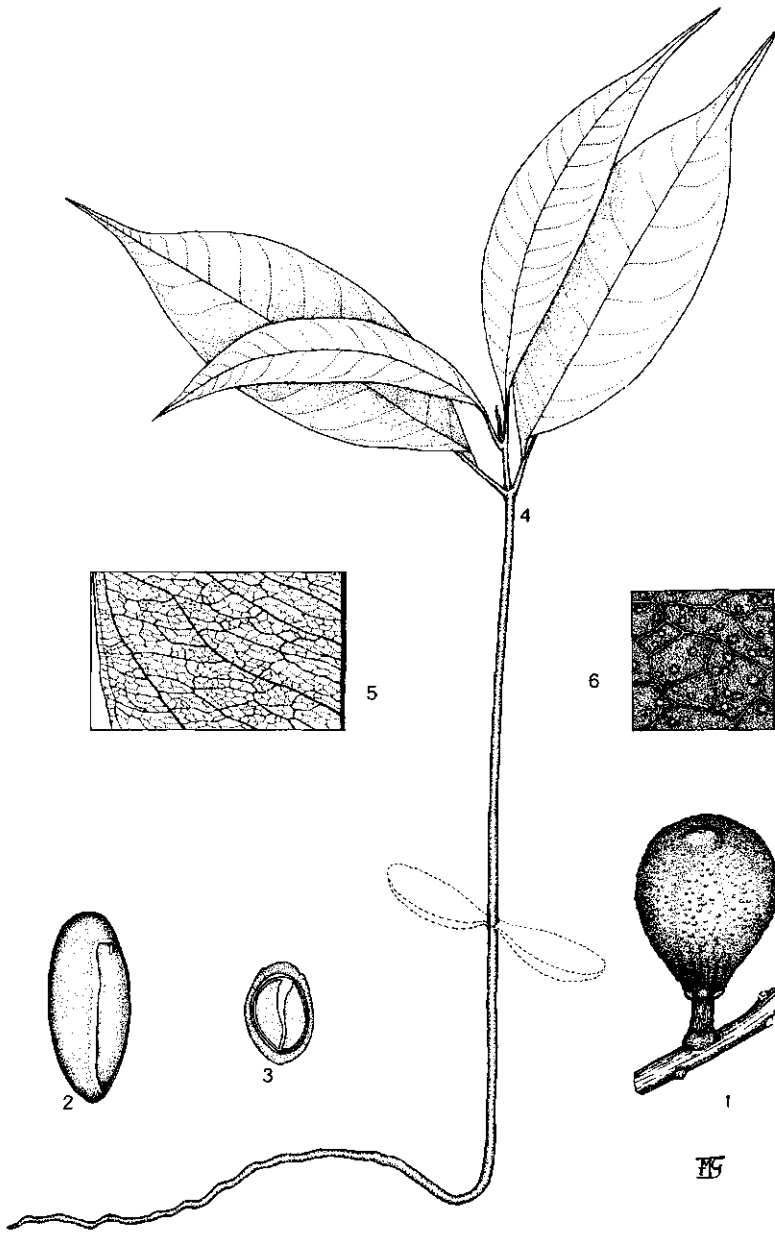


FIG. 8. *Chrysophyllum muerense* ENGL. - 1. fruit, $\frac{2}{3}\times$; 2. seed, $1\times$; 3. seed, transversal section, $1\times$; 4. habit $\frac{2}{3}\times$; 5. nervation pattern, $2\times$; 6. detail nervation with translucent dots, $40\times$.

After: Bokdam 4395 (1-3), 4349 (4-6).

looping and joining superadjacent tertiary veins; quaternary veins reticulating; areoles well developed, polygonal and elongate, parallel to the nearest vein of higher order.

Epicotyl straight, cylindrical, 0.2–1 cm long, ca. 0.5 mm in diam., pubescent with shortly stalked medifixed hairs with equal flat ferrugineous branches; cataphylls absent.

Eophylls alternate, papery, exstipulate; petiole up to 1.5 mm long, pubescent as in the epicotyl; lamina narrowly elliptic, 2.7–4.8 cm × 0.4–0.8 cm, base cuneate, apex acute, minutely papillate-punctate above, midrib pubescent beneath. *Nervation* brochidodromous with intramarginal vein; primary vein stout, straight, prominent below; 6–10 pairs of secondary veins, hairlike, divergent at moderately to narrowly acute angles, uniformly curved, terminating in the intramarginal vein; intersecondary veins very numerous, confluent with tertiary veins; tertiary veins reticulating with intersecondary veins and quaternary veins, building imperfect large elongate areoles, parallel to the secondary veins; sinuous lactiferous ducts are visible in transmitted light, parallel to the secondary veins.

Specimens examined:

GABON: *Breteler 7011* (WAG), 4 seedlings, voucher: *Breteler 6643* (WAG).

16. *Donella pruniformis* (PIERRE EX ENGL.) AUBRÉV. et PELLEGR. Fig. 9:2

Hypocotyl straight, quadrangular, brown, 4–10 cm long, 1.5–2 mm in diam., glabrous, rootcrown straight, apical green herbaceous part 3–4 mm long.

Cotyledons free, thinly coriaceous, persistent, petiole flattened, 1–3 mm long; lamina asymmetrical, narrowly ovate to narrowly elliptic, 4–6 cm × 1.5–2 cm, base obtuse, rounded or truncate, apex rounded, glabrous, minutely punctate beneath. *Nervation* (hypho-)brochidodromous; primary vein straight, weakly developed, prominent on both sides; 3–5 pairs of secondary veins of which 1–2 are basal pairs, slightly prominent above, divergent at narrowly acute angles; tertiary veins inconspicuous, reticulate; areoles well developed, triangular to polygonal, elongate and parallel to the secondary veins; veinlets present, once to twice forked.

Epicotyl straight, cylindrical, 0.5–4 cm long, ca. 1 mm in diam., pubescent with equal-branched shortly stalked appressed ferrugineous hairs; cataphylls present.

Eophylls alternate, papery, exstipulate; petiole flattened above, 1–3 mm long, pubescent, lamina narrowly elliptic, 2.5–5 cm × 0.5–1.5 cm, base cuneate, apex acuminate, acumen tapering and rounded, 0.4–0.8 cm long, lamina glabrescent on both sides with colourless equal-branched hairs, branches sinuous appressed; primary vein densely ferrugineously pubescent below. *Nervation* brochidodromous with intramarginal vein; primary vein straight, prominent below, of medium size; 15–30 pairs of weakly developed secondary veins, straight, parallel, divergent at right angles at the base of the



FIG

FIG. 9. 1. *Donella ogowensis* (A. CHEV.) AUBRÉV. et PELLEGR. – Habit, $\frac{2}{3} \times$.

2. *Donella pruniformis* (PIERRE ex ENGL.) AUBRÉV. et PELLEGR. – Habit, endosperm and testa sticking on the cotyledons, $\frac{2}{3} \times$.

After: Breteler 7011 (1); Bokdam 4593 (2).

leaf, the angle decreasing towards the apex; numerous intersecondary veins; tertiary veins reticulate; imperfect areoles elongate and parallel to the secondary and intersecondary veins; translucent lactiferous ducts visible between the midrib and the intramarginal vein.

Specimens examined:

ZAIRE: *Bokdam 4593* (WAG), 2 seedlings; *Bokdam 4611* (WAG), 1 seedling, voucher: *Bokdam 4566* (WAG); HPLY 1510 (YBI), voucher: *O 109* (YBI).

17. *Donella ubanguiensis* (DE WILD.) AUBRÉV.

Fig. 10: 1-4

Hypocotyl straight, cylindrical, 9-15 cm long, 2-4 mm in diam., glabrous, brown; rootcrown straight to slightly geniculate; apex green herbaceous, laterally grooved in fresh material, 2-8 mm long.

Cotyledons free, expanded to slightly erect, thickly coriaceous; petiole flattened, 1-7 mm long, glabrous; lamina asymmetrical, elliptic-ovate, 6-9 cm × 3-4.5 cm, base obtuse - truncate, apex rounded, glabrous but minutely papillate above. *Nervation* hypho-acrodromous; primary vein of moderate size, straight to slightly curved, prominent above; 1-3 basal pairs of secondary veins uniformly curved towards the apex; tertiary veins only on the exmedial side of the secondary veins; angle of divergence narrowly acute, joining superadjacent tertiary veins by a brochidodromous loop at an obtuse angle; veins of higher order not visible.

Epicotyl straight, cylindrical to compressed below the eophylls, 2-8.5 cm long, 2-3 mm in diam., pubescent, axillary buds well developed, densely pubescent with ferrugineous hairs.

Eophylls alternate (to subopposite), papery, exstipulate, petiole slightly canaliculate, 1-8 mm long, pubescent; lamina obovate to elliptic or narrowly so, 6-15 cm × 1.8-6 cm, base cuneate to obtuse, apex acuminate, acumen up to 2.5 cm long, obtuse to rounded, primary vein pubescent to glabrous beneath. *Nervation* brochidodromous with intramarginal vein; primary vein of moderate size, straight, prominent below; secondary veins 15-30 pairs, hairlike, angle of divergence right in the lower part of the leaf, decreasing to moderately acute in the upper part, straight towards the intramarginal vein, the latter 0.5-1 mm from the edge of the leaf, numerous intersecondary veins, ca. 2-4 between each superposed pair of secondary veins; tertiary veins originating exmedially and admedially at right angles, confluent with secondary and intersecondary veins; quaternary veins reticulating; areoles imperfect, elongate, small to medium sized, parallel to the secondary veins; lactiferous ducts translucent, between midrib and intramarginal vein.

Specimens examined:

CAMEROON: *Bokdam 4618* (WAG), 1 seedling, voucher: *J. J. de Wilde 8229A* (WAG).

IVORY COAST: *Cremers 615* (BR), 5 seedlings.

ZAIRE: *Bokdam 4302* (WAG), 1 seedling; *Bokdam 4571* (WAG), 1 seedling, voucher: *Bokdam 4233*; *Bokdam 4346* (WAG), 2 seedlings, voucher: *Bokdam 4345* (WAG); HPLY 3714 (YBI), voucher: *O 321* (BR, YBI); HPLY 1296 (YBI), voucher: *O 1672* (BR, YBI).

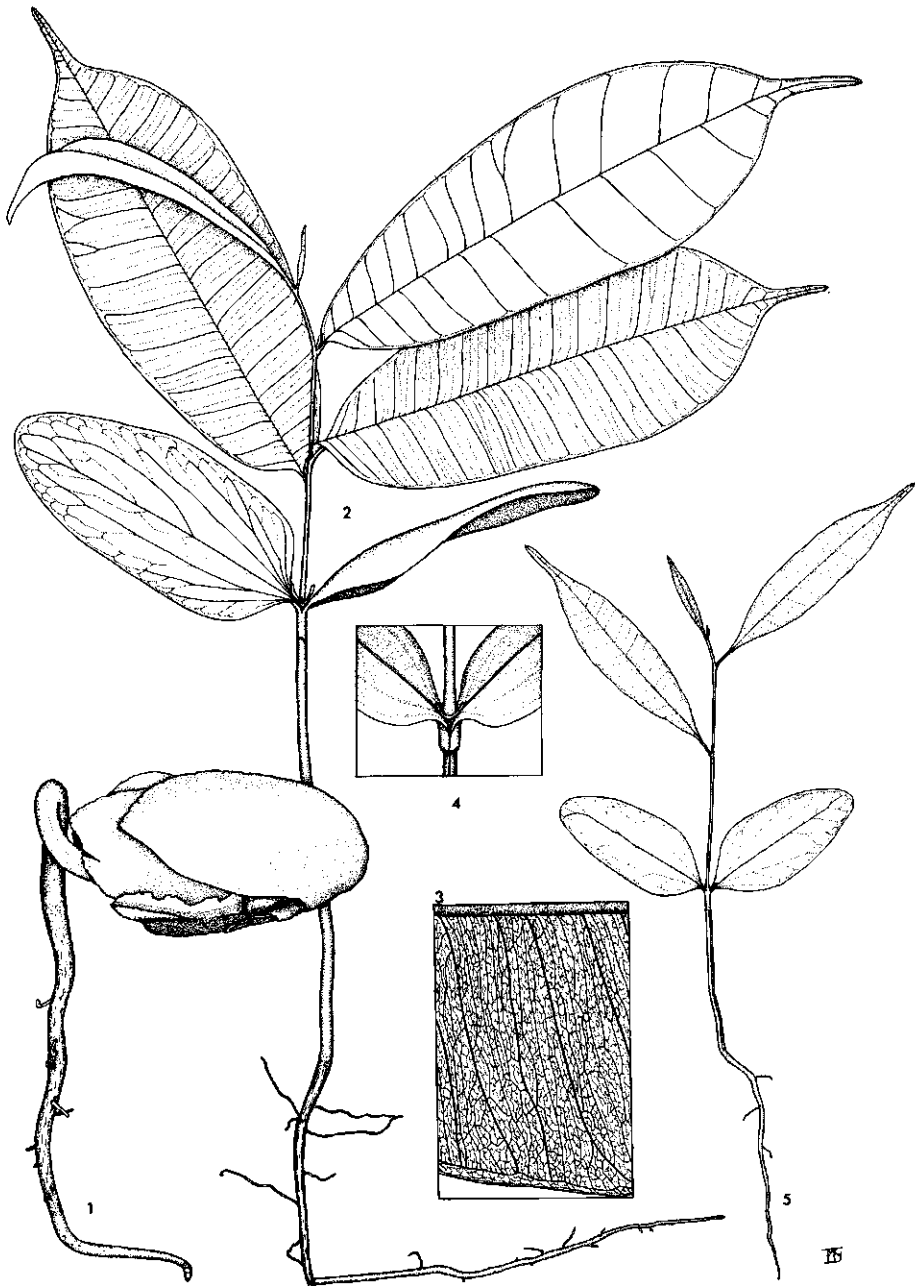


FIG. 10: 1-4. *Donella ubanguiensis* (DE WILD.) AUBRÉV. - 1. germinating seed, $\frac{1}{2} \times$; 2. habit, $\frac{1}{2} \times$; 3. nervation eophyll, $1\frac{1}{2} \times$; 4. apical part of the hypocotyl, $\frac{3}{4} \times$.

5. *Donella welwitschii* (ENGL.) PIERRE ex AUBRÉV. et PELLEGR. - Habit, $\frac{1}{2} \times$.

After: Bokdam 4618 (1); Cremers 615A (2, 3); Bokdam s.n. (4); Cremers 607 (5).

18. *Donella welwitschii* (ENGL.) PIERRE EX AUBRÉV. et PELLEGR. Fig. 10: 5

Hypocotyl straight, quadrangular, 4.5–5.5 cm long, brown; rootcrown straight (to slightly geniculate), green herbaceous apex up to 5 mm long.

