Chapter 1: Introduction, History and Literature review

1.1 Introduction

Dracaena L. belongs in the family Ruscaceae that was founded by Sprengel in 1826. Ruscaceae are represented in East Africa by three genera, namely *Dracaena* L., *Eriospermum* Willd. and *Sansevieria* Thunb. (APG II, 2003). *Dracaena* and *Sansevieria* were classified in the Agavaceae by Cronquist (1981), alongside *Agave, Nolina, Phormium, Yucca, Cordyline, Calibanus* and *Dasylirion*, on basis of their possession of a woody stem produced by a secondary thickening meristem. Dahlgren et al. (1985) using a phylogenetic analysis of morphological data, moved *Dracaena* and *Sansevieria* into a family of their own, Dracaenaceae, which was established earlier by Salisbury in 1866. The Angiosperm Phylogeny Group (APG, 1998) classified these two genera in the Convallariaceae, alongside *Convallaria, Liriope, Ruscus, Smilacina, Nolina, Calibanus, Comospermum, Peliosanthes*, and *Eriospermum*. Rudall et al. (2000) pointed out that the name Ruscaceae, published by Sprengel in 1826 had priority over Convallariaceae (established by Horaninov in 1834) and is therefore the correct name for this group in accordance with the rules of the International Code for Botanical Nomenclature. In addition, they pointed out that analyses of molecular data from *rbc*L (Chase et al. 1995) showed that genera formerly included in the Convallariaceae were paraphyletic to several other families (e.g. Nolinaceae, Dracaenaceae and Ruscaceae) and embedded within a larger, well-supported clade to which they applied the name Ruscaceae Spreng. The APG (1998), Rudall et al. (2000) and APG II (2003) all place the clade containing *Dracaena* (Ruscaceae *sensu lato*) in the Asparagales. APG II, (2003) accepted the treatment of Rudall et al. (2000) in classifying *Dracaena* in Ruscaceae.

Dracaena consists of some 38 species widespread in tropical Africa, from sea level to montane habitats. They comprise herbs, shrubs and trees, some with very specialised habitat requirements. *Dracaena* is an important component of both tropical lowland and montane forest in Africa. It frequently forms dense stands and may locally dominate the vegetation. The fragrant flowers and fleshy berries of some species are a diet for animals. Some species, for example *D. fragrans* and *D. ellenbeckiana*, have forms with variegated leaves which are major foliage ornamentals, particularly as indoor plants, while others, such as *D. steudneri*, are popular as landscaping aids in tropical gardens.

Despite the importance of *Dracaena* in ethnobotany, economics and systematics, it has not been revised or systematically documented for most of tropical Africa. The most modern work in this regard is the account of *Dracaena* in West Africa (Bos, 1984). Baker's

monograph (1875) and the Flora of Tropical Africa (1898) both date back to the nineteenth century and are outdated. This study aimed to produce a taxonomic account of *Dracaena* in Central, East and Southern Africa and to investigate the ecology of *Dracaena* species found in the Kakamega forest, Kenya.

1.2 **History and literature review**

Linnaeus circumscribed *Dracaena* in 1767; since then some 2200 names have been applied to *Dracaena*, with approximately 1600 combinations in *Dracaena* which refer to about sixty species. Early taxonomic work on *Dracaena* was based largely on living plants cultivated in green houses. Sometimes flowers and fruits were unknown and usually herbarium specimens were not conserved, not even of sterile specimens. The origin of much of the material under cultivation in Europe was not known (Bos, 1984).

Dracaena is much better known in West Africa, which has been a source of many varieties now in cultivation, than in East Africa. From its establishment by Linnaeus in 1767, the genus *Dracaena* has been invariably mixed up with *Cordyline* Commers. ex. Juss (*nom. cons*.). Planchon in his revision of the genus (Planchon, 1851) placed a majority of the true *Dracaena* in *Cordyline*, maintaining just a few species closely related to *D. draco* (L.) L. in *Dracaena* and referring the true *Cordyline* species to four other genera, namely *Dracaenopsis* Planch., *Calodracon* Planch., *Charlwooodia* Sweet and *Cohnia* Kunth (Bos, 1984). Baker (1875), among other workers, greatly contributed to assembling the genus and its constituent species: they were however unable to convince the contemporary horticulturalists who adopted the name *Dracaena* for the combined genera *Dracaena* and *Cordyline* (Bos, 1984). The popularity of variegated indoor ornamentals in the last quarter of the nineteenth century resulted in the production of many forms of variegated *Cordyline*, of which the commercially more promising clones were usually provided with an often validly published Latin binomial in *Dracaena*. Many such names were published in obscure ephemeral publications like catalogues, horticultural periodicals or advertisements in newspapers (Bos, 1984). It is surprising that horticulturalists did not separate *Dracaena* from *Cordyline*, despite the fact that the latter has pinnate nervature while the former has parallel nerves.

Brown (1914), in his revision of *Sansevieria* was unable to separate this genus from *Dracaena* satisfactorily. He proposed to divide *Dracaena* into two genera, in order to delineate *Sansevieria* against each of them. He revived *Pleomele* Salisbury, originally based on a species of *Dracaena* and one of *Sansevieria*, and amended this to accommodate the bulk of *Dracaena* species, leaving only a few close relatives around *D. draco* in

Dracaena. This division of *Dracaena* proved unsatisfactory and was largely rejected (Bos, 1980).

When Baker published his monograph of *Dracaena* in 1875, his descriptions were often based on living plants cultivated in botanical collections and commercial nurseries in London. The most significant attempt at infrageneric classification of *Dracaena* was made in this monograph. Baker arranged the species known to him in "stirps", each with a species as type. His groupings were not very convincing and have not been widely accepted. Baker's treatment of *Dracaena* in Flora of Tropical Africa (1898) treated the forty-seven species then known from tropical Africa. This work .has many inadequate species descriptions, indeed, some species, such as *D. hanningtonii* were apparently described from just a fragment of an inflorescence. Durand & Durand (1909) in their treatment of the flora of Congo, list 18 species of *Dracaena*. Robyns (1955) found six species of *Dracaena* in the Albert National Park while Marquet (1987) in his contribution to the Flora of Rwanda lists four species. Durand & Schinz (1896) lists five taxa, including two varieties of *D. spicata.* Troupin (1956) in his treatment of the Plants of Garamba National Park recorded only two species of *Dracaena*. An account of *Dracaena* for Flora of Ethiopia and Eritrea was published in 1997 (Bos & Teketay, 1997): it documented 5 species. Thulin (1995) in Flora of Somalia describes only one species while Mbugua et al. in the Flora of Tropical East Africa (in press) found nine species in the area of that Flora.

1.2.1 Present status of *Dracaena*

Dracaena is closely related to *Sansevieria*: indeed in the combined analyses of Rudall et al. (2000), they form a clade of their own, the Dracaenoid clade. The two appear morphologically distinct but the characters used to distinguish them overlap (Bos & Teketay, 1997). Brown (1914) found that apart from the form and fleshiness of the leaves there is no character by which *Sansevieria* can be reliably separated from *Dracaena.* There are shrubby and stemless species in both genera, some species of *Dracaena* have thick, coriaceous or sub-fleshy leaves, whilst the inflorescence, articulation of the pedicel, flowers, fruit and seed of *Sansevieria* are not different from those of many species of *Dracaena*.

Bos (1984) initiated the proposal and subsequent discussion as to whether the genus *Sansevieria* should be lumped into *Dracaena*. In his article he stated "a thorough analysis of *Sansevieria* is quite likely to prove the impossibility to retain *Dracaena* and *Sansevieria* as separate genera". Having stated the above he further admits that "…the fact that the species in *Sansevieria* are generally readily recognised and cannot be confused with the

various species in *Dracaena* , there do not seem to be dependable characters to support generic segregation.." He then goes on to show how similar the two genera are. As shown below there are distinct morphological differences between the two genera, and even more may be forthcoming from further studies, e.g. anatomy and phytochemistry. The points raised for their merger seem logical, but one is reminded of the same argument and indeed similar conclusions that Planchon (1851) and Brown (1914) arrived at.
Phillips (1951) in his treatment of the family Liliaceae in which *Dracaena* and *Sansevieria* were then placed, stated the differences between the two genera as summarised in table 1.0.

	Part	*Sansevieria*	*Dracaena*
1	Perianth	Tubular	Tube not evident
2	Stamens	Inserted in the throat	Inserted high or at the throat
3	Filaments	Not thickened at the middle	Thickened at the middle
4	Stigma	Single lobe (=unlobed)	3-lobed
5	Seeds	Fleshy	Horny at the middle

Table 1.0. Distinction between *Dracaena* and *Sansevieria* according to Phillips (1951).

These distinctions are very similar to those enumerated by Brown (1914) between his more narrowly circumscribed *Dracaena* and *Sansevieria*. In the wider concept of *Dracaena* used here, distinctly tubular flowers are found, for example in *D. mannii, D. cerasifera* and *D. cristula.* Leaf succulence is often used as a character to distinguish *Sansevieria* from *Dracaena*: all the species of *Sansevieria* are xerophytic leaf succulents with leaves that may be flattened or semi-cylindrical to cylindrical in the various species. Even the species with rather rigid leaves have succulent water storing tissue beneath the epidermis. On the other hand, *Dracaena* generally has leaves that are rather thin and are not usually fleshy. A number of the xerophytic species have leaves that are rigid and coriaceous (leathery), but not genuinely succulent.
Although the two genera have been distinguished on the basis of their growth form, they actually overlap in that respect and cannot be separated on that basis. Most of the species of *Sansevieria* are rhizomatous perennials but a few species in the genus such as *Sansevieria arborescens* Cornu and *S. bagamoyensis* N.E.Br.are actually small shrubs with erect stems. The majority of *Dracaena* species are shrubs or trees but a few species

such as *D. phrynioides* Hooker and *D. praetermissa* Bos are rhizomatous perennials. None of the *Sansevieria* species grow into massive trees like *D. draco* and its allies.
The flower types occurring in *Dracaena* can be divided into three groups on the basis of their form. *D. draco* and its allies have day blooming, short-tubed, stellate flowers that are adapted to bee pollination. The majority of the species, at one time placed in the genus *Pleomele* Salisbury, have nocturnal, long-tubes salverform whitish flowers that are adapted to moth pollination. A third group of Hawaiian species, allied to *D. aurea* have diurnal, tubular funneliform yellowish flowers that are adapted to pollination by birds.
The flowers of *Sansevieria* are similar to those of the nocturnal *Pleomele* type and can have floral tubes up to 15 cm long in *S. longiflora* Sims. The little known *S. sambiranensis* Perrier from Madagascar is unique in the genus by having reddish flowers.
The majority of *Dracaena* species have flowers in branched paniculate inflorescences, but in a few species, the inflorescence is reduced to an unbranched raceme or even congested into a head-like umbel. The range of inflorescence types in *Sansevieria* parallels that found in *Dracaena*. The majority of *Sansevieria* species have flowers in unbranched thyrsic racemes, but a few such as *S. arborescens* Cornu, *S. ehrenbergii* Schweinf. and *S. pinguicula* Bally have branched panicles while for others like *S. kirkii* Hooker and *S. hallii* Chahinian the inflorescence is compact and umbel-like.
The fruit of *Dracaena* is a berry containing one to three seeds. The ovary has three locules, each of which contains a single ovule. Frequently, the development of all but one ovule is suppressed, leaving the fruit with only viable seed. Although the fruit of *Sansevieria* has been described as being a berry by Brown (1915), other investigators have interpreted the fruiting structure of the genus quite differently. As in *Dracaena*, the ovary has three locules, each with a single ovule, but as the seeds develop the ovary wall falls away exposing the seeds. This gymnospermous development has prompted reviewers such as Bentham & Hooker (1883), Hooker (1892) and Nakai (1936) to ally *Sansevieria* with the Asiatic genus *Liriope* Loureiro, *Ophiopogon* Ker-Gawler and *Peliosanthes* Andrews which share this character rather than with *Dracaena*. The seeds have a fleshy covering (sarcotesta) that mimics a fleshy berry. As a result of the gymnospermous development the fleshy seeds of *Sansevieria* completely lack the terminal scar, beak or withered remains of the style typically seen on *Dracaena* fruit.
The pollen on *Dracaena* is monosulcate (elliptical with a length-wise slit) as it is in a wide range of monocotyledonous genera, while that of *Sansevieria* has a very different appearance. Ojeda, Ludlow-Wiechers & Orellana (1984) and Ojeda & Ludlow-Wiechers (1995) found the pollen of the two *Sansevieria* species they studied to be operculate

(shaped like a mushroom cap). The pollen shape of *Sansevieria* is not only distinctively different from *Dracaena*, it is of a type seldom seen in monocotyledons. Also the pollen surface in *Dracaena* is fossulate while for *Sansevieria* it differs in being psilate and ulcerate.

In this study, therefore, *Dracaena* is recognised as a genus distinct from *Sansevieria* on the basis of the significant differences in fruit, seed and pollen morphology expounded above.

1.3 Objectives of this study

The earth's biological resources are vital to peoples' economic and social development. As a result there is growing recognition of biodiversity as a global asset of great value to present and future generations. Meanwhile the threat to species and ecosystems has never been as great as it is today. In response to this situation, the United Nations Environment Programme prepared an international legal instrument for the conservation and sustainable use of biological diversity. This instrument eventually came to be known as the Convention on Biological Diversity. It came into force on 29 December 1993 (Maunder et al., 2002). The Convention comprises 42 articles: article 7 compels the countries that have ratified the Convention (Parties) to identify and monitor components of their biodiversity. Identification and Monitoring is frequently impeded by the lack of literature, institutions and knowledgeable personnel. In preparing an account of *Dracaena* for Central, East and Southern Africa, this work endeavours to contribute towards the realization of the objectives of the Convention on Biological Diversity. In addition, it aims to address issues of generic limits in *Dracaena* and *Sansevieria*, two genera of importance in the ornamental plant trade. This study is designed to fill part of the gap in the knowledge on this important family in Africa. As a result, the study is designed to cover Central, East and Southern Africa: regions on which literature about this genus is scarce or nonexistent. It will complement the treatment of *Dracaena* in West Africa (Bos, 1984).

Description of taxa needs to be supported by an insight into how they live and interact with the ecosystems in which they are found. This is the next level of biodiversity, and is an essential component in conservation. The ecology of *Dracaena* was investigated to determine the role of this genus as indicators of environmental quality. This ecological study was carried out in the Kakamega forest of western Kenya, the only representative of a tropical rain forest in Kenya. It is an ideal ecosystem for this study because *Dracaena* contributes strongly to the forest community, often dominating the undergrowth. In addition, animals that are potentially ecologically important abound in this forest.

Understanding the ecology of such a forest could provide valuable insights into forest conservation elsewhere in the region. To address these scientific and conservation concerns, two specific objectives were formulated: i. to revise the taxonomy of *Dracaena*; and ii. to investigate its ecological role in the Kakamega forest.

Objective 1: *Revision of the taxonomy of Dracaena in Central, East and Southern Africa.*
Morphological delineation of the genus *Dracaena* is unsatisfactory as indicated in the introduction. Floristic descriptions written according to the morphological species concept of Cronquist (Cronquist, 1978) need to be made to enable accurate identification of species. In this concept, species are defined as the smallest groups that are consistently and persistently distinct and are distinguishable by ordinary means. Numerical methods were devised to investigate and classify the morphology, in order to facilitate grouping and identification of the constituent species. Nomenclature of the genus was studied alongside herbarium material and related literature to determine the correct names to adopt. The provisions of the International Code for Botanical Nomenclature (Greuter et al., 1994) were followed in this work in order that it should be available to workers all over the world.
The phytogeography of *Dracaena* in East, Central and Southern Africa was investigated from literature and herbaria.

Objective 2: *Investigate the ecology of Dracaena in the Kakamega forest*
Species that are of common occurrence in the Kakamega forest were studied for their ecological roles to determine whether *Dracaena* species are indicators of any ecological conditions, for example disturbed forest, secondary forest, primary forest or non-forest zones. Flowering period, pollination, fruit production and interactions with the biotic environment were investigated.

Chapter 2. Materials and methods

2.1. Morphology

Morphological studies of *Dracaena* material from Central, East and Southern Africa was studied in the East African Herbarium, National Museums of Kenya (EA) in Nairobi; the herbarium at the National Botanic Garden of Belgium (BR) at Meise, Brussels; the herbarium at the Royal Botanic Gardens, Kew (K) and the Natural History Museum in Paris (P). Field studies of natural populations and collection of herbarium specimens were carried out in Kakamega forest, in the Taita Hills, on Mount Kenya, the Ngong Hills, Keiyo escarpment and in the coastal Kwale district.

2.1.1 Phenetics

The application of numerical techniques in the production of classification has become common among students of systematics (Stace, 1989). These techniques, termed numerical taxonomy, taxometrics or phenetics (Stace, 1989) are defined as "the grouping by numerical methods of taxonomic units into taxa on the basis of their character states". Phenetics provides a repeatable, operational methodology for the production of a classification, and reduces the subjectivity involved in handling the characters once they have been selected for use (Davis & Heywood, 1973). It seeks to base classifications on a large number of characters from many sets of data in a bid to produce an entirely phenetic classification of maximum predictivity

The basic unit of phenetics is the operational taxonomic unit (OTU) which is the term given to the lowest taxon being studied in any investigation. Each OTU is scored for the possession of one or another character state for each character in the investigation. This results in a data matrix, which is then subjected to further analyses, usually by computer. The computer sorts out (clusters) the OTUs according to their overall similarity. Such a process is called cluster analysis and is the usual method employed in phenetics.

The process of clustering consists of arriving at one or more partitions of a set of operational taxonomic units (OTU's). Clustering may result in the grouping of OTU's i.e. in the forming of a coarser partition from a finer one, or it may involve the break up of an entire set of OTU's into increasingly finer portions. The methods used in these analyses are generally called sequential, agglomerative, hierarchic, non-overlapping clustering (SAHN) methods (Sneath & Sokal, 1973).

Cluster analysis utilises a measure of distance (dissimilarity) of which there are several. The measure used in this analysis is Euclidean Distance. If we have t OTU's for which n = 2

characters were studied, we can draw a conventional pair of rectangular coordinates representing A-space, letting the horizontal axis represent character 1 and the vertical axis character 2. If we then plot the position of *t* OTU's with respect to the coordinate axes, any two coordinates identical in terms of the two characters under consideration will coincide, and the distance between them will be zero. The greater the disparity between them the greater will be their distance.

When we wish to estimate taxonomic distance on basis of three characters, we must add a third coordinate, x3, to our diagram. On paper such a model can only be shown in a two dimensional projection. Each new coordinate must be at right angles to all previous ones. The space in which these multiple axes are plotted is called Euclidian hyperspace and any distance measured therein is termed Euclidean distance. Thus we can have n dimensions for n characters and can compute the distance between any two OTU's in the hyperspace.

The Euclidean distance between two OTU's j and k in an n-dimensional space is given as

$$\Delta jk = [{}^{n}_{jk}\sum (xij-xik)^2]^{½}$$

(Sokal & Sneath, 1963)

Since Δjk increases with the number of characters used in the comparison, the average distance is usually computed as $djk = \sqrt{\Delta^2 jk/n}$

Two clustering methods are frequently used in this analysis, namely Complete Linkage and Group Average.

Complete linkage is also known as Furthest Neighbour clustering (Lance and Williams, 1967) or the maximum method (Johnson, 1967). An OTU that is a candidate for admission to an extant cluster has similarity to that cluster equal to its similarity to the furthest member within the cluster. When two clusters join, their similarity is that existing between the furthest pair of members , one in each cluster. The method will generally lead to tight hyperspherical discrete clusters that join others only with difficulty and at low overall similarity values. It is the antithesis of another clustering method called single linkage . This method produces an elongate growth of single linkage clusters, a phenomenon called chaining. This phenomenon is most noticeable when there are a number of equidistant points, or near equidistant points as are found in taxonomy or ecology. The phenograms resulting from such chaining are generally not very informative (Sneath & Sokal 1973), so this method was not used.

Group Average Linkage clustering is one of the techniques developed by Sokal & Michener (1958) to avoid the extremes introduced by either single linkage or complete linkage

clustering. It requires the computation of some kind of average similarity or dissimilarity between a candidate OTU or cluster and an extant cluster.

Twenty-nine species of *Dracaena* occurring in Central, East and Southern Africa, whose publication status could be verified, were studied in herbaria of the National Botanic Garden of Belgium (BR), The National Museums of Kenya (EA) and the Royal Botanic Gardens, Kew (K). The herbarium studies were supplemented with literature surveys and field observations in Kenya. From these studies, twenty taxonomically informative characters were selected for study, as well as 10 geographical characters. In a widely distributed genus such as *Dracaena*, geographical data becomes such a significant part of the taxa concept that these (geographical) data should be embedded in the classification of the taxon. Snaydon (1973) presented the case for the inclusion of such characters in the construction of classifications. He felt that such characters should be incorporated in classifications, not merely presented as supplementary information. The characters and their states are listed in table 2.1.

Character Number	**Character**	**States**
1	Habit	Shrub/tree (0); herb (1)
2	Leaf lamina shape	ovate/elliptic (0); linear/lanceolate/oblanceolate (1)
3	Leaf lamina proximal length/distal length ratio	0-0.6 (0); 0.9-1.2 (1); 1.3-1.6 (2)
4	Leaf lamina succulence	Succulent (0); non-succulent (1)
5	Leaf spacing on shoot	Overlapping (0); non-overlapping (1)
6	Petiole length/leaf lamina length ratio	0-0.5 (0); 0.6-1 (1); >1 (2)
7	Inflorescence orientation	Pendent/reflexed (0); or erect (1)
8	Bract Proximal length/distal length ratio	0-0.5 (0); 0.6-1 (1); >1 (2)
9	Position of pedicel articulation	below or at middle (0); above middle (1)
10	Inflorescence axis shape	terete (0); flattened (1)
11	Flowers	Floral clusters 1 or few-(<6) flowered (0); floral clusters many (10)-flowered
12	Underground perennating organ	Absent (1); present (0)
13	Inflorescence	Capitate (0); spicate (1); paniculate (2)
14	Peduncle texture	Smooth (0); scabrid (1)
15	Fruit shape	Globose (0); ellipsoid (1)
16	Fruit lobe orientation	Non-divergent (0); divergent (1)

17	Perianth tube/perianth lobe ratio	Tube longer than lobes (0); tube = lobes (1); tube shorter than lobes (2)
18	Guineo-Congolian Distribution	No (0); yes (1).
19	Zambesian Distribution	No (0); yes (1).
20	Sudanian Distribution	No (0); yes (1).
21	Somalia-Masai Distribution	No (0); yes (1).
22	Afromontane Distribution	No (0); yes (1).
23	Lake Vicoria Regional Mosaic Distribution	No (0); yes (1).
24	Swahilian/ Swahilian – Maputaland rtz Distribution	No (0); yes (1).
25	Tongaland-Pondoland Distribution	No (0); yes (1).
26	Seed indumentum	Absent (0); present (1)
27	Phytomelan	Absent (0); present (1)
28	Fruit dehiscence	Indehiscent (0); present (1)
29	Sahelian rtz distribution	Present (0); absent (1)
30	Guinea-Congolia/Zambezia rtz distribution	Present (0); absent (1)

Table 2.1. Characters used in the phenetic analysis and their states.

The twenty-nine species were scored for these characters and the resultant matrix (shown in Appendix II) analysed phenetically using the Furthest Neighbour and Group Average clustering algorithms in the Genstat release 4.23 Discovery Edition software (Lawes Agricultural Trust, 2003).

2.1.2. Phylogeny

Phylogenetic analysis, also called cladistic analysis or cladistics, is a method of analysing phylogenetic data objectively, in a manner similar to that in which phenetic analysis seeks to introduce objectivity into phenetic classifications. The methods of Wagner, Hennig, Swofford and many other cladists utilise the principle of parsimony. In this principle, the shortest hypothetical pathway of changes that explains the present pattern is considered the most likely evolutionary route. Cladistic methods differ fundamentally from phenetic ones in that *a priori* reasoning is used to determine routes of evolutionary change.
In cladistic analysis, one has to compare only homologous structures, as with phenetics. Once homology is established, the polarity (direction) of change in a character state is determined in two main ways: fossils and outgroup comparison. Since relevant fossil

evidence is rarely available, the latter method if often the only reliable one available (Stace, 1989). Since two or more states of a character are found in a single monophyletic group, the state that is also found in the outgroup is considered plesiomorphic (primitive) and that found only within the monophyletic group under study apomorphic (derived). Only monophyletic groups should be recognised as taxa, and sister groups should be recognised at the same taxonomic rank (Hennig, 1966).

The basic units that are manipulated in cladistics are evolutionary units (EU). Once a set of data relating to plesiomorphic versus apomorphic states has been accumulated for all the EUs, a data matrix is constructed. This matrix will normally include the hypothetical ancestor that has all the character states in the plesiomorphous state.

The cladograms that are obtained from analysis of the matrix are usually based upon the minimal (most parsimonious) way in which the EUs can be connected to account for the data in the matrix. The nodes in a cladogram are considered to represent ancestral monophyletic taxa . These are mostly hypothetical and are known (together with the single hypothetical ancestor) as hypothetical taxonomic units. They may be regarded as hypothetical ancestral species, but are usually now seen as supraspecific categories of various ranks (Stace, 1989).

Fourteen characters were selected for the phylogenetic analysis of *Dracaena* species occurring in the study area. These and their corresponding states are shown in table 3, below.

Character Number	**Character**	**States**
1	Stigma lobing	Unlobed (0); 3-lobed (1)
2	Seed development	Gymnospermous (0); Non-gymnospermous (1)
3	Pollen type	Monosulcate (0); Operculate (1)
4	Pollen surface	Fossulate (0); Psilate/ulcerate (1)
5	Leaf lamina succulence	Succulent (0); Non-succulent (1)
6	Flowers	Floral clusters 1 or few-(<6) flowered (0); Floral clusters many (>10)-flowered
7	Underground perennating organ	Absent (1); Present (0)
8	Inflorescence	Capitate (0); Spicate (1); Paniculate (2)
9	Peduncle texture	Smooth (0); Scabrid (1)
10	Fruit shape	Globose (0); Ellipsoid (1)
11	Fruit-lobe orientation	Non-divergent (0); Divergent (0)
12	Perianth tube/perianth lobe ratio	Tube longer than lobes (0); Tube = lobes (1); Tube shorter than lobes (2)
13	Seed indumentum	Absent (0); Present (1)

14	Fruit dehiscence	Indehiscent (0); Dehiscent (1)

Table 2.2. Characters used in the phylogenetic analysis and their states

The species under study were scored for these characters and the resultant matrix analysed using the PAUP package (Swofford, 1999).

2.1.3. Phytogeography of *Dracaena*

Phytogeography is the study of spatial distribution of plants. It is relevant to plant taxonomy because each taxon shows a certain pattern of distribution which is an aspect of its definition (Stace, 1989).

If the distribution of every species within a genus is drawn on a single map, it will usually be found that there are areas with a marked concentration of species (Stace, 1989). Such an area is termed as a centre of genetic diversity for that genus. Often there is a a single such area for a genus concerned and there are progressively fewer species found as the distance from the centre of diversity increases. This topic was first studied for crop plants, particularly cereals and legumes by Vavilov in the early part of the twentieth century (Vavilov, 1951, Stace, 1989). Vavilov and later workers found that there is frequently a coincidence in the centres of diversity for many unrelated taxa, and that a relatively small number of major centres of diversity can be recognised in the world for crop plants. Vavilov believed that the centres of diversity were also the centres of origin of the taxa concerned. The centres of diversity today probably hold the main remnants of the ancestral genetic material of the taxa concerned (Stace, 1989). The older the taxon, the less likely the coincidence of the centres of origin and diversity. Other workers, however, considered that the processes of evolution have operated in the past in a manner similar to the present time (principle of genetic uniformitarianism). Using this principle, one can deduce that angiosperms originally diversified in the semi-arid zones, since those areas now support the greatest number of species per genus.

Each monophyletic taxon has, by definition, a single centre of origin. An analysis of the characteristics of the taxon at its centre of diversity in relation to its characteristics progressively further from the centre, the major patterns of evolution and pathways of migration can often be deduced. Such an outward pattern of evolutionary migration is referred to as adaptive radiation (Stace, 1989). Analysis of the adaptive changes along the putative migration path may be of value in delimitation of the various biotypes.

Cytological study is often important in this regard – it has been found that in the temperate

regions, plants near the centre of diversity are often diploid, while those towards the edge of the range are frequently polyploid. The concept of genetic diversity and centres of origin has been criticised by vicariance biogeographers who prefer to think in terms of the generalised track of a taxon differentiating allopatrically in different regions.

The phytogeography of *Dracaena* within the study area was investigated through herbarium and literature studies. The distribution data so acquired was coded and incorporated in the phenetic analysis, table 2.1, in order to find out whether the distribution of *Dracaena* species is related to their adaptation to different climatic regimes. The identification and delimitation of the different climatic areas was done following the phytochoria described by F. White (1983) and modified by Clarke (2001).

2.2. Ecology of *Dracaena* in Kakamega Forest.

Ecology, the study of relationships of organisms with their environment, is a fascinating area of biology that has many important implications for taxonomy and biology as a whole. Two species of *Dracaena, D. fragrans* and *D. laxissima* are forest undergrowth species adapted to the low light intensities that characterise their habitat. Forest degradation and fragmentation are a perennial concern in this forest area: An investigation was therefore made to determine whether the two species could be indicative of forest quality, and to find out how they may be affected by zoological and abiotic factors in the Kakamega forest system.

The Kakamega Forest is located 80 km north of Lake Victoria in Kenya. Its is situated at an altitude of 1500 – 1700 m and receives 1500-2300 mm of rain annually. This area is densely populated, with the surrounding countryside intensively cultivated for sugarcane, tea and maize. The forest is therefore under intense pressure for extraction of wood and for grazing, as well as illicit cultivation. Some parts of the forest are, however, very well preserved, and offered ideal conditions for the study of these species.

The two species were studied for their population structure, phenology, fruit-set and seedling establishment. Line transects were laid out in five forest fragments, namely Colobus Trail, Buyangu Hill, Salazar, Kisere and Salazar Guava thicket-grassland mosaic. These areas were selected to cover the spectrum of forest quality, from nearly undisturbed forest (the nearest to primary forest one can get at Kakamega) through lightly disturbed to heavily disturbed and non-forest vegetation. On each transect five 25 m X 25 m plots were laid out at 25 m intervals. Each plot was divided into five 5-metre strips for convenience

of recording observations. These transects formed the basis for age structure and phenology studies, while fruit-set and seedling establishment were observed in suitable localities. This scheme is illustrated in figure 2.1.

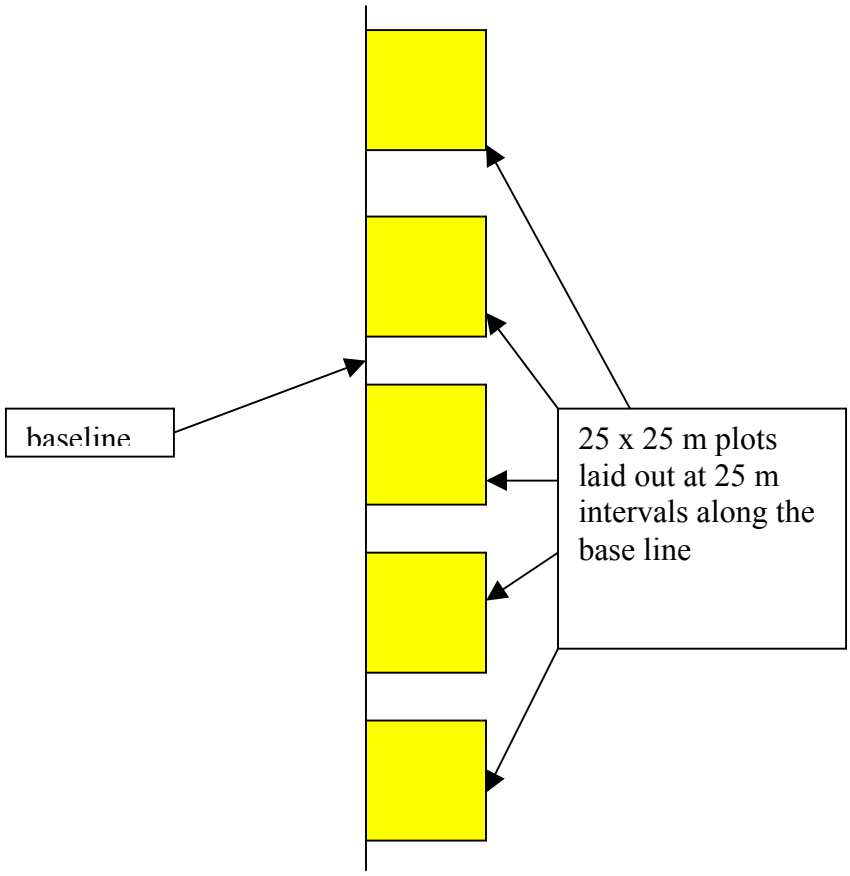


Figure. 2.1. Layout of the transects used for ecological studies.

2.3 Conservation

The World Conservation Union (IUCN) has established a procedure for assessing the conservation status of species in their natural range and communicating the result of the assessment in a codified and easily understood form. This procedure is termed Red Listing and uses the IUCN Red List Categories (IUCN, 2001). The IUCN Red List categories are intended to be an easily and widely understood system for classifying species at high risk of global extinction. The objective is to provide an explicit, objective framework for the classification of species according to their extinction risk. The present categories have been derived from pre-existing, more subjective ones that have been in use for over thirty years (Fitter & Fitter, 1987), and were adopted under a new Red List system in 1994.

The IUCN Red List categories and criteria aim to: i. Provide a system that can be applied consistently by different people; ii. Improve objectivity by providing users with clear guidance on how to evaluate different factors that affect the risk of extinction; iii. Provide a system which will facilitate comparisons across taxa; iv. Give people using threatened species lists a better understanding of how individual species were classified.
The Red List criteria can be applied to any taxonomic unit at or below the species rank, and from any taxonomic group, except microorganisms. The criteria may be applied within any specified geographical or political area. The categorization process should only be applied to wild populations within their natural range, and to populations resulting from benign introductions. The listing of a taxon in a higher category implies a higher expectation of extinction, and over time, taxa listed in a higher category are expected to go extinct than those in a lower one (without effective conservation action). However, the persistence of some taxa in high risk categories does not necessarily mean the initial assessment was inaccurate. All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable. Together, these categories are described as threatened. The threatened categories form a part of the overall scheme. The different criteria are derived from a wide review aimed at detecting risk factors across the broad range of organisms and the diverse life histories they exhibit. The criteria for the threatened categories are applied to a taxon whatever the level of conservation action affecting it. A taxon may require conservation action even if it is not listed as threatened.

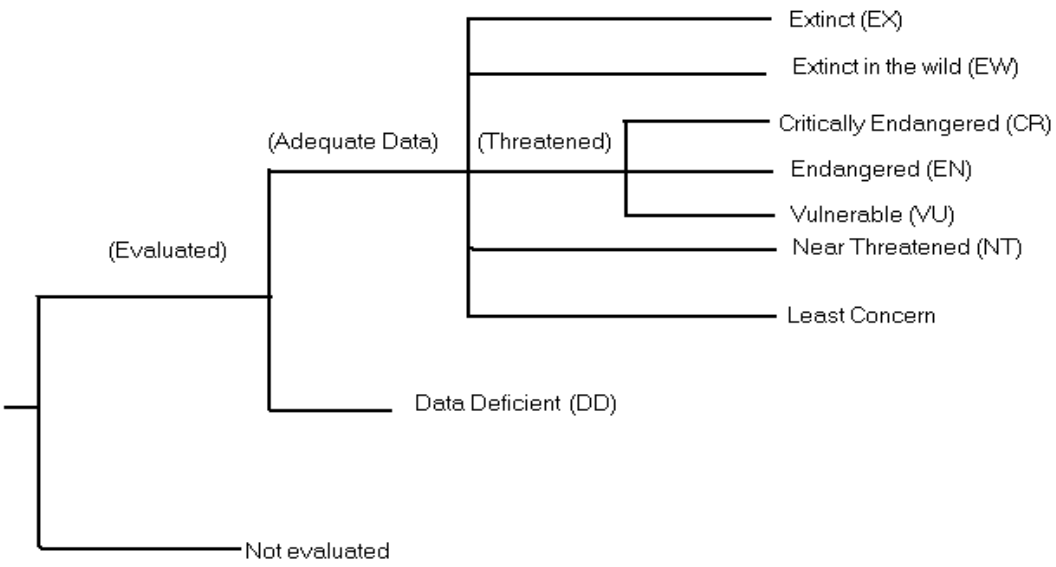


Figure 2.2. Structure of the IUCN Red List Categories

The conservation status of each species in this study was assessed using information from herbaria, the literature and the field and allocated a category. This assessment accompanies the species accounts in the taxonomic treatment.