Cotyledons free, coriaceous, persistent; petiole flattened, 1–2 mm long, glabrous; lamina asymmetrical narrowly ovate to narrowly elliptic, 2.4–4.3 cm × 1.4–2.5 cm, rounded to obtuse at base, rounded at apex, minutely papillate above. *Nervation* acro-brochidodromous; primary vein straight to slightly zig-zag, weakly developed, prominent above; secondary veins 2–5 pairs, of which 2 basal pairs and (1)2–3 pairs in upper part of the lamina; tertiary veins exmedially of basal veins, joining superadjacent tertiary veins by brochidodromous loops; quaternary veins inconspicuous, reticulating; an inconspicuous system of translucent lactiferous ducts radiating from the base and primary vein towards the margin of the blade, can be discerned in transmitted light.

Epicotyl straight, cylindrical to compressed below the node of the eophylls, 0.4–4 cm long, pubescent, with subsessile equal-branched ferruginous hairs; cataphylls absent.

Eophylls alternate, papery, exstipulate; petiole 1.5–3 mm long, pubescent; lamina narrowly elliptic, 7–8.5 cm × 1–2 cm, base cuneate to decurrent, apex acuminate, acumen 5–10 mm long, rounded to mucronate, glabrescent above, pubescent on the midrib beneath. *Nervation* brochidodromous with intramarginal vein; primary vein straight, prominent beneath; 8–11 pairs of secondary veins, divergent from the midrib at moderately acute angles, straight, terminating in the intramarginal vein; numerous intersecondary veins, 3–5 between each superposed pair of secondary veins; tertiary veins originating exmedially and admedially at right angles, confluent with intersecondary veins; translucent lactiferous ducts parallel to the secondary veins between the midrib and the intramarginal vein.

Specimens examined:

IVORY COAST: *Cremers* 607 (BR), 1 seedling.

ZAIRE: *HPLY* 809 (YBI), voucher: *O* 643 (YBI).

19. *Gambeya beguei* (AUBRÉV. et PELLEGR.) AUBRÉV. et PELLEGR. Fig. 11

Hypocotyl straight, quadrangular, 4–9 cm long, 1–2 mm in diam., glabrous, brown; rootcrown straight; green herbaceous apical part up to 5 mm long.

Cotyledons free, papery, persistent; petioles flattened, 0.5–2.5 mm long; lamina asymmetrical, ovate, 4–5.5 cm × 2–3.5 cm, base truncate to cordate, apex rounded, glabrous. *Nervation* acro-brochidodromous; primary vein slightly zig-zag, moderately developed, prominent on both sides; 4–6 pairs of secondary veins weakly developed, of which 1(–2) pairs are basal, slightly prominent below; some intersecondary veins, confluent with the tertiary veins; tertiary veins mainly on the exmedial side of the basal secondary veins; angle of

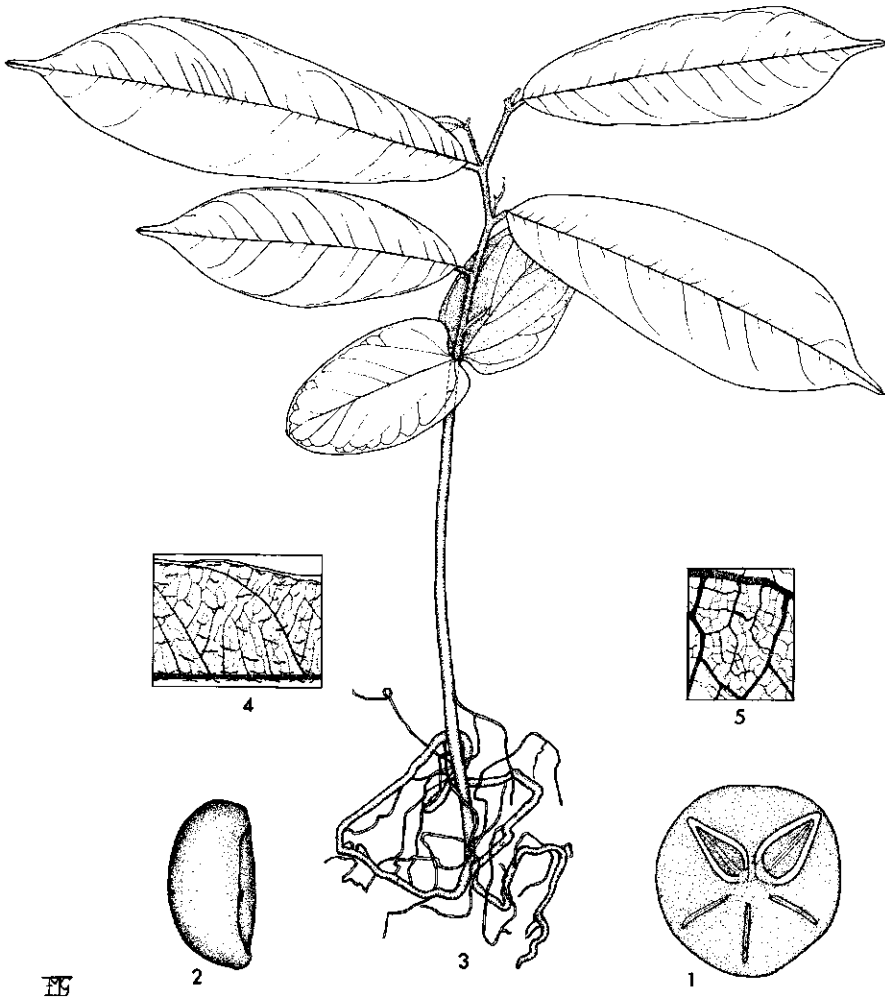


FIG. 11. *Gambeya beguei* (AUBRÉV. et PELLEGR.) AUBRÉV. et PELLEGR. - 1. fruit, transversal section, $\frac{2}{3} \times$; 2. seed, lateral, $\frac{2}{3} \times$; 3. habit, $\frac{2}{3} \times$; 4. detail of cophyll, underside, $2 \times$; 5. detail nervation eophyll, $4 \times$.

After: Bokdam 4402 (1-2); Teulings 15 (3-5).

origin exmedially moderately acute, admedially right; quaternary veins reticulating; areoles well developed elongate to rounded in shape, parallel to the secondary or tertiary veins, veinlets absent; translucent lactiferous ducts radiating from the midrib towards the margin of the blade, the ducts ca. 0.1–0.5 mm apart.

Epicotyl straight, cylindrical, 1.7–3.5 cm long, densely pubescent with ferruginous hairs; cataphylls present or not, pubescent.

Eophylls alternate, papery, exstipulate; petiole slightly canaliculate, 2–4 mm long, pubescent; lamina narrowly obovate, 3.5–9 cm × 1–3 cm, base cuneate to obtuse, apex acuminate, acumen mucronulate, 5–10 mm long; surface glabrescent above, pubescent below, mainly on the midrib, with equal-branched medifixed ferrugineous hairs. *Nervation* eucampto-brochidodromous; primary vein of moderate size, straight, prominent; secondary veins 5–9 pairs, divergent from the midrib at widely acute angles at the base and at moderately acute angles in the upper portion of the leaf, uniformly curved, eucamptodromous in the lower part and brochidodromous in the upper part of the leaf; intersecondary veins common, confluent with tertiary veins; tertiary veins originating exmedially at moderately to widely acute angles, admedially at obtuse to right angles, percurrent, perpendicular to the midrib; quaternary veins reticulating, hairlike; areoles large, well developed, scattered, triangular to polygonal; sinuous translucent lactiferous ducts running parallel to the secondary veins and radiating from the midrib towards the margin and looping to the apex, visible in transmitted light; mutual distance of these ducts ca. 0.5 mm.

Specimens examined:

ZAIRE: *Bokdam 4374* (WAG), 3 seedlings, voucher: *Bokdam 4362* (WAG); *HPLY 2874* (YBI), 1 seedling; *Teulings 15* (WAG), 1 seedling, voucher: *Bokdam 4402* (WAG).

20. *Gambeya boukokoensis* AUBRÉV. et PELLEGR.

Fig. 12

Hypocotyl straight, quadrangular, 4–7.5 cm long, 1–1.5 mm in diam., glabrous, brown; rootcrown straight; green apical part inconspicuous.

Cotyledons free, papery, persistent; petiole flattened, 1–2 mm long; lamina elliptic to ovate, 2–3.5 cm × 1–2.2 cm, asymmetrical, base truncate to rounded, apex rounded. *Nervation* acro-brochidodromous; primary vein slightly zigzag, prominent above; 1–2 basal pairs of secondary veins, ascending from the base and 3–6 lateral pairs in the upper part of the lamina; few intersecondary veins, confluent with the tertiary veins; tertiary veins mainly exmedially of the basal pairs of the secondary veins; quaternary veins reticulating, areoles well developed, with curved veinlets 1–3 times forked.

Epicotyl straight, cylindrical, 0.2–0.5 cm long, 0.5–1 mm in diam., grey-brown pubescent.

Eophylls alternate, papery, exstipulate; petiole flattened, 1–3 mm long, densely pubescent; lamina obovate to elliptic or narrowly so, 4–6.5 cm × 1.5–3 cm, base cuneate, apex acuminate, acumen 4–6 mm long, ± mucronulate; surface floccose to glabrescent with long medifixed hairs above, sericeous below with appressed, silvery-grey hairs (branches parallel to the secondary veins), and with sparse ferrugineous hairs; midrib densely pubescent with brown ferrugineous hairs. *Nervation* eucampto-brochidodromous; primary vein moderately developed, straight, prominent below; 5–8 pairs of secondary veins weakly developed, angle of divergence moderately to widely acute,

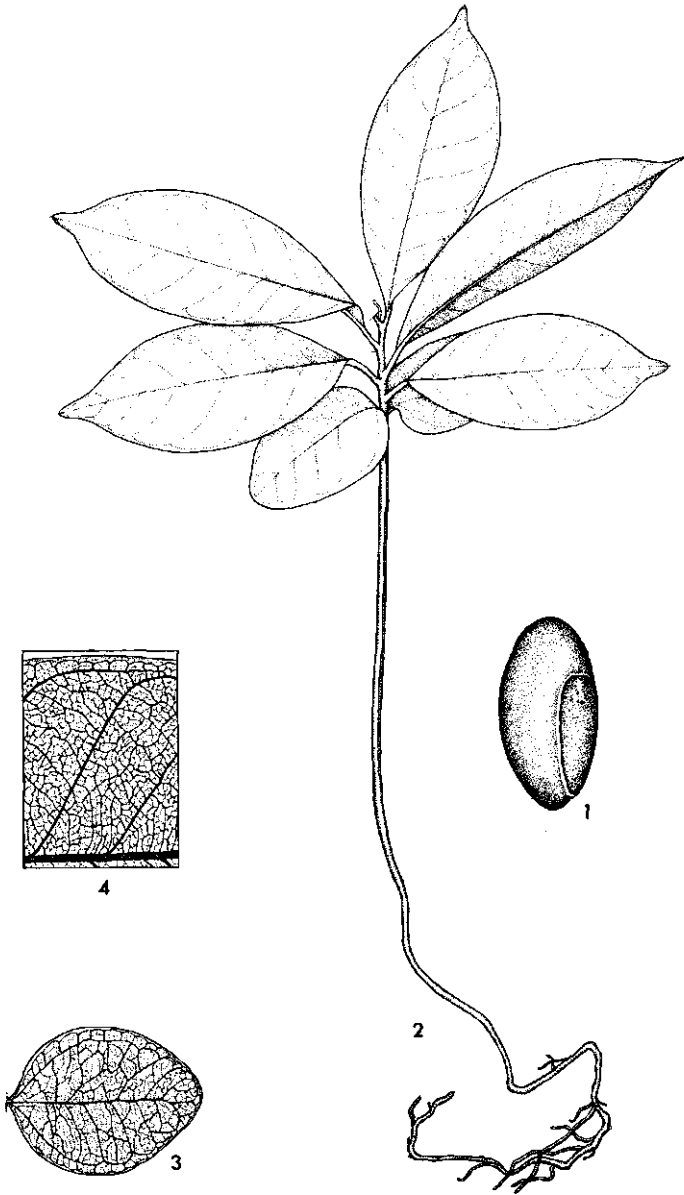


FIG. 12. *Gambeya boukokoensis* AUBRÉV. et PELLEGR. - 1. seed, 2×; 2. habit, $\frac{2}{3}$ ×; 3. cotyledon (nervation), 1×; 4. detail eophyll, underside, 2×.
 After: Bokdam 4250 (1, 3); De Bruijn s.n. (2, 4).

prominent below; some intersecondary veins, confluent with the tertiary veins; tertiary veins originating exmedially at moderately acute angles, admedially at right to obtuse angles, sinuously percurrent, oblique to perpendicular to the midrib; quaternary veins reticulating; areoles well developed, triangular to polygonal or elongate, parallel to the secondary veins; veinlets 1–2 times forked.

Specimens examined:

CAMEROON: *Breteler* 2625 (WAG), 5 seedlings, voucher: *Breteler* 1934 (WAG); *De Bruijn* s.n. (4-4-62) (WAG), 1 seedling, voucher: *Breteler* 1544 (WAG).

ZAIRE: *Bokdam* 4250 (WAG), 3 seedlings, voucher: *Bokdam* 4224 (WAG); *HPLY* 579 (YBI), voucher: *O* 173 (YBI).

21. *Gambeya lacourtiana* (DE WILD.) AUBRÉV. et PELLEGR.

Fig. 13

Hypocotyl straight, angular to quadrangular, 8–15 cm long, 1–2.5 mm in diam., brown, sometimes minutely verrucose; rootcrown straight; herbaceous apex 2–4 mm long.

Cotyledons free, papery, persistent; petiole flattened, (1)2–3(4) mm long; lamina asymmetrical, ovate, 4.5–8 cm × 2.5–5 cm, base obtuse to truncate, apex rounded, glabrous. *Nervation* (acro-)brochidodromous; primary vein zig-zag, weakly developed, prominent on both sides; 1(–2) basal pair(s) of secondary veins and 4–7 pairs of secondary veins towards the apex, weakly developed, prominent below; few intersecondary veins; tertiary veins slightly prominent below, angle of origin exmedially right to widely acute, admedially right to obtuse, percurrent or reticulating with the quaternary veins; quaternary veins reticulating; areoles well developed, triangular to polygonal, at random arranged, with 1–2 times forked, curved veinlets.

Epicotyl straight, cylindrical to slightly compressed, 0.5–1.5 cm long, densely pubescent with equal-branched, appressed ferruginous hairs; cataphylls absent.

Eophylls alternate, papery, exstipulate, petiole flattened above, 2–3 mm long, densely pubescent, lamina elliptic to narrowly elliptic, 10–14 cm × 3.5–5.5 cm, cuneate at base, acuminate at apex, acumen acute, 1.4–2 cm long, above with glabrescent midrib with colourless hairs, lower face similar but midrib puberulous with ferruginous hairs. *Nervation* brochidodromous; primary vein moderately developed, straight, prominent below; 9–12 pairs of secondary veins prominent beneath, divergent from the midrib at widely to moderately acute angles, uniformly curved; intersecondary veins present; tertiary veins originating exmedially at wide to right angles, admedially at right angles, sinuously percurrent, oblique to the midrib, quaternary veins reticulating; areoles well developed, triangular to polygonal, at random arranged; veinlets repeatedly forked and curved.

Specimens examined:

CAMEROON: *De Bruijn* s.n. (WAG), 1 seedling, voucher: *Breteler* 1735; *Bokdam* 4616

(WAG), 2 seedlings, voucher: *J. J. de Wilde 8220C* (WAG).

ZAIRE: *Bokdam 4662B* (WAG), voucher: *Bokdam 4662A* (WAG); *Bokdam 4608* (WAG), 1 seedling, voucher: *Bokdam 4549* (WAG); *HPLY 5582* (YBI), 2 seedlings, voucher: *O 107* (YBI).

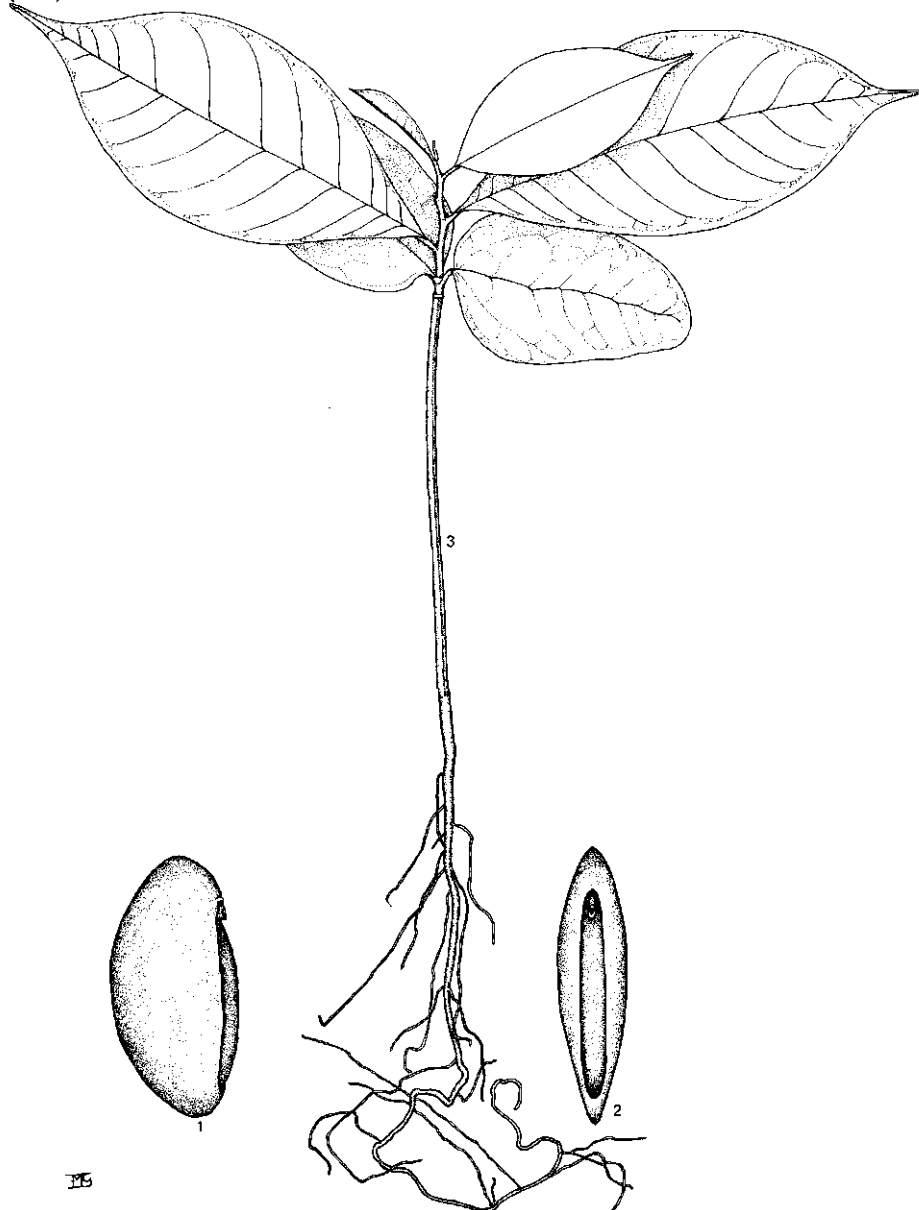


FIG. 13. *Gambeya lacourtiana* (DE WILD.) AUBRÉV. et PELLEGR. - 1. seed, lateral, 1×; 2. seed, ventral, 1×; 3. habit, $\frac{1}{2}$ ×.

After: *Bokdam 4549* (1, 2), *4608* (3).

22. *Gambeya perpulehra* (MILDBR.) AUBRÉV. et PELLEGR.

Fig. 14:1-5

Hypocotyl straight, 6–16 cm long, glabrous, in young herbaceous cylindrical stage yellowish-green with numerous longitudinal red stripes, in older stages brown, woody and quadrangular; rootcrown straight; green herbaceous apex up to 2–3 mm long.

Cotyledons free, papery, persistent, petiole 1–4 mm long, flattened; lamina asymmetrical, elliptic to ovate, 3.5–5 cm × 2–4 cm, base and apex rounded, glabrous. *Nervation* (acro-)brochidodromous; primary vein slightly zig-zag, prominent on both sides; 5–7 pairs of secondary veins, angle of divergence narrowly acute in the basal pair, moderately acute in other secondary veins; some intersecondary veins, confluent with tertiary veins; few distinct tertiary veins, exmedially originating at widely acute angles, admedially at obtuse to right angles, ramifying and imperfectly reticulating; quaternary veins reticulating; areoles well developed, triangular to polygonal; veinlets variably present.

Epicotyl straight, cylindrical, slightly compressed below the nodes, 0.5–2.5 cm long, 0.5–1.5 mm in diam., densely pubescent, ferruginous hairs with flat appressed equal branches; cataphylls absent.

Eophylls alternate, papery, exstipulate; petiole canaliculate, 2–4 mm long, densely pubescent; lamina narrowly elliptic to obovate, 4.5–9 cm × 2–3 cm, base cuneate to decurrent, apex acuminate, acumen acute, 1–1.5 cm long, glossy, glabrescent above with slender, stalked, equal-branched hairs with long, sinuous branches; covered by sericeous indumentum below, sparsely surmounted by equal-branched ferruginous hairs, these parallel to the nearest vein. *Nervation* eucampto-brochidodromous; primary vein stout, impressed above, prominent beneath; 8–12 pairs of secondary veins, prominent below, angle of divergence moderately acute, uniformly curved; few intersecondary veins; tertiary veins prominent above, originating exmedially at wide angles, admedially at obtuse angles, sinuously percurrent, oblique to the midrib, close together; quaternary vein reticulating; areoles well developed, at random arranged, of medium to small size, with few or no veinlets.

Specimens examined:

IVORY COAST: *Tolliez* 262, 273 (BR), 8 seedlings.

ZAIRE: *Bokdam* 4297 (WAG), 1 seedling, voucher: *Bokdam* 4296 (WAG); *Bokdam* 4398 (WAG), 5 seedlings, voucher: *Bokdam* 4397 (WAG); *Bokdam* 4554, 4569, 4610 (WAG), 10 seedlings, voucher: *Bokdam* 4553 (WAG).

23. *Gambeya subnuda* (BAK.) PIERRE

Fig. 14: 6–8

Hypocotyl straight, quadrangular, 6–12 cm long, 1–2.5 mm in diam., glabrous; rootcrown straight; green herbaceous apical part ca. 1 mm long.

Cotyledons free, papery, persistent; petiole 1–2 mm long, flattened; lamina asymmetrical, ovate to elliptic, 3–5 cm × 1.8–3.5 cm, glabrous, base rounded

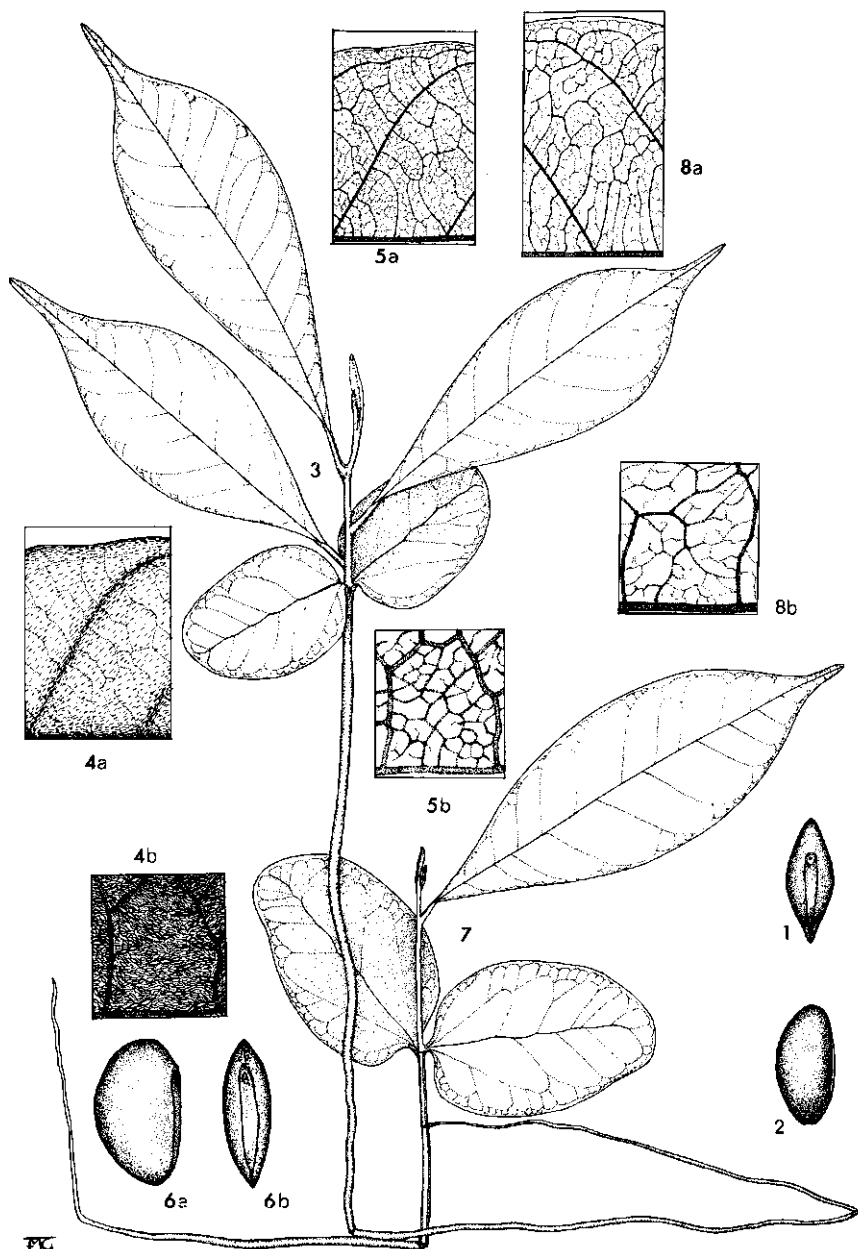


FIG. 14: 1-5. *Gambeya perpulchra* (MILDBR.) AUBRÉV. et PELLEGR. - 1. seed, ventral, $\frac{2}{3} \times$; 2. seed, lateral, $\frac{2}{3} \times$; 3. habit, $\frac{2}{3} \times$; 4a. detail eophyll underside, $2 \times$; 4b. detail eophyll, underside, $10 \times$; 5a. detail eophyll, upperside, $2 \times$; 5b. detail eophyll, upperside, $10 \times$.

6-8. *Gambeya subnuda* (BAK.) PIERRE - 6a. seed, lateral, $1 \times$; 6b. seed, ventral, $1 \times$; 7. habit, $\frac{2}{3} \times$; 8a. detail eophyll, upperside, $2 \times$; 8b. detail eophyll, upperside, $\frac{6}{3} \times$.
After: Bokdam 4553 (1, 2); Tolliez 273 (3-5); De Koning 2062 (6), 3320 (7, 8).

to truncate, apex rounded. *Nervation* (acro-)brochidodromous, primary vein slightly zig-zag, weakly developed, prominent on both faces; secondary veins 4–7 pairs; few or no intersecondary veins; tertiary veins exmedially originating at moderately acute angles, admedially at obtuse to right angles, percurrent and widely reticulating; quaternary veins reticulating; areoles well developed, elongate and parallel to the secondary veins, with linear, 2–3 times forked veinlets.

Epicotyl straight, cylindrical, compressed under the nodes, 0.5–3 cm long, 1–2 mm in diam., densely pubescent; cataphylls absent.

Eophylls alternate, papery, exstipulate; petiole slightly canaliculate, pubescent; lamina elliptic to narrowly elliptic, 7–11 cm × 3–5 cm, cuneate at base, apex acuminate, acumen obtuse to rounded, 0.5–1.2 cm long; glossy and glabrescent above, with very caducous, equal-branched slender hairs, silvery-grey, sericeous below, superimposed with sparse colourless to ferruginous hairs. *Nervation* brochidodromous; primary vein straight, prominent on both sides; 8–11 pairs of secondary veins, angles of divergence moderately to widely acute, prominent beneath, weakly developed, uniformly curved; tertiary veins prominent above, originating exmedially at a wide angle, admedially at right to obtuse angles, oblique to the midrib; quaternary veins reticulating; areoles well developed, large, at random arranged; veinlets present, simple or forked.

Specimens examined:

IVORY COAST: *De Koning* 2538, 2560, 3320, 3629 (WAG), 14 seedlings, voucher: *De Koning* 2062 (WAG).

24. *Gluema ivorensis* AUBRÉV. et PELLEGR.

Hypocotyl stout, straight, 1 cm long; rootcrown straight.

Cotyledons free, fleshy orange-brown, ca. 4 cm × 1.6 cm × 0.7 cm, petiole-like base 0.4 cm long.

Epicotyl straight, angular, 15–20 cm long, tomentose.

Eophylls alternate, exstipulate, papery; petiole short; lamina narrowly elliptic, ca. 7 cm × 1.5 cm. *Nervation* brochidodromous with ± 12 secondary veins.

References:

DE LA MENSBRUGE, 1966.

25. *Ituridendron bequaertii* DE WILD.

Fig. 15:1–4

Hypocotyl straight, quadrangular, 5–8 cm long, 1–2.5 mm in diam., brown, glabrous; rootcrown straight; apical part herbaceous, 2–3 mm long, turning brown rather soon, woody.