Chapter 3. Results

3.1. Morphology and Anatomy

Taxonomists rely on morphological characters, both for classification and for identification. Together with distribution and ecological data, they frequently form the only taxonomic evidence available. Even where other evidence, for example, chemical or secondary metabolite or semantide data, are available, practical considerations demand that these be correlated with morphological data (Mbugua, 1995).

In this section, I present information on the morphology of *Dracaena*, as obtained through herbarium and field studies as well as through literature review.

3.1.1. Vegetative morphology and Anatomy

3.1.1.1. Stem

Dracaena comprises trees, shrubs, unbranched suffrutices or rhizomatous geophytes, sometimes succulent, glabrous, from less than 10 cm to over 40 metres tall. Aerial stems often show characteristic persistent leaf scars. Arborescent species are capable of girth increment by secondary growth (Bos, 1984). Most shrubby and arborescent species root easily from stem cuttings and this is the preffered method of propagation for those species cultivated by man, for eaxample *D. fragrans, D. ellenbeckiana* and *D. arborea.*

3.1.1.2. Leaves

Dracaena leaves are alternate, distichously or spirally arranged, entire, ovate, strap-shaped or ensiform, usually amplexicaule with a sheathing base, occasionally exceeding 2 m in length, usually much shorter, sometimes variegated, the upper ones transformed into the inflorescence bracts. The leaves of *Dracaena* are of typical monocotyledon structure and simple. The blade has equidistant longitudinal strictly parallel nerves interconnected by a transverse pattern of wavy veins. A true midrib does not occur and where this seems to be present, a costa is formed by a median concentration of parallel nerves, impressed or discoloured above and often quite prominent beneath. The leaves are frequently contracted in rosettes either at the end of aerial branches or from the apex of a subterranean rhizome. In ovate leaves the primary veins diverge from the leaf base to convege at the apex. In some species the lamina narrow abruptly into a pseudopetiole in their lower half or towards the base. The generally oblong blade is usually more-or-less contracted towards the base, but it usually flares out and often it forms a sheath at the point of attachment, leaving a crescent shaped leaf-scar when shed. In many instances

leaves are sessile because a petiole is lacking. There are no hairs reported in this genus. Variegation in the leaves is caused by the absence of chlorophyll in one or more layers of the pallisade parenchyma resulting in pale green, yellow or white colours in strands, bands, dots or rings (Bos, 1984). In some species the underside of the leaves and particularly the inflorescence bracts may be dark purple-red.

3.1.1.3. Vegetative Anatomy

Microscopic features are often regarded as supplementary to macroscopic features rather than as a primary source of data. These features are now nevertheless recognized as valuable sources, just like the macro-morphological ones.

Caution is called for when studying the literature on the anatomy on *Dracaena* owing to widespread misidentification in the past. It is believed that most of the work reported was actually carried out on *Cordyline*, not *Dracaena* (Bos, 1984).

3.1. 2. Floral morphology and Anatomy

3.1.2.1 Inflorescence

The inflorescence is always strictly terminal. In cases where it appears to be axillary, the base of the peduncle contains several nodes lacking appendages and thus representing a dwarf shoot with a terminal inflorescence (Bos, 1984). Bracts tend to rapidly decrease in size from the basal branches in the inflorescence towards individual pedicels. Often the flowers inserted at the apex of (partial) inflorescences have no bracts at all. Bracteoles are very rare, if present, they are minute and accompany the articulation in the pedicel. Apart from the septal nectaries, inconspicuous extrafloral nectaries are usually present at the base of the pedicels on the axis of the inflorescence; they produce copious quantities of nectar. The flowers are distributed singly or in pairs, or in few to many-flowered glomerules, more-or-less aggregate in some species. Green, purple, purple-tinged, brown or white bracts and bracteoles may be present, tightly enveloping the flowers for a few centimetres or very small. The pedicels consist of a very short or long, persistent basal part, terminated by a distinct joint, and a stalk-like obconical receptacle below the ovary.

3.1.2.2 Flowers

The perianth measures 0.4–5 cm long, it is white, greenish or greenish purple, with membranous margins. The flowers open at night and have a strong scent. They consist of a tubular, fused basal part and 6 free lobes in two whorls of three. The lobes are recurved

at anthesis, and each lobe has a distinct median costa. Stamens are inserted at the throat of the perianth tube, or slightly higher. The filaments are inflated over their entire length, or in the upper part only, and have a subulate tip; anthers are basal-versatile, the thecae extending downwards below the connective and opening by longitudinal-lateral slits. Ovary is superior, cylindrical to bottle-shaped, with 3 uniovulate locules, and bears septal nectarines. The style equals the stamens in length and has a capitate, usually three-lobed stigma.

3.1.2.3. Pollen morphology

The pollen grains of *Dracaena* are monosulcate (elliptical with a length-wise slit) as it is in a wide range of monocotyledonous genera. Very little variation in surface sculpturing has been observed by Scanning Electron Microscopy. A screen of four species failed to reveal clear-cut interspecific variation

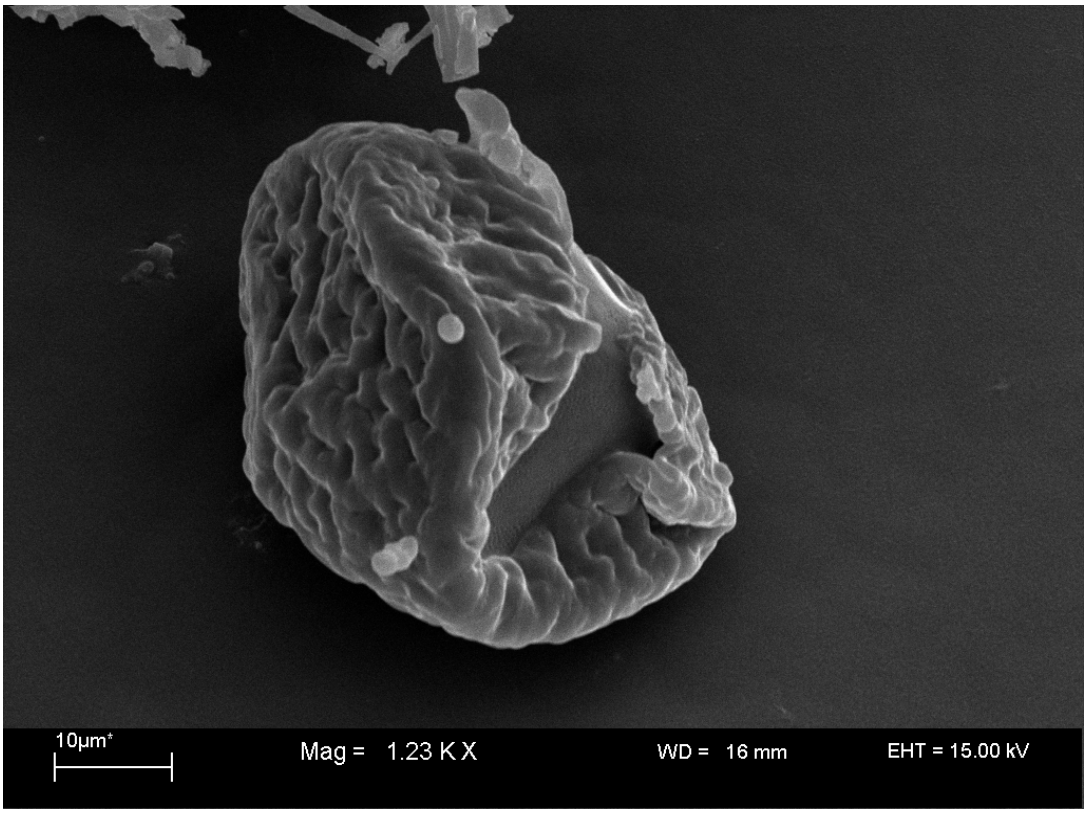


Figure 3.1.2.3. Electron micrograph of the pollen of *Dracaena camerooniana* Baker.

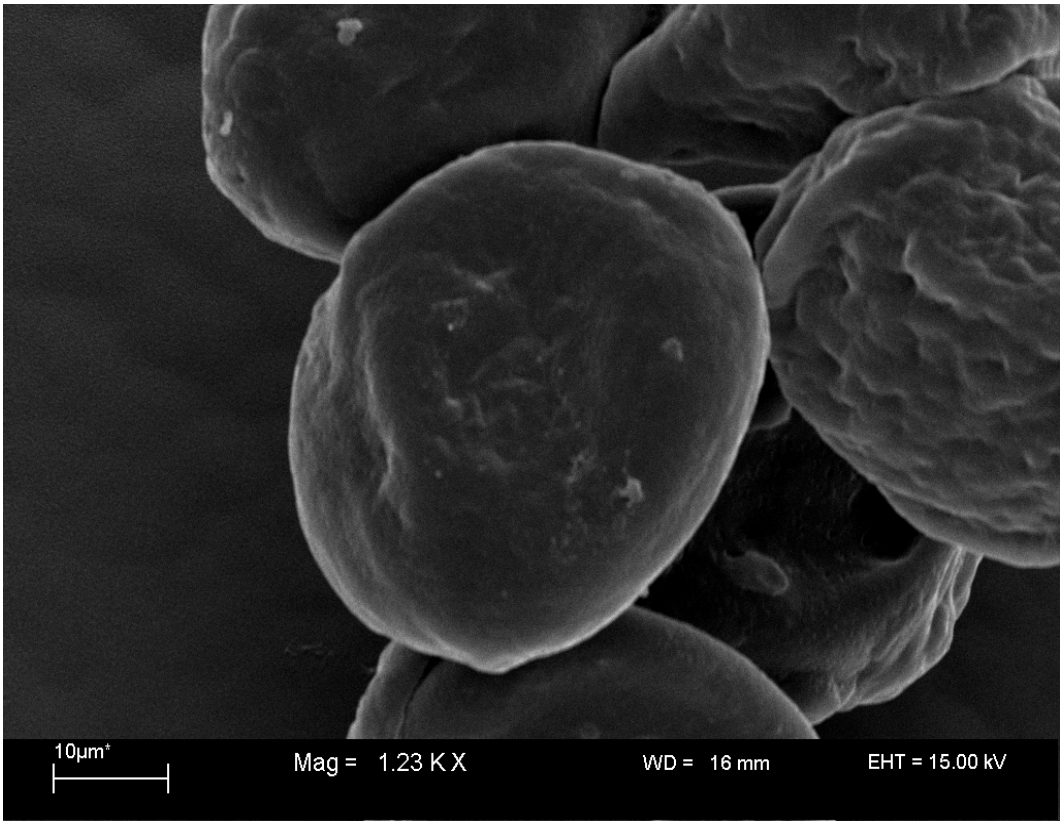


Figure 3.1.2.4**.** Electron micrograph of the pollen of *Dracaena reflexa* Lam.

3.1.2.4 Fruits and seeds

Dracaena fruits are fleshy, up to 3-seeded, with a smooth leathery exocarp, green when young turning bright yellow or orange-red when ripe. The fruit pulp usually paler in colour. They are globular, depressed globose to ellipsoid in shape and may be lobed or horned, and measure 0.5 –3 cm in diameter. Seeds are globose, discoid or of various irregular shapes, usually flattened against other seeds when these are present. They are white or brownish in colour, and consist of a ruminate endosperm and a cylindrical embryo. The seed is covered by a flimsy scarious envelope composed of the innermost layer of endocarp, containing sclerotised cells.

Seed coat ornamentation is frequently a useful source of taxonomic characters in the monocotyledons, for example among the Cyperaceae. No mention of this feature was found during the literature review. In this study a screening of seed-coat features under the scanning electron microscope did not show clear distinction between species.

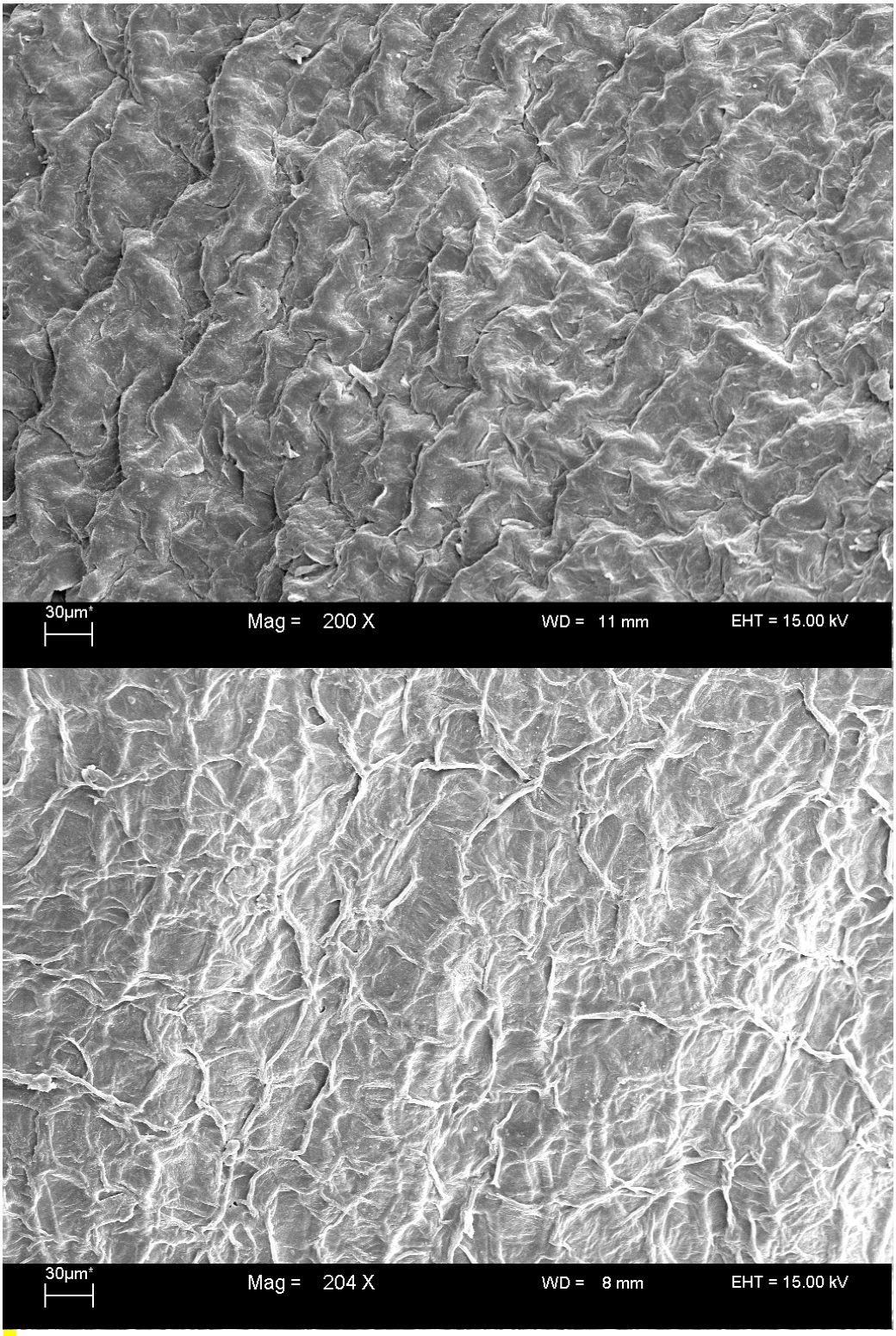


Figure 3.1.2.5. Electron micrographs of the seed coat of *Dracaena arborea* (Willd.) Link (above) and *D. ombet* Kotschy & Peyr. subsp. *schizantha* (Baker) Bos (below).

3.1.2.5. Reproductive biology

The nocturnal flowering habit, strong fragrance in the late evening and copious production of nectar on the inflorescence indicate pollination by animals active by night. Pollination by hawkmoths (sphingidae) has been observed in plants of *D. arborea* under greenhouse

cultivation in the Netherlands (Bos, 1998). Hawkmoths have also been seen to visit *D. fragrans* flowers in Kakamega, at about 2100 hrs, and have been filmed using infra-red techniques (Morimoto & Gikungu, *pers. comm*.). Ants were found on he inflorescence of *D. fragrans* during and after anthesis. They were seen to feed on the products of the extra-floral and floral nectaries – it was however not established whether they could play a role in pollination. However, the flower form and time of opening in *D. ellenbeckiana* and *D. ombet* suggest an adaptation to bee pollination.

3.2 Phenetics

Phenetic analysis by the Furthest Neighbour method produced 6 phenons at the 65% similarity level (Fig 3.2.1). The first two phenons are made up of species of a Guineo-Congolian distribution, but include some Somali-Masai species as well. The rest of the phenons are a mixture of all the other regions. The furthest neighbour method seems to have emphasised inflorescence type, with the paniculate species forming he largest of two phenons at the 65% similarity level. Correlation of morphological and geographical characters was low in this analysis. The full analysis is shown in appendix II.

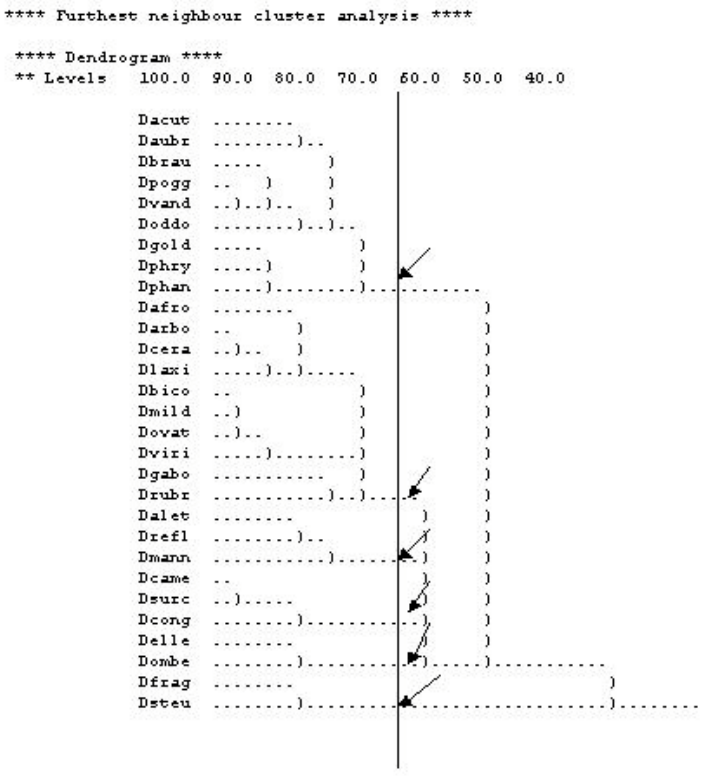


Figure 3.2.1. Result of the phenetic analysis using the furthest neighbour method.

When the matrix was analysed using the Group Average clustering method, four phenons are recognised at the 70% similarity level: phenon 1 comprises species of Guineo-Congolian distribution; there are four sub-phenons in this phenon. Phenon 2 is made up of Guineo-Congolian and eastern shrubs and trees with panicles of few-flowered clusters; phenon 3 comprises Somali-Masai shrubs with ensiform leaves; phenon 4 comprises *D. steudneri* and the pan-African *D. fragrans*. This result is depicted in figure 3.2.2.

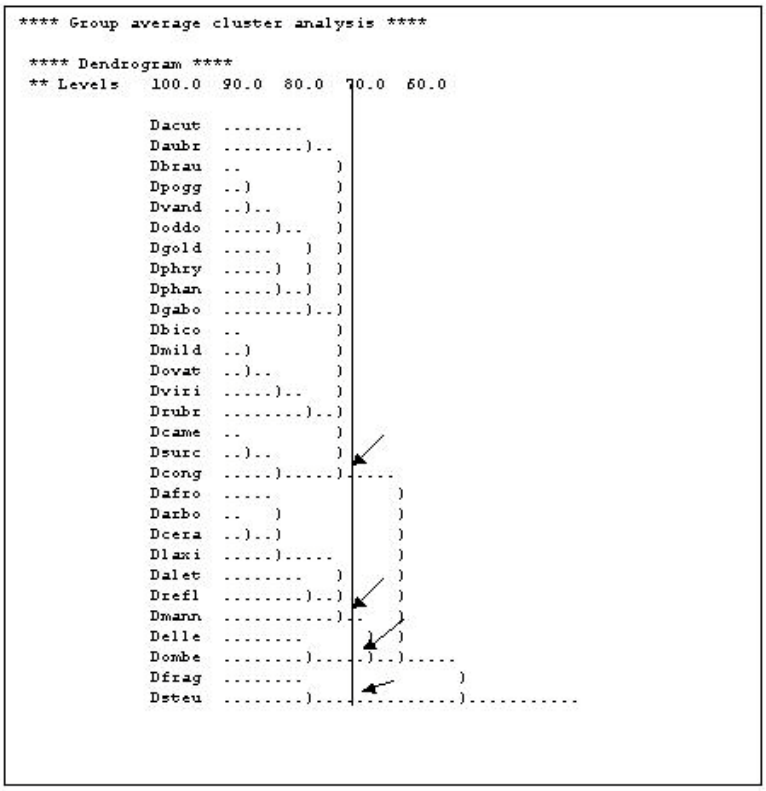


Figure 3.2.2. Result of the phenetic analysis using the Group Average method.

3.3 Phylogeny

The 29 species of *Dracaena* included in this study were scored for 14 morphological characters and the resultant matrix analyzed using the software PAUP v. 4.0 b4a. Table 3.3.1 shows the matrix obtained from the character-scoring, including the outgroup taxon, *Eriospermum abyssinicum.* The complete analysis is given in Appendix I.

From this tree, there was partial resolution of the species analyzed both on morphology and on habit. The first clade comprised the two species with spicate inflorescence and eliptic,

3-lobed fruits with divergent lobes. The second and largest clade consists of the species with paniculate inflorescence and globose fruits. This result is depicted in figure 3.3.2.

Dacutissima	11001111111100
Dafromontana	11001212000200
Daletriformis	11001212000200
Darborea	11001212000200
Daubryana	11001111011200
Dbicolor	11001110000000
Dbraunii	1100111101?200
Dcamerooniana	11001112000000
Dcerasifera	11001212000200
Dcongoensis	11001211000000
Dellenbeckiana	11001212000200
Dfragrans	11001212000200
Dgabonica	11001101000200
Dgoldieana	1100111O????00
Dlaxissima	11001212000200
Dmannii	11001212000200
Dmildbraedii	11001111000000
Doddonii	11001111000000
Dombet	11000212100200
Dovata	11001111000000
Dphanerophlebia	11001110000000
Dphrynioides	11001110011000
Dpoggei	1100111101l?00
Dreflexa	11001?120?0200
Drubroaurantiaca	110011?2011200
Dsteudneri	11001212000200
Dsurculosa	11001111000100
Dvanderystii	1100111101??00
Dviridiflora	11001?120?0000
Eabbysinicum	010?1111020210

Table 3.3.1. Morphological matrix used in the phylogenetic analysis. "?" indicates unavailability of the caharacter in the herbarium material observed.

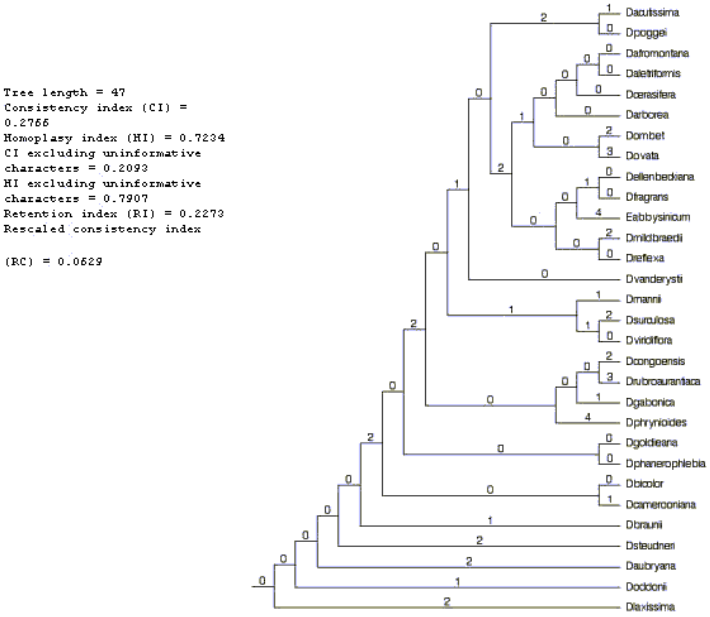


Figure 3.3.1 . One of 100 equally parsimonius trees resulting from the analysis.

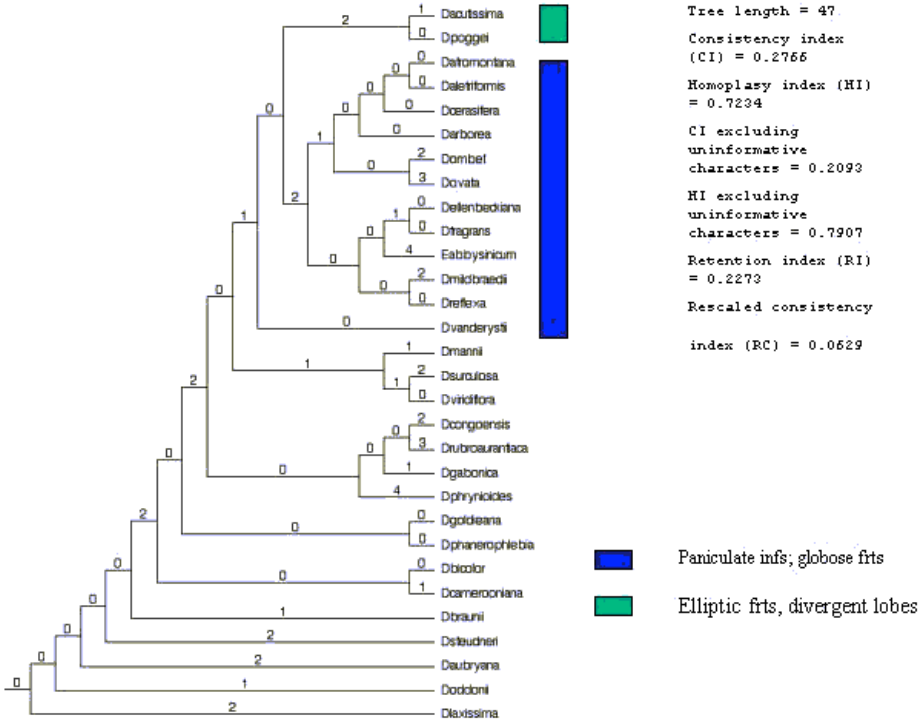


Figure 3.3.2. Resolution of the tree generated in terms of morphology.

The analysis also resolved the data set partially in terms of the habit. This is depicted in figure 3.3.3.

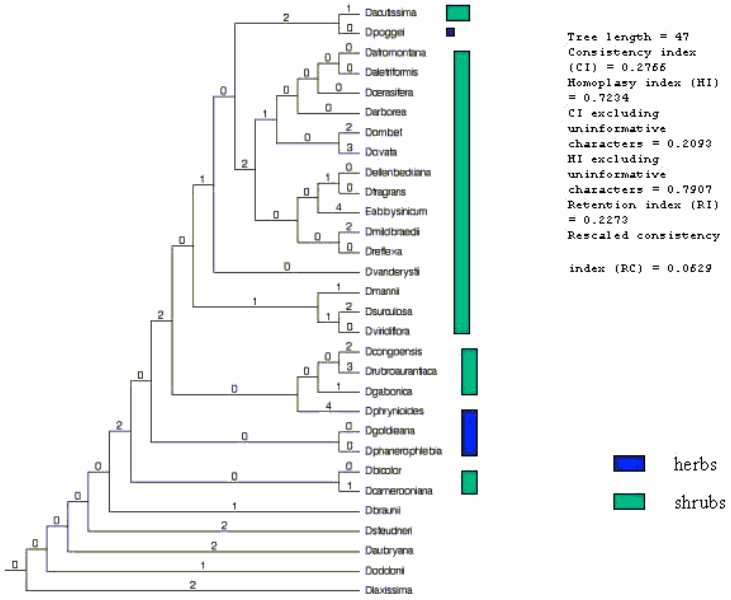


Figure 3.3.3. Resolution of the tree generated in terms of habit.

An attempt at bootstrap analysis on the tree resulted in collapse of the tree, except for 2 nodes as a result of extremely low support for the changes involved. This is shown in figure 3.3.4.

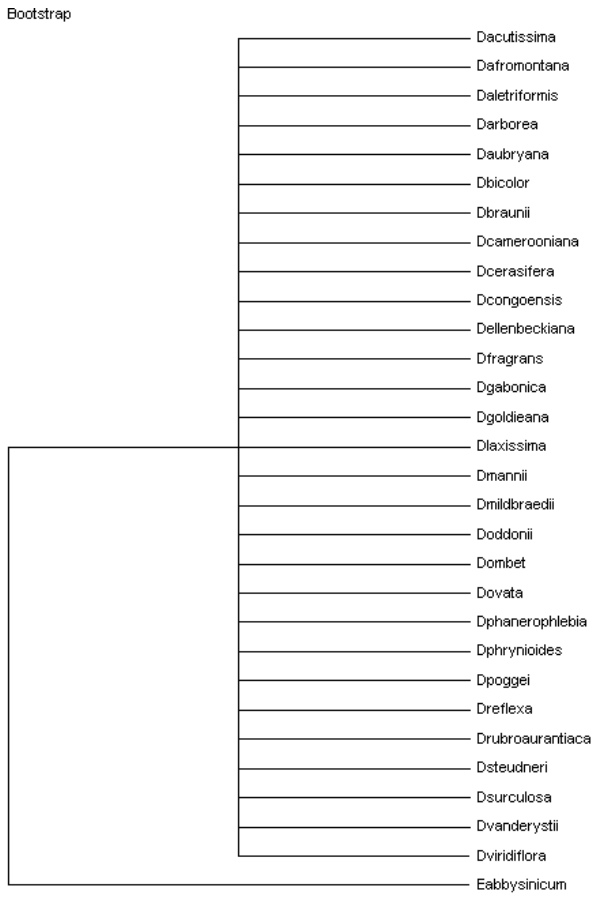


Figure 3.3.4. Bootstrap analysis of the tree generated in the analysis.

3.4. Ecology

3.4.1. Age-structure

The structure of the population of *Dracaena* in five forest fragments representing different stages of forest disturbance was studied between 2002-2003. Kisere, a forest with very low levels of disturbance had a total of 2356 individuals recorded in the plots, with an average of 106.2 seedlings, 75.2 juveniles and 89.8 adults per plot. Salazar, a forest fragment with light to moderate disturbance had a total of 1181 individuals recorded in the plots, with an average of 101.6 seedlings, 72.4 juveniles and 62.2 adults per plot. Buyangu Hill, a moderately disturbed forest patch had a total of 879 individuals recorded, with an average of 130.3 seedlings, 81 juveniles and 81.7 adults per plot. Colobus Trail, a heavily disturbed forest area had 834 individuals recorded, with an average of 91.6

seedlings, 41.4 juveniles and 33.8 adults per plot. The Salazar Guava thicket/grass mosaic area had 3 individuals recorded in the entire area, all of them seedlings. These results are illustrated in figures 3.4.1 and 3.4.2.

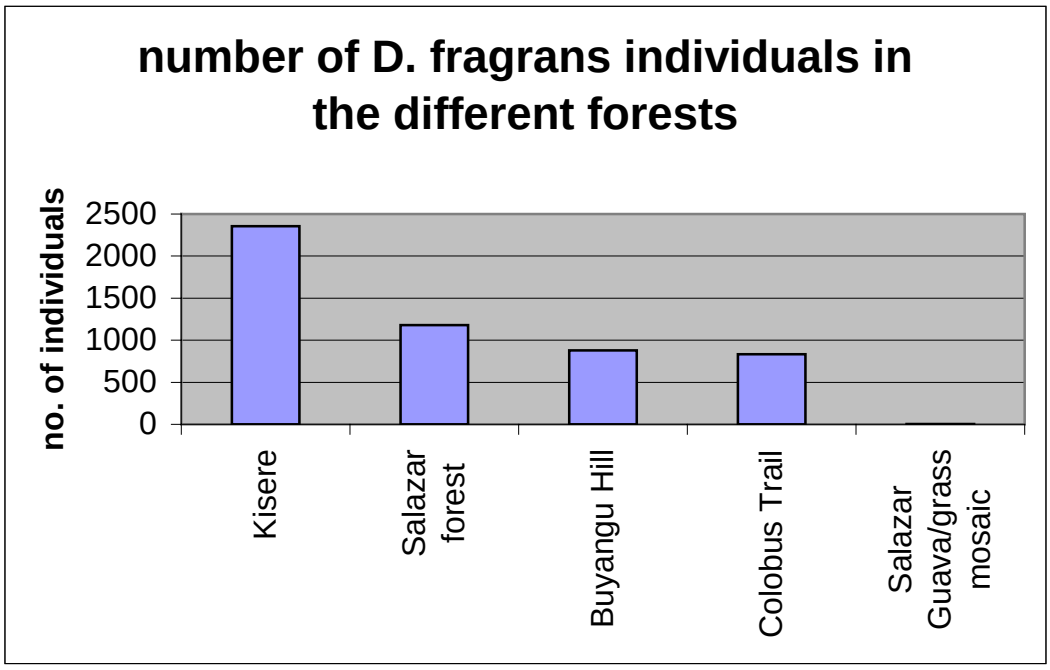


Figure 3.4.1. Relative *Dracaena* population in the forests studied

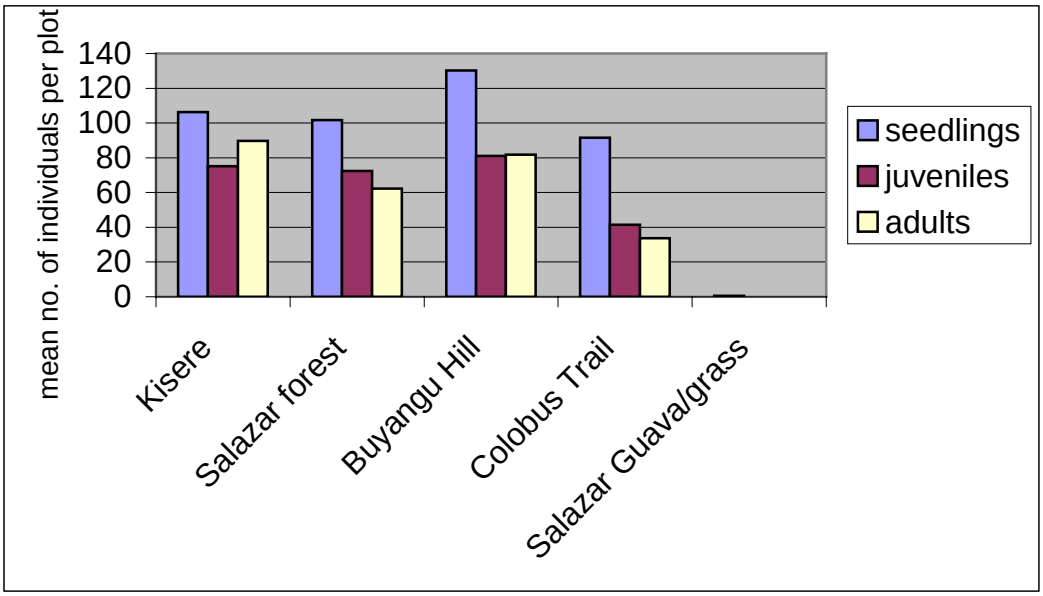


Figure 3.4.2 *Dracaena* population structure in the forests studied

3.4.2. Phenology

Phenological observations were made at Salazar area and at Kisere forest areas of the Kakamega forest system in Kenya. In the October 2002 observations on the Kisere

transect, of 1363 adult *D. fragrans* plants, 9 had ripe fruit, 7 had green fruit, 910 were flowering while the rest were sterile. In the July 2003 observations, of 1363 adult *D. fragrans* plants observed on the Kisere transect, only 3 had ripe fruits while none were flowering. In October 2002, of 591 mature plants of *D. fragrans* observed along the Salazar transect, 4 had ripe fruit, none had green fruit, 410 were flowering while 177 were sterile. In July 2003, of 591 mature plants of *D. fragrans* observed along the Salazar transect, none were flowering wile 365 bore ripe fruit, the rest were sterile. These results are illustrated in figure 3.4.3 and 3.4.4.