Cotyledons free, papery, persistent; petiole flattened, 1–2 mm long; lamina asymmetric, elliptic, 3.5–6 cm × 2–3.5 cm, base obtuse to rounded, apex

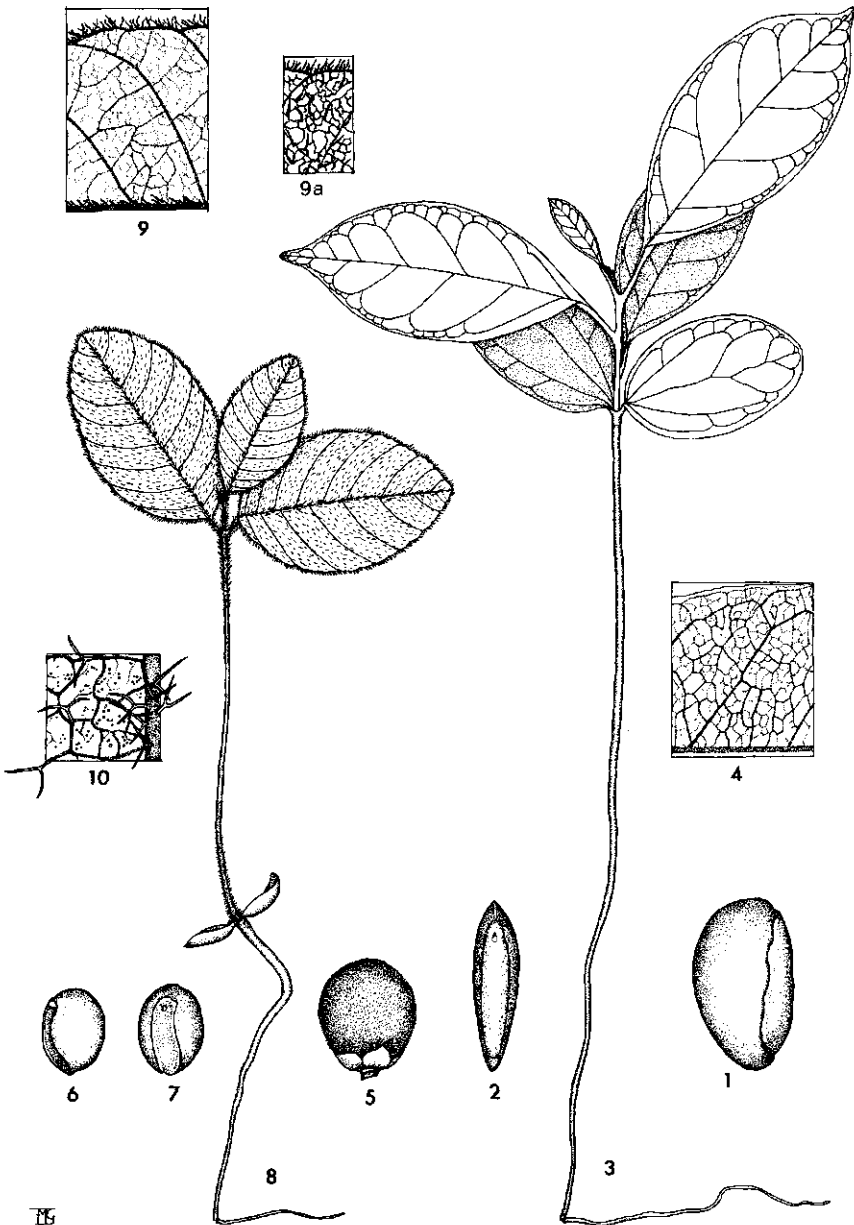


FIG. 15: 1-4. *Ituridendron bequaertii* DE WILD. - 1. seed, lateral, 1 × ; 2. seed, ventral, 1 × ; 3. habit, $\frac{2}{3}$ × ; 4. detail eophyll, underside, 2 × .

5-10. *Malacantha alnifolia* (BAK.) PIERRE - 5. fruit, 1 × ; 6. seed, lateral, 1 × ; 7. seed, ventral, 1 × ; 8. habit, 1 × ; 9. detail eophyll, upperside, 2 × ; 9a. detail eophyll, upperside, $\frac{6}{3}$ × ; 10. detail eophyll, underside, 10 × .

After: Breteler 2082 (1, 2); Cremers 677 (3, 4); Breteler 2719 (5-7), 7189 (8-10).

rounded, glabrous above, minutely papillate beneath (20 ×). *Nervation* acro-brochidodromous; primary vein zig-zag, weakly developed, yellowish, prominent on both faces; 3–4 pairs of secondary veins of which 1 pair basal, slightly prominent beneath; intersecondary veins absent; tertiary veins mainly developed from the basal secondary veins, exmedially originating at a right to widely acute angle, admedially at a right to obtuse angle; quaternary veins reticulating; areoles well developed, triangular to polygonal, large to very large with 2–3 times forked veinlets.

Epicotyl straight, cylindrical, 0.4–1.8 cm long, densely pubescent.

Eophylls alternate, papery, exstipulate; petiole flattened above, 1–7 mm long, sparsely pubescent; lamina narrowly elliptic to elliptic, 5–9 cm × 1.7–4 cm, base cuneate to decurrent, apex shortly acuminate, acumen rounded, up to 8 mm long; sparsely pubescent on both faces, mainly along the primary vein. *Nervation* brochidodromous; primary vein straight, moderately developed, yellowish, prominent on both faces; 4–8 pairs of secondary veins, angle of divergence moderately acute, uniformly curved; few intersecondary veins; tertiary veins originating exmedially at right to widely acute angles, admedially at right to obtuse angles, sinuously percurrent, slightly oblique to the midrib; quaternary veins reticulating, stout areoles well developed; veinlets present, 1–2 times forked.

Specimens examined:

CAMEROON: *Breteler* 3026 (WAG), 2 seedlings, voucher: *Breteler* 2082 (WAG).

IVORY COAST: *Cremers* 677, 677A (BR), 3 seedlings.

26. *Kantou guereensis* AUBRÉV. et PELLEGR.

Fig. 16: 1–3

Hypocotyl straight, cylindrical to angular, 4–7 cm long, 3–5 mm in diam., glabrous; rootcrown straight (– slightly geniculate).

Cotyledons free, fleshy, caducous (to somewhat persistent), sessile; lamina asymmetric, plano-convex, ovate to narrowly ovate, 2.5–3.5 cm × 1–1.5 cm × 0.3–0.5 cm, base and apex rounded, glabrous, wrinkled. *Nervation* hypodromous.

Epicotyl straight, compressed, 7–9 cm long, 1–2 mm in diam., glabrous or glabrescent, with few sparse medifixed colourless hairs; cataphylls absent.

Eophylls alternate (to subopposite), papery, exstipulate; petiole slightly canaliculate, 1.5–3 cm long, sparsely pubescent to glabrescent; lamina elliptic to narrowly elliptic, 8–12 cm × 2.5–6 cm, base cuneate to decurrent, apex acuminate, acumen acute, 1–1.7 cm long; glabrous above and sparsely pubescent on the veins beneath when young. *Nervation* aucampto-brochidodromous; primary vein straight, medium sized, impressed – prominent above, strongly prominent beneath; 6–11 pairs of secondary veins, prominent beneath, angle of divergence moderately acute; few intersecondary veins; tertiary veins exmedially originating at widely to moderately acute angles, admedially at right angles ramifying or percurrent, widely reticulating; quaternary veins reticula-

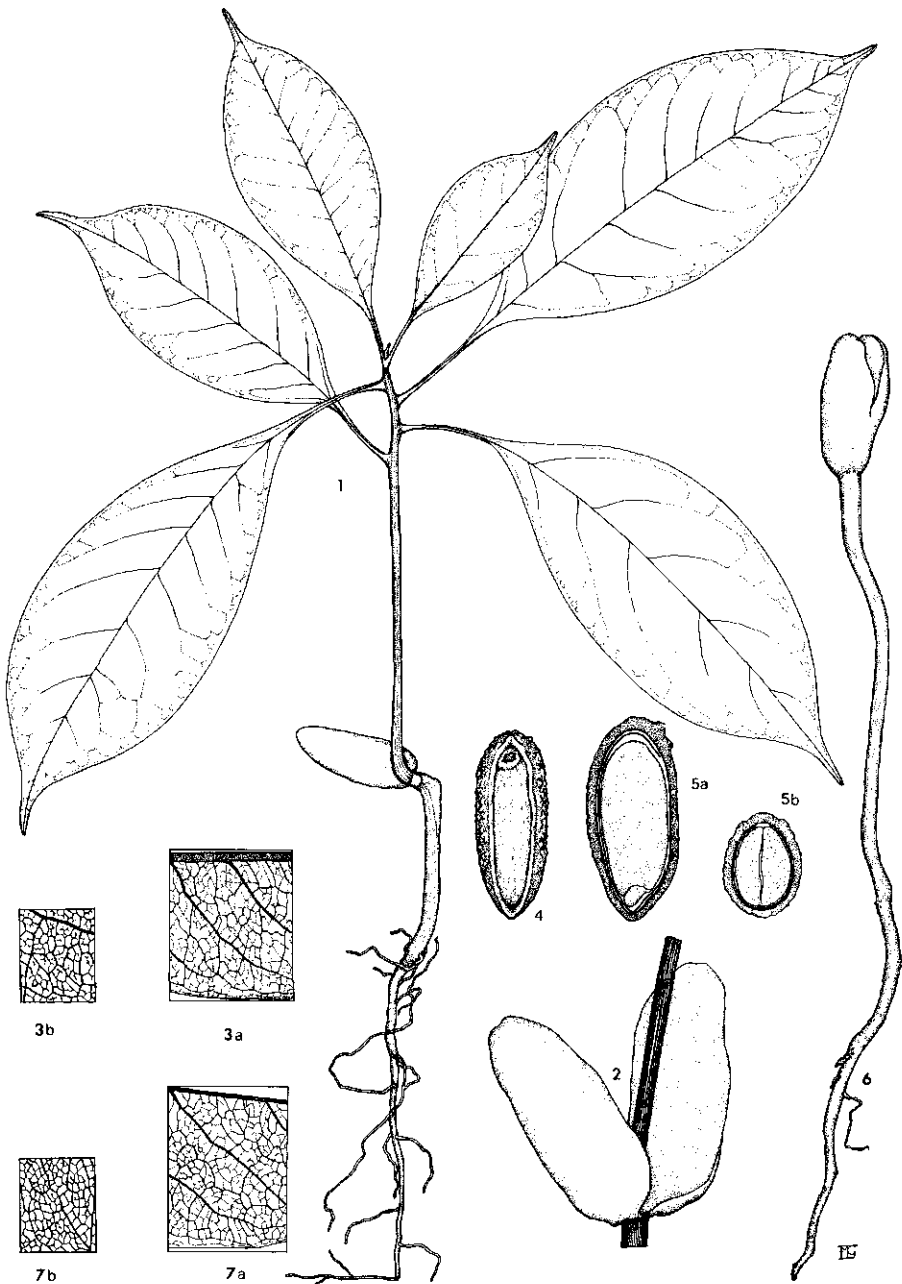


FIG. 16: 1-3. *Kantou guereensis* AUBRÉV. et PELLEGR. - 1. habit, one cotyledon removed, $\frac{1}{2} \times$; 2. position cotyledons in young seedling, $1 \times$; 3a. detail nervation eophyll, $1 \times$; 3b. detail nervation eophyll, $2\frac{1}{2} \times$.

4-7. *Kantou* sp. - 4. seed, ventral, $\frac{1}{2} \times$; 5a. seed, longitudinal section, $\frac{1}{2} \times$; 5b. seed, transversal section, $\frac{1}{2} \times$; 6. young seedling, cotyledons fused at the base, $\frac{1}{2} \times$; 7a. detail nervation eophyll, $1 \times$; 7b. detail nervation eophyll, $2\frac{1}{2} \times$.

After: Tolliez 380 (1-3); Bokdam 4480 (4, 5), 4582 (6), 4481 (7).

ting; areoles well developed, 4–6-angular, at random arranged; veinlets simple or forked.

Specimens examined:

IVORY COAST: *Tolliez 380* (BR), 2 seedlings.

27. *Kantou* sp.

Fig. 16: 4–7

Hypocotyl straight, cylindrical at germination but becoming quadrangular, stout, 8–13 cm long, 3–4 mm in diam., glabrous; rootcrown straight, cylindrical.

Cotyledons free, fleshy, erect with adnate margins before epicotyl development, later on horizontally expanded and caducous, green, asymmetrical plano-convex, elliptic to narrowly elliptic, 3–4 cm × 1–1.8 cm × 0.5–0.7 cm, base and apex rounded. *Nervation* hypodromous.

Epicotyl straight, strongly compressed, 8–15 cm long, glabrous; cataphylls absent.

Eophylls alternate, papery, exstipulate; petiole canaliculate, 2–3 cm long with a ca. 1 cm long blackish, glabrous basal part; lamina narrowly elliptic to ovate, 7–12 cm × 3–5 cm, base cuneate to decurrent, apex acuminate, acumen acute, 0.6–1.5 cm long; sparsely pubescent on the primary and secondary veins below with sessile equal-branched colourless hairs. *Nervation* eucamptodromous; primary vein moderately developed, straight, impressed to prominent above, strongly prominent below; 4–9 pairs of secondary veins, impressed above, prominent below, angle of divergence narrowly to moderately acute, uniformly curved; intersecondary veins confluent with the tertiary veins; tertiary veins originating exmedially at widely acute to right angles, admedially at right to obtuse angles, percurrent and ramifying, slightly oblique to the midrib; quaternary veins reticulating; areoles well developed, at random arranged, triangular to polygonal, small to medium sized; veinlets absent or rare.

Specimens examined:

ZAIRE: *Bokdam 4481* (WAG), 2 seedlings, voucher: *Bokdam 4480* (WAG); *Bokdam 4582* (WAG), 1 seedling, voucher: *Bokdam 4480* (WAG).

28. *Malacantha alnifolia* (BAK.) PIERRE

Fig. 15: 5–10

Hypocotyl straight, cylindrical, 0.2–0.5 cm long, 1.5–2.5 mm in diam., hirsute to glabrescent, with medifixed unequal-branched hairs with obliquely erect branches; rootcrown geniculate.

Cotyledons free, fleshy, caducous, horizontally expanded, sessile, plano-convex, elliptic, 0.5–1.1 cm × 0.3–0.5 cm × 0.1–0.2 cm, glabrous. *Nervation* hypodromous.

Epicotyl straight, cylindrical, slightly compressed below the eophylls, 6–10

cm long, 0.5–1 mm in diam., densely hirsute with unequal-branched medifixed pale brown to colourless hairs.

Eophylls opposite, papery; exstipulate; petiole slightly canaliculate, 3–5 mm long, densely hirsute; lamina elliptic, 3.5–7 cm × 2–3.5 cm, obtuse to rounded at base and apex; veins and veinlets hirsute above, with medifixed hairs of which one branch is completely or nearly completely reduced, the other branch is oblique-erect; below with shortly stalked, equal-branched hairs with erect branches on the primary vein and with long-stalked hairs on veins of lower order; margin ciliate; translucent glandular dots present in the mesophyll. *Nervation* craspedodromous; primary vein moderately developed, straight, impressed above, prominent below; 6–8 pairs of secondary veins, prominent below, angle of divergence widely acute to right near the base, decreasing towards the apex, uniformly curved, joining marginal vein; tertiary veins originating exmedially and admedially at right angles, percurrent, oblique to the midrib; quaternary veins reticulating; areoles well developed, small, quadrangular to polygonal; veinlets absent (to very rarely present), simple.

Specimens examined:

GABON: *Breteler* 7189 (WAG), 6 seedlings.

IVORY COAST: *Cremers* 407 (BR), 2 seedlings.

29. *Manilkara obovata* (SABINE et G. DON) J. H. HEMSLEY
(= *Manilkara lacera* (BAK.) DUBARD)

Hypocotyl straight, 5–7 cm long, glabrous.

Cotyledons free, coriaceous, persistent; lamina asymmetrical, elliptic to ovate, ca. 3 cm × 1.2–2 cm, base obtuse, apex rounded. *Nervation* acro-brochidodromous; tertiary veins reticulating.

Epicotyl 1–2 cm long.

Eophylls alternate, exstipulate; petiole short, canaliculate; lamina narrowly elliptic, ca. 4 cm × 1.5 cm, base decurrent, apex acuminate. *Nervation* brochi-dodromous with numerous secondary veins; primary vein prominent beneath.

References:

DE LA MENSBRUGE, 1966;

VOORHOEVE, 1965.

30. *Mimusops* sp.

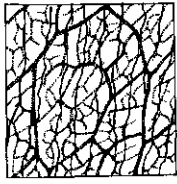
Fig. 17

Hypocotyl straight, angular, 5–7 cm long, brown, woody, glabrous; root-crown straight; green herbaceous apical part with longitudinal slits up to 5–7 mm long.

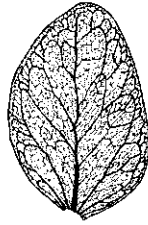
Cotyledons free, coriaceous, persistent; petiole flattened, 1–2 mm long, 2–3 mm wide; lamina elliptic to ovate, asymmetric, 2–3.5 cm × 1.4–2 cm, glabrous, glossy above. *Nervation* acro-brochidodromous; primary vein

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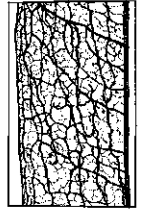
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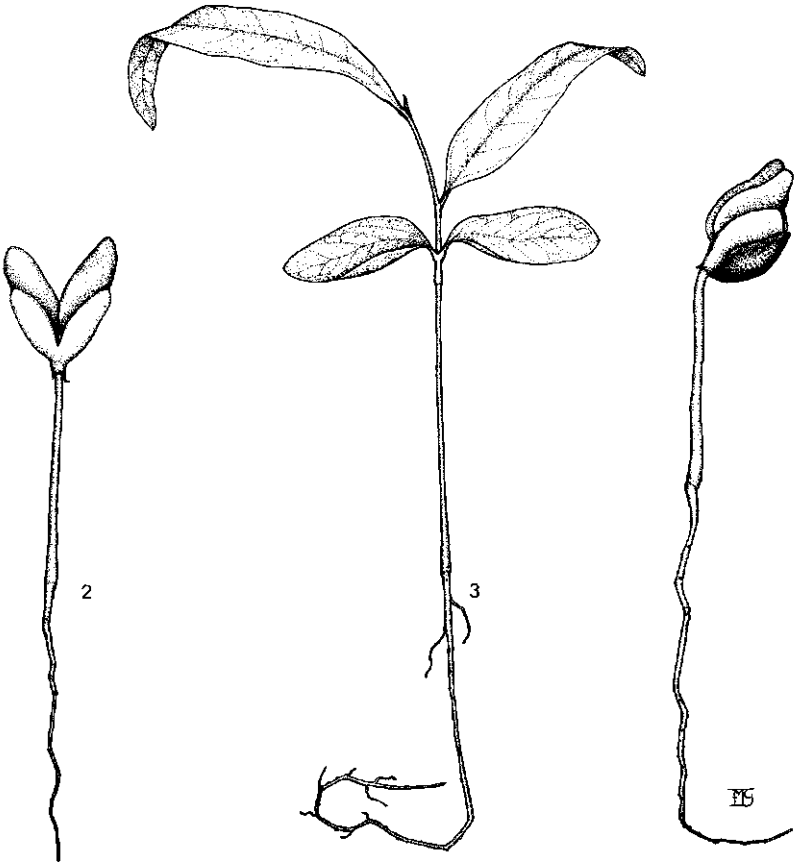


FIG. 17. *Mimusops* sp. – 1. young seedling, cotyledons emerging from endosperm and testa, $\frac{2}{3} \times$; 2. young seedling, base of cotyledons still enveloped by endosperm, $\frac{2}{3} \times$; 3. habit of seedling in eophyll stage, $\frac{2}{3} \times$; 4. cotyledon, $1 \times$; 5. detail cotyledon, lactiferous ducts visible, $6 \times$; 6. detail eophyll, lactiferous ducts visible, $2 \times$.

After: J. J. de Wilde s.n.

slightly prominent on both sides; 3–5 pairs of secondary veins; few intersecondary veins; tertiary veins mainly exmedially from basal secondary veins, angle of origin narrowly to moderately acute; quaternary veins reticulating; areoles imperfect, large to medium in size, parallel to the secondary or tertiary veins; veinlets simple to several times forked; translucent lactiferous ducts parallel to the secondary veins.

Epicotyl straight, compressed, 0.6–1 cm long, shortly pubescent, with whitish appressed equal-branched hairs; cataphylls absent.

Eophylls alternate, papery, stipules subulate, 0.4–0.5 mm long, pubescent; petiole flattened above, 2–4 mm long, sparsely pubescent; lamina narrowly elliptic, 4–8 cm × 1.5–2 cm, base cuneate to decurrent, apex obtuse to rounded, glabrescent with silvery hairs in young stage, glabrous when older, except for pubescence on the midrib below. *Nervation* brochidodromous; primary vein weakly developed, straight, prominent on both sides; 6–9 pairs of secondary veins, slightly prominent on both sides, divergent at a widely acute angle, straight with abrupt loops towards an intramarginal vein; intersecondary veins numerous, confluent with tertiary veins; tertiary veins originating exmedially at right to obtuse angles, admedially at right angles, confluent with intersecondary and quaternary veins; quaternary veins reticulating; areoles imperfectly developed, at random arranged, translucent lactiferous ducts parallel to the secondary veins, but abruptly ascending near the margin.

Specimens examined:

ETHIOPIA: *J. J. de Wilde s.n.* (WAG), 6 seedlings, voucher: *J. J. de Wilde 5859* (WAG).

31. *Omphalocarpum elatum* MIERS

Hypocotyl straight, cylindrical to angular, ca. 9–10 cm long, 3–4 mm in diam., brown, glabrous; rootcrown straight; green herbaceous apical part with 2 longitudinal grooves.

Cotyledons free, papery, persistent; petiole flattened, 4–6 mm long; lamina asymmetric, elliptic, 7–8 cm × 4.5–6 cm, rounded to truncate at base, rounded at apex, minutely papillate on both faces; lactiferous ducts radiating from the midrib towards the margin, inconspicuous below. *Nervation* brochidodromous; primary vein slightly zig-zag, prominent on both faces; 5–7 pairs of secondary veins, slightly prominent below, angle of divergence narrow to moderately acute, straight with abrupt brochidodromous loops; intersecondary veins rare; tertiary veins oblique to the midrib; quaternary veins reticulating; areoles well developed, triangular to polygonal, at random arranged; veinlets simple to repeatedly forked.

Epicotyl straight, slightly compressed below the nodes, 2–3.5 cm long, sparsely pubescent with short medifixed hairs; cataphylls present; buds densely pubescent.

Eophylls alternate, papery, exstipulate; petiole slightly canaliculate, 3–6 mm long, pubescent; lamina narrowly obovate, 11–14 cm × 3–5 cm, base cuneate,

apex shortly acuminate, acumen acute, up to 1 cm long; sparsely pubescent to glabrous on both faces, mainly on the veins. *Nervation* brochidodromous; primary vein weakly developed, straight, prominent below; 7–11 pairs of secondary veins, angle of divergence narrow to moderately acute, prominent below, uniformly curved; tertiary veins originating exmedially at right to obtuse angles, admedially at right angles, sinuous, percurrent, oblique to the midrib; quaternary veins reticulating; areoles well to imperfectly developed, small to medium in size; veinlets repeatedly forked.

Specimens examined:

IVORY COAST: *De Bruijn 1957* (WAG), 2 seedlings, voucher: *Versteegh 645* (WAG).

32. *Omphalocarpum lecomteanum* PIERRE ex ENGL.

Fig. 18

Hypocotyl straight, cylindrical, 10–20 cm long, brown, glabrous; rootcrown straight; apical green herbaceous part 4–15 mm long.

Cotyledons free, papery, persistent; petiole flattened, 0.5–1.2 mm long; lamina elliptic, asymmetrical, 7–12 cm × 5–8 cm, base truncate to cordate, apex rounded; both faces with minute colourless papillae. *Nervation* brochidodromous; primary vein slightly zig-zag, weakly developed, prominent on both faces; 6–10 pairs of secondary veins weakly developed, prominent below, angle of divergence narrowly to moderately acute, straight, abruptly looped to join the superadjacent secondary vein at a wide angle; few intersecondary veins; tertiary veins originating exmedially at moderate to widely acute angles, admedially at right angles, percurrent, sinuous; quaternary veins reticulating; areoles imperfect to well developed, at random arranged; veinlets mostly present.

Epicotyl straight, cylindrical, 1–2.5 (4.5) cm long, pubescent to glabrescent, 1–2 pubescent cataphylls present.

Eophylls alternate, papery, exstipulate; petiole semi-terete, canaliculate, 4–7 mm long; lamina narrowly obovate to elliptic, 6–22 cm × 2.8–8 cm, base cuneate, apex acuminate, acumen rounded, 0.4–2.5 cm long, glabrous above, glabrescent below, mainly on the midrib. *Nervation* eucampto-brochidodromous; primary vein weakly developed, straight, prominent on both faces; 6–10 pairs of secondary veins, prominent below, angle of divergence moderately acute; tertiary veins originating ex- and admedially at right angles, sinuously percurrent; quaternary veins reticulating; areoles imperfect to well developed, triangular to polygonal, at random arranged; veinlets simple to repeatedly forked.

Specimens examined:

ZAIRE: *Bokdam 4390* (WAG), 3 seedlings, voucher: *Bokdam 4389* (WAG); *Bokdam 4590* (WAG), 1 seedling, voucher: *Bokdam 4567* (WAG); *HPLY 7850* (YBI), voucher: *O 2741* (YBI); *HPLY 689* (YBI), voucher: *O 373* (YBI); *Bokdam 4311*, *Teulings 8, 12* (WAG), 5 seedlings, voucher: *Bokdam 4312* (WAG).

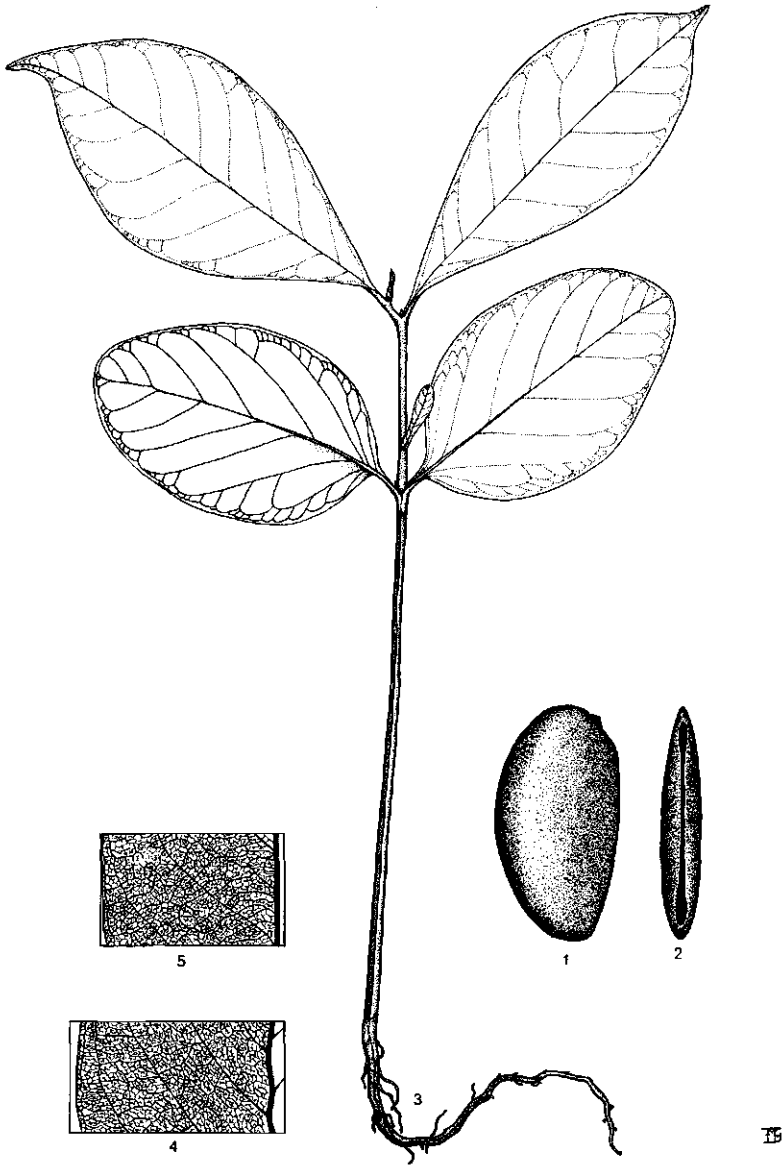


FIG. 18. *Omphalocarpum lecomteanum* PIERRE ex ENGL. - 1. seed, lateral, $\frac{1}{2} \times$; 2. seed, ventral, $\frac{1}{2} \times$; 3. habit, $\frac{1}{2} \times$; 4. detail nervation cotyledon, $1 \times$; 5. detail nervation eophyll, $1 \times$.

After: Bokdam 4389 (1-3), 4590 (4, 5).

33. *Omphalocarpum procerum* P. BEAUV.

Hypocotyl straight, cylindrical to angular, 7–16 cm long, 1.5–4 mm in diam., glabrous, brown; rootcrown straight to slightly geniculate; green herbaceous apical part 0.5–1 cm long.