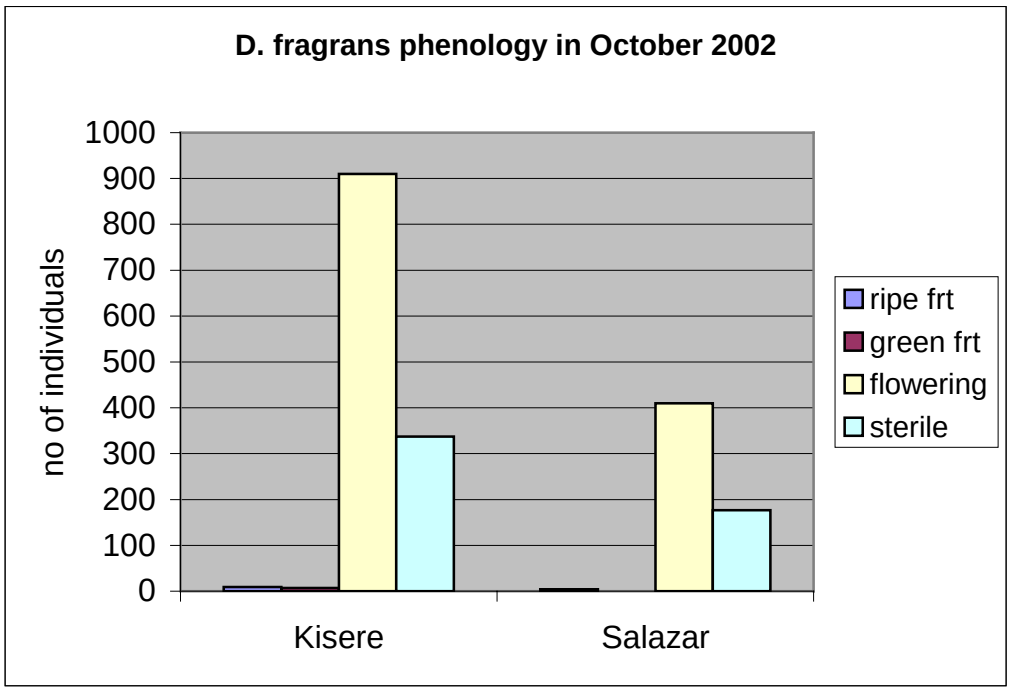


Figure 3.4.3 *D. fragrans* phenology in October 2002

At the same time no mature plants of *D. laxissima* were found on the Kisere transect during either observation period, while 6 were found on the Salazar transect, 2 of these were flowering, while the rest were sterile (July 2003), while all had been sterile in October 2002.

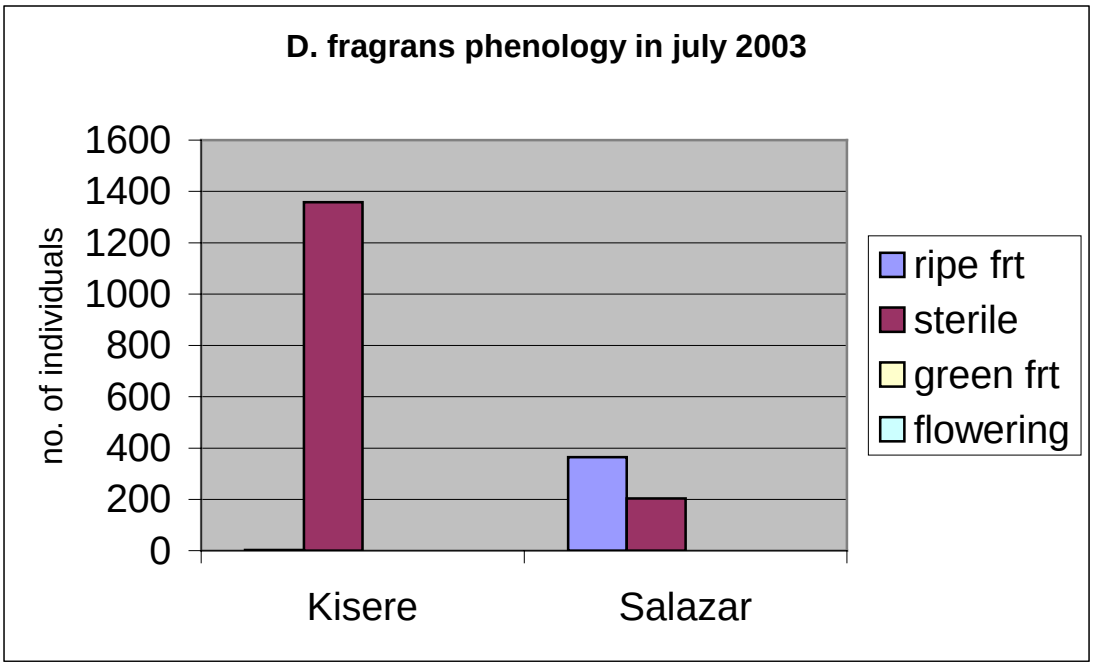


Figure 3.4.4. *D. fragrans* phenology in July 2003

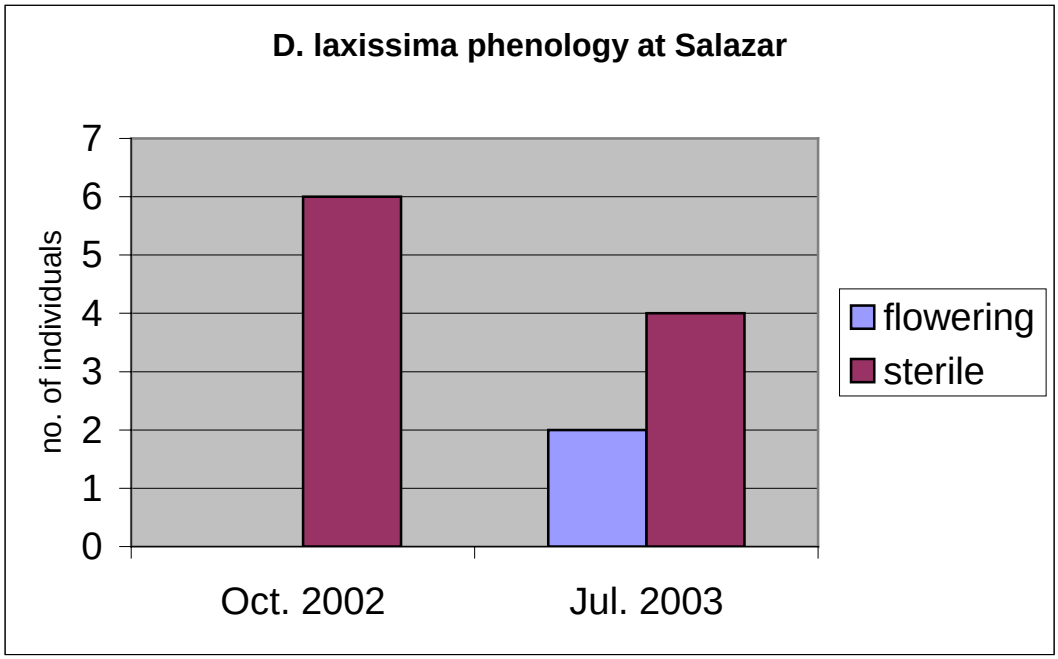


Figure 3.4.5. *D. laxissima* phenology in October 2002 and July 2003.

3.4.3 Fruit-set observations

In order to determine fruit-set success, seven shrubs of *D. fragrans* were marked along the "Yellow Flash" trail of the Colobus Trail forest and monitored through the season. As discussed in the morphological section, the flowers of *D. fragrans* are usually densely clustered in glomerules. To determine the number of flowers on a tree, an average of the

number of flowers to be found in a glomerule was obtained actual count based on five glomerules per shrub.
The results are summarized in table 3.4.3.1.

Plant	Average number of flowers/glomerule	Number of glomerules	Estimated number of flowers	Number of fruits set	% fruit-set success
CTF/01/GM	75	7	525	164	31.24
CTF/02/GM	170	6	1020	345	33.82
CTF/03/GM	75	7	525	212	40.4
CTF/04/GM	50	10	500	296	59.2
CTF/05/GM	52	10	520	131	25.2
CTF/06/GM	50	11	550	60	10.9
CTF/07/GM	50	8	400	84	21

Table 3.4.3.1. *D. fragrans* fruit set observations.

Table 3.4.3.1 shows that fruit-set success ranged between 10.9-59.2%, with an average success rate of 31.05%. Casual field observations show that fruit predation rate at immature stages is quite low, mostly by an unknown wasp. As much as 80% of the fruit set survives to ripening stage.

From March 2002 through January 2004, periodic observations on *Dracaena* interaction with animals showed no herbivory on the vegetative phases of *Dracaena*. The fruits of both *D. fragrans* and *D. laxissima*, when ripe and bright yellow in colour, were eaten by unknown birds. These birds seemed invariably to squeeze out the seed and its surrounding pulp, eating those parts and discarding the exocarp, figure 3.4.6. This was observed even when the ripe fruits were not abundant in the forest.
At times of great *Dracaena* fruit abundance, as occurred in August to September 2003, baboons (*Papio cyncephalus anubis*) could be seen devouring great quantities of these fruits. It seems however that they are not a choice food and their consumption on such a large scale was indicative of baboon persecution by people in the surrounding farms, or of a shortage of other fruits, such as figs and guavas (local informant).

Fig. 3.4.6**.** *D. fragrans* exocarp discarded on the forest floor.

Germination observations were made using naturally fallen fruit in the forest floor, ripe fruit harvested from the tree and seed in baboon dung. Ripe fruit remaining on the tree was also observed for germination. Seed from fruit harvested from the tree showed very low germination when wrapped in a damp paper towel and kept at room temperature for three weeks. Of 40 seeds in such two separate trials, only two germinated. Seeds from baboon dung showed a much higher germination, with 19 of 36 seeds tested in a similar manner germinating. Indeed, masses of seedlings encountered on the forest floor invariably arise from primate, mostly baboon, dung as shown in figure 3.4.7 i and 3.4.7 ii.

Seeds were seen to germinate while the fruit is still attached to the parent plant during the initial visit to Malava Forest Reserve in March 2002. This phenomenon appears to be quite rare it was neither encountered in subsequent visits, nor in other parts of the Kakamega Forest.

Fig. 3.4.7**.** i. *Dracaena* seeds in baboon dung (above); ii. Mass of *D. fragrans* seedlings growing out of baboon dung atop a tree stump at Ikwiva, Sept. 2003 (below).

3.5. Phytogeography

Dracaena is largely African in its distribution with outlying species in Arabia, Indonesia, the Canary islands, Central America and Hawaii. Virtually all the species are tropical, except for *D. aletriformis*, *D. draco* and *D. tanaranae*, which are either restricted to, or extend into the subtropics.

This study is restricted to the tropical species occurring in Central, East and Southern Africa, i.e. all of the African mainland east of the Nigeria-Cameroon border and south of the 15º N latitude. This area includes the following phytochoria (White, 1983). I. The Guineo-Congolian regional centre of endemism; II. Zambezian regional centre of endemism; III. Sudanian regional centre of endemism; IV. Somalia-Masai regional centre of endemism; V. The cape regional centre of endemism; VI. Karoo-Namib regional centre of endemism; VIII. Afromontane archipelago-like regional centre of endemism; X. Guineo-Congolia/Zambesia regional transitional zone; XI. Guineo-Congolia-Sudania transition zone; XII. Lake Victoria regional mosaic. XIIIa Swahilian regional centre of endemism; XIIIb. Swahilian-Maputaland regional transition zone; XIV. Kalahari highveld regional transition zone; XV. Tongaland-Pondoland regional mosaic These phytochoria are shown in map 3.5.1.

3.5.1. Distribution of *Dracaena* in relation to the major African phytochorological divisions.

a. Guineo-Congolian region

The main area of the Guineo-Congolian region extends as a broad band north and south of the equator from the Atlantic coast eastwards through the Congo Basin to the western shores of lake Kivu. This is the area included in this study. A smaller western area occurs in upper Guinea from the Guinea republic to Ghana; the dry Dahomey Gap separates the two areas. This region covers some 2 800 000 km². The altitude in this region is generally less than 1000 m, except in the east, where the land rises rapidly into the Afromontane centre of endemism. Most of the Guineo-Congolian Region receives between 1600 and 2000 mm of precipitation a year. Areas receiving more rain than this are confined to the coastal parts of Upper and lower Guinea. Only a small part of the Congo basin receives more than 2000 mm per year. Rainfall in excess of 3000 mm per year is received in two restricted areas, namely a coastal belt from Guinea Republic to Liberia and a narrow coastal region of Cameroon adjacent to the the Gulf of Biafra (White, 1983).

There are about 12 000 species of angiosperms in this region. The vegetation comprises wet and dry rain forest, transitional rain forests, swamps and secondary grasslands. The

rhizomatous, non-caulescent species of *Dracaena* namely, *D. braunii, D. goldieana, D. phrynioides, D. phanerophlebia, D. aubryana* and are restricted to this region. Arborescent and shrubby species occurring here are *D. gabonica, D. camerooniana, D. surculosa* var *maculata, D. surculosa* var. *surculosa, D. poggei, D oddonii, D. congoensis, D. bicolor, D. ovata, D. vanderystii, D. cerasifera, D. mannii, D. arborea, D. rubroaurantiaca, D. acutissima, D. viridiflora* and *D. mildbraedii*. It is by far the richest phytochorion in *Dracaena* species.

b. Somalia-Masai Region

The Somalia-Masai region occupies a large part of the continent of Africa between 16ºN and 9ºS and 34ºE and 54ºE. It includes Eastern and Southern Ethiopia (except the mountains), South-east Sudan, North-east Uganda, most of Kenya between the highlands and the coastal belt and Central and North Tanzania south of the Great Ruaha valley. It spreads across the red sea into Southern Arabia. It occupies about 1 873 000 km². Most of the area is below 900 m and descends in the north-east to seal level. The climate is arid, and deciduous bushland and thicket is the climax vegetation over the greater part of this region. This vegetation is characterised by dense bush, 3-5 m tall with scattered emergent tree to 9 m tall (White, 1983). *Dracaena* species found in this region are *D. steudneri, D. ellenbeckiana* and *D. ombet* subsp. *schizantha* only.

c. The Zambezian Region

The Zambezian region extends from 3ºS to 26ºS and from the Atlantic ocean to close to the Indian Ocean. It includes the whole of Zambia, Malawi and Zimbabwe, large parts of Angola, Tanzania and Mozambique and small parts of Congo (Kinshasa), Namibia, Botswana and South Africa. It covers 3 770 000 km², most of which lies above 900 m altitude and merges with the Afromontane region at over 2000 m.
The Zambezian region is the largest African phytochorion after the Sahara, has the second richest and diversified flora and also the largest diversity of vegetation types. It holds some 8500 plants species (Clarke, 1998). *Dracaena* species occurring here are *D. arborea, D. camerooniana*, and *D. mannii*

d. The Sudanian Region

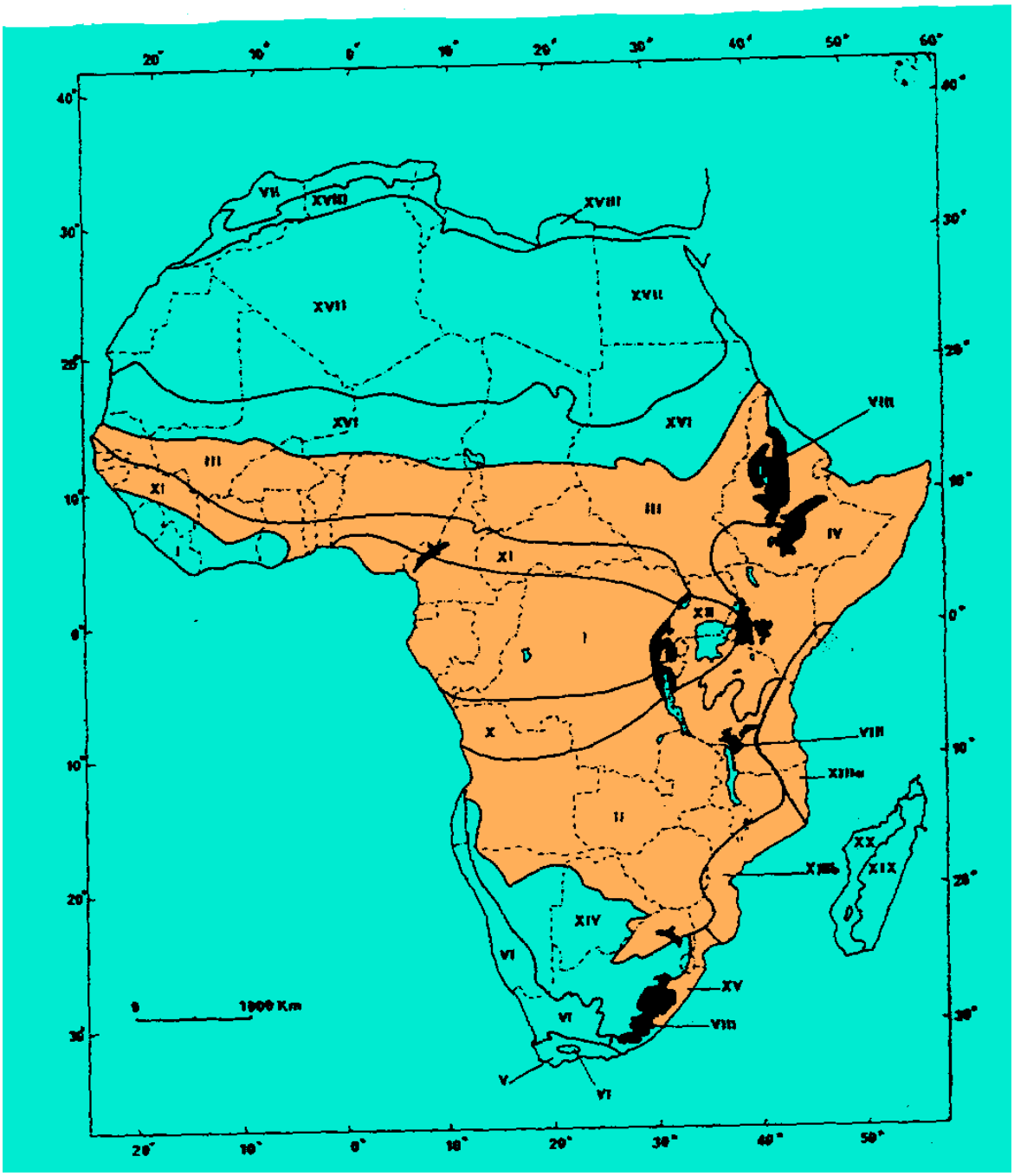
The Sudanian region extends as a narrow band across Africa from the coast of Senegal to the foothills of the Ethiopian Highlands. It is mostly between 500 and 700 km wide but becomes narrower in the west and broadens in the east. It covers some 3 731 000 km^2. This region is rather floristically depauperate, with probably no more than 2750 species

represented. Only *Dracaena acutissima* and *D. steudneri* are represented in the parts of this region covered by this study.

f. Swahilian regional centre of endemism (Clarke, 2001)

This, and the next two regions, were defined recently (Clarke, 2001) to replace the heterogenous Zanzibar-Inhambane regional centre of endemism of White (1983).
This region occupies a coastal belt from southern Somalia to the mouth of the Moçambique Island, about 60 km S of the city of Nacala. It is 50-200 km wide except where it penetrates further inland along broad river valleys. Small enclaves occur to the west on the windward slopes of mountainous massifs below 1500 m where the local increase in precipitation and dry season relative humidity favours the development of lowland and transitional rain forest: it covers 250 000 km^2. Most of the land lies below 200 m but in the northern part there are scattered hills and plateaux rising considerably higher. These include the Shimba Hills and Mrima Hill in Kenya; the Pugu Hills and Rondo plateau in Tanzania and the Macondes plateau in northern Mozambique.
Rainfall is between 800 and 1200 mm per year with a well-defined rainy season. In most parts of this region the rainfall is comparable in amount to that of the Zambezian Region, but is more evenly distributed through the year, with no month being completely rainless (White, 1983, Clarke, 2001).
There are about 4 000 species of plants with four endemic genera, namely *Cephalosphaera, Englerodendron, Grandidiera* and *Stuhlmannia*. *Dracaena aletriformis, D. fragrans, D. laxissima, D. mannii* and *D. reflexa* are recorded in this region. *Dracaena reflexa* conforms to the biogeographical trend linking the flora of this region with that of Madagascar observed in diverse genera such as *Bivinia, Hirtella, Ludia* and *Hymenaea.*

These phytochorological divisions are shown in map 3.5.1.



Map 3.5.1. The major phytochoria of Africa and Madagascar (after White, 1983, and Clarke, 2001). The areas in brown indicate the phytochoria included in this study.

I. Guineo-Congolian regional centre of endemism. II. Zambezian regional centre of endemism. III. Sudanian regional centre of endemism. IV. Somalia Masai regional centre of endemism. V. Cape regional centre of endemism. VI. Karoo-Namib regional centre of endemism. VII. Mediterranean regional centre of endemism. VIII. Afromontane archipelago-like regional centre of endemism, including IX, afro-alpine archipelago-like region of extreme floristic impoverishment (not shown separately). X. Guineo-Congolia /Zambezia regional transition zone. XI. Guinea-Congolia/Sudania regional transition zone. XII. Lake Victoria regional mosaic. XIIIa. Swahilian regional centre of endemism. XIIIb. Swahilian-Maputaland regional transition zone. XIV. Kalahari-Highveld regional transition zone. XV. Tongaland-Pondoland regional mosaic. XVI. Sahel regional transition zone. XVII. Sahara regional transition zone. XVIII. Mediterranean/Sahara regional transition zone. XIX. East Malagasy regional centre of endemism. XX West Malagasy regional centre of endemism

g. Swahilian-Maputaland regional transition zone (Clarke, 2001)

This transition zone forms the southern part of White's Zanzibar-Inhambane regional mosaic south of Moçambique Island. It contains 3 300 species of which about 100 are endemic (Clarke, 2001). Only *D. aletriformis* has been recorded in this regional transition zone.

h. Maputaland-Pondoland (Clarke, 2001)

This region extends from the Limpopo river mouth to Port Elizabeth. In the north it is up to 240 km wide, but in the south where the mountains come close to the sea, its width is only 8 km. It also penetrates inland along river valleys for a considerable distance. It covers 148 000 km^2. The rainfall is high and well-distributed, both in space and in time. There are 3000 species, about 40% of which are endemic. There are no endemic genera or families (White, 183). *Dracaena aletriformis*, that also occurs in the Swahilian region, is the only *Dracaena* species found here.

i. Guinea-Congolia/Zambezia regional transition zone.

The transition zone that separates the Guineo-Congolian and Zambezian regions extends from the Atlantic Ocean eastwards to the plateaus surrounding the northern end of L. Tanganyika. Its maximum width is 500 km, covering an area of some 705 000 km^2. There about 2 000 species in this transition zone, about 14 of which are endemic. These include *Combretum camporum, Croton dybowskii, Diospyros grex, D. heterotricha, D. wagemansii, Hymenostegia laxiflora, Pteleopsis diptera* and *Rinorea malembaensis* (White, 1983).

Dracaena mannii, D. arborea, D. aubryana, D. camerooniana, and *D. fragrans* occur in this zone.

j. Guinea-Congolia/Sudania regional transition zone.

This transition zone, separating the Guineo-Congolian and Sudanian Regions extends across Africa from Senegal to western Uganda. Between eastern Ghana and Benin it reaches the coast where the 'Dahomey Gap' separates the Guineo-Congolian rain forests into two blocks. There are about 2000 species in this area, most of which are Guineo-Congolian or Sudanian in their distribution, or linking species with even wider distributions. Endemic species include *Bafodeya benna*, *Fleurydora felicis* and *Diospyros feliciana* (White, 1983).

Dracaena surculosa is recorded from this transition zone within the study area.

k. Afromontane archipelago-like regional centre of endemism.

The Afromontane is an archipelago-like centre of endemism that extends from the Loma mountains and the Tingi Hills in Sierra Leone in the west to the Ahl Mescat mountains in Somalia in the east, and from the Red Sea Hills in Sudan in the north to the Cape Peninsula in the south. A few Afromontane species descend almost to sea level, even in the tropics, but outside the Afromontane region they are usually very rare. In the tropics the Afromontane communities are found above 2000 m, but where the climate is more oceanic, they occur as low as 1200 m. Further south, they descend even lower, and occur only a few hundred metres above seal level on the Cape Peninsula. The climate is variable, with rainfall reaching over 1000 mm in most areas. This region covers approximately 715 000 km^2.

There are over 4000 species in this region with about 75% endemism. The family Barbeyaceae and the genera *Afrocrania, Balthasarea, Ficalhoa, Hagenia, Kiggelaria*, *Leucosidea, Platypterocarpus*, *Trichocladus* and *Xymalos* are endemic to this region. *Dracaena afromontana, D. laxissima* and *D. fragrans* frequently inhabit the more tropical areas of this region.

l. Lake Victoria regional mosaic

This region includes most of Uganda, the whole of eastern Rwanda and Burundi, and small parts of Democratic Republic of Congo, Kenya and Tanzania. The Ruzizi valley, north of Lake Tanganyika, is part of this mosaic. It covers 224 000 km^2.

Climatic gradients are often steep and are related to the physiography and distance from the lake, which is an important source of precipitation. The rainfall ranges between 1500 mm and 2000 mm per annum, sufficient to sustain rain forest in most places. In a few areas the rain is low, and scrub forest and semi-evergreen bushland and thicket form the climax vegetation. There are less than 3000 species, very few of which are endemic. There are no endemic genera (White, 1983) *Dracaena fragrans, D. aubryana* and *D. laxissima* occur in this mosaic.

The analysis of the phytogeography of *Dracaena* show that the Guinea -Congolian regional centre of endemism is the most species-rich, followed by the Guineo-Congolian/Zambesian regional transition zone. The Maputaland-Pondoland regional mosaic and the Guinea-Congolia/Sudania regional transition zone are the poorest, having only one species each. The results are summarized in figure 3.5.1

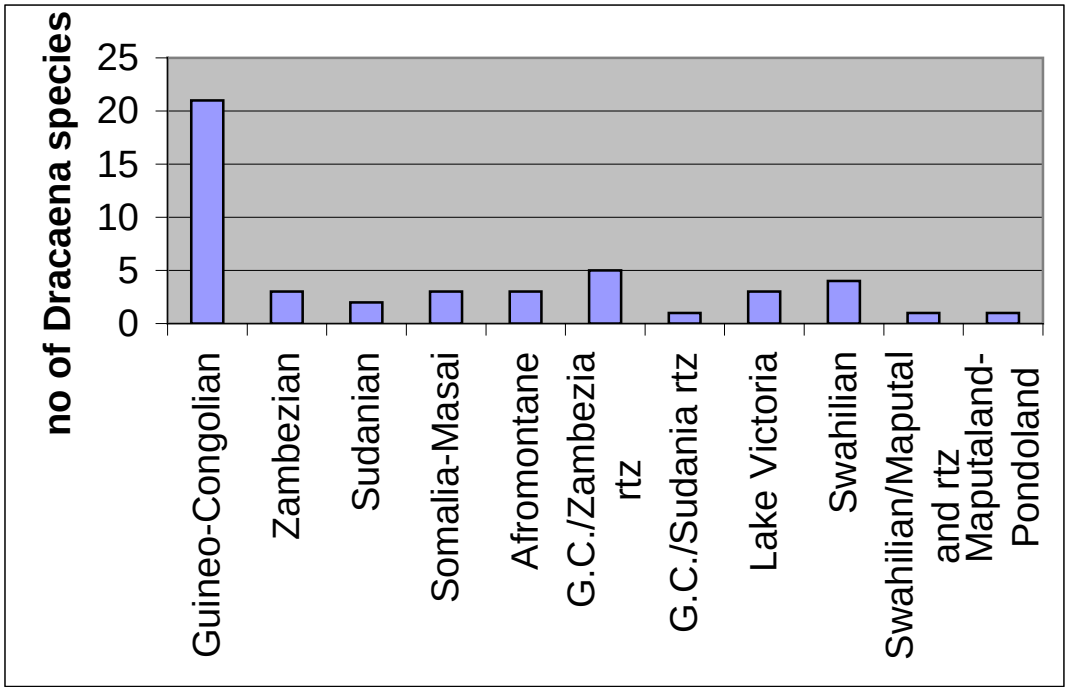


Figure 3.5.1. Analysis of the species richness amongst the African phytochoria included in this study.

Chapter 4. Discussion and Conclusions

4.0. Overview

This study endeavoured to revise the taxonomy of *Dracaena* in east, central and southern Africa, and to investigate the ecology of *Dracaena* species in Kakamega forest. This is the first taxonomic treatment of *Dracaena* this area since Baker's monograph of 1875. In this work, a classification based on analysis of morphological and geographical data has been constructed. From this infrageneric relationships can be examined in relation to their geographical distribution.

The genus *Dracaena* is delimited from *Sansevieria* on the basis of its fruit development and palynology, features which seem to have been overlooked in recent times, given several proposals to merge the two genera. The distinctions between the two established by Nakai (1936), Ojeda, Ludlow-Wiechers & Orellana (1984) and Ojeda & Ludlow-Wiechers (1995) ought to be re-evaluated against the works of Bos (1998) and Bos & Teketay (1997) before a decision is made.

4.1. Phenetics

The phenetic analysis of biogeographical and morphological data enables us to conveniently classify the genus into groups that are not only morphologically distinct, but are also largely distinct in their distribution. In the materials and methods (chapter 3) I found that the Furthest Neighbour clustering method results in tight hyperspherical discrete clusters that join others only with difficulty and at low similarity levels. (Johnson, 1967). This in practice means that it creates a tendency to split up groups that are similar im many respects, resulting in artefacts in the analysis. For this reason, the result we saw, with six phenons at 65% similarity will not be discussed here. The Group Average method overcomes many of the problems associated with the Furthest Neighbour Method. The four phenons identified at the 70 % similarity level are here discussed.

<u>Phenon 1.</u>

This comprises *Dracaena* species of mostly Guinea-Congolian distribution. Some may extend into the neighbouring transition zones, namely the Guinea-Congolian-Zambezian transition zone and the Guinea-Congolian-Sudania regional transition zone. This phenon comprises 4 sub-phenons as follows:

1 a. This comprises *D. aubryana* and *D. acutissima*. These species have different leaf form but share the inflorescence type. They differ in many respects, such as perianth size

and texture of the inflorescence axis. I consider this subphenon an artifact of the analysis owing to the fact that *D. acutissima* was the first in the matrix.

1 b. This subphenon comprises species with a distinct pseudopetiole that is at least half as long as the lamina. They are mostly herbs or rhizomatous shrubs of dimunitive stature. The species included are *D. braunii, D. poggei, D. vanderystii, D. oddonii, D. goldieana, D. phrynioides, D. phanerophlebia* and *D. gabonica*.

1c. This subphenon comprises *D. bicolor, D. mildbraedii, D. ovata, D. viridiflora* and *D. rubroaurantiaca*. These are shrubs with pseudopetiolate leaves, and inflorescences made up of flower clusters with few (1-4) flowers each.

1 d. This subphenon comprises *D. congoensis, D. surculosa* and *D. cameroониana* which are shrubs with pseudopetiolate leaves bearing their flowers in multi-flowered glomerules.

Phenon 2

This phenon comprises *D. afromontana, D. arborea, D. cerasifera, D. laxissima, D. aletriformis, D. reflexa* and *D. mannii*. These are trees and shrubs with lax or pendent inflorescences bearing flowers in clusters of 1-4, they are pan-African or eastern (Swahilian, Swahilian Maputaland, Maputaland-Pondoland) or Afromontane in their distribution.

Phenon 3

This phenon is made up of those species that have ensiform leaves, have their flowers singly or in clusters of up to four, and occur in the Somali-Masai phytochorion only. These are *D. ombet* subsp *schizantha* and *D. ellenbeckiana.*

Phenon 4.

This phenon comprises *D. fragrans* and *D. steudneri*. These species have large sword-shaped or strap-shaped sessile leaves, bear their flowers in dense, multi-flowered glomerules and have the perianth lobes slightly longer (± equal) than the tube. They are eastern (Lake Victoria regional mosaic, Afromontane) in their distribution.

The aim of the phenetic analysis was to produce a classification based on the totality of the similarities in morphology and biogeography. With thirty characters covering different aspects of the plant body and its distribution, the resulting groupings are sufficiently robust to form the basis of an infra-generic classification for the genus.

Phenon 1 comprises the Aubryana group, with the possible exception of *D. acutissima* Hua. It is here proposed to delimit *Dracaena* subgenus *Aubryana* on the basis of this

group with *D. aubryana* as the type species of the subgenus. The placing of *D. acutissima* remains in doubt, owing to its unique morphology that is intermediate between that of subgenus *Aubryana* and that of *D. ombet* and its allies. The four subpheneons in this phenon are proposed as sections of subgenus Aubryana, as follows: 1a. section aubryana; 1 b. section phrynioides; 1 c. section ovata and 1 d. section surculosa.
Phenon 2 is proposed as subgenus Arborea, with *D. arborea* as type species for the subgenus.
Phenon 3 is proposed as subgenus Ombet, with *D. ombet* as type species for the subgenus.
Phenon 4 is proposed as subgenus Fragrans, with *D. fragrans* as type species for the subgenus.
I am convinced that this analysis is sufficiently robust to accommodate the species in west Africa that are not included in this study. Compared to the infrageneric classification of Baker (Baker, 1875) the current work has the advantage that it is derived in a repeatable analysis, and that the said analysis incorporated geographic data. This implies a consideration of the adaptation of the various species to the conditions obtaining in the range of their distribution.

4.2. Phylogeny

The phylogenetic analysis of morphological data using resulted in a low resolution of groups. When analysed with *Eriospermum abyssinicum* as out group, the herbaceous, petiolate species end up in four different clades, while *D. laxissima* forms the sistergroup to the rest of the *Dracaena* species, including the out-group taxon. The analysis shows a very low consistency index and a rather high homoplasy index. This is probably due to the few characters available from herbarium material for phylogenetic analysis. No attempt is made to group species on the basis of the phylogenetic analysis, until more characters from the field, as well as molecular ones are used in the analysis.

4.3. Ecology

Studies on the ecology of *Dracaena* in the Kakamega forest show that occurrence, absolute numbers , i.e. density of *Dracaena* in a forest area, and age structure are all indicative of forest quality. Both *D. fragrans* and *D. laxissima* do not occur in grassland or thicket, they are exclusively forest-dwelling. High densities of *Dracaena* i.e. numbers of individuals per plot, is also indicative of forest quality. Kisere, a relatively undisturbed forest had the greatest density at 471.2 , followed by Salazar forest (236.2), Buyangu Hill (175.8) and Colobus Trail (166.8), these forests follow the same order in their degree of

disturbance as determined by other means. In the less disturbed forests, the percentage of seedlings in the population was lower than in the very highly disturbed ones. In non-forest areas, only seedlings are found. This indicates lack of success in establishment attributable to various factors. *Dracaena* species are therefore indicators of non-forest (absence, or seedlings only) and forest (all ages present). It would appear that the greater the contribution of seedlings and juveniles, the more intense the disturbance, or the shorter the period since last disturbance.