Cotyledons free, papery, persistent; petiole flattened, 4–7 mm long; lamina asymmetric, elliptic, 5–10 cm × 3–7 cm, base obtuse to rounded, apex rounded, both faces with minute colourless papillae. *Nervation* brochidodromous; primary vein weakly developed, zig-zag, prominent on both faces; 4–7 pairs of secondary veins prominent on both faces, angle of divergence narrowly to moderately acute, straight, abruptly looping and joining the superadjacent secondary vein; few intersecondary veins; tertiary veins originating exmedially at narrowly acute to right angles, admedially at right angles, sinuously percurrent, oblique to the midrib; quaternary veins reticulating; areoles imperfect or well developed, triangular to polygonal, at random arranged; veinlets simple to repeatedly forked.

Epicotyl straight, cylindrical, 0.5–4 cm long, pubescent to glabrescent; cataphylls mostly present, pubescent, caducous.

Eophylls alternate, papery, exstipulate; petiole slightly canaliculate, glabrescent, 3–6 mm long; lamina narrowly obovate to narrowly elliptic, 9–24 cm × 3–7 cm, base cuneate to decurrent, apex acuminate, acumen rounded, acute, up to 1 cm long, glabrescent below. *Nervation* eucampto-brochidodromous; primary vein straight, prominent on both faces; 5–8(10) pairs of weakly developed secondary veins prominent on both faces, angle of divergence moderate to widely acute, uniformly curved; intersecondary veins rare; tertiary veins originating ex- and admedially at right angles, percurrent, oblique to the midrib; quaternary veins reticulating; areoles imperfectly developed, triangular to polygonal; veinlets simple to repeatedly forked.

Specimens examined:

CAMEROON: *Bokdam 4589* (WAG), 3 seedlings, voucher: *J. J. de Wilde 7835* (WAG).

ZAIRE: *Bokdam 4329, 4572* (WAG), 4 seedlings, voucher: *Bokdam 4328* (WAG); *Bokdam 4382, Teulings 7* (WAG), 3 seedlings, voucher: *Bokdam 4382A* (WAG); *Bokdam 4422, 4577, Teulings 11, 17* (WAG), 9 seedlings, voucher: *Bokdam 4421* (WAG); *Bokdam 4613* (WAG), 2 seedlings, voucher: *Bokdam 4564* (WAG).

34. *Omphalocarpum* sp.

Hypocotyl straight, cylindrical, 8–12 cm long, 3–4 mm in diam., woody, brown; rootcrown straight; green herbaceous apical part 4–8 mm long.

Cotyledons free, papery, persistent; petiole flattened, 4–8 mm long, lamina asymmetric, broadly elliptic to circular, 5–8.5 cm × 4–7.5 cm, base obtuse, truncate or slightly cordate, apex rounded, minutely papillate on both faces. *Nervation* brochidodromous; primary vein slightly zig-zag, prominent on both faces; 5–8 pairs of secondary veins, angle of divergence moderate to narrowly acute, uniformly curved; intersecondary veins absent; tertiary veins originating

exmedially at narrow to moderately acute angles, admedially at obtuse to right angles, sinuously percurrent, oblique to perpendicular to the midrib; quaternary veins reticulating; areoles well developed; veinlets simple to repeatedly forked.

Epicotyl straight, cylindrical, 1.5–3.5 cm long, sparsely pubescent; 1 cataphyll present, pubescent.

Eophylls alternate, papery, exstipulate; petiole flattened, 3–4 mm long, sparsely pubescent; lamina narrowly obovate, 10–18 cm × 3–7 cm, base cuneate, apex acuminate, acumen rounded to acute, 0.5–1.5 cm long, midrib glabrescent below. *Nervation* eucamptodromous; primary vein straight, prominent on both faces; 6–13 pairs of secondary veins, prominent below, angle of divergence widely to moderately acute, uniformly curved; few inter-secondary veins; tertiary veins originating ex- and admedially at right angles, percurrent, oblique to the midrib; quaternary veins reticulating; areoles imperfectly developed; veinlets simple or 1–2 times forked.

Specimens examined:

ZAIRE: Bokdam 4499, 4575 (WAG), 5 seedlings, Teulings 10 (WAG), 2 seedlings, voucher: Bokdam 4392 (WAG).

35. *Pachystela bequaertii* DE WILD.

Fig. 19: 1–4

Hypocotyl straight, cylindrical, 2–5 cm long, glabrous, brown.

Cotyledons free, fleshy, caducous, horizontally expanded, plano-convex, elliptic to narrowly elliptic, ca. 1.5 cm × 0.6 cm × 0.3 cm, base and apex rounded, wrinkled, glabrous. *Nervation* hyphodromous.

Epicotyl straight, cylindrical at base to compressed below the eophylls, 4–11 cm long, ca. 1 mm in diam., pubescent with grey-brown, equal-branched, appressed hairs; cataphylls absent.

Eophylls opposite, firmly papery; stipules caducous, linear, 1.5–2.5 mm long, brown, densely pubescent; petiole 1.5–2.5 mm long, slightly canaliculate, densely pubescent; lamina elliptic to obovate, 4–10 cm × 2.5–5 cm, base cuneate and ultimately rounded, or decurrently so, apex acuminate, acumen slender, acute to obtuse, up to ca. 1 cm long; glabrescent, minutely gibbous (corresponding with the areoles) above, glossy silvery grey sericeous, the hairs parallel to the nearest vein, and with some grey-brown hairs below. *Nervation* eucampto-brochidodromous; primary vein straight, impressed to prominent above, strongly prominent below; 7–11 pairs of secondary veins, angle of divergence widely acute at base, decreasing to moderately acute near the apex of the leaf, uniformly curving in sub-marginal loops, impressed above, prominent below; tertiary veins originating exmedially at acute angles, admedially at obtuse to right angles, sinuously percurrent, oblique to the midrib; quaternary veins reticulating; areoles well developed, triangular to polygonal, very small, in transmitted light with 1–several dark dots but without veinlets, at random arranged.

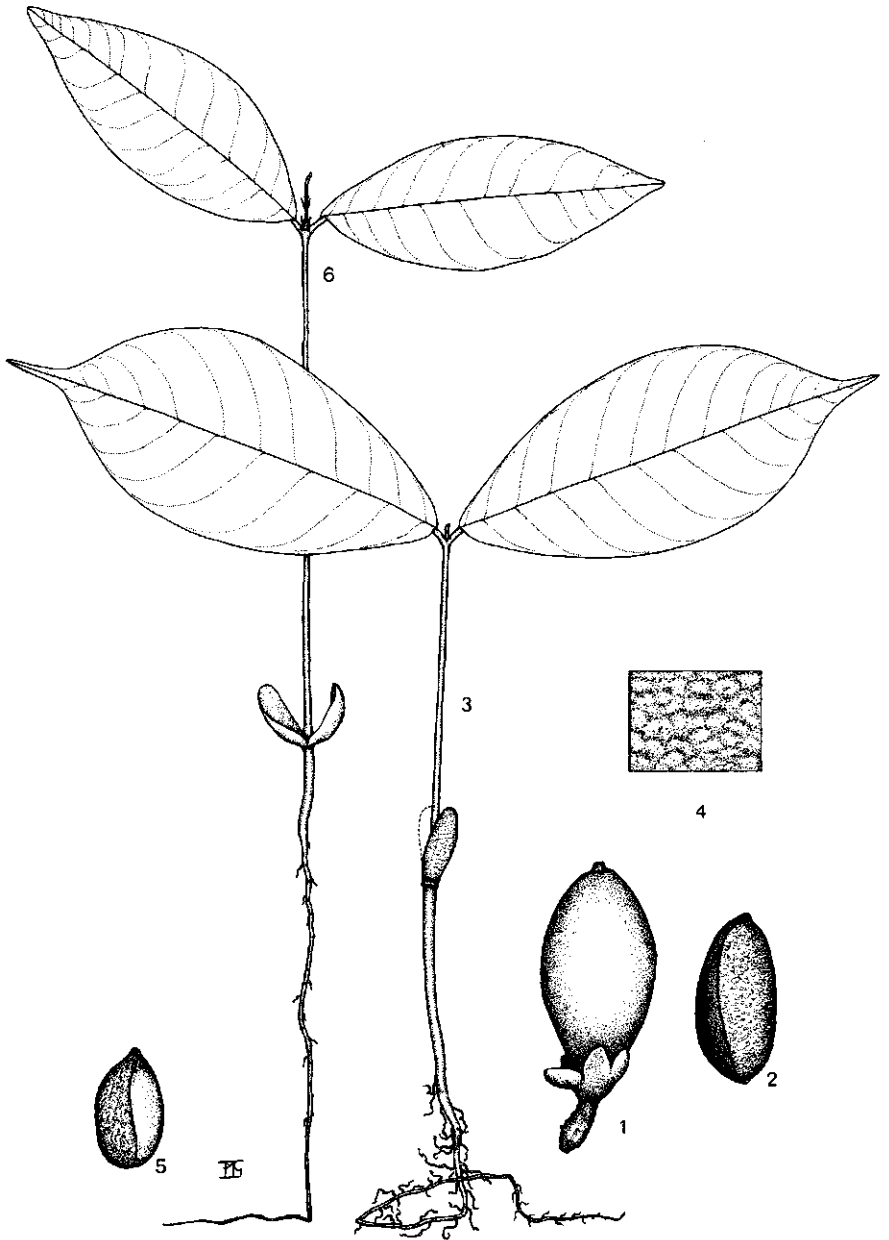


FIG. 19: 1-4. *Pachystela bequaertii* DE WILD. - 1. fruit, 1 × ; 2. seed, lateral, 1 × ; 3. habit, $\frac{2}{3}$ × ; 4. gibbous surface of upper side of the eophyll, 8 × .

5-6. *Pachystela brevipes* (BAK.) ENGL. - 5. seed, lateral, 1 × ; 6. habit, $\frac{2}{3}$ × .

After: Bokdam 4565 (1, 2); Teulings 18 (3, 4); Bokdam 4507 (5); Tolliez 236 (6).

Specimens examined:

ZAIRE: *Bokdam* 4333, 4573 (WAG), 5 seedlings, voucher: *Bokdam* 4332 (WAG); *Bokdam* 4594, *Teulings* 18 (WAG), 4 seedlings, voucher: *Bokdam* 4565 (WAG); *HPLY* 1129 (YBI), voucher: *O* 757 (YBI); *HPLY* 1288, 1360 (YBI), 2 seedlings, voucher: *O* 694 (YBI).

36. *Pachystela brevipes* (BAK.) ENGL.

Fig. 19: 5-6

Hypocotyl straight, cylindrical, 1.5-2.5 cm long, 1-1.5 cm in diam., brown, glabrous.

Cotyledons free, fleshy, caducous, obliquely erect to horizontally expanded, sessile, plano-convex, elliptic, 1.0-1.4 cm × 0.3-0.5 cm × 0.2-0.3 cm; base truncate; apex rounded to emarginate. *Nervation* hypodromous.

Epicotyl straight, cylindrical at base, compressed below the eophylls, 7-11 cm long, densely pubescent with equal-branched golden-brown hairs.

Eophylls opposite, firmly papery; stipules linear, caducous, 1.5-3 mm long, densely pubescent; petiole slightly canaliculate, 1-2 mm long, densely pubescent; lamina elliptic to narrowly so, 5-8 cm × 2.5-4 cm, cuneate at the base; apex acuminate, acumen broad, rounded, 2-6 mm long; surface glabrescent, minutely gibbous above (corresponding with the areoles), sericeous below, glossy, with dense silvery or greyish-green indumentum, superimposed by short-stalked equal-branched brown hairs. *Nervation* eucampto-brochidodromous; primary vein of medium size, straight, impressed to prominent above, strongly prominent below; 6-10 pairs of secondary veins weakly developed, impressed above, prominent below, angle of divergence widely to moderately acute, uniformly curved in submarginal loops; few intersecondary veins; tertiary veins originating exmedially at narrowly acute to right angles, admedially at obtuse to right angles; percurrent, oblique to the midrib; quaternary veins reticulating; areoles well developed, triangular to polygonal, small to very small, with 1-several dark dots in transmitted light, at random arranged.

Specimens examined:

IVORY COAST: *Tolliez* 236 (BR), 6 seedlings.

ZAIRE: *Bokdam* 4630 (WAG), 1 seedling, voucher: *Bokdam* 4507 (WAG).

37. *Pseudoboivinella oblanceolata* (S. MOORE) AUBRÉV. et PELLEGR.

Hypocotyl short or not developed.

Cotyledons remaining enclosed within the testa, fleshy, plano-convex, ± persistent.

Epicotyl straight, ca. 8 cm long, pubescent with appressed ferruginous hairs.

Eophylls opposite, stipulate; petiole 2-3 mm long, pubescent; lamina elliptic to narrowly elliptic, ca. 5 cm × 1.8 cm, pubescent on the veins below.

Nervation brochidodromous with 10-12 pairs of secondary veins.

References:

DE LA MENSBRUGE, 1966;

AUBRÉVILLE, 1960.

Hypocotyl not developed; rootcrown geniculate.

Cotyledons remaining enclosed in the testa, fleshy, slightly diverging to free the epicotyl, plano-convex, elliptic-ovate or narrowly so, ca. 1.5 cm × 0.4–0.6 cm × 0.4 cm, rounded at base and apex, glabrous, light green to pale yellowish.

Epicotyl straight, cylindrical at base to slightly compressed below the eophylls, 4–6 cm long, glabrous with grey-brown appressed hairs.

Eophylls opposite, exstipulate, papery; petiole slightly canaliculate, pubescent, 1–2 mm long; lamina narrowly elliptic, 3–4.5 cm × 1.4–1.8 cm, cuneate at base, apex acute to shortly acuminate, with a broad rounded acumen; glabrous above, midrib glabrescent beneath. *Nervation* brochidodromous; primary vein straight, prominent on both faces; 8–12 pairs of secondary veins, prominent beneath, angle of divergence widely acute; intersecondary veins rarely present; tertiary veins originating exmedially at wide to right angles, admedially at obtuse to right angles, zig-zag percurrent, oblique to the midrib; quaternary veins are repeated ramifications of tertiary veins directed towards the midrib; areoles incompletely developed; a criss-cross pattern of minute short translucent lines is visible in transmitted light.

Specimens examined:

Bokdam 4595 (WAG), voucher: *greenhouse nr. 713* (WAG) (= *Bokdam 4586* (WAG)); *Bokdam 4623* (WAG), voucher: *greenhouse nr. 713* (= *Bokdam 4621* (WAG)); both voucher plants are flowering and fruiting in the greenhouse at Wageningen.

Hypocotyl not developed; rootcrown geniculate.

Cotyledons remaining enclosed in the testa, fleshy, slightly diverging to free the epicotyl; rarely freed from the testa and borne obliquely erect (*Teulings 13*); plano-convex, elliptic, 1.0–1.5 cm × 0.3–0.7 cm × ca. 0.2 cm, glabrous.

Epicotyl straight, geniculate at base, cylindrical, compressed below the eophylls, 4.5–10 cm long, 0.5–1 mm in diam., pubescent to glabrescent with appressed brown hairs.

Eophylls opposite (rarely subopposite), stipules not observed (either early caducous or not developed in seedlings); petiole slightly canaliculate, 1.5–2.5 mm long, pubescent; lamina elliptic to narrowly elliptic, (2)4–8 cm × (1)2–3.5 cm, acute to obtuse at base, slightly acuminate at apex, acumen short, rounded, 3–4 mm long; midrib pubescent on both faces. *Nervation* brochidodromous; primary vein straight, prominent on both faces, yellowish beneath; secondary veins 8–12 pairs, prominent, yellowish beneath, angle of divergence right to widely acute at the base, decreasing and widely to moderately acute near the apex of the eophyll; few intersecondary veins; tertiary veins originating exmedially at wide angles, admedially at right to obtuse angles, sinuously

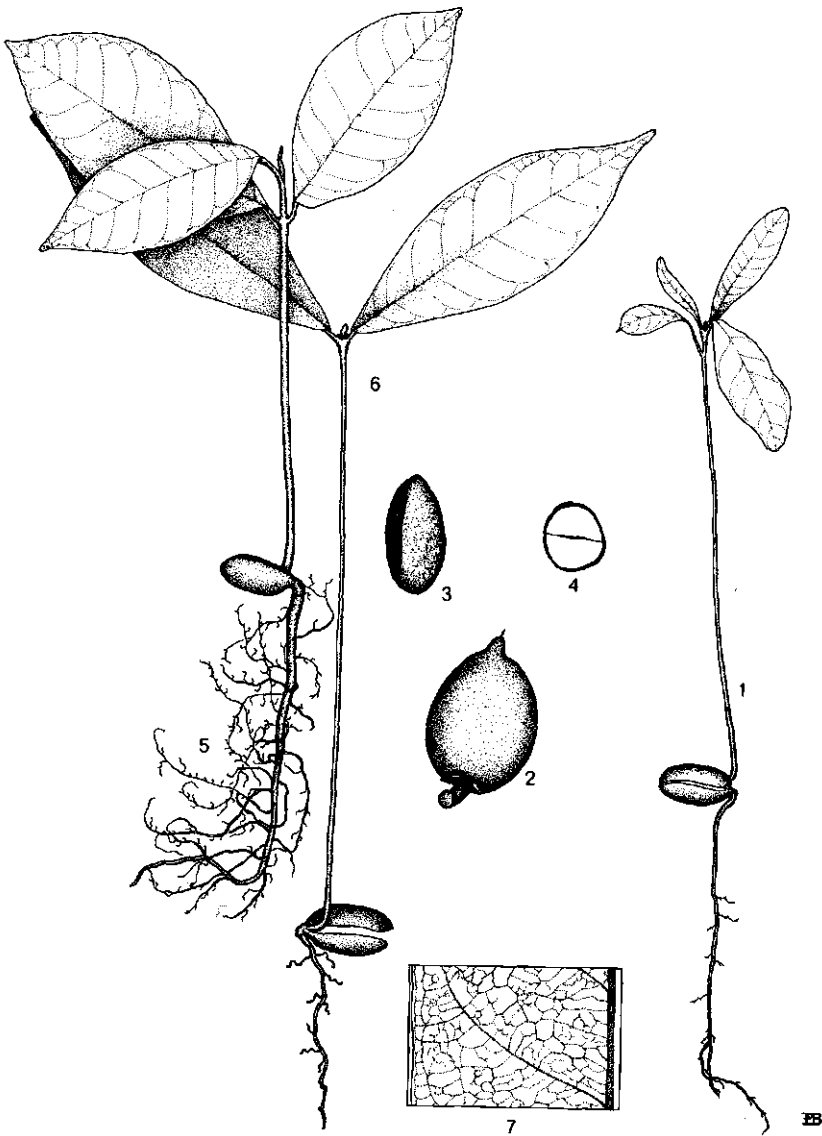


FIG. 20: 1. *Synsepalum dulcificum* (SCHUM.) BAILL. - Habit, $\frac{2}{3} \times$.
 2-5. *Synsepalum stipulatum* (RADLK.) ENGL. - 2. fruit, $1 \times$; 3. seed, lateral, $1 \times$;
 4. seed, transversal section, $1 \times$; 5. habit, $\frac{2}{3} \times$.
 6-7. *Synsepalum subcordatum* DE WILD. - 6. habit, $\frac{2}{3} \times$; 7. detail nervation of
 eophyll, $2 \times$.

After: Bokdam 4623 (1), 4541 (2-4); Teulings 14 (5), 16 (6-7).

percurrent; quaternary veins are repeated ramifications of tertiary veins, directed towards the midrib; areoles lacking; a criss-cross pattern of minute short translucent lines is visible in transmitted light.

Specimens examined:

ZAIRE: *Bokdam* 4218, 4256 (WAG), voucher: *Bokdam* 4072 (WAG); *Bokdam* 4496, 4591, 4607, 4612, *Teulings* 13, 14 (WAG), voucher: *Bokdam* 4495 (WAG).

40. *Synsepalum subcordatum* DE WILD.

Fig. 20: 6-7

Hypocotyl not developed; rootcrown geniculate.

Cotyledons fleshy, remaining enclosed in the testa, slightly diverging to free the epicotyl (rarely freed and obliquely or unilaterally erect), sessile; lamina plano-convex, narrowly ovate-elliptic, 1.0-1.5 cm × 0.4-0.6 cm × 0.1-0.3 cm, base truncate, apex rounded, wrinkled. *Nervation* hypodromous.

Epicotyl straight, geniculate at the base, cylindrical but slightly compressed below the eophylls, 4-13 cm long, 0.5-1 mm in diam., pubescent to glabrescent with ferruginous, equal-branched hairs; cataphylls absent.

Eophylls opposite (rarely subopposite), papery, exstipulate; petiole slightly canaliculate, 1-3 mm long, pubescent with stalked, equal-branched ferruginous hairs; lamina narrowly elliptic, 4.5-9 cm × 1.5-3 cm, cuneate but ultimately rounded, apex acuminate, acumen broad, rounded, 0.5-1.0 cm long; glabrescent above, pubescent on the midrib below. *Nervation* eucamptobrochidodromous; primary vein straight, prominent on both faces; 8-13 pairs of secondary veins comparatively weakly developed, prominent below, angle of divergence acute, right at the base, decreasing to moderately acute towards the apex of the eophyll, uniformly curved; intersecondary veins present; tertiary veins originating exmedially at widely acute to right angles, admedially at right angles, percurrent and oblique to the midrib; quaternary veins are repeated ramifications of tertiary veins towards the midrib; areoles lacking; a criss-cross pattern of short translucent lines is visible in transmitted light.

Specimens examined:

ZAIRE: *Bokdam* 4217, 4255 (WAG), 8 seedlings, voucher: *Bokdam* 4069 (WAG); *HPLY* 6986 (YBI), voucher: *O* 161 (YBI); *Teulings* 16 (WAG), 4 seedlings, voucher: *Bokdam* 4550 (WAG).

41. *Tieghemella africana* PIERRE

Fig. 21: 1-5

Hypocotyl very stout, straight, cylindrical to angular below the cotyledons, 10-17 cm long, 4-6 mm in diam.; rootcrown straight.

Cotyledons free, fleshy, caducous, horizontally expanded to obliquely erect, sessile, asymmetric, narrowly elliptic, plano-convex, ca. 4 cm × 0.8-1 cm × 0.6-0.7 cm, base truncate, apex rounded, glabrous, green. *Nervation* hypodromous.

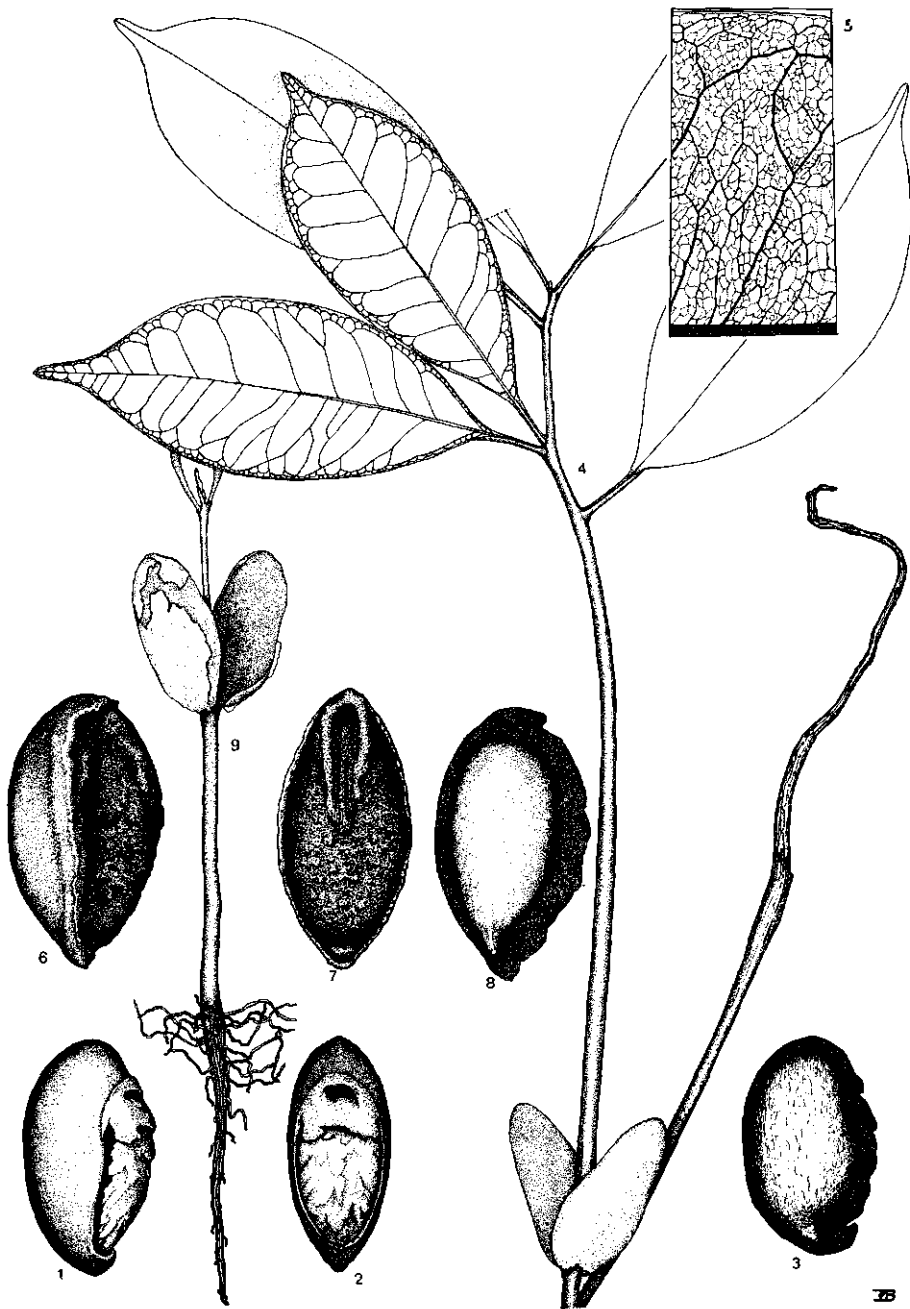


FIG. 21: 1-5. *Tieghemella africana* PIERRE - 1. seed, lateral, $\frac{1}{2} \times$; 2. seed, ventral, $\frac{1}{2} \times$; 3. seed, longit. section, $\frac{1}{2} \times$; 4. seedling, habit, $\frac{1}{2} \times$; 5. detail nervation eophyll, $1\frac{1}{2} \times$.
 6-9. *Tieghemella heckelii* PIERRE - 6. seed, lateral, $\frac{1}{2} \times$; 7. seed, ventral, $\frac{1}{2} \times$; 8. seed, longitudinal section, through testa, embryo and endosperm complete, $\frac{1}{2} \times$; 9. young seedling, membranous endosperm persisting on cotyledons, $\frac{1}{2} \times$.

After: Bokdam 4420 (1-3); Teulings 6 (4-5); Voorhoeve 680 (6-8); De Bruijn 1943 (9).

Epicotyl straight, strongly compressed with sharp edges, 10–17 cm long, 2–5 mm in diam., glabrous; cataphylls absent.

Eophylls alternate to subopposite, papery, exstipulate; petiole flattened to slightly canaliculate above, rounded below, 0.6–1.5 cm long, glabrous; lamina obovate to narrowly obovate, 7–12(16) cm × 3–6 cm, base cuneate to decurrent, apex acuminate, acumen rounded, 0.4–2 cm long; glabrous. *Nervation* brochidodromous; primary vein straight, impressed to prominent above, prominent below; 7–12 pairs of secondary veins weakly impressed above, slightly prominent below, angle of divergence widely to moderately acute, uniformly curved; intersecondary veins present; tertiary veins originating ex-medially and admedially at right angles, ramifying over the intersecondary space; quaternary veins present as ultimate ramifications of tertiary veins towards the midrib; areoles lacking; a conspicuous pattern of parallel, sinuous lactifers between midrib and margin of the eophyll is visible in transmitted light; they are spaced at ca. 0.5 mm.

Specimens examined:

ZAIRE: *Bokdam* 4408, 4498 (WAG), 2 seedlings, voucher: *Bokdam* 4407; *Bokdam* 4578, *Teulings* 6 (WAG), 7 seedlings, voucher: *Bokdam* 4420 (WAG); *Dubois* 217 (BR), 2 seedlings, voucher: *Dubois* 217 (BR).

42. *Tieghemella heckelii* PIERRE

Fig. 21: 6–9

Hypocotyl straight, cylindrical to angular, compressed below the cotyledons, ca. 6–10 cm long, ca. 3 mm in diam., glabrous, dark green; rootcrown straight.

Cotyledons free, fleshy, light to dark green, rather caducous, sessile, plano-convex, elliptic-ovate or narrowly so, asymmetrical, 4–5 cm × 1.5–2.2 cm × 0.6–0.7 cm, glabrous. *Nervation* hyphodromous.

Epicotyl straight, strongly compressed, (3)5–6.5 cm long, 2.5–3 mm in diam., glabrous; cataphylls absent.

Eophylls alternate, papery, exstipulate; petiole slightly grooved, glabrous, 5–8 mm long; lamina elliptic to obovate, ca. 7.5 cm × 3.5 cm, base decurrent, apex acuminate-mucronate. *Nervation* brochidodromous, with 7–8 pairs of secondary veins; a pattern of sinuous lactiferous ducts, from base and midrib to the margin and parallel to the secondary veins, is conspicuous in young eophylls.