Dracaena in Kakamega seem dependent on animals for successful seed dispersal and subsequent establishment. Though *Dracaena* reproduces vegetatively quite easily, animal activity that leads to breakage of shoots promotes this further. *Dracaena* will also rely on the dispersing influence of primates, especially baboons, for maintenance of a healthy level of genetic exchange and colonization of new habitats. In this respect *Dracaena* contributes food to the animals while the animals disperse its seeds and strengthen possibilities for vegetative propagation. *Dracaena* therefore occupies an important position in the ecology of the forest.

4.4. Phytogeography

This study showed that the Guineo-Congolian phytochorion is the richest in species of *Dracaena* in Africa, i.e. the genus is most diverse in that phytochorion. Stace (1989) remarked that centres of diversity probably hold the main remnants of the ancestral genetic material. As far as *Dracaena* is concerned, the ancestral species would be a shrub or a herb with pseudopetiolate leaves and an unbranched inflorescence, as this is the predominant form in the centre of diversity. There seems to have been a burst of speciation events associated with the Rift system, giving a minor centre of diversity in the East African highlands, especially for the arborescent species. Mapping the evolution of different morphologicall characters in relation to the major phytochoria could give a valuable insight into how the genus has adapted to increasing aridity and altitude as it migrated away from the centre of diversity.

4.5. Conclusion and perspectives for future work

This study used four approaches to investigate the sytematics and ecology of *Dracaena* in Central East and Southern Africa. It has found evidence that the apparent close relationship between *Sansevieria* and *Dracaena* is based on overall morphology but has not taken into consideration palynology and ontogenetic studies. It is interesting that in both the morphological and molecular analyses of Rudall et al. (2000), *Dracaena* and

Sansevieria come out as separate entities. This coupled with the distinctions pointed out by Nakai (1936), Ojeda et al. (1984) and by Ojeda & Ludlow-Wiechers, 1995) indicate that the two genera are distinct and should be maintained as such. Ontogenetic work along the lines of that carried out by Nakai (1936), palynological and molecular studies are very likely to yield further evidence that the apparent similarity between the two genera is superficial and bears no phylogenetic value. To further elucidate relationships between the two genera, studies must include the Madagascan species of both genera: species of both *Sansevieria* and *Dracaena* occurring there seem aberrant in relation to the African ones and could yield useful clues on the evolution of the Ruscaceae in general.

The infrageneric classification of *Dracaena* proposed here is meant to facilitate the classification of the observed diversity. It differs from that of Baker (1875) in that only three subgenera are recognised here while 7 "stirps" were recognised in the former work. Furthermore, the basis for the sub-genera here recognised is explicit, while it was implicit or unknown in the previous work.

In this taxonomic revision, 29 species were recognised while the identity of two others could not be verified. I know one species included in the revision only from the description, as no material has been seen. Five names were found to be of uncertain application and are listed at the end of the taxonomic treatment.

Geographically, The Guineo-Congolian centre of endemism (White, 1983) is the richest in *Dracaena* species. The majority of these occur in the Gulf of Guinea area, leading me to speculate that this is the centre of origin of this genus. The species in the east, namely subgenus Ombet, and subgenus Fragrans are of quite a different life form, compared to those in the Guineo-Congolian region proper. I therefore postulate that there are two centres of diversity in the study area: one in the Guineo-Congolian region and the other in the Afromontane and Somali-Masai regions.

Worldwide, the occurrence of *Dracaena* in the New World needs further investigation, as these reports may be based on a taxonomic confusion between *Dracaena, Cordyline* and *Nolina*. Its occurrence in these parts ought to be verified in the field. Studies of the relationships between the African lineages covered in this study, the southeast Asian/Madagascan and Arabian/Saharan groups are essential for a worldwide understanding of this fascinating and economically important genus.

4.6. Taxonomic Treatment

Dracaena L. Syst. Nat. ed. 12, II: 246 (1767) & Mant. Pl. I: 63 (1767); Juss., Gen. Pl. II: 40 (1789); Engl. In Engler & Prantl, Nat. Pfl. II,5: 73 (1888); Bos in Kubitzki et al.., Fam. Gen. Vasc. Pl. 3: 240 (1998)

Dracaena Vand. Diss. (1702); *Draco* Crantz. Duab. Dracon. Arb. 13 (1768); *Drakaina* Rafin. Fl. Tellur. Iv 17 (1836); *Oedera* Crantz. Duab. Dracon. Arb. 30 (1768); *Pleomele* Salisb. Prod. 245 (1796); *Terminalis* Medic. Theodora 83 (1786); *Stoerkia* Crantz. Duab. Dracon. Arb. 25 (1768)

Trees, shrubs, sometimes scandent or rhizomatous herbs, 10 cm to over 40 cm high; roots usually orange in colour. Stems showing secondary thickening in the arborescent species, bark bearing persistent leaf scars, generally greying with age. Leaves generally spirally arranged on leaves and branches, alternate or distichous in some species, or crowded into terminal pseudowhorls or tufts; transitional leaves intermediate in shape and size between ordinary leaves and floral bracts often present at the base of the peduncle. Leaves somewhat coriaceous smooth, glossy, pale to dark green, usually distinctly paler beneath, concolorous or variegated; shape and size variable, always simple, entire and mucronate. Proximal end of lamina in some species constricted into a pseudopetiole, the base usually amplexicaule, nerves strictly parallel, concentrated at the middle of the upper surface forming a distinct midrib. Inflorescence usually a terminal panicle, very small to over 1.5 m long, occasionally appearing racemose by reduction of primary branches; pedicel of a peg-like basal part crowned by a distinct joint, and an obconical receptacle, persistent in fruit. Flowers distributed singly, in pairs or in few- to multi-flowered glomerules; bracts and bracteoles may be present, sometimes tightly enveloping the flowers to very small and obsolescent. Perianth less than 4 mm to over 5 cm long, nocturnal, opening for a few hours only, fragrant; consisting of a tubular fused base and 6 free lobes in two whorls of 3, each lobe showing a median costa. Stamens inserted in the throat or higher, with inflated filaments; anthers versatile, opening by lateral slits. Ovary ovoid, cylindrical or bottle-shaped, smooth, 3-locular, each locule bearing a single ovule; style terminal, terete, slender, as long as or longer than the perianth, stigma capitate, usually distinctly 3-lobed. Fruit fleshy, 1–3-seeded; exocarp smooth and leathery, green, turning yellow, orange or orange-red on ripening, pulp paler, containing the seeds; globular, depressed globose to ellipsoid, sometimes lobed or horned, 0.5 cm to over 2.5 cm in diameter, the receptacle usually persistent, attached to

the fruit. Seeds globose or discoid, usually flattened against adjacent seeds when present, white or brownish.

Dracaena occurs in Africa, Canary Islands, Cape Verde Islands, Madagascar, Mascarene Islands, Arabia, South-east Asia, Hawaii, Central America and Cuba. Most of the species occur in Africa south of the Sahara, with a lesser centre of diversity in Southeast Asia.

Key to *Dracaena* species in Central, East and Southern Africa

1. Leaves pseudopetiolate, herbs and shrubs. 3
   Leaves sessile, non-pseudo petiolate, habit various.....2

2. Leaves linear, ensiform, widest at the base, flowers in clusters of 1–3 along the inflorescence axes.....18
   Leaves linear-lanceolate, widest above the bottom quarter of their length, flowers variously arranged.....19

3. Perianth lobes equal to, or longer, than the tube 4
   Perianth lobes shorter than the tube 7

4. Flower clusters made up of 1–4 flowers 5
   Flower clusters made up of 5 or more flowers .....2. *D. aubryana*

5. Herbs from a subterranean rhizome, leaves lanceolate, inflorescence spicate.....3. *D. braunii*
   Shrubs with a woody stem, without a subterranean rhizome, leaves elliptic to rotund, inflorescence paniculate 6

6. Scandent shrubs, leaves elliptic, lamina at least 5 times as long as petiole.....22.. *D. laxissima*
   Erect shrubs, leaves broadly elliptic to rotund, lamina 2–4 times as long as the petiole.....10. *D. gabonica*

7. Flower clusters made up of 1–4 flowers 8
   Flower clusters made up of over 5 flowers.....16

8. Leaves in pseudo-whorls, elliptic to elliptic-acuminate, pseudopetiole shorter that ¼ the length of the lamina 9
   Leaves not in pseudo-whorls, lanceolate or ovate, pseudopetioles at least ¼ as long as the lamina 10

9. Leaves obovate, pseudopetioles over 10 mm long .....16. *D. camerooniana*
   Leaves elliptic, pseudopetioles less than 10 mm long.....17. *D. surculosa*

10. Leaves variegated, variegation usually of an irregular transverse pattern.....7. *D. goldieana*
    Leaves not variegated, or variation not of irregular transverse pattern.....11

11. Pseudopetiole slender, c. twice as long as lamina; lamina variegation of elliptic, transversely oriented yellow-green dots, or not variegated.....…..15
Pseudopetiole various, shorter than or equal to lamina, lamina not variegated....…....12

12. Shrubs, flowers and leaves various, not growing in fresh water, or water logged conditions 13
Herb, leaves without prominent veins on either side of the mid-rib, petiole with a sheathing base 2 cm or more in length, , fruits ellipsoid; growing in fresh water, or water-logged conditions .....…….4. *D. poggei*

13. Leaves lacking prominent veins on either side of the mid-rib; perianth lobes remaining straight when dried .....…….…….....14
Leaves with up to 3 prominent veins on either side of the mid-rib, perianth lobes twisted spirally on drying.....…….....6. *D. oddonii*

14. Leaf lamina ovate, elliptic or obovate, inflorescence bearing concave, long-cuspidate bracts .....18. *D. congoensis*
Leaf lamina oblanceolate, inflorescence bearing triangular, purple-tinged bracts …….11. *D. bicolor*

15. Fruits globular.....…….....9. *D. phanerophlebia*
Fruits distinctly horned, with a bifid tip to each horn.....…….…8. *D. phrynioides*

16. Leaves lanceolate, in pseudowhorls, flowers/fruits not in dense glomerules ……..…...…13. *D. ovata*
Leaves various, not in pseudowhorls, flowers/fruits in dense glomerules.....…….....17

17. Leaf lamina ovate, elliptic or obovate, inflorescence bearing concave, long-cuspidate bracts .....…18. *D. congoensis*
Leaf lamina oblanceolate, inflorescence bearing triangular, purple-tinged bracts ……...……...11. *D. bicolor*

18 Leaves fleshy, perianth 3–5 mm long, inflorescence branches puberulous ……...……27. *D. ombet* subsp. *schizantha*
Leaves herbaceous, perianth 7–10 mmm long, inflorescence branches glabrous .....…26. *D. ellenbeckiana*

19 Plant a herb, perianth 4.5–6 cm long …….……..5. *D. vanderystii*
Plant a shrub or a tree, perianth up to 4.2 cm long …..……...……...….20

20 Perianth lobes longer than tube .....…..……...21
Perianth lobes shorter than tube.....…….…..….28

21. Inflorescence pendent, or erect, flower clusters made up of up to 4 flowers…….22
Inflorescence erect, flower clusters made up of five or more flowers.....…….....23

22. Leaves born in pseudowhorls, inflorescence pendent, pedicels 1.5–2.3 cm long……..….21. *D. cerasifera*
Leaves not borne in pseudowhorls inflorescence pendent or erect , pedicels up to 1 cm long……..23

23. Perianth 1–2.5 cm long, yellow-green, mauve or purple.....…….…....24

Perianth 3– 4 cm long, yellow-white on the outside, cream-yellow inside.25. *D. mannii*

24. Perianth 12–15 mm long, leaves narrowly lanceolate ……19. *D. afromontana*
Perianth 18–30 mm long, leaves narrowly oblanceolate to sword-shaped.....…...…25

25. Inflorescence an erect, rarely reflexed or pendent panicle, fruits ellipsoid or globose……26
Inflorescence a pendent panicle, fruits depressed globose …….20. *D. arborea*

26. Leaves 30–160 cm long, 2–12 cm wide, pedicel 0.5–3 mm long……...……27
Leaves 2–10 cm long, 1–1.6 cm wide, pedicel to 5 mm long, fruits globose ……24. *D. reflexa*

27. Leaves lanceolate, bracts subtending inflorescence branches linear-lanceolate, persistent; fruits ellipsoid …….15.*D. rubroaurantiaca*
Leaves strap-shaped; bracts subtending inflorescence branches triangular, caducuous; fruits globose ……...28. *D. fragrans*

28. Leaves with a scarious margin, pedicel 5–10 mm long, articulated above the middle, not at the top……23 *D. aletriformis*
Leaves without a scarious margin, pedicel up to 3 mm long, if longer articulated at the top……..29

29. Leaves lanceolate, narrowly lanceolate or oblanceolate ……..30
Leaves linear …….31

30. Leaves over 40 cm long, at least 4 cm wide; perianth 10–15 mm long ……29 *D. steudneri*
Leaves up to 25 cm long, 0.7–2 cm wide; perianth 20–26 mm long .12..*D. mildbraedii*

31. Leaves with prominent parallel nerves; inflorescence axis scabrid; perianth 3–5 mm long …….……..…1. D*. acutissima*
Leaves with indistinct parallel nerves; inflorescence axis smooth; perianth 2.5–3 cm long …….14. *D. viridiflora*

Dracaena L. subgenus **Aubryana Mwachala** subgenus nov**. Type** : Cultivated in Hort. Paris, 1859, *Wentzel* in Herb. Martius (BR, lecto., chosen by Bos l.c.)
This subgenus comprises herbs and shrubs with petiolate leaves, and mostly spicate inflorescences. It is largely Guineo-Congolian in its distribution.

1. **D. acutissima** *Hua***,** Bull. Soc. Hist. Nat. Autun 10: 669 (1897) Type: Congo: Foret du Kaka, prés de Brazzaville, July 1958, *Koechlin* 9551 (P!, Neotype, here selected).
SYNONYMY. *D. le-testui* Pellegr. In Bull. Mus. Hist. Nat. Paris, 1930, Ser. 2. ii. 571. Type: Congo, not seen.
D. laurentii Wildem. Enum. Pl. Laurent 1: 42, t. 22 (1902); Syll. Fl. Congolanae: 565 (1909).

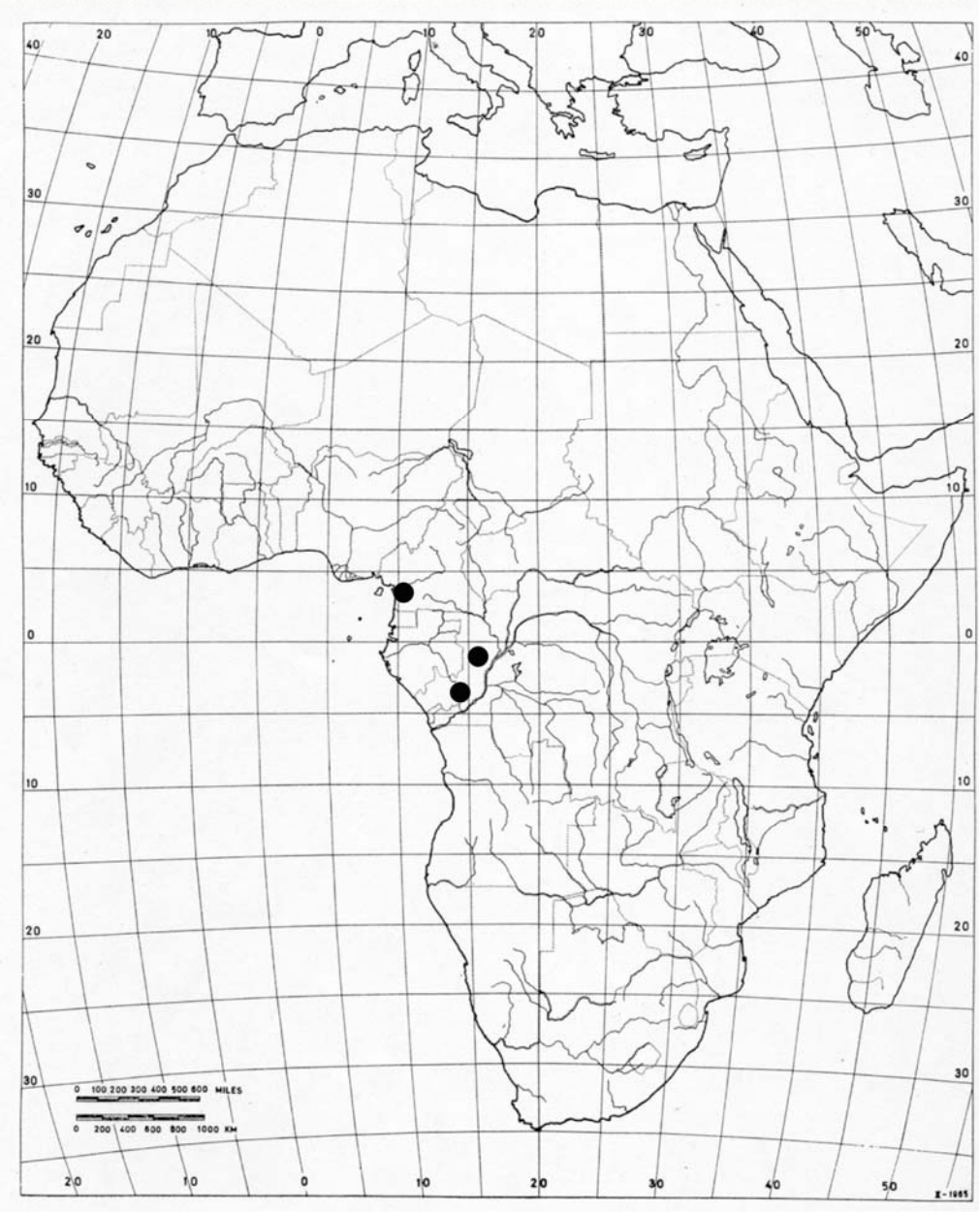
Suffrutescent herb, several stems growing from the same rootstock, to 3 m. Leaves linear, spaced evenly along the shoot, 13–28 cm long, 0.5–1.7 cm wide, base amplexicaule, apex

attenuate, forming a 1 cm long sheath at the base, nerves and midrib obscure above, prominent below and on the sheath. Topmost leaves grading into inflorescence bracts, petiole non-existent. Inflorescence paniculate, terminal, erect, to 22 cm long, bearing linear to narrowly triangular scarious bracts at the nodes, these 5–20 mm long, 1–2 mm wide, each subtending a sessile cluster of flowers (glomerule), each flower subtended by a scarious linear to triangular bracteole to 0.5 mm long . Inflorescence axis scabrid, 8 cm long, 3 cm wide. Flowers 3–4 mm long, colour unknown, lobes ± equal to the tube, borne on a pedicel 1 mm long, articulated at the base, this accrescent in fruit to 5 mm long. Stamens and stigma not known. Fruit colour not known, 10 mm long (including three 5 mm long horns) and 5 mm thick. Seeds unknown. Fruits globose, 0.7–1 cm long, 1 cm wide; 1–3 seeded. Seeds wedge-shaped, 5 mm long, 6 mm wide, brown.

CAMEROON. 16 km on the road from Ebolwa to Minkok. 4 September 1975, *De Wilde* 8443.
CENTRAL AFRICAN REPUBLIC. Bomme-Bomme, *le Testu* 1376 (BR)
CONGO. Region of the Alima river, a tributary of the lower Congo, *Thollon* 913 (K!); Brazzavile, 31 Dec 1913, *Chevalier* 11213 (BR); Kaka forest, near Brazzaville, Jul 1958 *Koechlin* 5046 (P).

DISTRIBUTION. Cameroon southwards to the Congo.
HABITAT. Primary forest undergrowth and forest edges.
USES. None recorded
CONSERVATION NOTES. Near Threatened (NT). Known from less than ten herbarium collections.

Figure 4.6.1. *Dracaena acutissima* Hua. 1. fruiting branch; 2. leaf base (from de Wildeman, 1902)



Map 4.6.1. Distribution of *Dracaena acutissima* Hua.

2. **D. aubryana** *E. Morren*, Belg. Hort. 10: 348 (1860) & in Bull. Fed. Soc. 1860: 302 (1861); Consp. Fl. Africanae: 326 (1895); Bos, *Dracaena* in W Afr.: 29 t. 4, photo. 10 (1984). Type: Cultivated in Hort. Paris, 1859, *Wentzel* in Herb. Martius (BR, lecto., chosen by Bos l.c.)

SYNONYMY. *Dracaena thalioides* Regel, Gartenflora 20: 147 (1871); Baker in Fl. Trop. Afr. 7: 445 (1898) pro parte; Fl. W. Trop. Afr. ed. 2, 3 (1): 156 (1968). Type: Belg. Hort. 10: t. 24 (1860).

D. monostachya Baker var. *angolensis* Baker, Fl. Trop. Afr. 7: 442 (1898). Type: Golungo Alto, Welwitsch 3745 (BM).

D. monostachya Baker var. *monostachya* Baker, trans. Linn. Soc. Ser. 2,1: 252 (1878). Type: Principe, Welwitsch 3744 (BM)

D. thalioides C. Morren Enum. Pl. Laurent 1 : 42 (1905) ; Pl. Bequaert.: 39, (1921) Invalid name.

D. humilis Baker in J. Bot. 12: 166 (1874) & in J. Linn. Soc. Bot. 14: 534 (1875) & in Fl. Trop. Afr. 7: 444 (1898); Fl. W. Trop. Afr. ed. 2, 3 (1): 156 (1968). Type: Sierra Leone, Bagroo R., *Mann* 898 (K, holo., A, P, iso.).

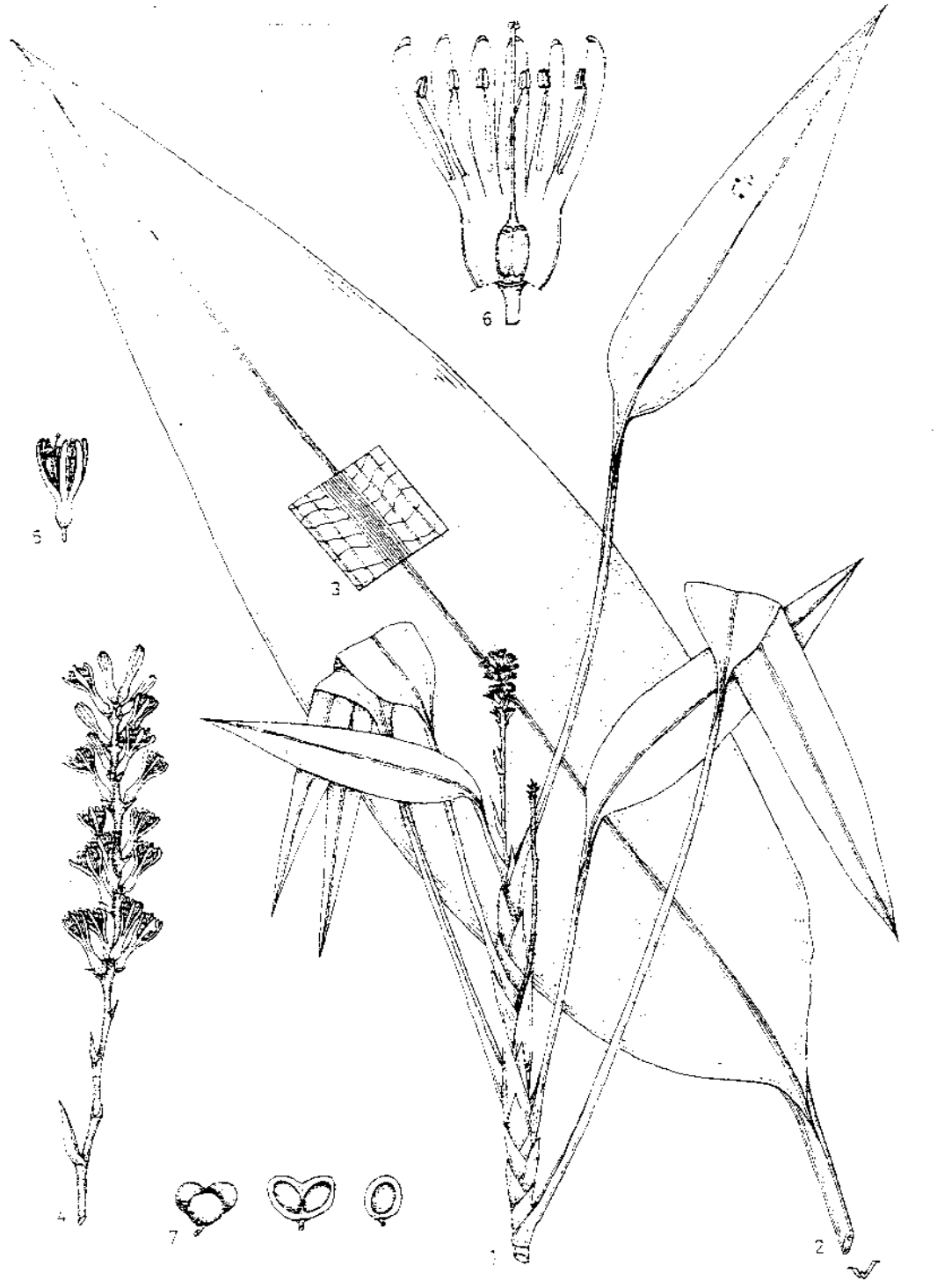
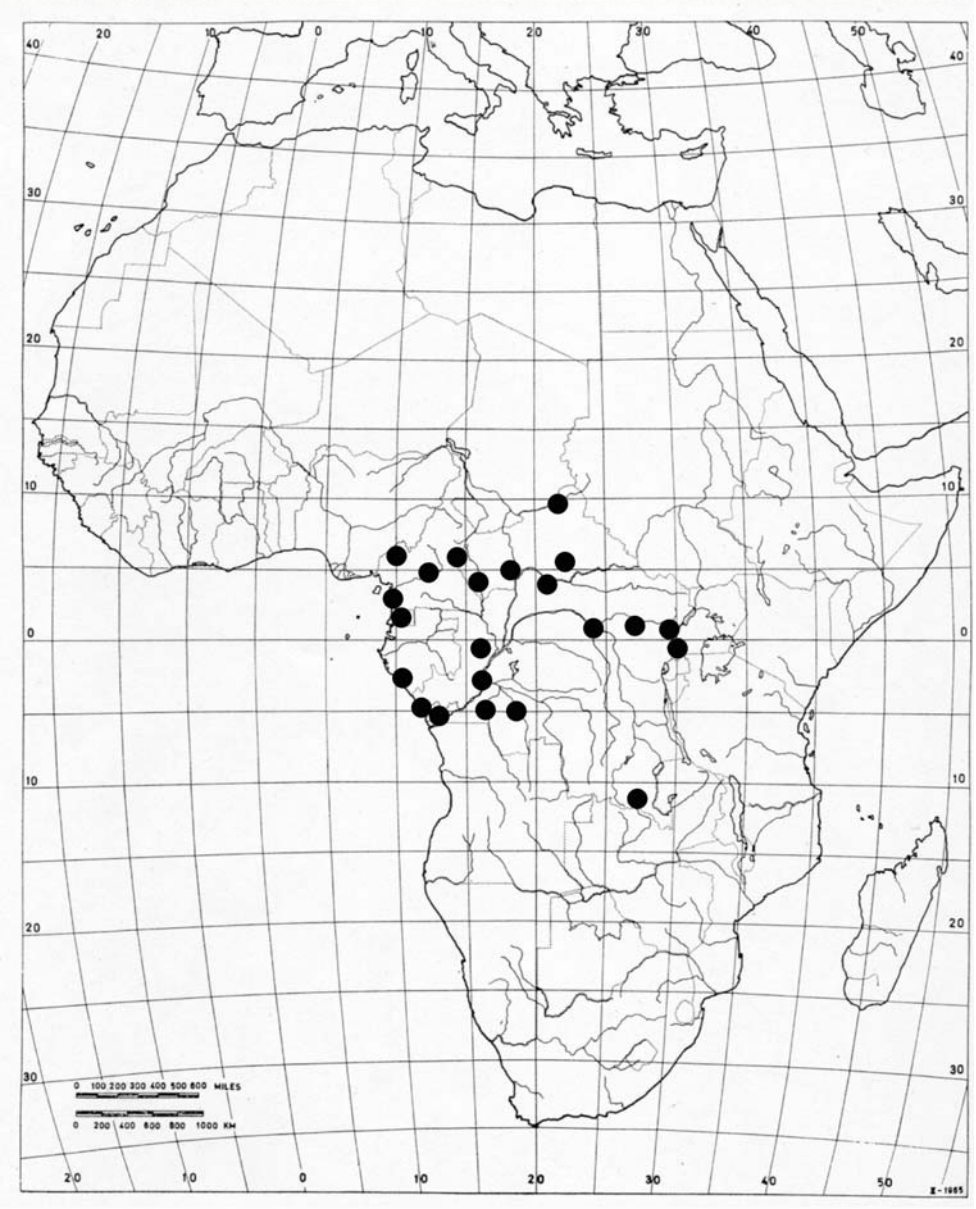


Figure 4.6.2. *Dracana aubryana* E. Morren: 1. Habit; 2. leaf-blade; 3. inset: leaf detail; 4. inflorescence; 5. flower; 6. flower laid open; 7. fruits, whole and in section (from Bos, 1984).



Map 4.6.2. Distribution of *Dracaena aubryana* E. Morren

Pleomele thalioides (Regel) N.E. Brown in Kew Bull. 1914: 279 (1914) Type: Cultivated in Hort. Paris, 1859, *Wentzel* in Herb. Martius (BR, lecto., chosen by Bos l.c.).

Dracaena kindtiana De Wild. in Ann. Mus. Congo ser. 5, 2: 119, t. 65, 66 (1907); Durand & Durand, Syll. Fl. Congolanae: 565 (1909); Pl. Bequaert.: 38 (1921) Type: De Wild. in Ann. Mus. Congo ser. 5, 2: 119, t. 65 (1907).

Shrub 0.4–2.5 m high, usually unbranched; stem erect, often twisted spirally. Leaves distichous, ovate to narrowly ovate, often asymmetric, petiolate, 10–40(–60) cm long, (1.5–)4–10(–15) cm wide, base rounded or cuneate, apex acute to cuspidate; petiole 5–30(–100) cm long sheathing at base. Inflorescence erect, spicate or paniculate, 9–70 cm long, unbranched or with a few branches near the base; flowers in groups of 1–3(–7) on

distinct knobs with a single triangular bract to 10 mm long; pedicel 0–2 mm long articulated above the middle. Flowers white or greenish-white, each lobe often with purple-red central band, (10–)15–30(–55) mm long, lobes as long as to twice as long as the tube, to 2.5 mm wide. Fruits shiny bright orange, deeply 1–3-lobed, lobes ovoid, 8–18 mm long, 4–9 mm in diameter, each lobe 1-seeded; seeds dirty white, ovoid, 6–14 × 5–7mm.

ANGOLA. Cabinda District: Jun. 1920, Gossweiler 6566 (K)

CAMEROON. Yaounde District: River Nyong, Chutes Mpome, 9 km S of Makak, 4 Mar 1977, *Lowe* 3199 (K); Betare Oya District: 13 km NE of Betare Oya, W of the Lom River, 22 Feb 1961, *Breteler* 1083 (K); Lom & Kade District: Betare Oya to Garoua Belai, 54 miles from Betare Oya, 12 March 1969, *Sanford* 6177 (K)

CENTRAL AFRICA. Chari Oriental District : pays de Snoussi, 17 Jan 1903, *Chevalier* 7283 (K); Lobaye District: Lobe forest reserve, south end, near river Lobaye, 10 Dec 1969, *Hepper* 4164 (K); Bamingui-Bangoran District: Koumbala Creek, Manovo-Gounda-St. Floris National Park, *Fay* 4393 (K).

DEMOCRATIC REPUBLIC OF CONGO. Kasai District: Yangambi, 21 Jan 1936, *Louis* 113 (K); & 2 Dec 1974, *Woolhouse* s.n. (K); & 14 Jan 1940, *Germain* 98 (K); Mayombe District: Gimbi, Sekebanza, 15 Sep 1959, *Compere* 388 (BR); Bas-Congo District: Mvuazi, foret de Sangi, 25 Jul 1952, *Devred* 1198 (BR).Kasai District: Kikwit, 21 Nov 1990, *Masens* 360 (BR); Forestier-Central District, Lesse, 25 Mar 1914; *Bequaert* 3199 (BR).& Yangambi, 23 Dec 1937, *Louis* 7194 (K).

GABON. Gaboon river, *Mann* 1036; Sibange farm, 5 Jul 1880, *Soyaux* 96 (K);

UGANDA. Toro District: Bwamba, Feb. 1939, *A.S. Thomas* 2784! & May 1989, *Katende* 3690 (K)

DISTRIBUTION. West Africa from Sierra Leone to Ivory Coast, from Nigeria to Uganda and Angola

HABITAT. Moist forest; may be locally common; 600–850 m

USES. None recorded

CONSERVATION NOTES. Least Concern (LC).

3. **D. braunii** E*ngl* Bot. Jahrb. Syst. 15: 479, t 20 (1893); Consp. Fl. Africanae: 326 (1895). Type: Plate 20 in Bot. Jahrb. Syst. 15: 479 (1893), Lectotype, selected here.

Herb–30 cm high, single-stemmed; stem to 1.5 mm in diameter, from an orange rhizome, roots orange. Leaves clustered near the base of the shoot, narrowly elliptic to broadly lanceolate, 8–12 cm long, 2.5–3 cm wide, base cuneate, apex acuminate. Petiole 8–14 cm long, with an amplexicaul base forming a sheath to 3 cm long. Inflorescence terminal, erect, spicate, 6 cm long, borne on a peduncle 19 cm long, flowers in clusters of 1–3; bracts triangular, to 2 mm long; pedicel 2 mm long, articulated above the middle. Flowers pale purplish, filaments white, anthers creamy, lobes 4–5 mm long, 0.6–0.8 mm wide, tube 7–8 mm long. Fruits unknown; seeds unknown.

CAMEROON. Kribi District: between Kribi and Lonji, 19 Mar 1968, *Mezili* 90 (P); & Kribi, 6 Dec 1974, *de Wilde* 7819 (BR); District unknown, Chutes de Lobe, 6 Jan

1968, Bamps 1708 (BR); District unknown, near Rocher du Loup, 17 Mar 1978, Lowe 3614.

GABON. Mayumba peninsula. ±15 km south of Mayumba town. 18 Nov 1983, *de Wilde* et al. 654 (K); Behind Okala, 18 Feb 1993, Dibata 1111 (BR).

HAB. Undergrowth in deep shade at edge of coastal forest 5 m

USES. None recorded

CONSERVATION NOTES. Vulnerable VU B2b(iii). known from only a few collections from the beaches of Cameroon and Gabon

NOTE. A Lectotype is chosen here as enquiries have failed to show where Engler's material could be. Since he did not designate a type in the protologue, the plate is chosen here as Lectotype.

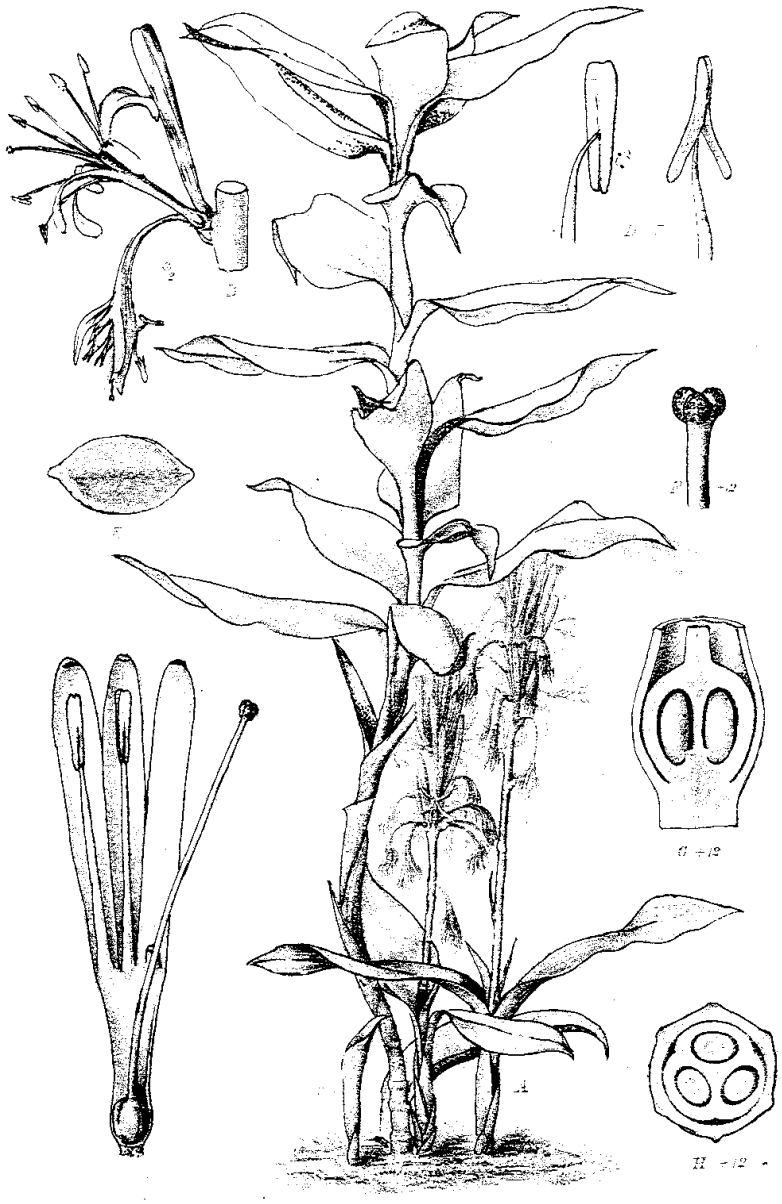
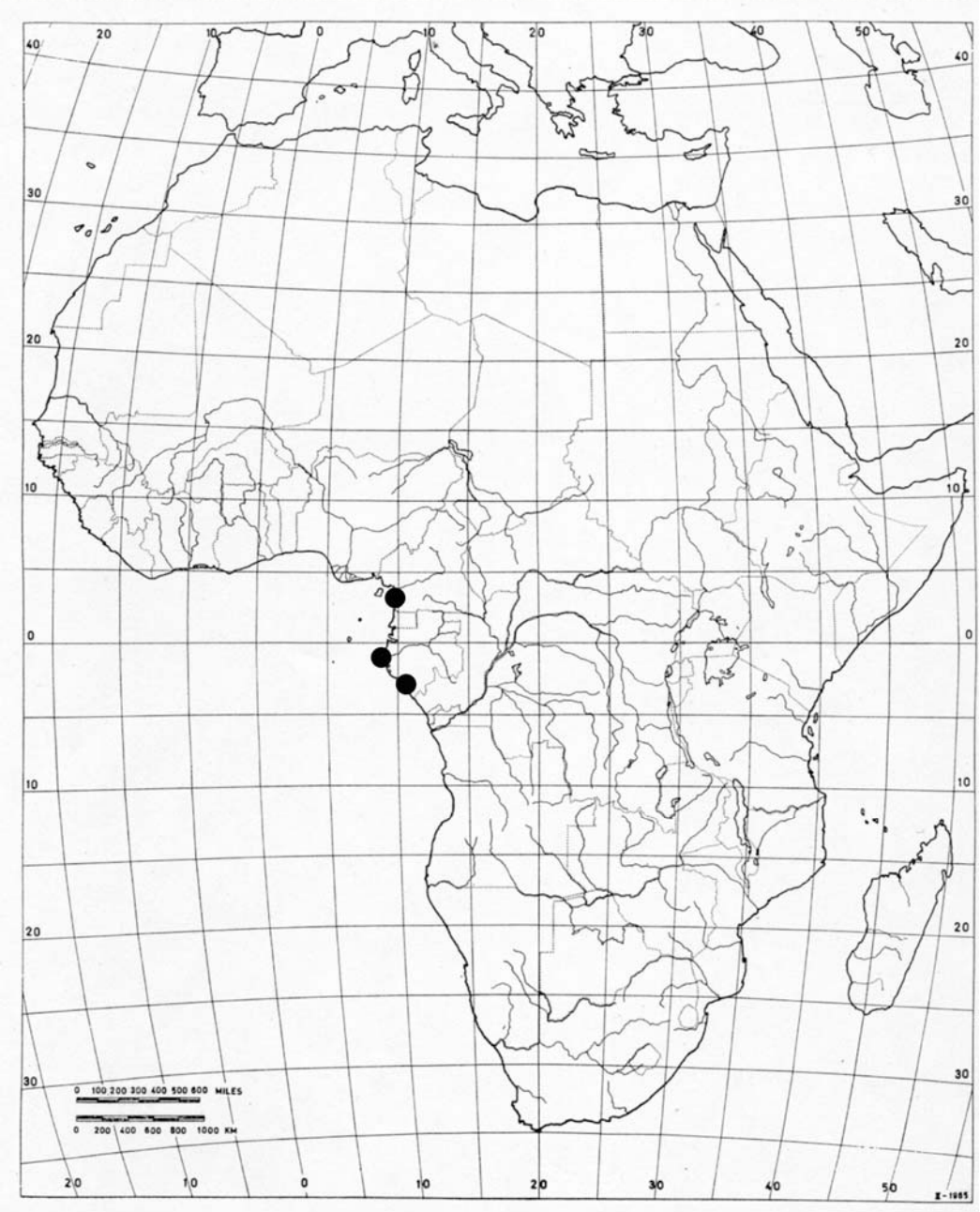


Figure 4.2.3. *Dracaena braunii* Engl. Clockwise from bottom left: flower laid open; seed; inflorescence detail; habit; detail of stamen; detail of stigma; ovary in longitudinal section; ovary in cross-section (from Engler, 1893).



Map 4.6.3. Distribution of *Dracaena braunii* Engl.

4. D. poggei *Engl.* Bot. Jahrb. Syst. 15: 478 (1892); Consp. Fl. Africanae: 329 (1895); Enum. Pl. Laurent 1: 42 (1905); Syll. Fl. Congolanae: 566 (1909); Pl. Bequaert.: 39 (1921). Type: Democratic Republic of Congo, Lulua [Kananga], *Pogge* 1456. (BR).
SYNONYMY. *D. poggei* Engl. var. *elongata* De Wild., Enum. Pl. Laurent 1: 43,t.23 (1905).

Suffrutescent herb to 1.5 m tall. Leaves lanceolate to linear, spaced evenly along the entire shoot, 15–22 cm long, 1–4.5 cm wide, base cuneate, apex acute to acute-acuminate. Petiole 4–5.5 cm long, with an amplexicaul base forming a sheath 2–4 cm long, midrib hardly discernible adaxially. Inflorescence spicate, 3–6 cm long, borne on a peduncle to 8 cm long. Flowers white or very pale pink, scented, 4–6 cm long, lobes 1–2 cm long, half

as long as the tube. Pedicel 1mm long, articulation uncertain. Fruits ellipsoid, 8–12 mm long, 4–6 mm wide, 2–3 mm thick, deeply 2–3-lobed, the lobes divergent. Seeds ellipsoid, 6–10 mm long, 2–5 mm wide and 2–3 mm thick, bony.

DEMOCRATIC REPUBLIC OF CONGO. Forestier Central District, Businga, between Karawa and Businga, Jan. 1931, *Lebrun* 1951 (EA); Chutes de Foulakari, 15 Oct. 1965, *Farron* 4704 (P); Kasai District: Yangambi, ile Tutuku. 17 Feb. 1955, *Germain* 8484 (BR)
CAMEROON. Yaounde District: Bank of the Nyong River, 40 km SE of Yaounde, 9 Nov 1961, *Breteler* 2004. (P)
DISTRIBUTION. Cameroon, Democratic Republic of Congo, Gabon.
HABITAT. Riverine vegetation in gallery forest.
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

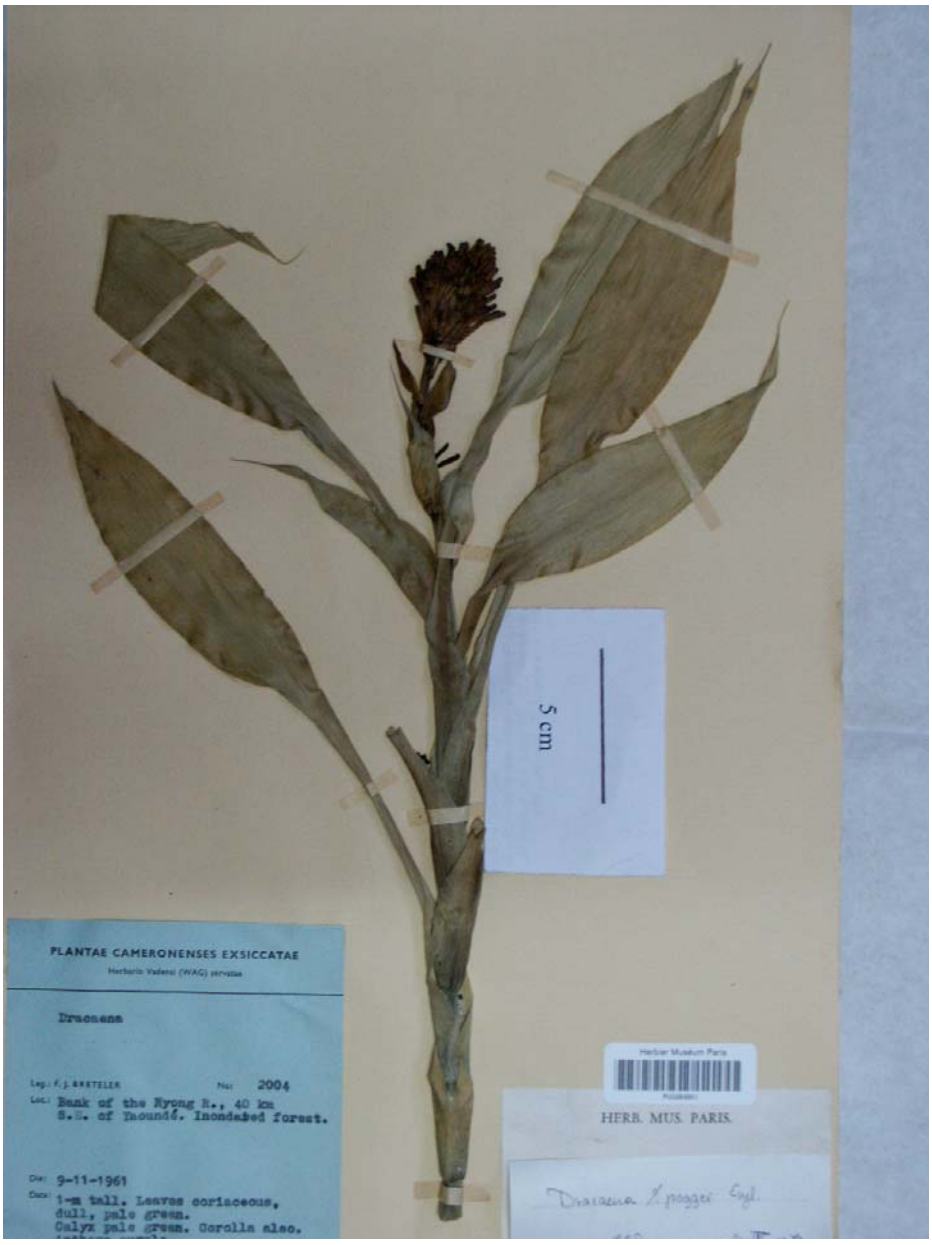
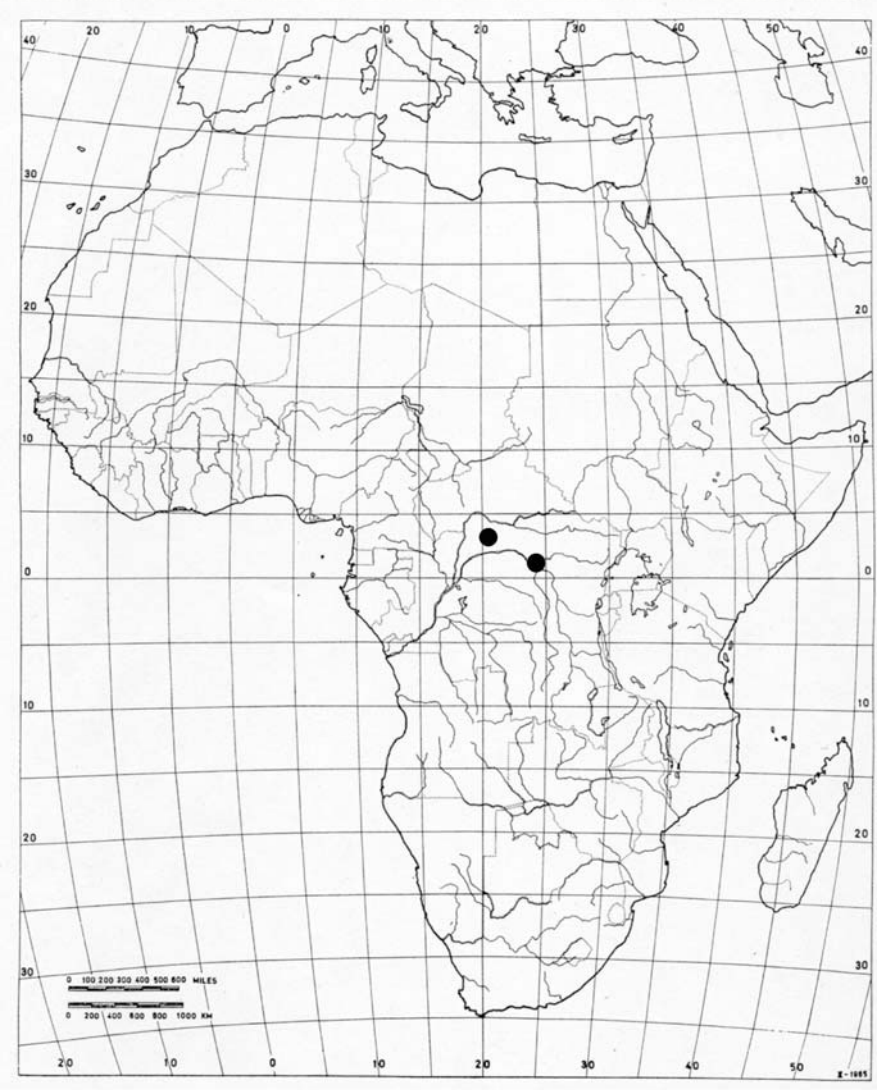


Figure 4.6.4. *Dracaena poggei* Engl.: herbarium specimen of flowering branch.



Map 4.6.4. Distribution of *Dracaena poggei* Engl.

5. **D. vanderysti** De Wild., Bull. Jard. Bot. Brux 5: 6–7 (1915). Type: Democratic Republic of Congo, Wombali, Aug. 1913, *Vanderyst* 2003 (P!. Lectotype, here selected).

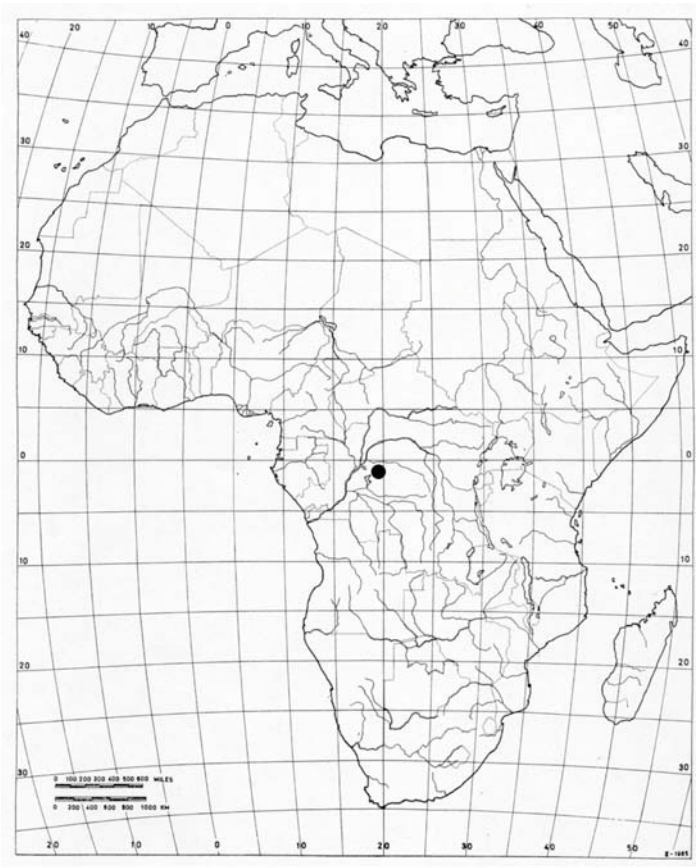
Shrub to 1.25 m tall, roots fibrous. Lower leaves amplexicaule or not, 20–38 cm long, shathing base to 16 mm wide, petiole 3–6 mm thick, lamina lanceolate, 8–20 mm wide, lase long cuneate, apex acute. Inflorescence spicate, terminal, peduncle bractelate, 7–12 cm long, rachis 2–3 cm long, accrescent post-anthesis, and to 4 cm long ; Flowers ±white, 4.5–6 cm long, 0.5 cm wide, proportion of perianth tube to lobes not known ; fruit 2–3 lobed, seeds ellipsoid, subreniform, c.10 long, 5–6 mm wide.

De Wildeman did not cite a type for this specimen. The first specimen he cited in the protologue has been therefore selected as lectotype. The lectotype was not

available to me for imaging, this description is therefore not accompanied by an illustration.

DEMOCRATIC REPUBLIC OF CONGO : Wombali, August 1913, *Vanderyst* 2003, 2425 (BR) ; Eala, June 1907, *Pynaert* 1461 (BR), and May 1910, *Seret* 1205 (BR); Foret du Sankuru, 18 Nov 1903, *Laurent & Laurent* s.n. (BR) ; Bomana sur-Giri, 1912, *Sapin* s.n. (BR); Entre wangata et Mosole, 15 Aug. 1908, *Seret* 935 (BR) ; Forestier-Central District, Monkoto, 1 Oct. 1957, Evrard 2764 (BR); village du chef Evoloko, Oct. 1913, *Nannan* 63 (K). **(The last locality has not been traced.)**

DISTRIBUTION. Democratic Republic of Congo.
HABITAT. Not known
USES. None recorded
CONSERVATION NOTES. Near threatened (NT). No recent herbarium collections are known.



Map 4.6.5. Distribution of *Dracaena vanderystii* De Wild.

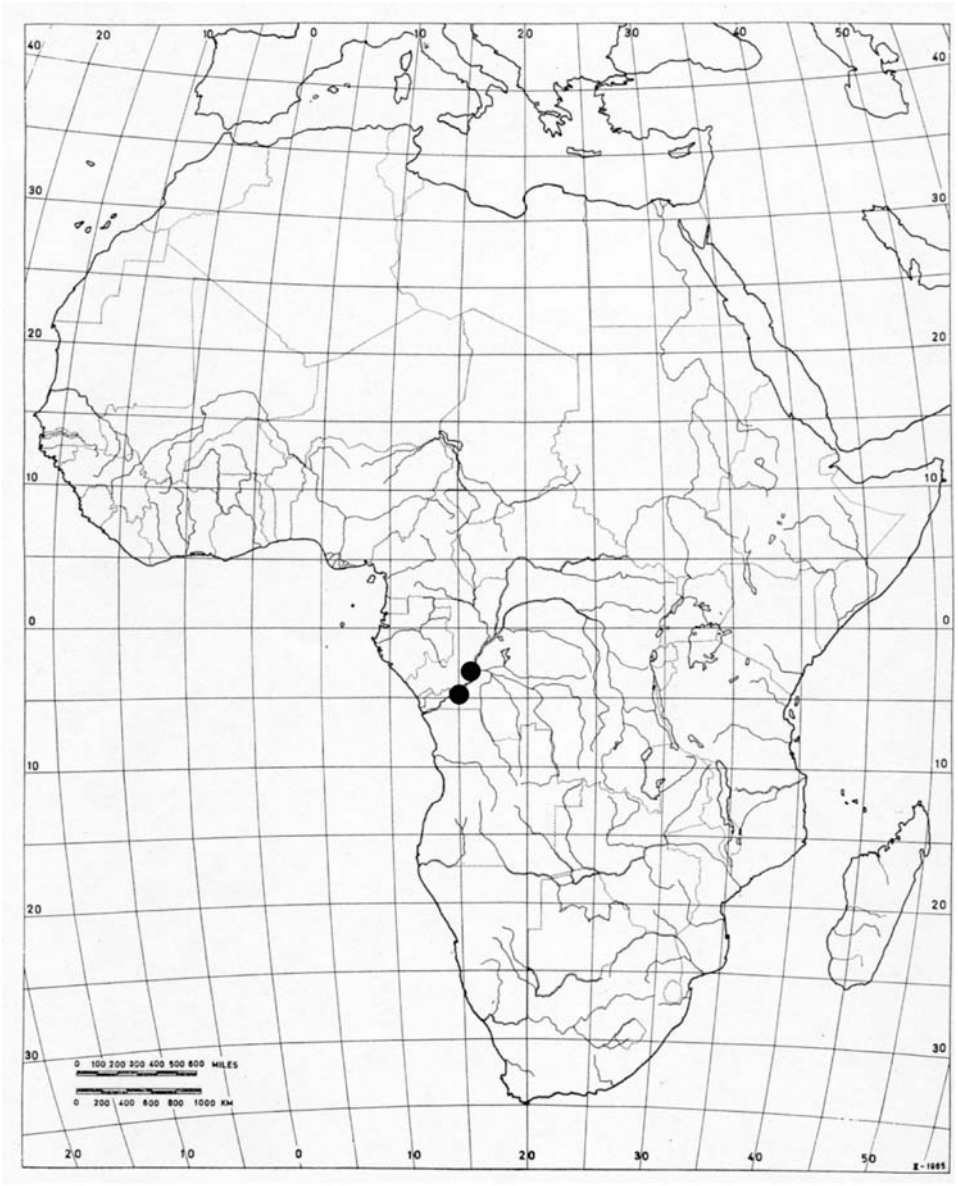
6. **D. oddonii** *De Wild*. Etud. Fl. Bas-et Moy-Congo 1: 227, t.57 (1903); Syll. Fl. Congolanae: 565 (1909). Type: t. 57 in Etud. Fl. Bas-et Moy-Congo 1: 227 (1903).

Branched shrub to 1 m tall; Leaves clustered toward the tips of the branches, petiolate, petiole canaliculated , 3.5–8 cm long, widening abruptly at the bottom to 8 mm wide, lamina oblong, cuneate at the base, apex acute, 12–28 cm long, 4–9 cm wide, midrib not prominent. Inflorescence spiciform, 13–20 cm high, bracts o 3.5 cm long, caducuous, the

upper and lower ones smaller than the ones in between. Flowers in glomerules of more than six , pedicel about 12 mm long, articulated at the bottom, perianth of about 13 mm long, twisted after anthesis, anthers c 2mmm long. Fruits berry-like of 1–3 seeds, red-orange in colour, 5–17 mm in diameter, 10 mm high.

DEMOCRATIC REPUBLIC OF CONGO. Environs de Sanda, 1903 *Gillet* 3333; Kinkosi, Leopoldville, 2 Jul. 1959, *Pauwels* 3699 (K!)

Figure 4.6.6. *Dracaena oddonii* De Wild l-r: Detail of post-anthesis flower; ovary in longitudinal section; detail of stamen; ovary in cross-section, fruiting branch; flowering branch; detail of open flower.



Map 4.6.6. Distribution of *Dracaena oddonii* De Wild.

DISTRIBUTION. Democratic Republic of Congo (Bas Congo), possibly in southern Congo as well.
HABITAT. Primary lowland forest.
USES. None recorded
CONSERVATION NOTES. Vulnerable. VU B1b(iii).

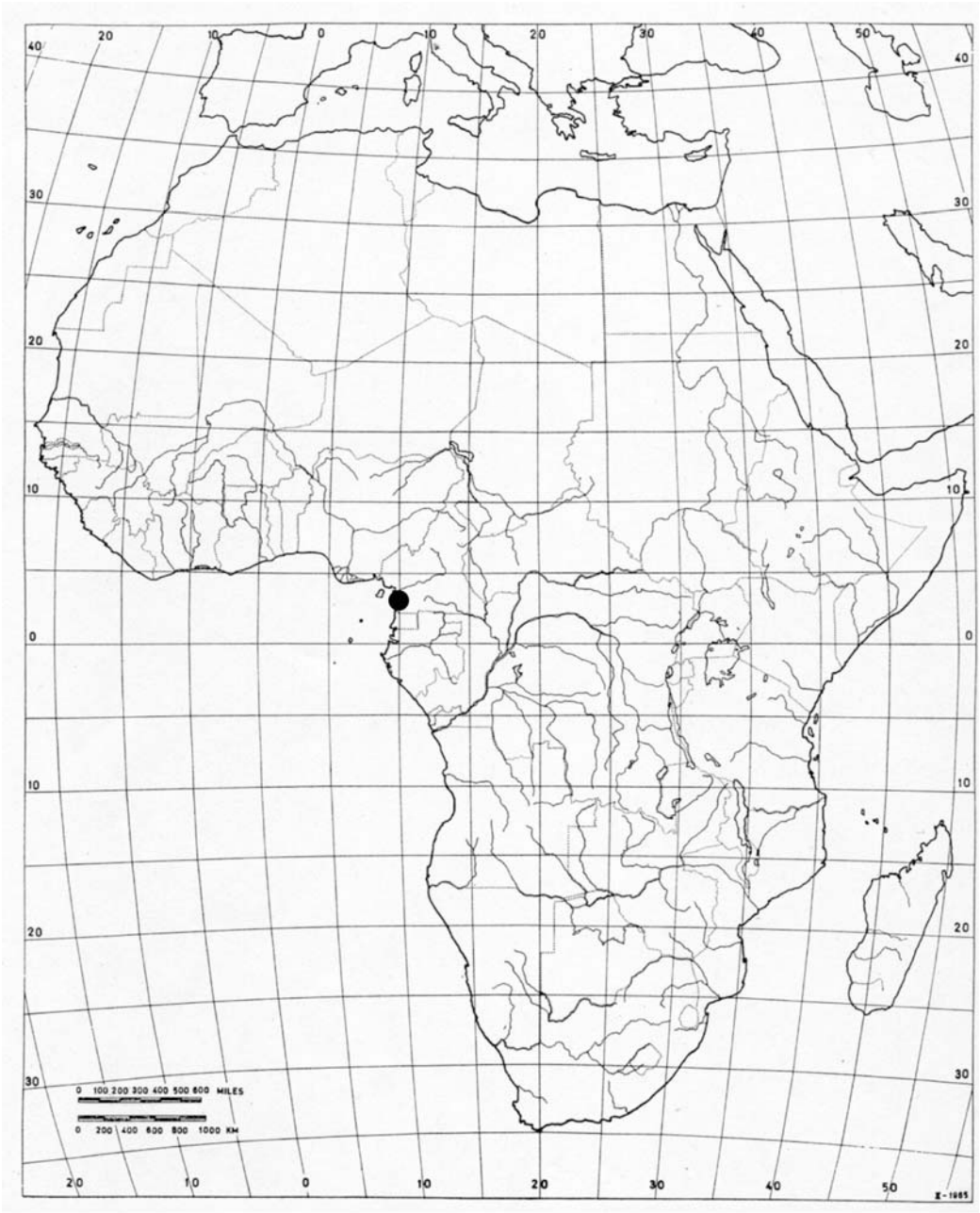
7**. D. goldieana** Mast. & Moore, Gard. Chron. 1872: 1232; Baker, Bot. Mag.: t. 6630 (1882); Consp. Fl. Afr.: 328 (1893); Fl. Trop. Afr. 7: 449 (1898); Krause in Engler & Prantl, Nat. Pfl. Fam. Ed. 2, 15a: 359 (1930); Fl. W. Trop. Afr. 2: 384 (1936); Fl. W. Trop. Afr. Ed 2, III-I: 156 (1968); Bos, *Dracaena* in W Afr.: 76, t.14, 2 (1984): Type: a plant cultivated in Edinburgh.
Erect shrub 30–60 cm high, stem to 1 cm in diameter, leafy for its entire length. Leaves 18–30 cm long, ovate, 18–27 cm long, 4.5–6.5 cm wide, base rounded, passing into a 3–7 cm long petiole with an amplexicaule base, apex acuminate with a 3–5 mm long filiform mucro. Adaxial surface dark green with with irregular, grey transverse bands, abaxial

surface concolorous. Inflorescence terminal, inclined or distinctly nodding, capitate consisting of several densely packed clusters of about three bracteate sessile flowers each. Flowers sessile, 25–30 mm long, perianth lobes 10–15 mm long, white. fruits and seeds not seen at the herbaria consulted.

CAMEROON. Bipinde, 12 December 1928, *Zenker* 98 (P)

DISTRIBUTION: South east Nigeria, extending into Cameroon and Gabon (Bos, 1984)
HABITAT. Undergrowth of primary high forest.
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

Figure 4.6.7. *Dracaena goldieana* Mast. & Moore, whole plant.



Map 4.6.7. Distribution of *Dracaena goldieana* Mast. & Moore

8. **D. phrynioides** *Hook*. Bot. Mag. T. 5352 (1862); Gard. Chron.1862: 1199; Durand & Schinz, Consp. Fl. Afr. 5: 329 (1893); Fl. Trop. Afr. 7: 447 (1898); Fl. W. Trop. Afr. 2: 384 (1936); Hepper in Hutchinson & Dalziel, Fl. W. Trop. Afr. Ed. 2, 3-1: 156 (1968); Bos, *Dracaena* in W Afr.: 97, t. 19 (1984). Type: Bot. Mag. T. 5352 (1862).

SYNONYMY

Draco phrynioides (Hook.) Kuntze: Kuntze, Rev. Gen. Pl. II : 710 (1891). Type as for ***D. phrynioides*** Hook.

Pleomele phrynioides (Hook.) N.E. Br.; Brown, Kew Bull. 1914: 278. Type as for ***D. phrynioides*** Hook.

Suffrutescent herb 75 cm tall, usually unbranched, rarely with up to four branches from anear the base, a few prophylls sometimes presenr below the leaves. Leaves alternate in a

dense basal rosette, lanceolate 9–25 cm long, 3–9 cm wide, base rounded, apex acute to acute-acuminate; glossy dark green adaxially, variegated with transversely oriented oval light to yellowish green dots; rarely unvariegated petiole 9–20 cm long, concolorous with the lamina, base amplexicaule, transitional prophylls sometimes present at the base of the infloresecence, directly above the leaves. Inflorescence terminal, inclined or distinctly nodding, capitate consisting of several densely packed clusters of about three bracteate sessile flowers each. Flowers white, sometimes purple tinged towards the tip, 20 mm long, perianth tube to 14 mm long, lobes to 8 mm long, filaments inflated, shorter than the corresponding perianth lobe, style ± equal to the perianth, stigma capitate. Fruits orange-red when ripe, two-horned, 7–14 mm in diameter, the horns c. 10 mm long, 6–8 mm wide, each with a bifid tip. Seeds straw-coloured, molar-shaped 7x4x7–8 mm.

CAMEROON. NW of Ndoknabao, c 30 km SW of Ndikinimiki, 18 Dec 1971, *Letouzey* 10861 (BR, P); 30 km Kumba-Victoria road, S of Bombe, 2 Nov 1972, *Leeuwenberg* 10612 (BR)
EQUATORIAL GUINEA. Bioco, Malabo-Cupapa, km 22–23, 5 Oct 1989, *Carvalho* 4132 (K)
DISTRIBUTION.Liberia eastwards to Cameroun and Equatorial Guinea
HABITAT.Wet deep-shade localities in undisturbed primary forest
Uses. Frequently cultivated as a foliage ornamental
Conservation notes. Least Concern (LC)

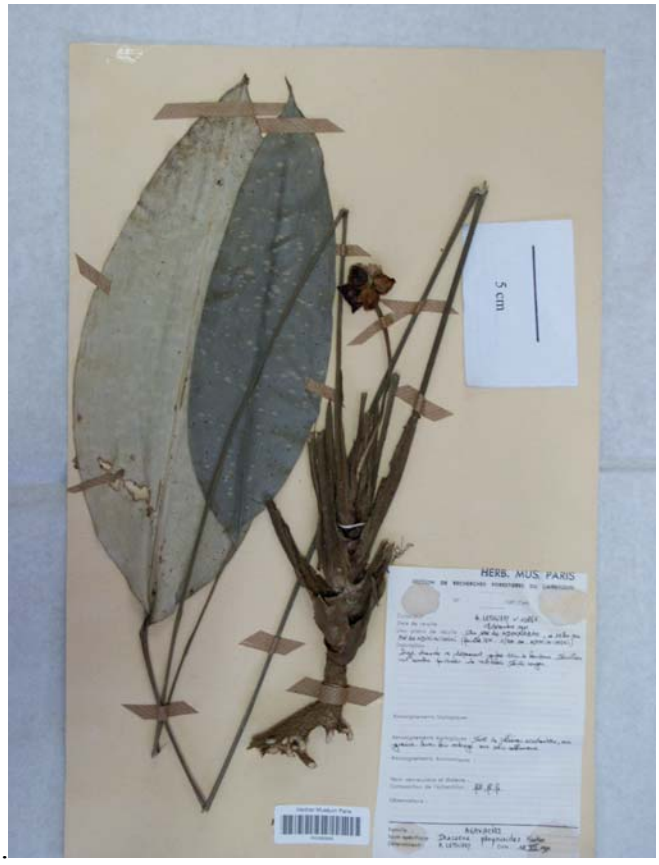
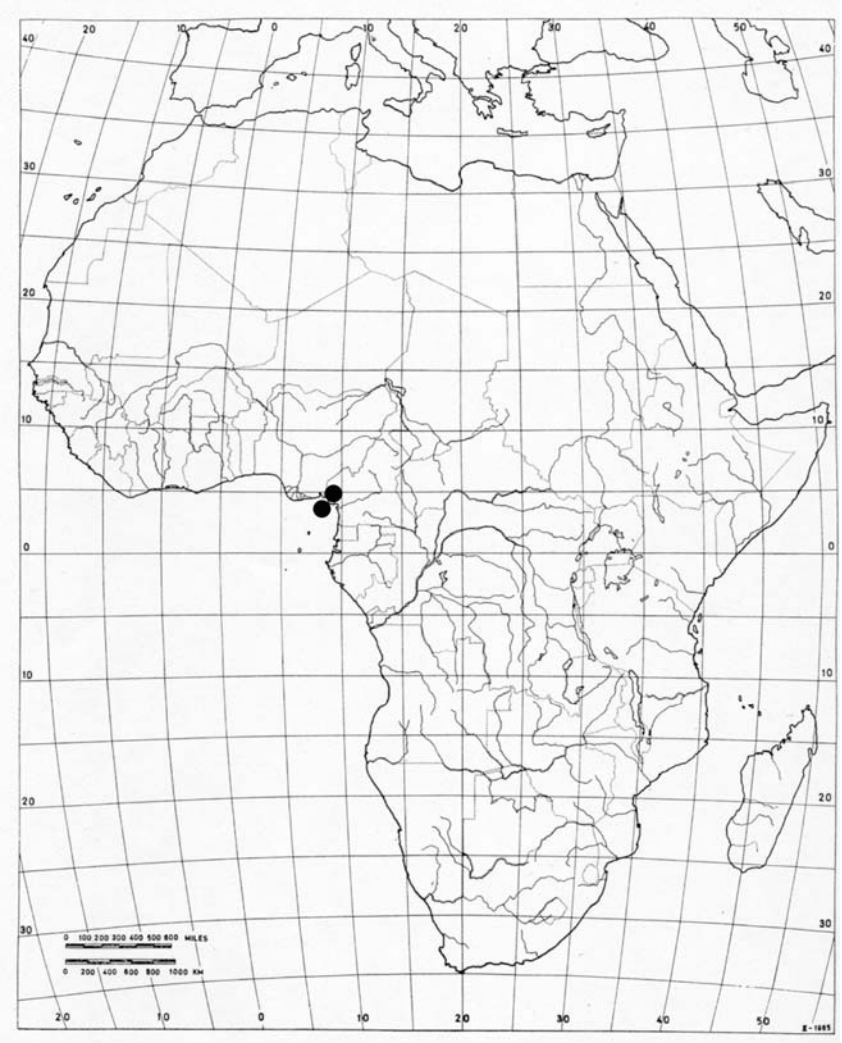


Figure 4.6.8. *Dracaena phrynioides* Hook.: Letouzey 10861 (P).