Specimens examined:

IVORY COAST: *De Bruijn* 1943 (WAG), 2 seedlings, voucher: *Versteegh* 782 (WAG).

References:

DE LA MENSBRUGE, 1966.

43. *Tridesmostemon claessensii* DE WILD.

Fig. 22: 1-3

Hypocotyl straight, cylindrical, glabrous, ca. 10–20 cm long, brown, woody, basal part 4–9 cm long, green herbaceous apical part 7–10 cm long, with 2 longitudinal slits.

Cotyledons free, papery, persistent; petiole flattened, 0.5–1.0 cm long; lamina slightly asymmetric, elliptic, 5–7 cm × 3–4.5 cm, truncate to slightly cordate at base, apex rounded; both faces are covered by minute colourless papillae. *Nervation* acro-brochidodromous; primary vein zig-zag, prominent on both faces; 5–7 pairs of secondary veins, angle of origin narrowly to moderately acute, straight but abruptly looped to join the superadjacent vein; few intersecondary veins; tertiary veins originating exmedially at acute to right angles, admedially at obtuse to right angles, percurrent, oblique to the midrib; quaternary veins inconspicuous, reticulating; areoles imperfect to well developed, elongate and parallel to the secondary and tertiary veins.

Epicotyl straight, cylindrical to compressed, 0.3–6 cm long, glabrous, axillary buds of cotyledons with medifixed hairs; cataphylls 1–3.

Eophylls alternate, papery, exstipulate; petiole flattened above, rounded below, glabrous, 0.3–1.3 cm long; lamina elliptic to obovate or narrowly so, 7–12 cm × 3–4.5 cm, cuneate to decurrent at base, apex acuminate, acumen slender, acute, up to 1.2 cm long, glabrous. *Nervation* eucamptodromous; primary vein straight, impressed to prominent above, prominent below; 8–10 pairs of secondary veins, slightly prominent on both faces, angle of divergence narrow to moderately acute, uniformly curved; few intersecondary veins; tertiary veins originating exmedially and admedially at right angles, zig-zag percurrent or reticulating; quaternary veins are the ultimate ramification of tertiary veins, reticulating; areoles incomplete, at random arranged.

Specimens examined:

ZAIRE: *Bokdam 4337* (WAG), 4 seedlings, voucher: *Bokdam 4336* (WAG); *Bokdam 4592*, *4609* (WAG), 7 seedlings, voucher: *Bokdam 4563* (WAG).

44. *Tridesmostemon omphalocarpoides* ENGL.

Fig. 22: 4-5

Hypocotyl straight, cylindrical, 11–18 cm long, basal part woody, brown, 2–6 cm long, apical herbaceous part green, 9–15 cm long, separated by an oblique line; longitudinal slits between the bases of the cotyledons directed downwards.

Cotyledons free, papery, persistent; petiole flattened, 0.5–1 cm long; lamina asymmetric, elliptic, 7–9 cm × 4.5–5.5 cm, base deeply cordate, apex rounded; with minute colourless papillae (20×) on both faces. *Nervation* (acro-) brochidodromous; primary vein zig-zag, prominent on both faces; secondary veins 4–7 pairs, slightly prominent on both faces, angle of divergence moderately acute at the base of the cotyledons, straight but abruptly looping to join the superadjacent secondary vein; few intersecondary veins; tertiary

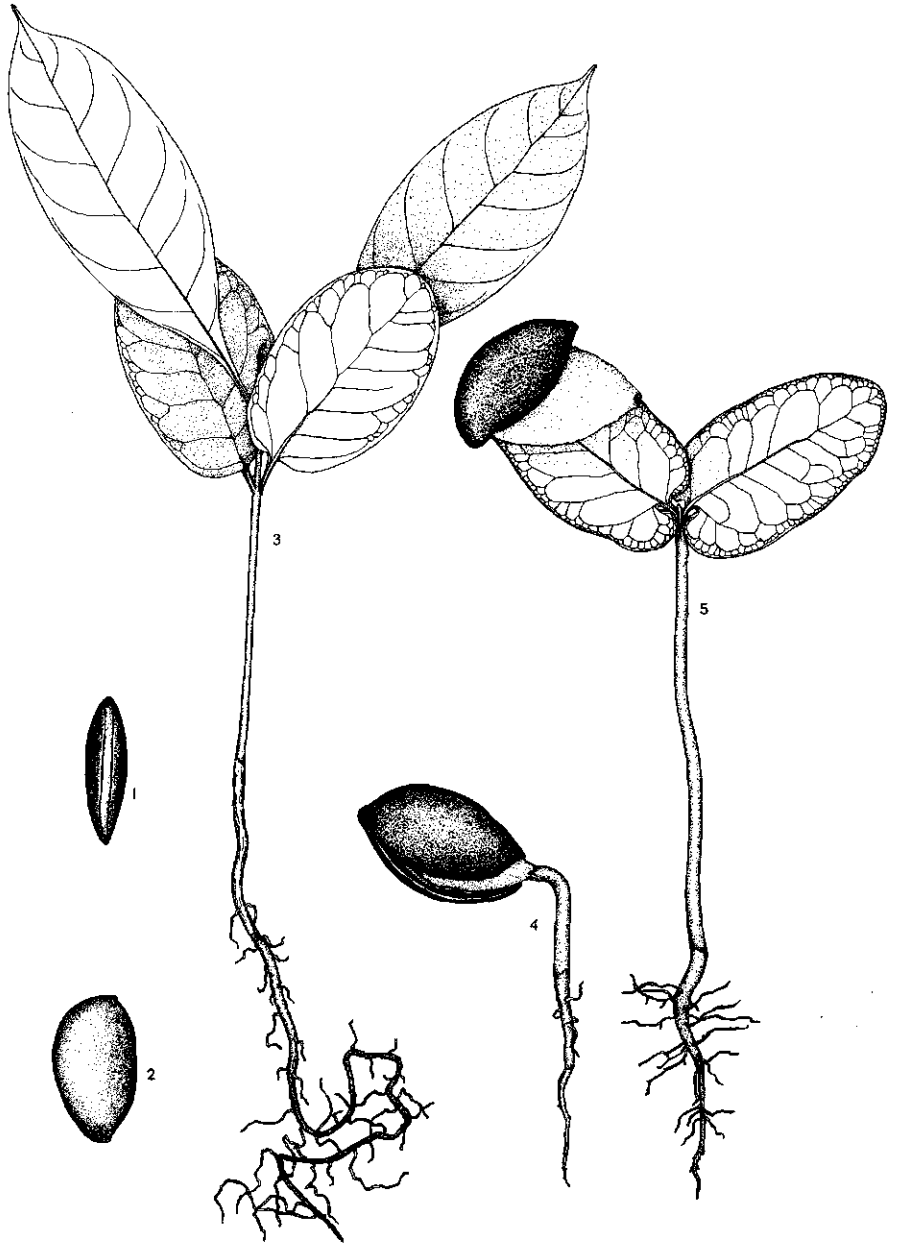


FIG. 22: 1-3. *Tridesmostemon claessensii* DE WILD. - 1. seed, ventral, $\frac{1}{2} \times$; 2. seed, lateral, $\frac{1}{2} \times$; 3. seedling, habit, $\frac{1}{2} \times$.

4-5. *Tridesmostemon omphalocarpoides* ENGL. - 4. germinating seed, $\frac{1}{2} \times$; 5. seedling in cotyledon stage, endosperm and testa persisting on the margin of the cotyledon, $\frac{1}{2} \times$.

After: Bokdam 4563 (1-2), 4609 (3), 4620 (4-5).

veins exmedially originating at right angles, admedially at obtuse to right angles, oblique to the midrib; quaternary veins reticulating; areoles well developed, 3-polygonal elongated, parallel to the secondary veins; veinlets curved, 1-2 times forked.

Epicotyl straight, cylindrical, herbaceous, green, 2-4.5 cm long, glabrous, 2 opposite (extra-)axillary buds strongly developed, bearing silvery, medifixed hairs; cataphylls mostly 1.

Eophylls alternate, papyraceous, exstipulate; petiole slightly swollen in fresh material, 0.5-0.9 cm long, glabrous; lamina narrowly elliptic, 12-19 cm × 4-5 cm, base strongly decurrent, apex acuminate, acumen slender, acute to rounded, 1.5-2.5 cm long, glabrous. *Nervation* brochidodromous, with tendency to a marginal vein; primary vein straight, mainly prominent below; 8-13 pairs of secondary veins, prominent below, angle of divergence moderately to widely acute, slightly curved; tertiary veins exmedially and admedially originating at right angles, reticulating with quaternary veins or confluent with intersecondary veins; quaternary veins reticulating, areoles small, imperfectly developed, with 1-2 times ramified curved veinlets.

Specimens examined:

CAMEROON: *Bokdam* 4620, 4631 (WAG), 6 seedlings, voucher: *J. J. de Wilde* s.n. (WAG).

45. *Tulestea seretii* (DE WILD.) AUBRÉV. et PELLEGR.

Hypocotyl not developed (up to 1 mm long); rootcrown geniculate to straight.

Cotyledons free, fleshy, persistent, borne obliquely erect, plano-convex, narrowly elliptic, 2-2.4 cm × 0.6-0.8 cm × 0.4-0.5 cm, black-brown, glabrous, wrinkled.

Epicotyl straight, up to 10 cm long, 1-2 mm in diam., brown, pubescent; cataphylls 2-4, caducous, pubescent.

Eophylls opposite (to subopposite), papery, exstipulate; petiole slightly canalicate, 2-3 mm long; lamina elliptic to narrowly elliptic, 10-12 cm × 3.5-5 cm, base cuneate to decurrent; apex acuminate, acumen obtuse, 8-12 mm long, margin slightly undulate, glabrous. *Nervation* brochidodromous, with 7-9 pairs of secondary veins, prominent beneath, tertiary and quaternary veins reticulating; areoles well developed.

Specimens examined:

ZAIRE: *HPLY* 6132 (YBI), 2 seedlings, voucher: *O 854* (YBI).

46. *Wildemaniodoxa laurentii* (DE WILD.) AUBRÉV. et PELLEGR.

Fig. 23

Hypocotyl not or scarcely developed, straight, cylindrical, up to 3 mm long, glabrous.

Cotyledons free, fleshy, caducous, horizontally expanded, plano-convex, elliptic, 0.8-1.2 cm × 0.3-0.6 cm × 0.1-0.3 cm; bases truncate, connate by a

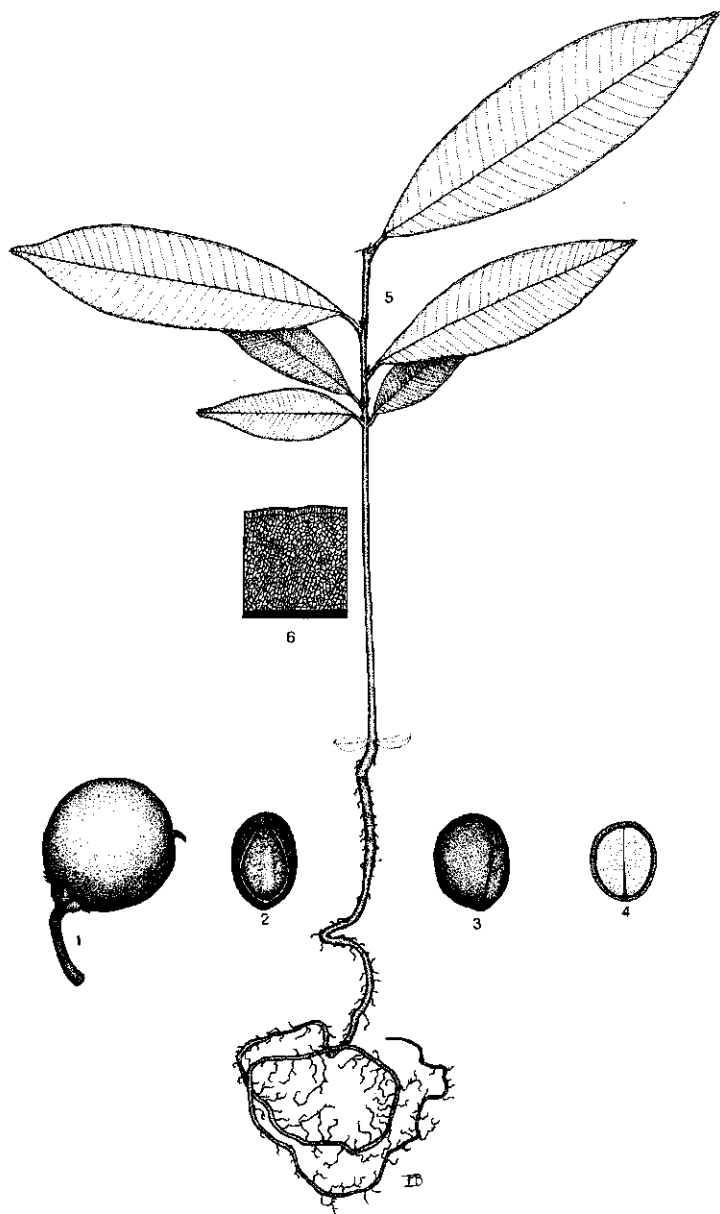


FIG. 23. *Wildemaniodoxa laurentii* (DE WILD.) AUBRÉV. et PELLEGR. - 1. fruit, 1×; 2. seed, ventral, 1×; 3. seed, lateral, 1×; 4. seed, transversal section, 1×; 5. seedling, habit, $1\frac{1}{2}$ ×; 6. detail nervation eophyll, 2×.
 After: Breteler 2005 (1-4), 3033 (5-6).

rim on the cotylar node; apex rounded. *Nervation* hyphodromous.

Epicotyl straight, cylindrical, ca. 8.5 cm long, 1.5 mm in diam., pubescent with grey-brown hairs; cataphylls absent.

Eophylls opposite, coriaceous; stipules linear to subulate, 1–1.5 mm long, pubescent; petiole canaliculate, 2–3 mm long, pubescent, orange-brown; lamina narrowly elliptic to narrowly ovate, 4–5 cm × 1–2 cm, cuneate at base, broadly acuminate at apex, acumen emarginate, 3–4 cm long, glabrous, glossy above, sericeous below with silvery greyish hairs, sparsely superimposed by ferruginous hairs. *Nervation* brochidodromous with intramarginal vein; primary vein straight, stout, impressed above, prominent below; secondary veins 12–16 pairs hairlike, angle of divergence widely acute, straight, ending in the conspicuous marginal vein; numerous intersecondary veins, confluent with tertiary veins; tertiary veins reticulating; areoles well developed, 3–polygonal, small, at random arranged.

Specimens examined:

CAMEROON: *Breteler 3033* (WAG), 1 seedling, voucher: *Breteler 2005* (WAG).

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