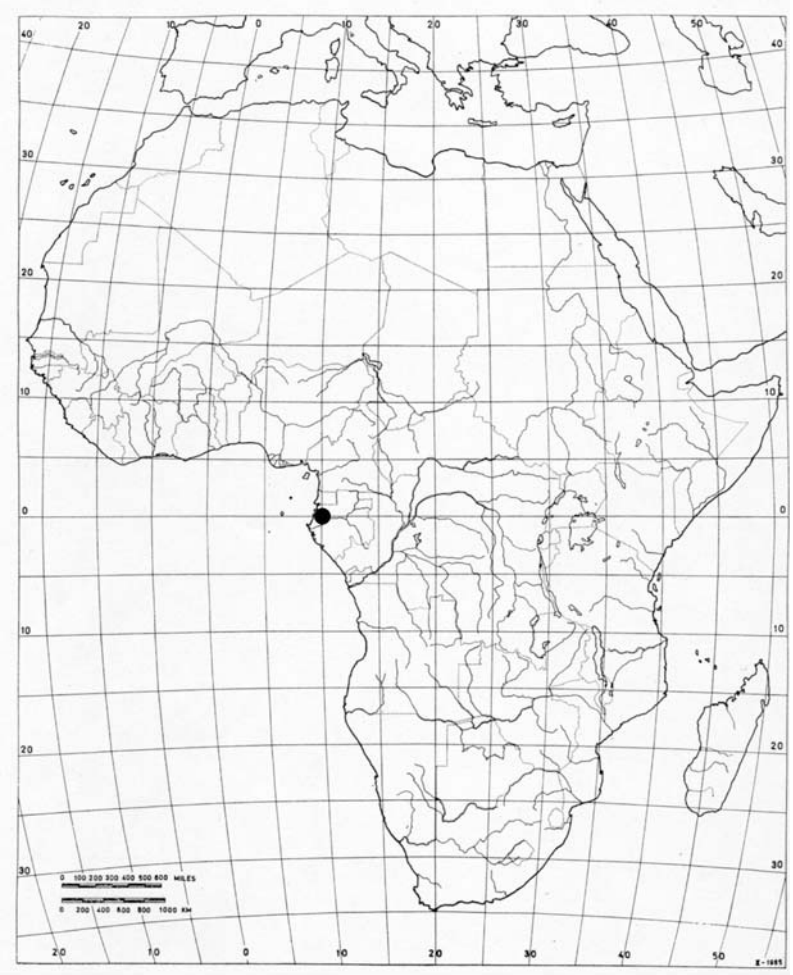
Map 4.6.8. Distribution of *Dracaena phrynioides* Hook.

9. **D. phanerophlebia** *Baker* in Fl. Trop. Afr. 7: 448 (1898). Type: Gabon, Siera del Crystal, July 1862, *Mann* 1625 (K!).

Suffrutescent herb 75 cm tall, usually unbranched, rarely with up to four branches from anear the base, a few prophylls sometimes presenr below the leaves. Leaves alternate in a dense basal rosette, lanceolate 9–25 cm long, 3–9 cm wide, base rounded, apex acute to acute-acuminate; glossy dark green adaxially, variegated with transversely oriented oval light to yellowish green dots; rarely unvariegated petiole 9–20 cm long, concolorous with the lamina, base amplexicaule, transitional prophylls sometimes present at the base of the infloresecence, directly above the leaves Inflorescence terminal, inclined or distinctly nodding, capitate consisting of several densely packed clusters of about three bracteate sessile flowers each. Flowers white, sometimes purple tinged towards the tip, 20 mm long, perianth tube to 14 mm long, lobes to 8 mm long, filaments inflated, shorter than the

corresponding perianth lobe, style ± equal to the perianth, stigma capitate. Fruit globose, orange when ripe.

GABON. Siera del Crystal, July 1862, *Mann* 1625 (K)
DISTRIBUTION. Known only from the type locality
HABITAT. Undergrowth in primary forest
USES. None recorded.
CONSERVATION NOTES. Vulnerable. VU B1 a + b (iii)



Map 4.6.9. Distribution of *Dracaena phanerophlebia* Baker.

10**. Dracaena gabonica** *Hua*, Bull. Soc. Hist. Nat. Autun 10: 669 (1897). Type: Gabon, Munda, Sibange Farm, 16 Jul. 1880, *Soyaux* 98 (K!, Isosyn.).

Shrub of unknown height m tall. Leaves clustered toward the tips of the branches, roadly elliptic to rotund, 13–15 cm long, 5–7.5 cm wide, base base deltoid, apex cuspidate. Petiole 3–10 cm long. Inflorescence racemose, lax. Flowers few per fascicle, perianth 2–2.6 cm long, lobes ± equal to the tube. Fruits unknown; Seeds unknown.

GABON. Munda, Sibange Farm, 16 Jul. 1880, *Soyaux* 98 (K); Environs de Libreville, , 26 Sep. 1902, *Klaine* 3132 (P).

DISTRIBUTION. Only known from Gabon
HABITAT. Not known
USES. None recorded
CONSERVATION NOTES. Endangered. EN B1 a + b(iii).

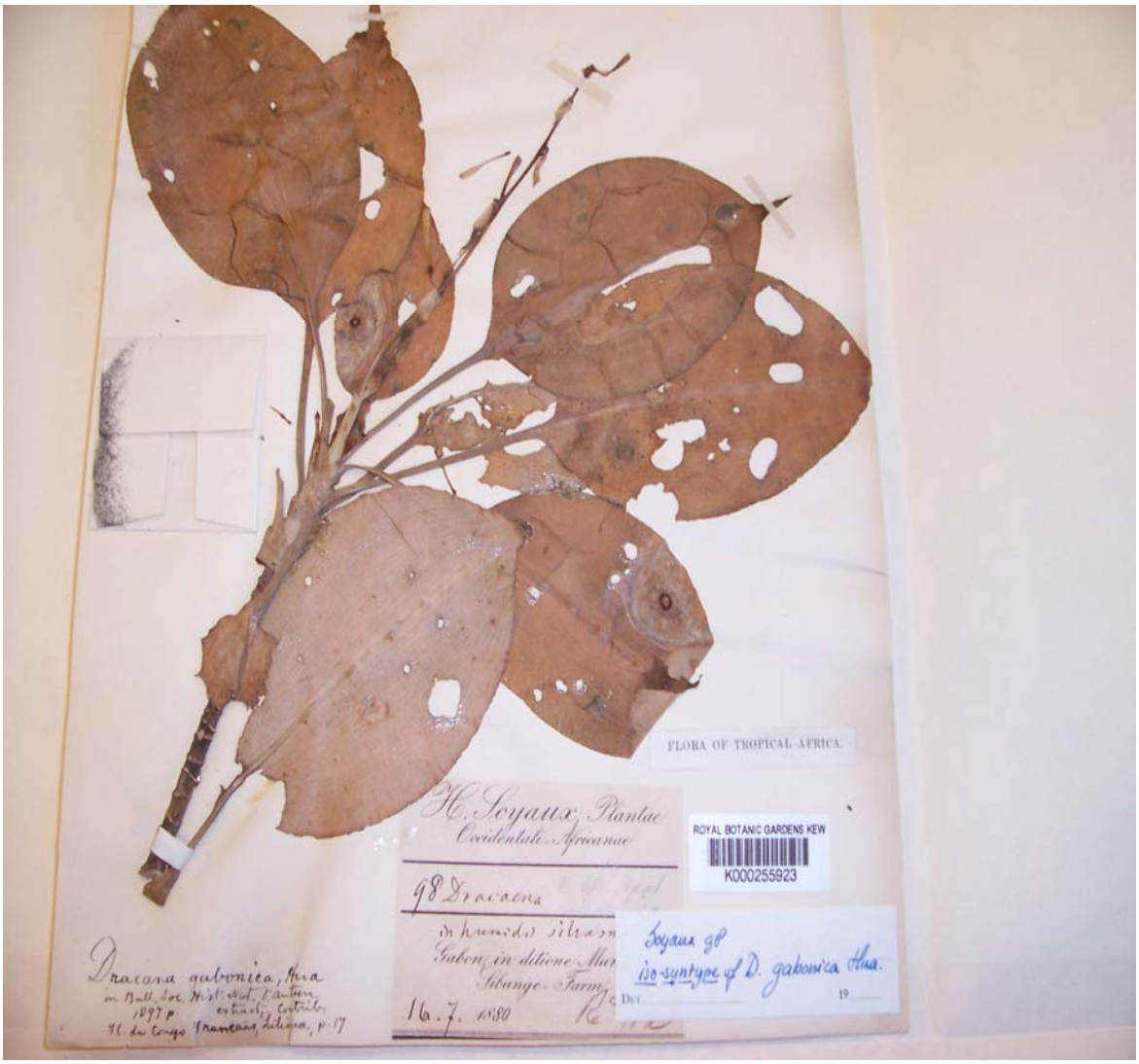
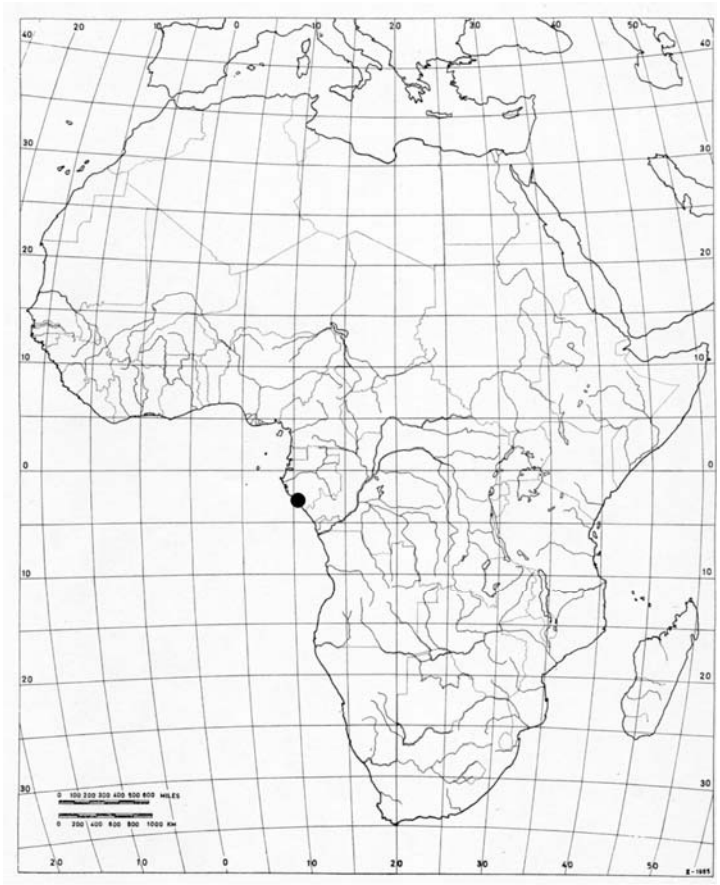


Figure 4.6.10. *Dracaena gabonica* Hua. *Soyaux* 98 (K) Isosyntype (K).

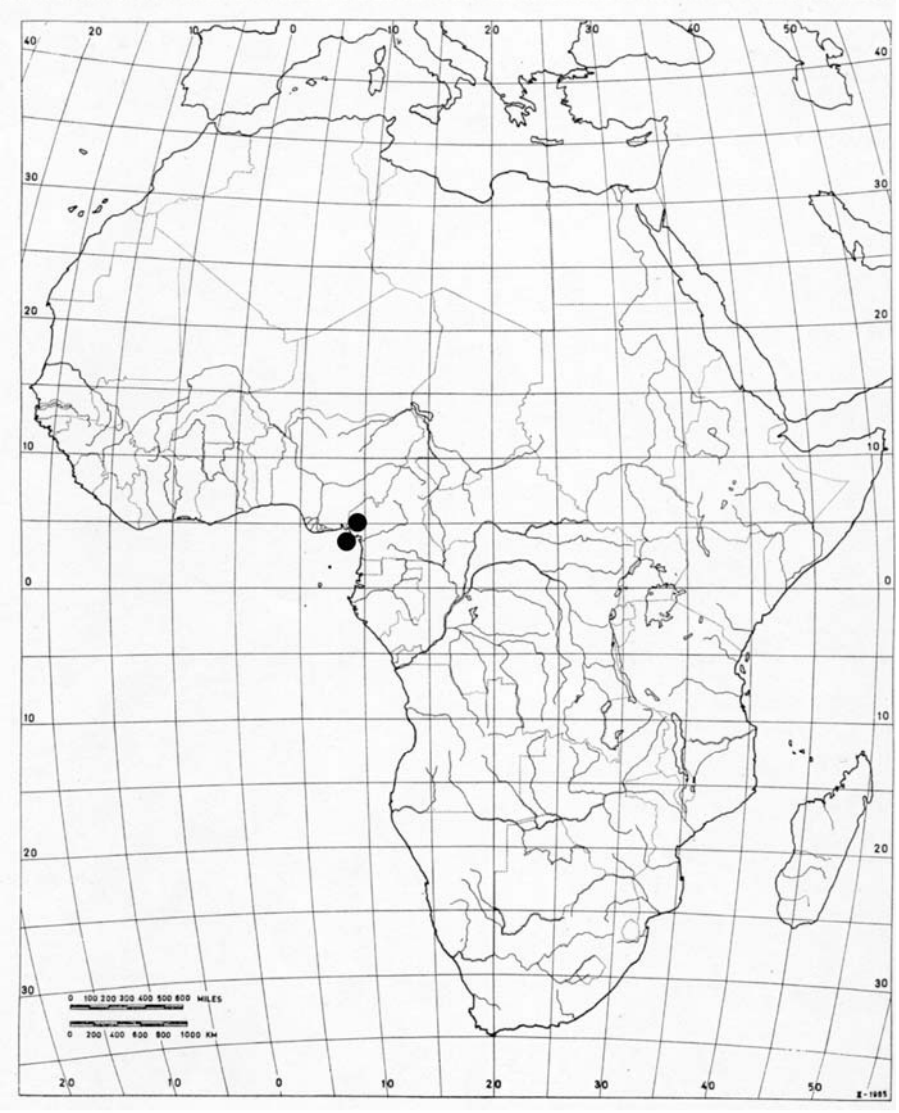


Map 4.6.10. Distribution of *Dracaena gabonica* Hua.

11**. D. bicolor** *Hook*. Bot. Mag. t. 5248. (1861);Consp. Fl. Afr. V: 326 (1893); Fl. Trop. Afr. VII:449 (1898); Hepper, Kew Bull. 22: 450 (1968); Fl.W. Trop. Afr. ed 2, 3-1: 157 (1968); Bos, *Dracaena* in W Afr.: 38, t. 5 (1984). Type: Culta Hort. Kew ex *Mann* s.n., Fernando Po, Feb. 1861, (K!, lecto)
Pleomele bicolor (Hook.) N.E. Br. ; Brown, Kew Bull. 1914: 277. Type: Culta Hort. Kew ex *Mann* s.n., Fernando Po, Feb. 1861, (K!, lecto)
Dracaena cylindrica Hook.f.: Hooker f. Bot Mag. 1870: t5846. Type: Culta Hort. Kew. Ex Edinburgh ex Thomson (K, lecto).
Draco cylindrica (Hook.f.) Kuntze; Kuntze, Rev. Gen. Pl. II: 710 (1891). Type: Culta Hort. Kew ex *Mann* s.n., Fernando Po, Feb. 1861, (K!, lecto)
Pleomele cylindrica (Hook. F.) N.E. Brown; Brown, Kew Bull.: 278 (1914). Type: Type: Culta Hort. Kew ex *Mann* s.n., Fernando Po, Feb. 1861, (K!, lecto)

Shrub 1–2 m high, stem single , to 1 cm in diameter, leaves distributed along the stem but congested toward the top. Leaves oblanceolate, 10–35 cm long, 4–10 cm wide, base attenuate, apex acuminate; petiole 2–18 cm long, base amplexicaule. Inflorescence terminal , paniculate (fragrans type), erect. Flowers white, sometimes purple-tinged, 25–30 mm long, tube 15–16 mm long, lobes 9–11 mm long 2 mm wide, with a single median

Figure 4.6.11. *Dracaena bicolor* Hook. 1. inflorescence; 2. part of infructescence (after Bos, 1984).



Map 4.6.11. Distribution of *Dracaena bicolor* Hook.

vein. Fruits presumably orange, drying black, globose 9–12 mm in diameter. Seeds unknown.

EQUATORIAL GUINEA. Bioco, Malabo-Aeropuerto, km 2, 17 November 1986, *Carvalho* 2713 (BR, K); Bioco, Malabo-Cupapa,, km 22-23, *Carvalho*, 3667 (K).
CAMEROON. Loum District: West side of Mt Kupe, near Mbule, 07 Dec 1971, *Leeuwenberg* 8818! (BR,K)
HABITAT. Undergrowth in high forest
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

12**. D. mildbraedii** *K. Krause* Bot. Jahrb. Syst. 51. 447 (1914) Type: Cameroon, Moloundou District, *Mildbraed* 4976 (B holo, HBG iso)
SYNONYMY.
Dracaena vaginata Hutch. In Hutchinson & Dalziel, Fl. W. Trop. Afr. 2: 383, 384 (1936). Type: Nigeria, Oban, *Talbot* 729 (K! holo, BM, Z iso).

Shrubs or small tree to 5 m. Leaves sessile, evenly spaced along the stems, not congested at the branch apices, linear to narrowly lanceolate, 5–39 cm long, 7–18 mm wide, base cuneate, amplexicaul, forming a sheath to 15 mm long. apex with a long acute tip, mucro subulate, up to 9 mm long. Inflorescence unbranched, 2.5–9 cm long, terminal, sometimes apparently axilary when terminating dwarf shoots, always erect.. Flowers arranged in few-(3–5) flowered sessile clusters subtended by concave bracts, the largest of which basal, to 4.5 cm long, the next bracts decreasing in sizeto I cm at the apical clusters. The bracts enveloping the 2–10 mm pedicel, that is usually articulated at the top. Flowers green, 14–27 mm long, lacking an extended receptacle below the ovary, perianth tube c.14 mm, lobes 12 mm long, 2 mm wide, filaments shorter than the corresponding perianth lobe. Style exserted, stigma capitate, slightly lobed. Fruits orange to orange yellow, whenmature, globose 13–16 mm in diameter. Seeds globose when single, flattened against adjacent seeds, or bilobed in 3-seeded fruits, 9–12 mm wide, 9 mm tall and 1–6 mm deep.

EQUATORIAL GUINEA: Bioco, km 56, Malabo-Riaba. 4 Aug 1987, *Carvalho* 3028.(BR)
DISTRIBUTION. Ghana eastwards to Nigeria, Cameroon and Equatorial Guinea.
HABITAT. Primary forest
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

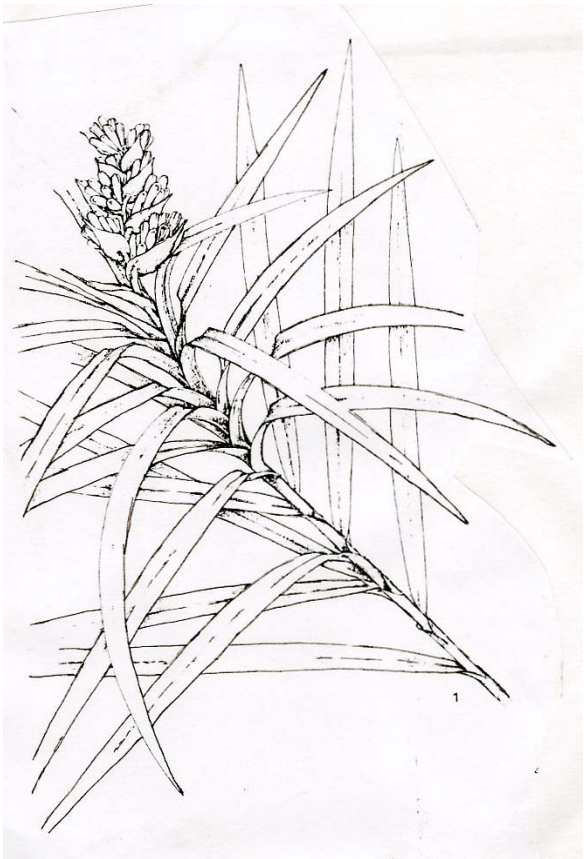
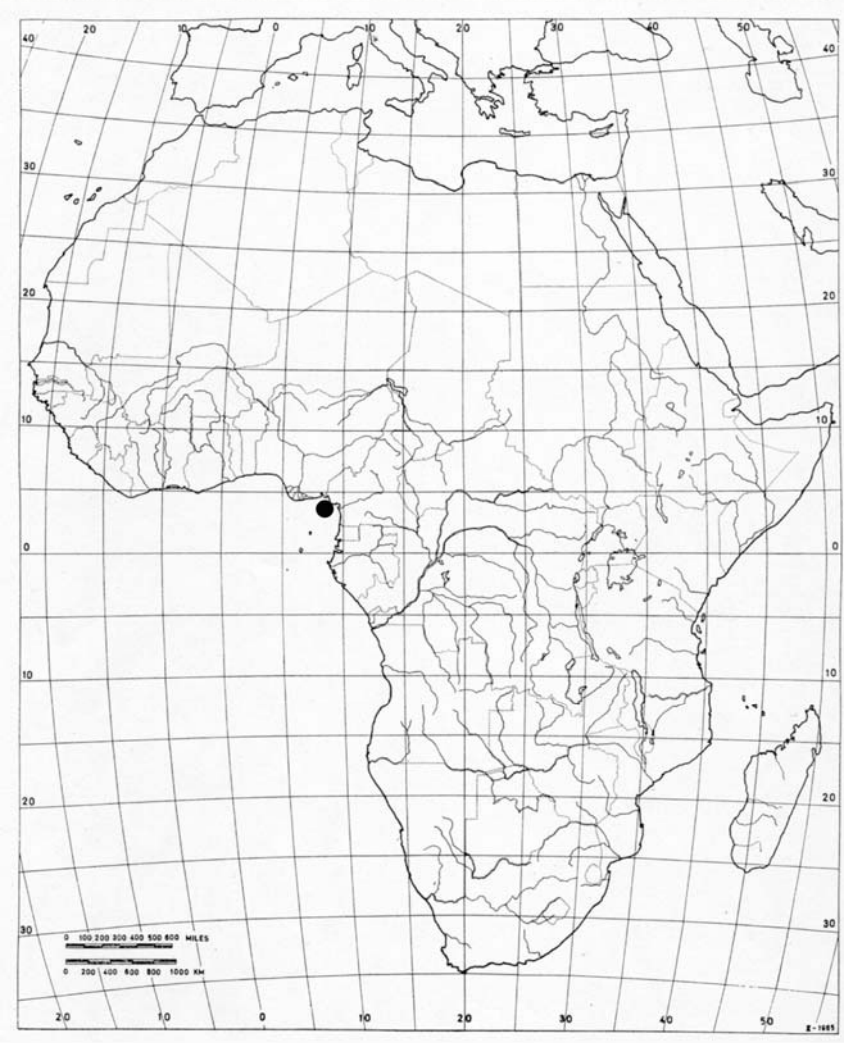


Fig. 4.6.12. *Dracaena mildbraedii* K. Krause. Flowering shoot (from Bos, 1984).



Map 4.6.12. Distribution of *Dracaena milbraedii* K. Krause.

13. **D. ovata** *Ker Gawl.* In Bot. Mag. t. 1180. (1809); Consp. Fl. Africanae: 328 (1895); Hutchinson in Hutchinson and Dalziel, Fl. W. Trop. Afr. II: 386 (1936); Hepper in Hutchinson and Dalziel, Fl. W. Trop. Afr. ed. 2, 3-1: 157 (1968) ; Bos, *Dracaena* in W Afr.: 92, t.18, photo 13 (1984) Type: Bot. Mag. t. 1180. (1809)

SYNONYMY.

Cordyline ovata (Ker Gawl.) Planchon in Fl. Serres 6: 111, 132, 136 (1850); Goeppert, Nova Acta: 55 (1854). Type: Bot. Mag. t. 1180. (1809).

Draco ovata (Ker Gawl.) Kuntze, Rev. Gen. Pl. 2: 488 (1891). Type: Bot. Mag. t. 1180. (1809).

Aletris pumila Donn non Aiton (non illeg.); Donn, Hort. Cant. Ed. 4: 75 (1807).

Dracaena leonensis Lodd. Ex Loudon in Hort. Britt.: 130 (1830). Type: a living plant in a garden in England in 1830. Neotype: Sierra Leone, York Pass, *Morton & Gledhill* SL 791 (WAG holo, K, SL, iso).

Dracaena afzelii Baker, J. Bot. 12: 167 (1874); id., J. Linn. Soc 14: 536 (1875); Consp. Fl. Africanae: 326 (1895). Type: Sierra Leone, Afzelius 'Aletris 4' (BM holo, UPS iso).

Dracaena prolata C.H. Wright, J. Linn Soc. 27: 115 (1905). Type Liberia, Monrovia, Whyte s.n. (K, lecto), Sinoe Basin, Whyte s.n. (K. para).

Pleomel prolata (C.H. Wright) N.E.Br., Kew Bull. 1914: 279 (1914). Type Liberia, Monrovia, Whyte s.n. (K, lecto), Sinoe Basin, Whyte s.n. (K. para).
Dracaena sessiliflora C.H. Wright, Kew Bull. 1914: 338 (1914). Type: Sierra Leone, Heddles Farm, Lane Pool 155 (K holo).

Shrub 0.3–2 m tall, not producing cane-like shoots. Stems usually yellowish brown, rarely grey-green, regularly covered with fibrous or cloth-like prophylls, these tattered when old,pale gray in colour, 0.5–6 cm long, wrapping the stem. Stems terminated by a pseudowhorl of leaves, the top leaf of each whorl usually reduced, branching usually in the axils of well-developed leaves. Leaves petiolate, ovate-elliptic, 10–28 cm long, 2.5–5 cm wide, base cunete, apex acuminate, evenly spaced along the younger branches. Petiole

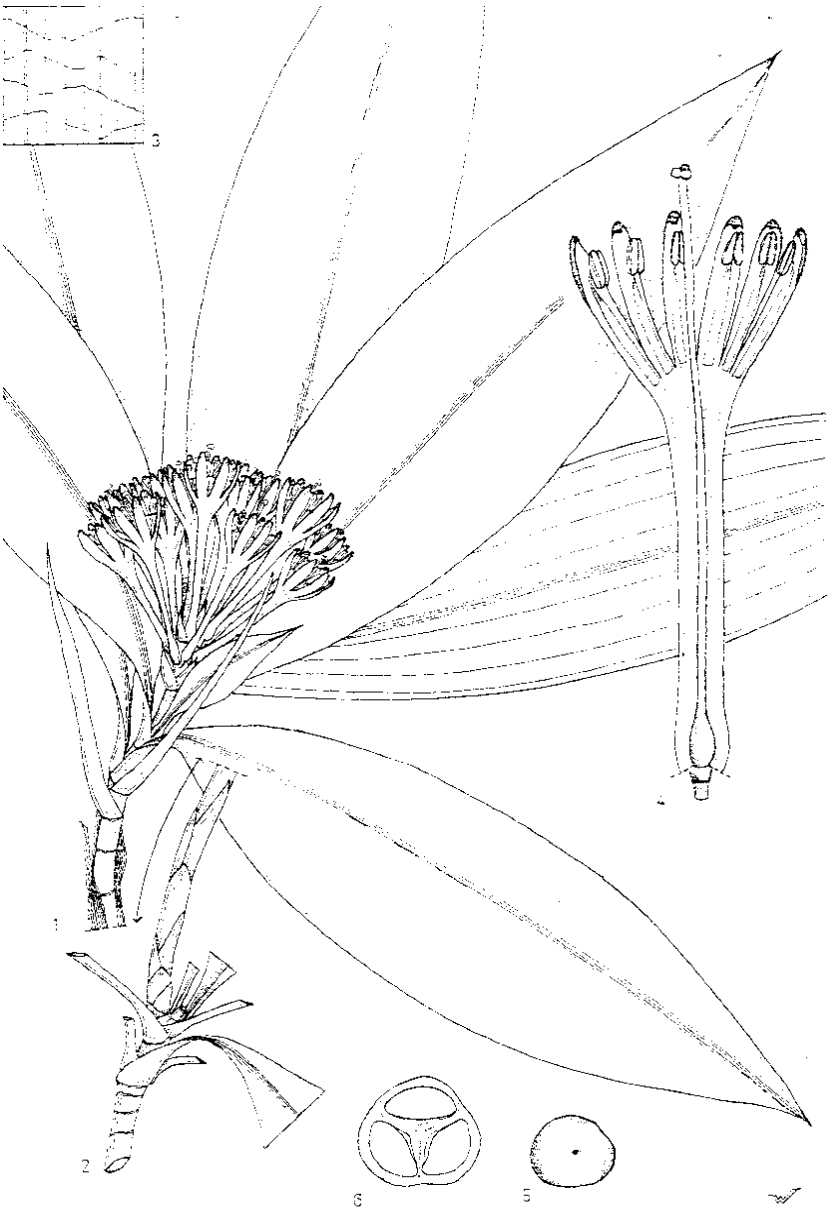
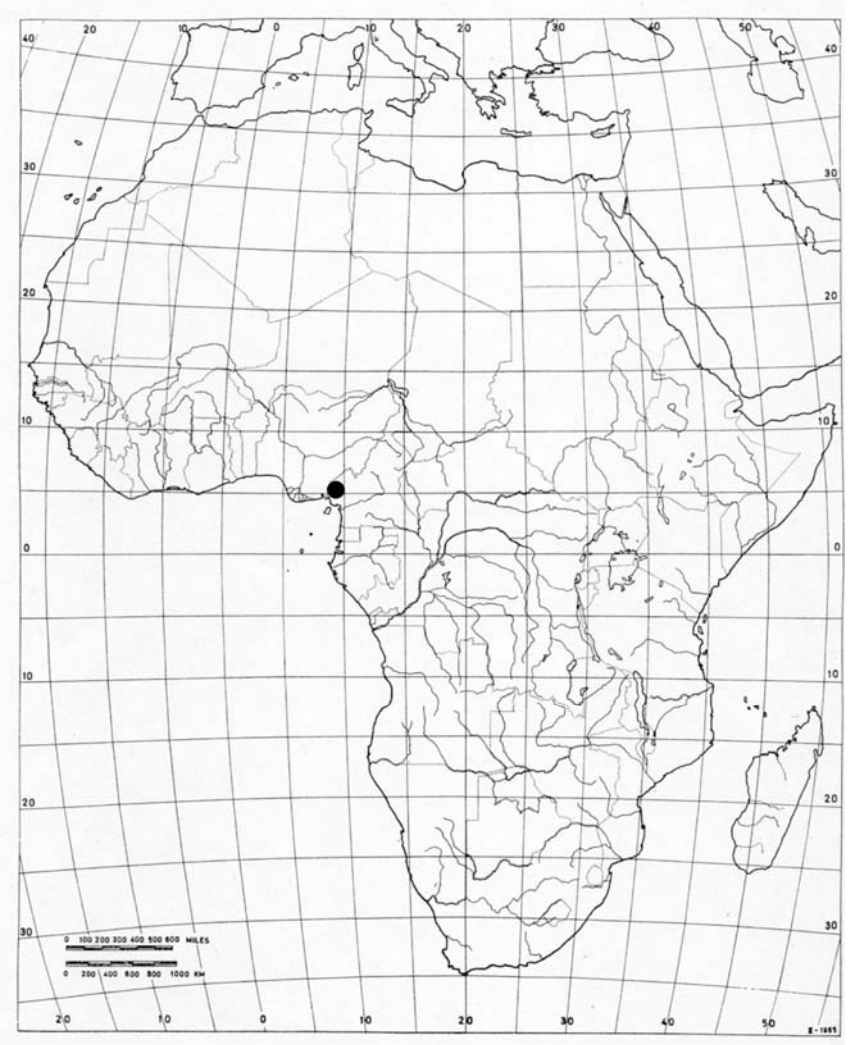


Figure 4.6.13. *Dracaena ovata* Ker Gawl. 1. Flowering branch; 2. base of flowering branch; 3. inset: detail of leaf; 4. flower laid open; 5. fruit; 6. fruit, cross-section (from Bos 1984).



Map. 4.6.13. Distribution of *Dracaena ovata* Ker Gawl.

4 mm long with an amplexicaul base forming a (partial) sheath c. 1 cm long. Inflorescence a terminal short raceme, 1–6 cm long, continuous with and the same diameter as the supporting stem, usually erect. Flowers white, 1–1.3 cm long, lobes 4–10 mm long, tube 6–10 mm long, filaments inflated with a subulate tip, shorter than the corresponding perianth lobe, style filiform, stigma capitate to slightly lobed., to 1 mm diameter. Pedicel 2–2.5 mm long, articulated above the middle. Fruits dark green in development, yellow orange when ripe, globose to depressed globose, 15–25 mm in diameter. Seeds dirty white, lens-shaped, flattened against adjacent seeds in fruits with more than one seed, 8–10 mm long, 4–6 mm wide.

CAMEROON. Mamfe District. Ejachan, 15 km west of Mamfe. 18 May 1975. *Letouzey* 13531 (BR); Edge of L. Ejagham, 45 km W of Mamfe, 18 May 1975, *Letouzey* 13537 (K); Lake Ejachan, Entre Tabo et reviere Akoumayip, Mamafe, *Letouzey* 13705 (K).
HABITAT. Undisturbed rain forest.

DISTRIBUTION: Known only fron SW Cameroon in our area, widespread from Sierra Leone to Ghana.
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

14. **D. viridiflora** *Engl. & Krause* Bot. Jahrb. 45: 151–153 (1911). Type: Cameroon. near Bipindi farm in shadowed primary forest of Lokundje valley, Jul. 1904, *Zenker* 3223 (B, destroyed)

Multi-branched shrub to 5 m tall, branches 1.5–3 cm long and up to 4 mm thick. The leaves coriaceous, drying greenish-yellowish-brownish, oblanceolate 14–17 cm long and 2.2–3 cm broad, base hardly narrowing as it passes into the amplexicaule sheath 1.2–1.8 cm long, apex acuminate. The inflorescence reach 5–8 cm long, flowers 3 cm long, including the 1 cm long perianth lobes pale green. Fruits globose, 12–15 mm in diameter, orange, seeds not seen

CAMEROON. near Bipindi farm in shadowed primary forest of Lokundje valley, Jul. 1904, *Zenker* 3223 (BR); 15 km NW of Yaounde, 11 Jan. 1961, *Breteler* 882 (K); 50 km SE of Ebolowa, 30 Jan. 1970, *Letouzey* 9929 (K); Summit of Mt. Kupe, 14 Feb 1984, *Thomas* 3168 (K).
EQUATORIAL GUINEA: inland near Mabungo about 450 m above seal level, 29 Jan. 1908, *Tessmann* 153 (K)

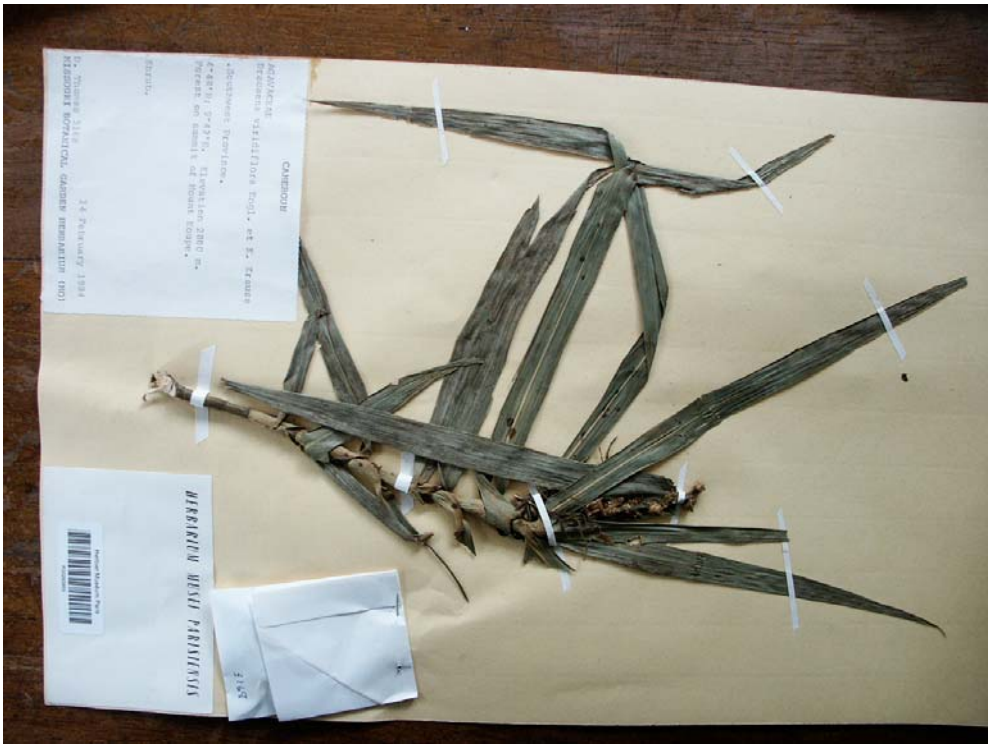
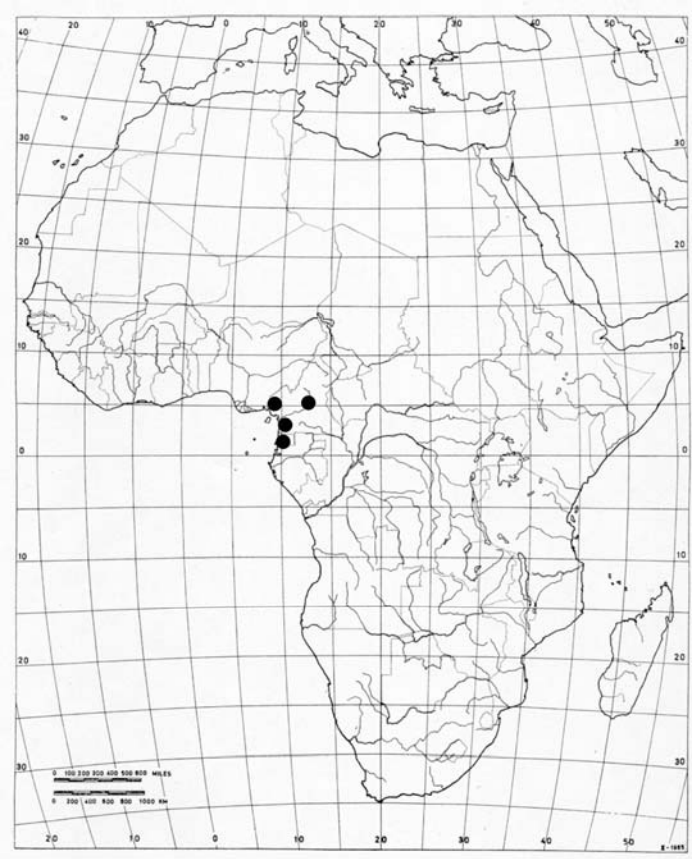


Figure. 4.6.14. *Dracaena viridiflora* K. Krause. Thomas 3168 in P.

DISTRIBUTION. Cameroon and Equatorial Guinea.
HABITAT. Undergrowth in primary forest.
USES. None recorded

CONSERVATION NOTES. Least Concern (LC).
NOTE. This species may turn out to be conspecific with *D. mildbraedii* K. Krause. I however keep them apart until I have examined more complete fertile material.



Map 4.6.14. Distribution of *Dracaena viridiflora* Engl. & K. Krause

15. **D. rubroaurantiaca** De Wild**.** Etudes Fl. Bas- et Moyen-Congo 1: 228, t. 58 (1903); Syll. Fl. Congolanae: 566 (1909). Type: Plate 58 in De Wild. Etudes Fl. Bas- et Moyen-Congo 1: 228, Lectotype, here selected.

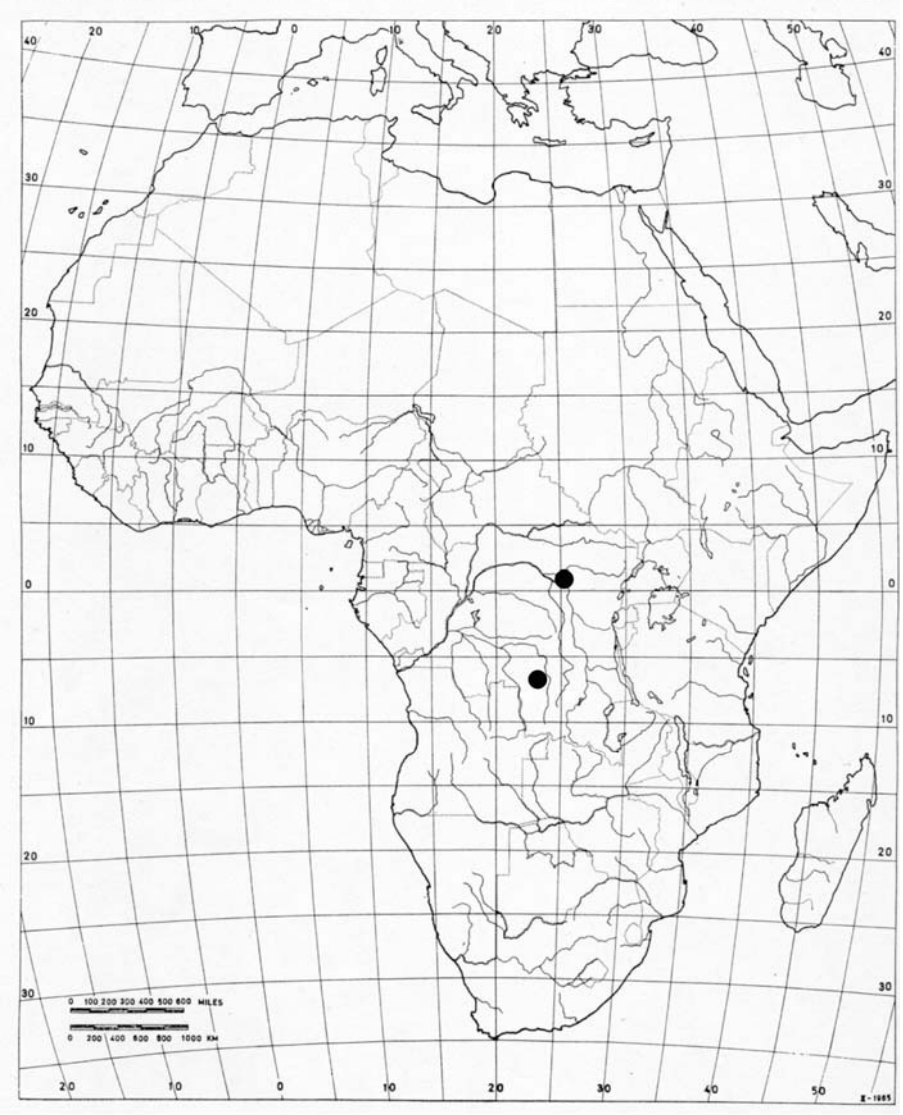
Shrub attaining a height of 2 m, with lanceolate, rigid sessile leaves attaining 1.6 m long, sheathing at the base, covering nearly the whole shoot, and of 6–7 cm wide at the middle, ending in an acuminate apex in which the mid-rib is quite clearly visible. Panicle over 60 cm long, flowers small, in groups along the panicle branches, pedicelle non-existent, or very short, in fruit sometimes attaining 1 mm long, articulated at the top, bracts scarious. Flowers c. 3 cm long, perianth white, the lobes as long as or a little longer than the tube; stamens a little exserted from the perianth, style exceeding the stamens, capitate at apex. Fruit red-orange, with 1,2 or 3 seeds.

In the absence of material traceable to the protologue, the plate accompanying the protologue is here selected as lectotype.

DEMOCRATIC REPUBLIC OF CONGO. Ile du Congo, dans environs de Malella, 20 Jul. 1895 *Dewevre* s.n. (BR); Yangambi, 31 May 1938, *Louis* 9618 (K!)
DISTRIBUTION. Democratic republic of Congo
HABITAT. Forest undergrowth.
USES. None recorded.
CONSERVATION NOTES. Vulnerable VU B1 a + b (iii)

Note. De Wild did not cite a type for this species. In absence of material from the type locality, I select the plate accompanying the protologue as type.

Figure 4.6.15. *Dracaena rubroaurantiaca* De Wild. L-R : ovary in cross-section ; flower, stigma ; flowering shoot ; ovary in longitudinal section ; flower bud ; part of infructescence.



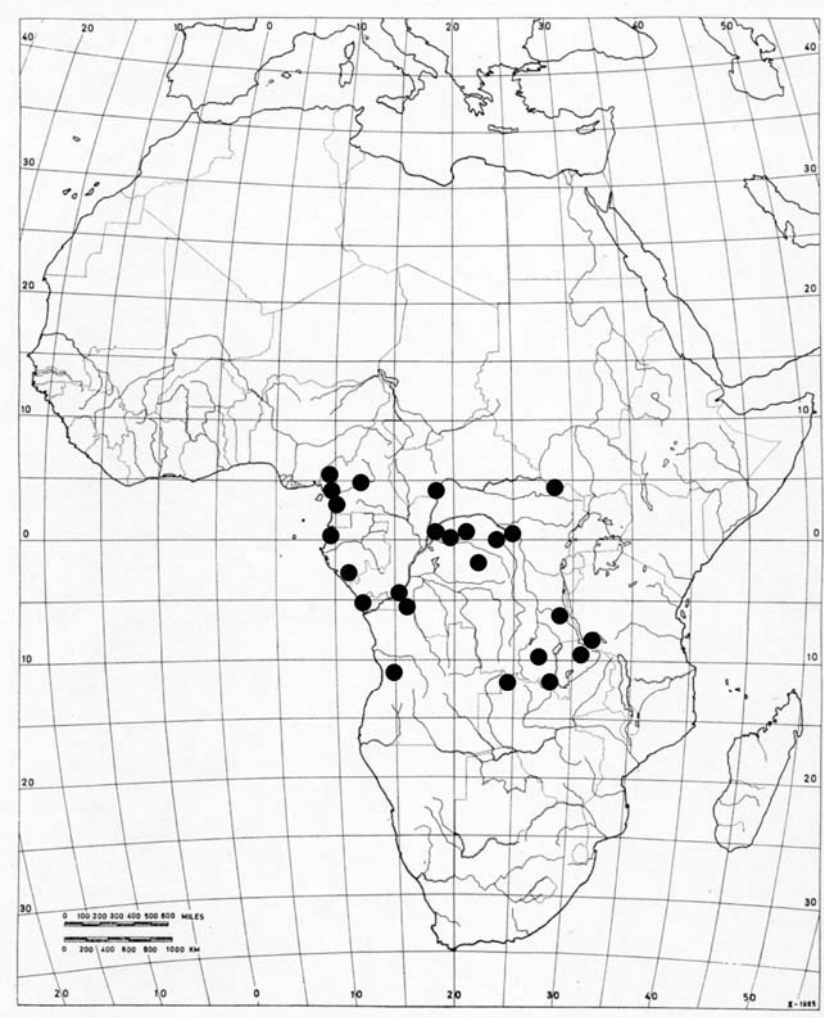
Map 4.6.15. Distribution of *Dracaena rubroaurantiaca* De Wild.

16. **D. camerooniana** *Baker* in J. Bot. 12: 166 (1874) & J. Linn. Soc. Bot. 14: 538 (1875) & in Fl.. Trop. Afr. 7: 442 (1898); Consp. Fl. Africanae: 326 (1895); Forest Fl. N. Rhodesia: 16 (1962); Fl. W. Trop. Afr. ed. 2, 3 (1): 157 (1968); Bos, *Dracaena* in W Afr.: 45, t. 7, 8 (1984). Type: Cameroon, Mt Cameroon, *Mann* 1204 (K, holo., A, P, iso.)

SYNONYMY. *D. interrupta* Baker in Trans. Linn. Soc. London ser. 2, 1: 252 (1878) & in Fl. Trop. Afr. 7: 443 (1898); Consp. Fl. Africanae (1898)Type: Angola, Pungo Andongo, *Welwitsch* 3738 (BM, holo., B, COI, G, K, P, iso.).

D. capitulifera De Wild. & Th. Durand in Ann. Mus. Congo 1, 1: 59 (1899); Enum. Pl. Laurent 1: 41 (1905); Syll. Fl. Congolanae: 565 (1909); Pl. Bequaert.: 38 (1921). Type: Democratic Republic of Congo, Bolobo, *Dewèvre* 701 (BR, holo.).

Figure 4.6.16. *Dracaena camerooniana* Baker. 1. Inflorescence; 2. inset: leaf detail; 3. flower laid open; 4. fruit; 5. fruit in cross-section.



Map 4.6.16. Distribution of *Dracaena camerooniana* Baker

D. gentilii De Wild., Et. Fl. Bas- et Moyen Congo 1, 3: 228 (1906) ; Enum. Pl. Laurent 1: 41 (1905); Syll. Fl. Congolanae: 565 (1909). Type: Democratic Republic of Congo, Luebo-Luluabourg, *Gentil* 54 (BR, holo.).

D. ueleensis De Wild., Et. Fl. Bas- et Moyen Congo 2: 20, t. 8, 9 (1907) ; Enum. Pl. Laurent 1: 41 (1905); Syll. Fl. Congolanae: 567 (1909). Type: Democratic Republic of Congo, Suronga, *Seret* 397 (BR, holo.).

D. frommii Engl. & K. Krause in Bot. Jahrb. Syst. 45: 151 (1910). Type: Tanzania, Kitungulu, M *unzner* in exped. *Fromm* 245 (B, holo.).

D. dundusanensis De Wild. in Bull. Jard. Bot. Belg. 5: 5 (1915) ; Pl. Bequaert.: 38 (1921). Type: Democratic Republic of Congo, Dundusana, *De Giorgi* 1069 (BR, lecto.).

Shrub 0.3–3.5(–8) m high; stems branched, producing cane-like shoots, leafy or clad in caducous white or pale green prophylls with distant pseudowhorls of leaves; prophylls triangular, to 10 cm long, sheathing the stem; branches at right angles to the stem, piercing the sheathing base of the supporting leaf. Leaves obovate, petiolate, 5–33 cm long, 1–8.5 cm wide, base cuneate to attenuate into the 1–4 cm long petiole, the very base amplexicaul, apex acuminate. Inflorescence pendent,

spicate, 5–50 cm long; Flowers in groups of 2–20; pedicels 2–5 mm long, articulated above the middle. Flowers white or with some purple on the lobes, 1.6–3.5 cm long, tube as long as or twice as long as the lobes, lobes 0.4–1 cm long, ± 2 mm wide. Fruits orange or red, globose or depressed globose, lobed when more than 1-seeded, 7–21 mm in diameter; seeds dirty white, hemispherical when single, flattened when several, 4–11 × 5–14 × 2–9 mm.

ANGOLA. Cabinda District, Chiluango, 1919, *Gossweiler* 8217 (K).
CAMEROON. Douala District: 25 km NE of Douala, along the road to Edea, 12 Aug 1965, *Leeuwenberg* 6322 (K); Kribi District: 20 km from Kribi, Lolodorf road, 30 May 1969, *Bos* 4698 (K); Bagodo District: Rives de Djere entre le confluent de la riviere Vina sud, 18 July 1966, *Letouzey* 7445 (BR)
CENTRAL AFRICAN REPUBLIC Bangui District: Bangui. 18 Dece 1903, *Chevalier* 10927 (K).
DEMOCRATIC REPUBLIC OF CONGO. Katanga District: Keyberg, pres d'Elisabethville, 16 Mar 1966, *Symoens* 12354 (K); Equateur District: Bohimbuloko, 19 Nov 1957, *Evrard* 2998 (K); Equateur District: entre Eyala et Boyeka, 8 Sep 1925 *Robyns* 473 (K)
GABON. Libreville District: Environs de Libreville, 25 Mar 1904, *Klaine* s.n. (K) ; Region du Nyanga, 3 Jul 1919, *Le Testu* 2001 (K); Munda District : Sibange farm, 30 Jan 1880, *Soyaux* 61 !
TANZANIA. Ufipa District: Kitungulu, M*unzner* in exped. *Fromm* 245 (K)
ZAMBIA. Mbala District, Kamboli escarpment, 13 Jun. 1961, *Richards* 15266 (K); Mwinilunga District, Muzera river, 16 km W of Kakoma, 29 Sep. 1952, *White* 3405 (K).
DISTRIBUTION.West Africa from Guinea to Central African Republic, Democratic Republic of Congo, Tanzania and Zambia
HABITAT. Associated with riverine forest. 0–1820 m.
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

17**. Dracaena surculosa** Lindl. In Bot. Reg. 14, t. 1169 (1828); Fl. Trop. Afr. VII: 443; Bos, *Dracaena* in W Afr. : 108 (1984). Type :Bot. Reg. 14 : t. 1169 (1828).
SYNONYMY. *Nemampsis ternifolia* Rafinesque, Fl. Tellur. IV: 16 (1936.) Type :Bot. Reg. 14 : t. 1169 (1828).
Draco surculosa (Lindl.) Kuntze; Kuntze, Rev. Gen. Pl. II: 710 (1891). Type :Bot. Reg. 14 : t. 1169 (1828).
Pleomele surculosa (Lindl.) N.E. Br; Brown, Kew Bull 1914: 278. Type :Bot. Reg. 14 : t. 1169 (1828).

Branched shrubs 1– 8 m tall, with tuberous roots. Leaves elliptic, 4–10.5 cm long, 1.5–6 cm wide, base broadly cuneate, apex acuminate, petiole 0.3–0.6 cm, its base semi–amplexicaule. Inflorescence unbranched, capitate or spicate, c0.5 cm long, 0.5 cm wide, borne on a peduncle 3.6–9 cm long. Flowers greenish to white,1.5 – 4 cm long, perianth tube 8–12 mm long, lobes 6–16 mm long ± equal to the tube, pedicel 2–7 mm long,

articulated below the middle. Fruits orange, globose or lobed to 2 cm diameter. Seeds white or straw-coloured, globular to hemispherical, 4–13 mm in diameter.

Key to varieties (from Bos, 1984)

1. Leaves not variegated, or this character not available ……..……2
   Leaves variegated ……....…….…...3

2. Jointed pedicel of open flowers and fruits less than 1 cm long
   ……...*D. surculosa* var. *surculosa*
   Jointed pedicel of open flowers and fruits 1–2.5 cm long
   ……..…..….*D. surculosa* var. *maculata*

3. Variegation consisting of pure white, sometimes yellowish white, round dots, very sparse to very abundant and fused into one another, clearly distinct on both surfaces of the leaf ……*D. surculosa* var. *surculosa*
   Variegation consisting of sparse to abundant dots, rings or irregula fused patterns of paler to very pale green, not white, distinct above, but often indistinct beneath ……*D. surculosa* var. *maculata*

D. surculosa Lindl. **var. surculosa**, Bot. Teg. 14: t. 1169 (1828); Bos, Misc. Pap. Landbouwhoogeschool 19: 71 (1980), Bos, *Dracaena* in W Afr. : 111, t. 22, 23 (1984). Type: Bot. Reg. 14: t. 1169 (1828).

Dwarf shrubs 1–2 m tall, branches bearing leaves in pairs or in threes, variegated with white to yellow dots, these distinct on both surfaces of the leaf. Inflorescence 2–9 cm long, with 3–7 glomerules of flowers, very rarely only one terminal glomerule present; axxillary clusters 1–5 flowered, the terminal one 5–9 flowered, jointed pedicel to 1 cm long, flowers greenish white. Fruits 10–15 mm long, 10–20 mm in diameter, globose or depressed globose. Seeds hemispherical to irregularly discoid, 4–8 mm long, 6–10 mm diameter.

CAMEROON. 20 km W of Mamfe, *Letouzey* 13701 (K)
DISTRIBUTION. Sierra Leone, Cote d'Ivoire and eastwards to western Cameroon
HABITAT. Forest undergrowth
USES. Variegated forms widely cultivated as foliage ornamentals
CONSERVATION NOTES. Least Concern (LC).

D. surculosa Lindl. var. **maculata** Hook.f. Bot. Mag.: 5662 (1867); Bos, Misc. Pap. Landbouwhoogeschool 19: 75 (1980); Bos, *Dracaena* in W Afr.: 115, t. 22, 23; photo 18 (1984) Type; Nigeria, Old Calabar, *Mann* 2327 (K! lecto; P. iso).

Shrubs up to 4 m, exceptionally up to 8 m tall, lateral branches bearing pseudowhorls of 3–4 leaves in a horizontal plane; variegation, if present, with dots, rings or irregular fused patterns of paler shades of green, never white, not showing on the abaxial leaf surface.

Inflorescence 3–18 cm long, usually with a single terminal glomerule of 15–30 flowers, rarely with up to five few-flowered clusters below the terminal one. pedicels 1–2.5 cm long, jointed below the middle. Fruits 6–11 mm long, 6–17 mm in diameter, globose, bi- or tri-lobed, according to the number of seeds. Seeds globose or flattened, 5–7 x 6–8 x 7–11 mm.

EQUATORIAL GUINEA. Bioko, Malabo-Baney by the coast road, km 16–17, 14 Aug 1988, *Carvalho* 3574 (K).

DISTRIBUTION. From Guinea eastwards to western Cameroon, except Benin
HABITAT. Primary forest undergrowth.
USES. Cultivated in botanic gardens as foliage ornamentals. Not as popular as *D. surculosa* var. *surculosa*.
CONSERVATION NOTES. Least Concern (LC).

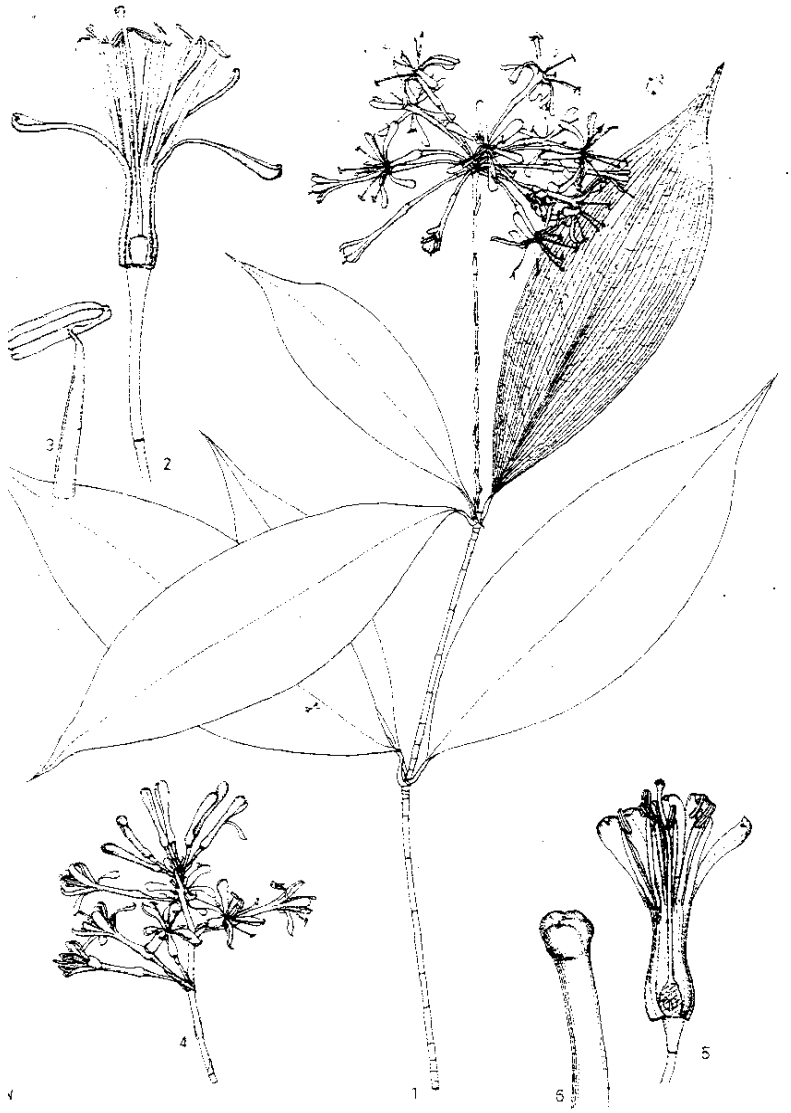
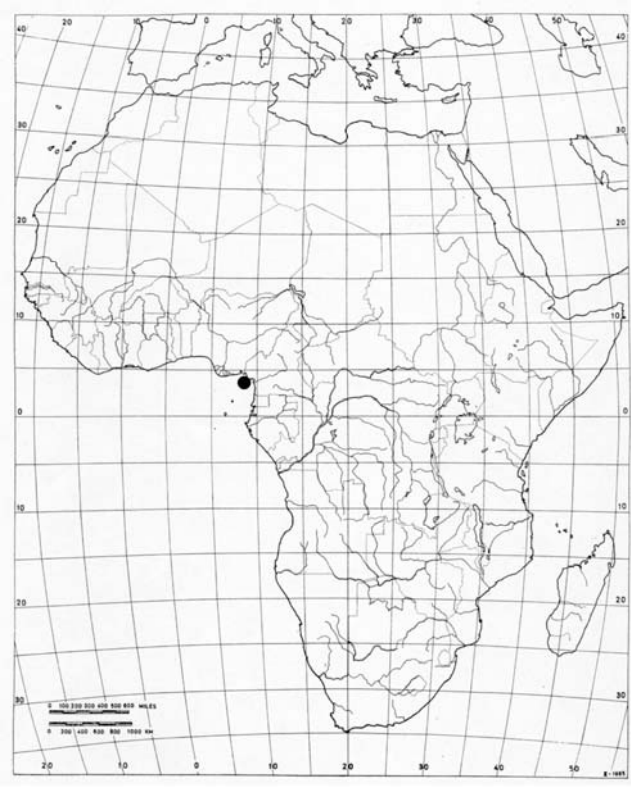
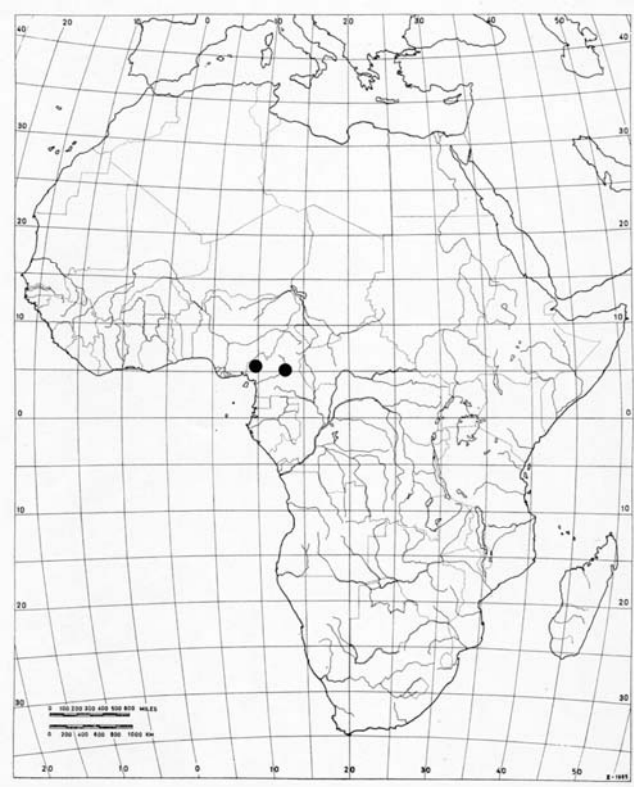


Figure 4.6.17. *Dracaena surculosa* Lindl. var. *maculata* Hook.f.: 1. Flowering branch; 2. flower laid open; 3. detail of stamen.
D. surculosa Lindl. var. *surculosa*: 4. inflorescence; 5. flower laid open, ovary in section; 6. Tip of style showing the stigma (from Bos, 1984)



Map 4.6.17a. Distribution of *Dracaena surculosa* Lindl. var. *maculata* Hook.f.



Map 4.6.17b. Distribution of *Dracaena surculosa* Lindl. var. *surculosa*.

18**. D. congoensis** *Hua*, Contr. Fl. Congo. Fr., Lil.: 16 (1897); De Wildeman & Durand, Contr. Fl. Congo I-1: 60 (1899); Enum. Pl. Laurent 1 : 42 (1905); Fl. W. Trop. Afr. II (1936): 386; Fl. W. Trop. Afr. ed 2, III-I: 156 (1968); Bos, *Dracaena* in W Afr.: 60, t. 11 (2) (1984). Type: Gabon, Mayumbe Forest, *Thollon* s.n. (P. Holo, K. drawing).
SYNONYMY. *Pleomele congoensis* (Hua) N.E.Br.; Brown, Kew Bull. 1914: 277 (1914) Type: Gabon, Mayumbe Forest, *Thollon* s.n. (P. Holo, K. drawing).

Low monocaulescent, rarely branched shrubs up to 1.8 m high with slender stems, leaves clustered at the stem apex. Leaves ovate elliptic or obovate-lanceolate 12–45 cm long, 3–9 cm wide, apex acuminate with a subulate mucro, base tapering into a winged pseudopetiole 4–10 mm wide with a shating base 1–4 cm long, midrib not prominent above, in fresh leaves indicated by a farrow, prominent beneath, not quite reaching the tip. Inflorescence terminal, erect 5–25 (–33) cm long, peduncle bearing concave, long-cuspidate bratcs that leave distinct scars when shed, these decreasing in size up the peduncle. Flowers in 4–6 flowered, sessile glomerules, the lowetst glomerule sometimes stalked with a stalk to 2 cm long, the floer subtended by a white sacrious bract to 2 mm wide. Basal part of jointed pedicel persistent 1–2 mm long. Flowers white with red tinge, 24–28 mm long, perianth tube 10–15 mm long, longer than the 7–10 mm long lobes, each lobe with a median vein. Filaments inflated, anthers 2 m long, 1 mm wide, style filiform with a 3-lobed stigma that may be exserted or not. Fruits orange-yellow, globose, 10–14 mm in diameter with a persistent 3–4 mm long stalk-like receptacle. Seeds pale brown 8mm long, 6–7 mm wide and 4–5 mm deep.

GABON. Gabon, Mayumbe Forest, *Thollon* s.n (P, holotype).

DISTRIBUTION. Gabon
HABITAT. Not known
USES. None recorded
CONSERVATION NOTES. Endangered. EN B1a + b (iii)

Subgenus **arborea** Mwachala; subgenus nov**. Type:** . Nigeria, Nun river, *Mann* 454 (K , Neo., A,P,S isoneo.).

Trees and shrubs with lanceolate, sessile leaves; pendent or deflexed;inflorescences; flowers borne singly or in groups of no more than 3. Guineo-Congolian and eastern in distribution.

19. **D. afromontana** *Mildbr*., Wissensch.. Ergebnisse Deutsch. Zent. Afr. Exped,. 1907–1908, 2: 63, t. 5, g-k. (1914); Pl. Bequaert.: 36 (1921); Troupin, Fl. Pl. Lign. Rwanda: 68 (1982); Forests & Forest Trees of Northeast Africa.: 264 (1992); Kenya Trees Shrubs & Lianas: 639 (1994); Bos in Fl. Ethiopia 6: 76, t. 185/1–4 (1997). Type: *Mildbraed* 1033, 1360, 2525 (B†, syn.); lectotype: plate V in Wissensch.. Ergebnisse Deutsch. Zent. Afr. Exped,. 1907–1908, 2: 63, t. 5, g-k. (1914); chosen by Bos, 1997

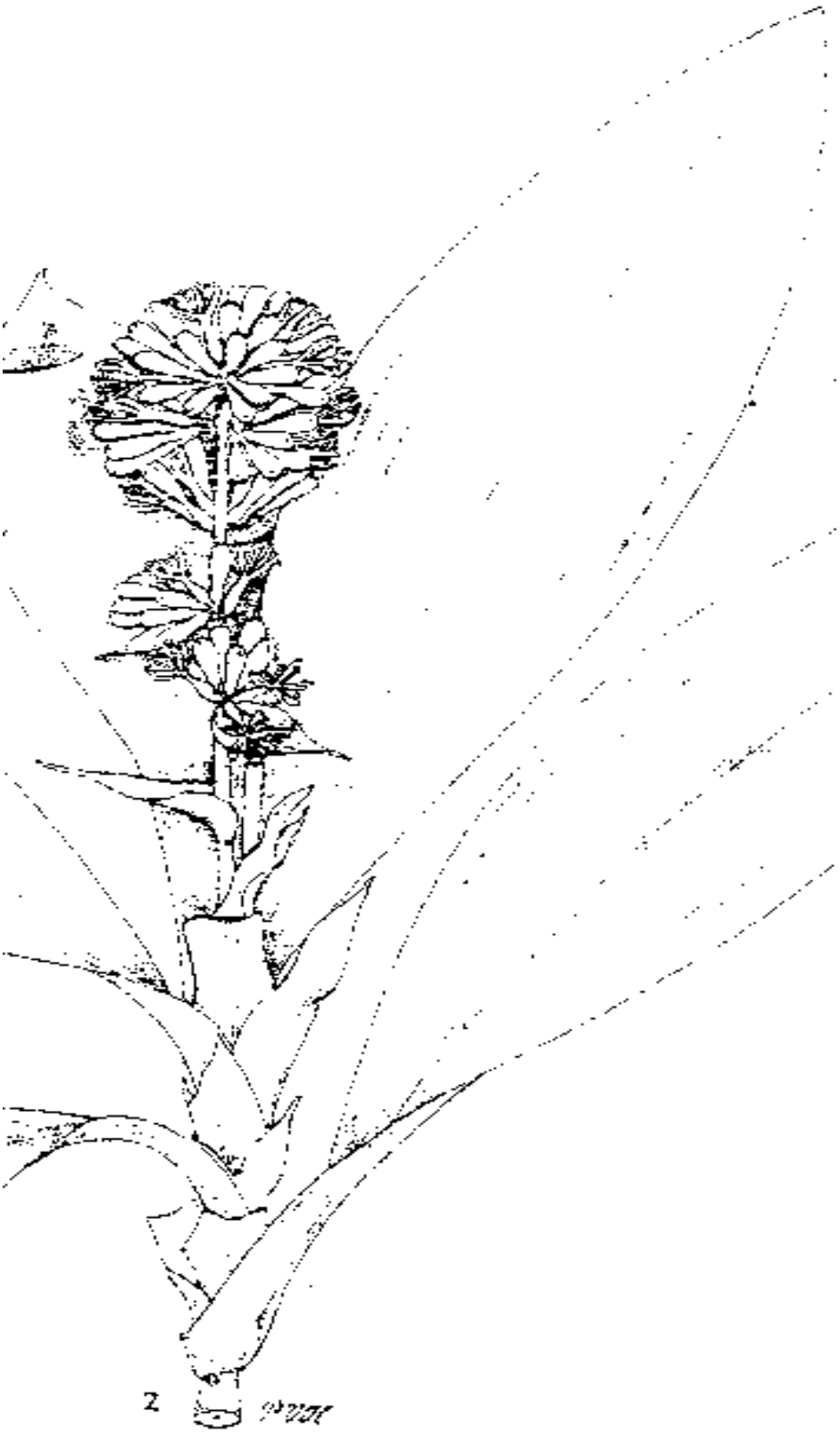
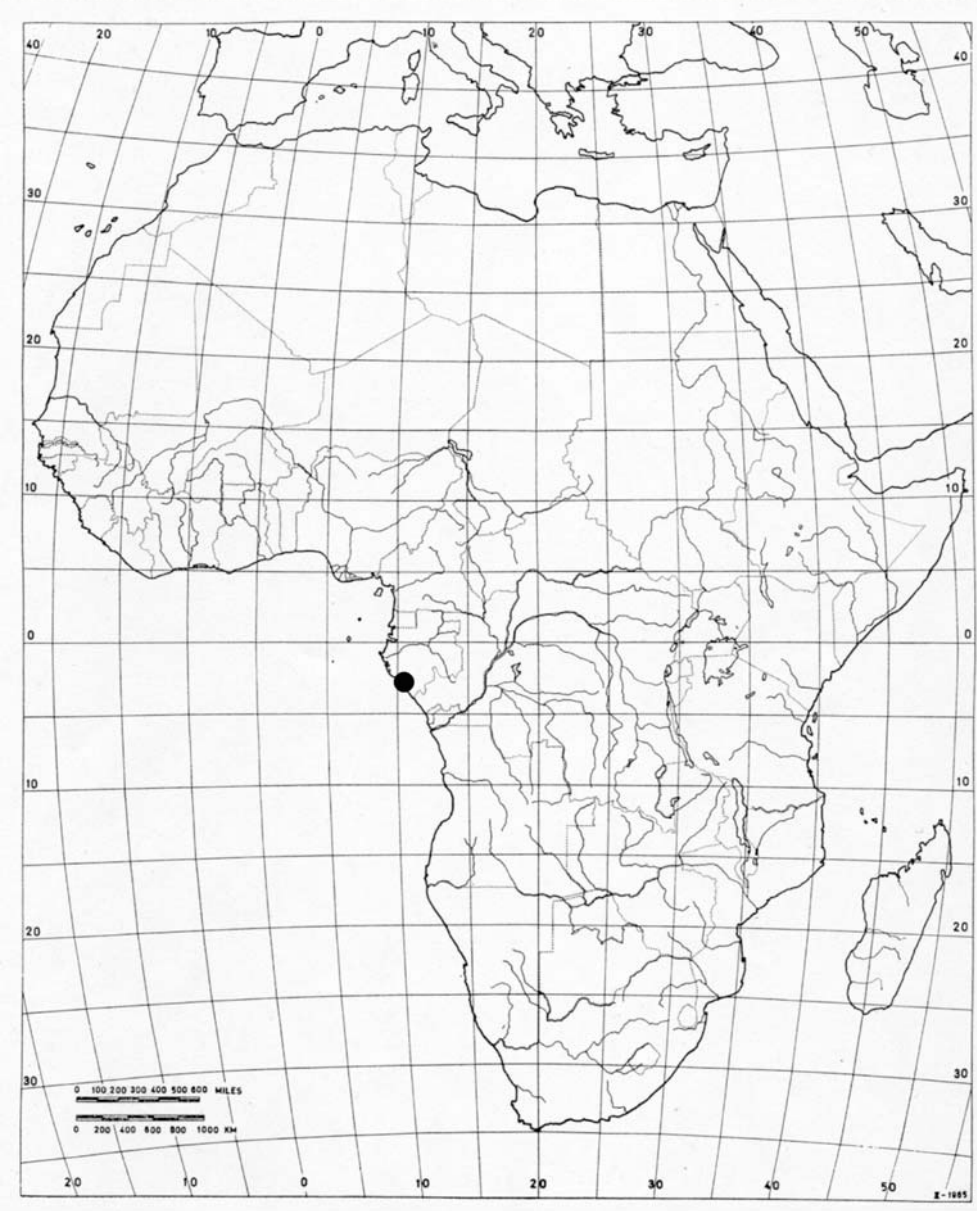


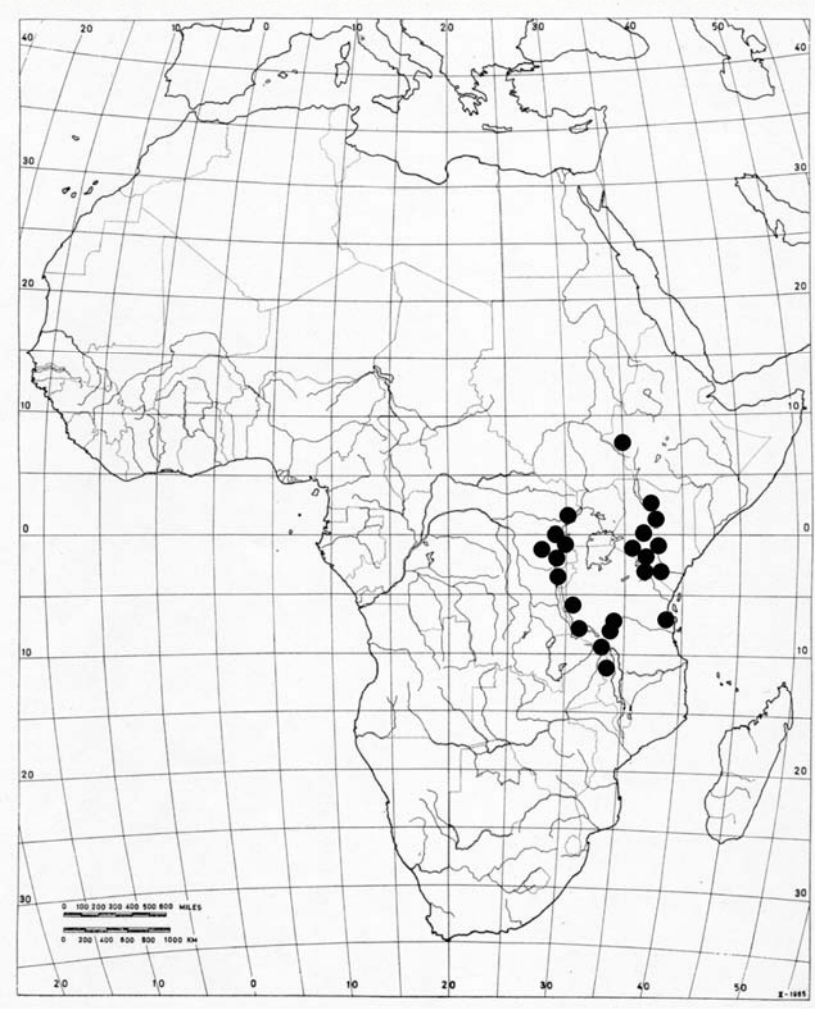
Figure 4.6.18. *Dracaena congoensis* Hua: flowering branch (from Bos, 1984).



Map 4.6.18. Distribution of *Dracaena congoensis* Hua.

Shrub or tree, 2–12 m high, sometimes straggling; stem to 25 cm in diameter, branches few, arching, with a distinct pattern of horseshoe-shaped leaf-scars. Leaves narrowly lanceolate, sessile, 12–35 cm long, 1.5–3 cm wide, base hardly constricted and clasping, apex acute. Inflorescence pendulous, paniculate, 20–60 cm long; flowers in groups of 1–3; pedicels 4–12 mm long, articulated above the middle. Flowers white, pale green or with a purple tinge outside, somewhat translucent, 1-ribbed, 15 mm long; tube 1 mm long, lobes 14 mm long, 2–3 mm wide, spreading at anthesis. Fruits orange, globose or lobed when several-seeded, 12–20 mm in diameter; seeds dirty white, 6–9 mm in diameter.

Figure 4.6.19. *Dracaena afromontana* Mildbr.: flowering shoot. Photo. E. Fischer.



Map 4.6.19. Distribution of *Dracaena afromontana* Mildbr.

BURUNDI. Muramvya District: Nyabigondo, 20 Jan 1967, *Lewalle* 1511 (BR); Muramvya District: Foret de Bugarama, 19 Nov 1966, *Lewalle* 1272 (K); Ngozi District: Banga, 13 Nov 1966, *Lewalle* 1231 (EA)

DEMOCRATIC REPUBLIC OF CONGO. Bukavu District: Mt. Kahusi, 25 Dec 1945, *Hendrickx* 3700 (EA); Kivu District: Mt. Nyiragongo, Parc National Albert, 26 Jan 1945, *Germain* 3478 (K); Kivu District, Mt. Biega, *Humbert* 7622 (K)

ETHIOPIA. Omo North District: Malo Koza Mt., c. 70 km N of Jinka, 15 May 1994, *Fujimoto* 442 (K)!; Kaffa Province, 3 km S of Bonga, 8 Jan 1972, *Ash* 1443 (EA); Kaffa Province, Kaffa, June 1975, *Chaffey* 234 (EA)

KENYA. Northern Frontier District: Mt Kulal, Narangani, June 1960, *Oteke* 97 (EA); Trans Nzoia District: Cherangani Mts, Kabolet, Aug. 1963, *Tweedie* 2709 (EA< K); Mt Kenya, 3 km below Castle Forest Station, Jan. 1967, *Perdue & Kibuwa* 8361 (EA)

MALAWI. Misuku Hills, Mugesse Forest, *Chapman* 1909 (K); Nyamkhowa Forest, Sep. 1902, *McClounie* 183 (FHO)

RWANDA. Kibuye District, Wisumo, Centre forestier Suisse, 2 June 1978, *Troupin* 16028!

TANZANIA. Kilimanjaro, above Kilimanjaro Timbers, May 1994, *Grimshaw* 94/519!; Ufipa District: Mbizi Forest Reserve, Nov. 1987, *Ruffo & Kisena* 2871!; Njombe District: Ndumbi Forest, Mtorwi, Nov. 1986, *Goldblatt & Lovett* 8236!

UGANDA. Karamoja District: Saosa catchment near Mt Moroto, Jan. 1959, *Kerfoot* 715!; Toro District: Ruwenzori foothills, Sep. 1936, *Mukibi* in *Thomas* 2627!; Elgon, Oct. 1923, *Snowden* 804!
DISTRIBUTION. Kenya, Uganda, Tanzania, Burundi, Rwanda, Democratic Republic of Congo, Ethiopia, Malawi
HABITAT. Afromontane rainforest, or bamboo forest, often forming dense stands in the understorey. 1600–2700 m
USES. Cultivated as live fencing and internationally traded as a foliage ornamental.
CONSERVATION NOTES. Least Concern (LC).

20. **D. arborea** *Link*, Enum. Hort. Berol. i: 341; Enum. Pl. Laurent 1 : 42 (1905); Syll. Fl. Congolanae : 564 (1909). Type : A living plant in Hort. Berol. In 1809. Neotype : Nigeria, Nun river, *Mann* 454 (K !, holo, A,P,S iso).
SYNONYMY. *Cordyline arborea* (Willd.) Goeppert; Goeppert, Nova Acta: 55 (1854). Type as for *D. arborea* (Will.) Link: Type : A living plant in Hort. Berol. In 1809. Neotype : Nigeria, Nun river, *Mann* 454 (K !, holo, A,P,S iso).
Draco arborea (Willd.) Kuntze, Kuntze, Rev. Gen. Pl. 2: 710 (1891); Baillon Hist., Pl.: 488 (1894). Type as for *D. arborea* (Will.) Link.
Pleomele arborea (Willd.) N.E.Br.; Brown, Kew Bull. 1914: 277 (1914). Type as for D. *arborea* (Will.) Link.
Dracaena knerkiana K. Koch, Wochenschr. IV: 394 (1861); Baker, J. Bot. 12: 164 (1974); Baker, Fl. Trop. Afr. 7: 439 (1898). Type as for *D. arborea* (Will.) Link.
D. excelsa Tenore, Ind. Sem. Neap.: 8 (1839). Type: the protologue.
Aletris fragrans Hort. Cels. Invalid name.
Dracaena arborea (Willd.) Link var. *baumannii* Engl., Bot. Jahrb. Syst. 59 beibl. 131: 20 (1924). Type: Togo, Misahohe, Baumann 330 (B holo). Neotype: Sierra Leone, Regent, *Morton* SL 122 (WAG holo, GC,K,SL iso).

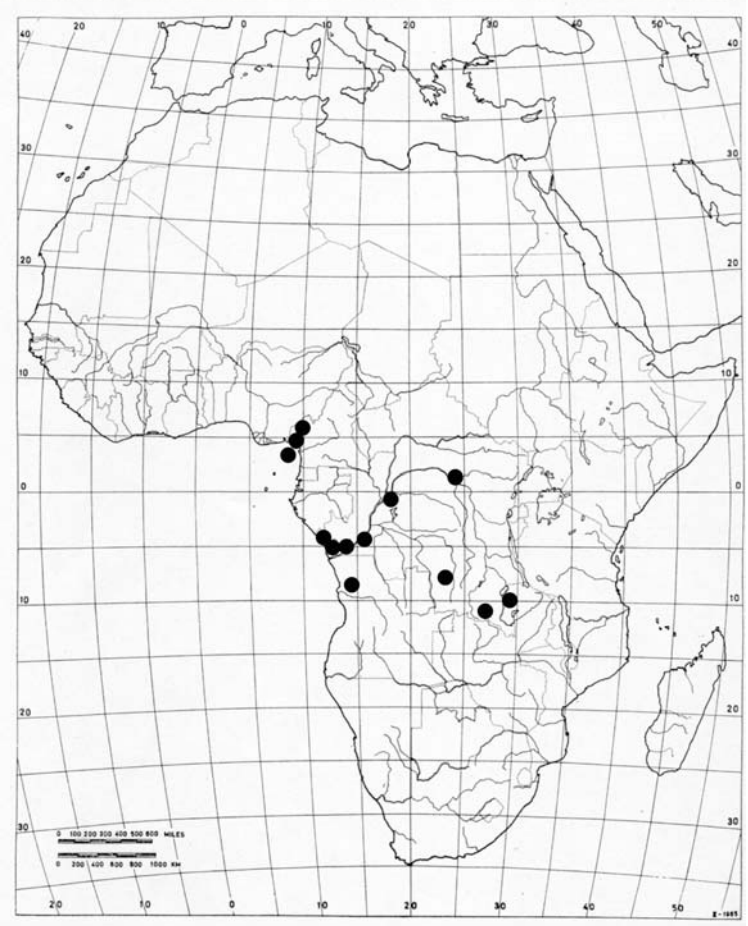
Tree to 20 m tall, young stems yellow-brown, old stems grey. Leaves narrowly oblanceolate to lanceolate, (50) 60–100(–150) cm long, 5–7(–10) cm wide, the widest part just above the middle, sessile, apex acute, shortly mucronate; base narrowly cuneate, abruptly widening into a semi-amplexicaule base. Inflorescence paniculate, 50 –150 (–200) cm long and broad, pendent, yellow, smooth. Flowers in clusters of 3–5, sometimes the clusters crowded, white; pedicels 3–5 mm long, articulated above the middle; perianth tube 5–8 mmlong, the lobes up to twice as long,10–13 mm long. Fruit bright orange, globose to depressed globose, lobed when more than one seeded, 12–24 mm long, 12–25 mm in diameter. Seeds 2–3, flattened-globular, c.1 cm long, 1 cm wide and 1 cm deep, straw-coloured.

ANGOLA. Cabinda District: Angolares in Praia Grande, not dated, *Moller* 13 & *Moller* 107 (not seen)
CAMEROON. I km S of Longii, 23 Apr 1968, *Bos* 4362 (BR); Pres Chefferies Foutoni, 20 km N Bafang, 22 Nov 1974, *Satabie* 111(K); Pres Dchang, 25 June 1975, *Letouzey* 13928 (BR); In and just SW of Mbu village, 28 Oct1986, *Manning* 656 (K).
DEMOCRATIC REPUBLIC OF CONGO. Kasenga District, Kasenga Mission, 30 Sep. 1962, *Schmitz* 8033 (EA); Lukula District, INEAK Luki, 1 Sep. 1955, *Hombert* 174 (BR)

EQUATORIAL GUINEA: Bioco, Malabo-Cupapa, estrada km 25, 5 Aug. 1986, *Carvalho* 2225 (K); Bioco, Malabo-Aeroporto Estrada km 6, pation Casa Joana, 23 Jul 1986.*Carvalho*, 2083 (K)

DISTRIBUTION. West and Central Africa and south into Angola
HABITAT. Forest and forest edges
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

Figure 4.6.20. D*racaena arborea* (Willd.) Link: 1. infructescence; 2. leaf; 3. fruit; 4. seed. (from Bos, 1984)



Map 4.6.20. Distribution of *Dracaena arborea* Link.

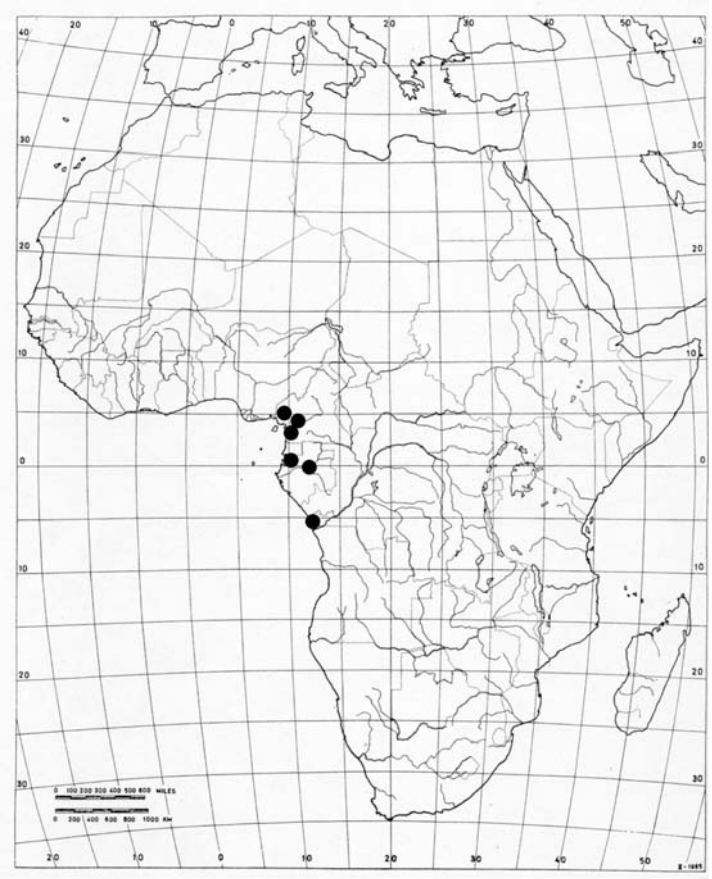
21**. D. cerasifera** *Hua*., Contr. Fl. Congo Franc., Lil. 11. (1897); Bos, *Dracaena* in W Afr.: 54, t.9,10 (1984). Type: Gabon, Ogooue river, *Leroy* s.n. (P holo).
SYNONYMY. *Pleomele cerasifera* (Hua) N.E. Br.; Brown in Kew Bull. 1914: 277. Type as for *D. cerasifera* Hua.
Dracaena scoparia A. Chev. Bot 1: 647 (1920). Type: Côte d'Ivoire, Alépé, *Chevalier* 17484 (P.).

Shrub to 8 m tall, single-stemmed or branched; stem smooth, grey with flaking bark, young stems yellow, leafy toward the ends of the branches. Leaves narrowly obovate to obovate, sessile, 10–50 cm long, 1–7 cm wide, base narrowly cuneate, flaring into a semi-amplexicaule base, apex narrowly acute to acuminate. Inflorescence paniculate, pendent, 25–75 cm long, with up to 13 usually simple branches to 25 cm long. Flowers in clusters of 1–6; pedicels 5–25 mm long articulated above the middle, perianth greenish-white, occasionally purple-tinged, 20–30 mm long, perianth tube 7–10 mm long, shorter than the 9–15 mm long, 2–3 mm wide lobes. Fruits bright orange, depressed globose or globose, 18–30 mm long, 12–30 mm in diameter. Seeds pale brown with paler venation and a wide pale area around the micropile, somewhat flattened, 8–15 x 8–15 x 6–14 mm.

CAMEROON: 40 km S of Badjob, c 50 km SW of Eseka, 18 Dec 1963 *De Wilde.* 1546 (EA, K); 49 km SE of Eseka, c 1km N of Song-Mbong, 12 March 1965 *Leeuwenberg* 5138 (EA); 11 km N of Kribi, not dated, *Bos* 3565 (not seen); 15 km N of Kribi, not dated, *Bos* 3729 (not seen).
GABON: 8 km SSW of Makokou, not dated, *Leeuwenberg* 11462 (EA)
ANGOLA: Cabinda, Belize, not dated, *Gossweiler* 7933 (ot seen)

DISTRIBUTION. Liberia to Ghana in W Africa and Cameroon, Gabon and Angola in central Africa
HABITAT. Deep shady localities in undisturbed rain forest
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

Figure 4.6.21. *Dracaena cerasifera* Hua: De Wilde & De Wilde 1546A in P.



Map. 4.6.21. Distribution of *Dracaena cerasifera* Hua.

22. **D. laxissima** *Engl*. in Bot. Jahrb. Syst. 15: 478 (1892); Etud. Fl. Cgo.: 265(1896); Consp. Fl. Africanae: 328 (1895) (as *D. laevissima*); Fl. Trop. Afr. 7: 446 (1898); Syll. Fl. Congolanae: 565 (1909); Forest Fl. N. Rhodesia: 16 (1962); Fl. W. Trop. Afr. ed. 2, 3 (1): 157 (1968); Troupin, Fl. Pl. Lign. Rwanda: 68 (1982); Bos, *Dracaena* in W Afr.: 79, t. 14 (1984); Kenya Trees, Shrubs & Lianas: 640 (1994). Type: Democratic Republic of Congo: Mukenge, *Pogge* 1462 (B, holo.)

SYNONYMY. *Dracaena elegans* Hua in Contr. Fl. Congo fr., Lil: 13 (1897); Baker in Fl. Trop. Afr. 7: 446 (1898). Type: Gabon, Sanga, *Leroy* s.n. (P, holo., K !, iso.).

Shrub, often sprawling, sarmentose or scrambling, 1–6 m high and long. Leaves elliptic or less often ovate or obovate, petiolate, (4–)8–20 cm long, (1–)2.5–7 cm wide, base cuneate to rounded into an amplexicaul sheath, apex acuminate. Petiole 5–20 mm long. Inflorescence horizontal to pendent, paniculate, (5–)15–50 cm long, flowers occurring singly; pedicel 2–17 mm long, articulated above the middle. Flowers white, greenish white or pink, 15–20 mm long, tube to 3 mm, lobes 9–10 mm long, 2.5 mm wide. Fruits orange-

red, globose, lobed when several-seeded, 6–12 mm in diameter; seeds globose or flattened, 4–7 mm in diameter.

BURUNDI. Kitega District: Confluent Ruvuvu-Karuzi, 25 Jun 1958, *Van der Ben* 2120 (K) ; Muramvya District: Bugarama, *Lewalle* 3597 (K).
CAMEROON. Mamfe district: Entre Mbakem et Tabo, 20 km W of Mamfe, 2 Jun 1975, *Letouzey* 13692 (K): South West Province:, Mt. Etinde, vers Boanda, 10 km

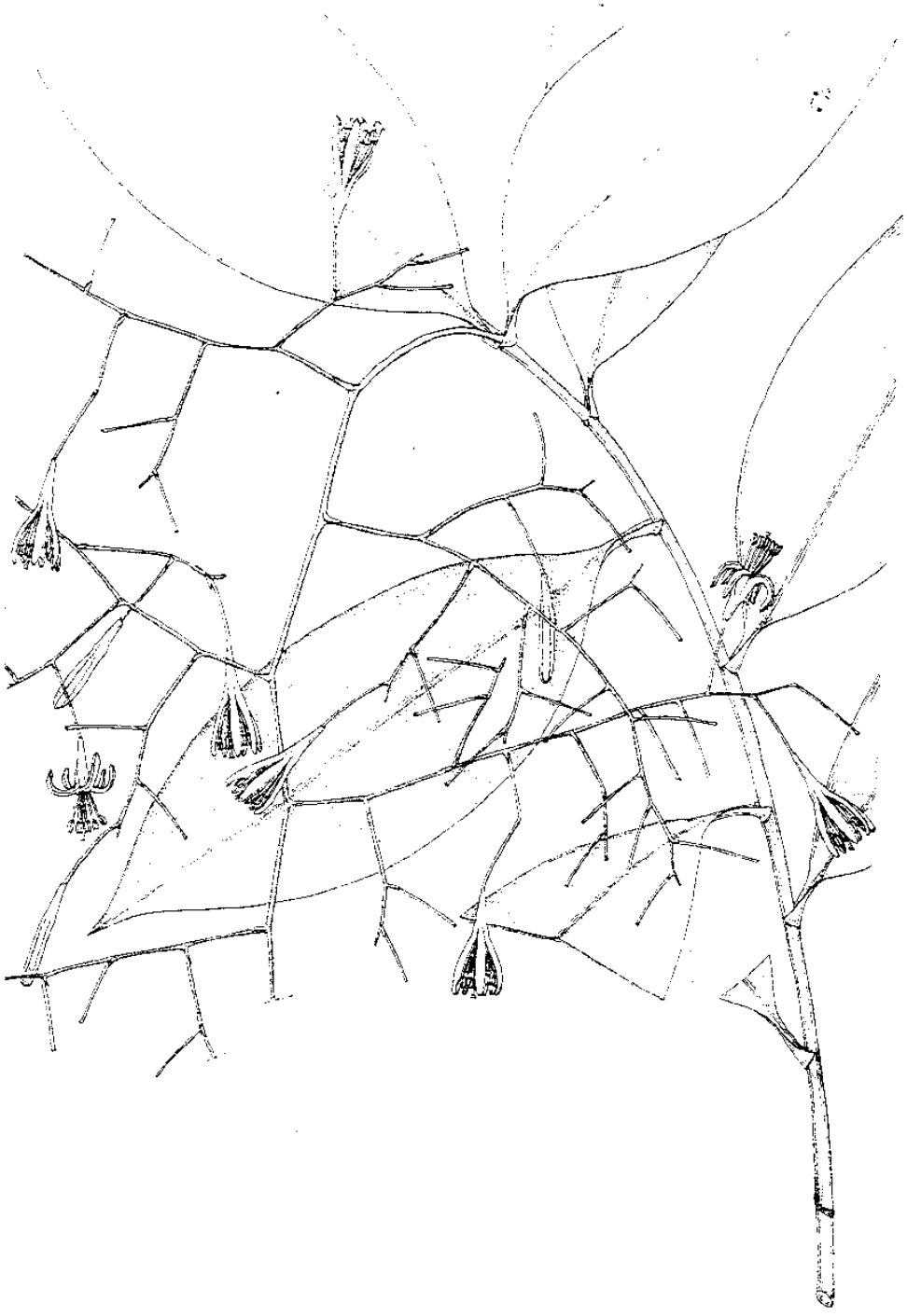
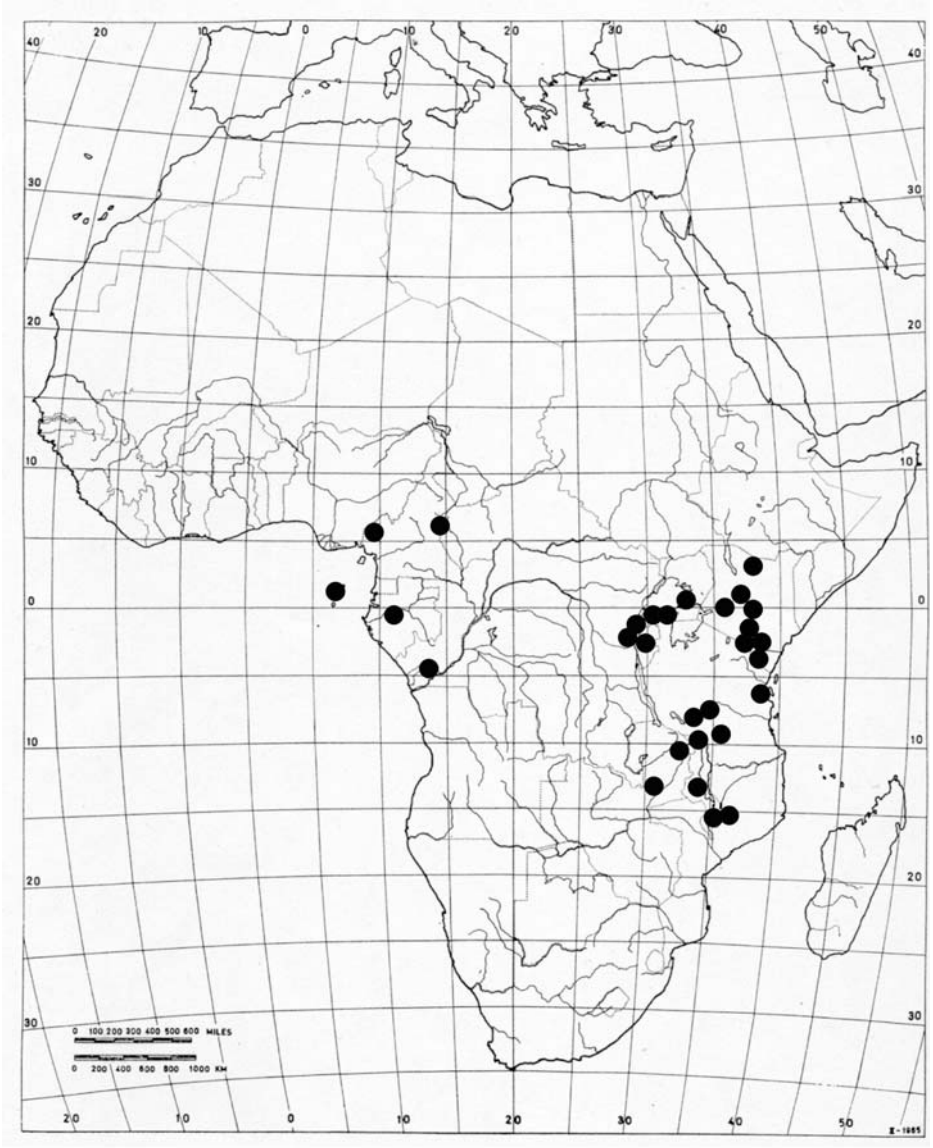


Figure 4.6.22. *Dracaena laxissima* Engl.: 1. Flowering branch (after Bos, 1984).



Map 4.6.22. Distribution of *Dracaena laxissima* Engl.

NW Victoria, 24 May 1976, *Letouzey* 14965 (K); South West Province, Ajaman, near northern edge of Korup National Park, 23 May 1988, *Thomas et al*. 7833 K).
DEMOCRATIC REPUBLIC OF CONGO. Kivu District: Rumangobo, Rutshuru, 15 Dec 1944, *Germain* 3019 (K); & Lamera, Kalehe, 7 Dec 1955, *Christiensen* 1216 (K).
EQUATORIAL GUINEA. Rio Muni: S.Nicolau-Macambara road, near S. Nicolau, 20 Oct 1993, *Figueiredo & Arriegas* 62 (K); Rio Muni: Ponta de Bahia, Feb. 1885, *Quintas* 1 (K)
KENYA. Northern Frontier District: Marsabit, Jan. 1961, *Polhill* 345 (EA); Nairobi, Karura Forest, May 1949, *Bogdan* 2445 (K); Teita District: Sagala Hill, June 1985, *Taita Hills Exped.* 1076 (K)
MALAWI. Chitipa District, Jembya forest reserve, 18 km SSE of Chisenga, 4 Jan. 1989, *Thompson & Rawlins* 5976 (K); Ntchisi forest reserve, 25 Mar. 1970, *Brummit & Evans* 9385 (K); Mt. Mulanje, Lichenya Palteau, Nessa forest path, 23 Dec 1988, *Chapman & Chapman* 9452 (K).
MOZAMBIQUE. Serra do Gurue, 24 Feb. 1966, *Torre & Correia* 14850 (K)
TANZANIA. Lushoto District: Amani road to Derema, June 1970, *Kabuye* 193 (K); Morogoro District: N Nguru Mts, Mt Kanga, Dec. 1987, *Lovett & Thomas* 2680

(K); Rufuna Forest Reserve, Mufindi, Nov. 1982, *Leliyo* 346 (K); District: Pemba: Ngezi Forest, 1929, *Taylor* 96/2 (K)

UGANDA. Ankole District: Kalinzu Forest, July 1938, *Eggeling* 3783 (K); Kigezi District: Murole Hill, Apr. 1948, *Purseglove* 2692 (K); Masaka District: Bukoto, Bugonzi, July 1971, *Katende* 1165 (K)

ZAMBIA. Isoka District, Mafinga Mts, 6 km W of Chisenga rest house, *White* 3725 (K); Lundazi District, Nyika plateau, upper slopes of Kangampande mt., 7 May 1952, *White* 2755 (K).

DISTRIBUTION. Kenya, Tanzania, Uganda, Nigeria, Cameroon, most of tropical Africa

HABITAT. Moist forest, in dry forest usually near water, riverine forest; may be locally common; 1–2250 m

USES. Root decoction as minor medicine

CONSERVATION NOTES. Least Concern (LC).

23. **D. aletriformis** (*Haw*.) *Bos* in Fl. Southern Africa 5, 3: 3 (1992); Kenya Trees, Shrubs & Lianas : 639 (1994). Type: South Africa, Cape, Uitenhage, van Stadens R., *Drège* 4494a (K!, neo., G, MO, P, isoneo.), chosen by Bos

SYNONYMY. *Yucca aletriformis* Haw. in Phil. Mag. Ann. 1832: 415 (1831)

Cordyline rumphii Hook. in Bot. Mag. 3rd ser., 3: t. 4279 (1847) pro parte, quoad descr. excl. syn., *nom. illeg*. Type: t. 4279 (lecto.), chosen by Bos

Dracaena hookeriana K. Koch in Wochenschr. Gartn. Pflanzenk. 4: 394 (1861); Baker in J. Linn. Soc. Bot., Bot. 14: 527 (1875) & Fl. Cap. 6: 275 (1896); Consp. Fl. Africanae: 328 (1895); Coates Palgrave, Trees S. Afr.: 86 (1977), *nom. illeg*. Type as for *Cordyline rumphii*.

Pleomele hookeriana (K. Koch.) N.E. Br. in Kew Bull. 1914, 8: 278 (1914)

Small tree 3–5 m high; branched or not. Leaves congested towards branch ends, narrowly to broadly strap-shaped, the poldest ones pendent, sessile, 25–100 cm long, 2.5–11 cm wide, with a scarious edge ± 1 mm wide; base sheathing, apex acute, tapering gradually into a filiform tip. Inflorescence erect, 0.2–1.5 m long, paniculate; flowers in groups of 1–4, more in terminal clusters; pedicel 5–10 mm long, articulated above the middle. Flowers greenish white, sometimes flushed with pink, 25–35(–42) mm long; tube 7–12 mm long, lobes 12–20 mm long,1.5–2 mm wide, lobes ± 1.5 × as long as the tube. Fruit orange or red, usually globose and single-seeded, sometimes lobed and 2–3-seeded, 7–19 mm in diameter. Seed dirty white, ovoid, 5–10 mm long, 8–12 mm wide.

KENYA. Kilifi District: Rabai, Apr. 1963, *Verdcourt* 3606 K) & Kaya Kambe, July 1987, *Robertson & Luke* 4781 (EA); Kwale District: Mrima Hill, 2 Feb 1989, *Schmidt* 1712 (EA)

MOZAMBIQUE. Namaacha, Mt. Ponduini, Jul. 1980, *Schafer* 7206 (K)

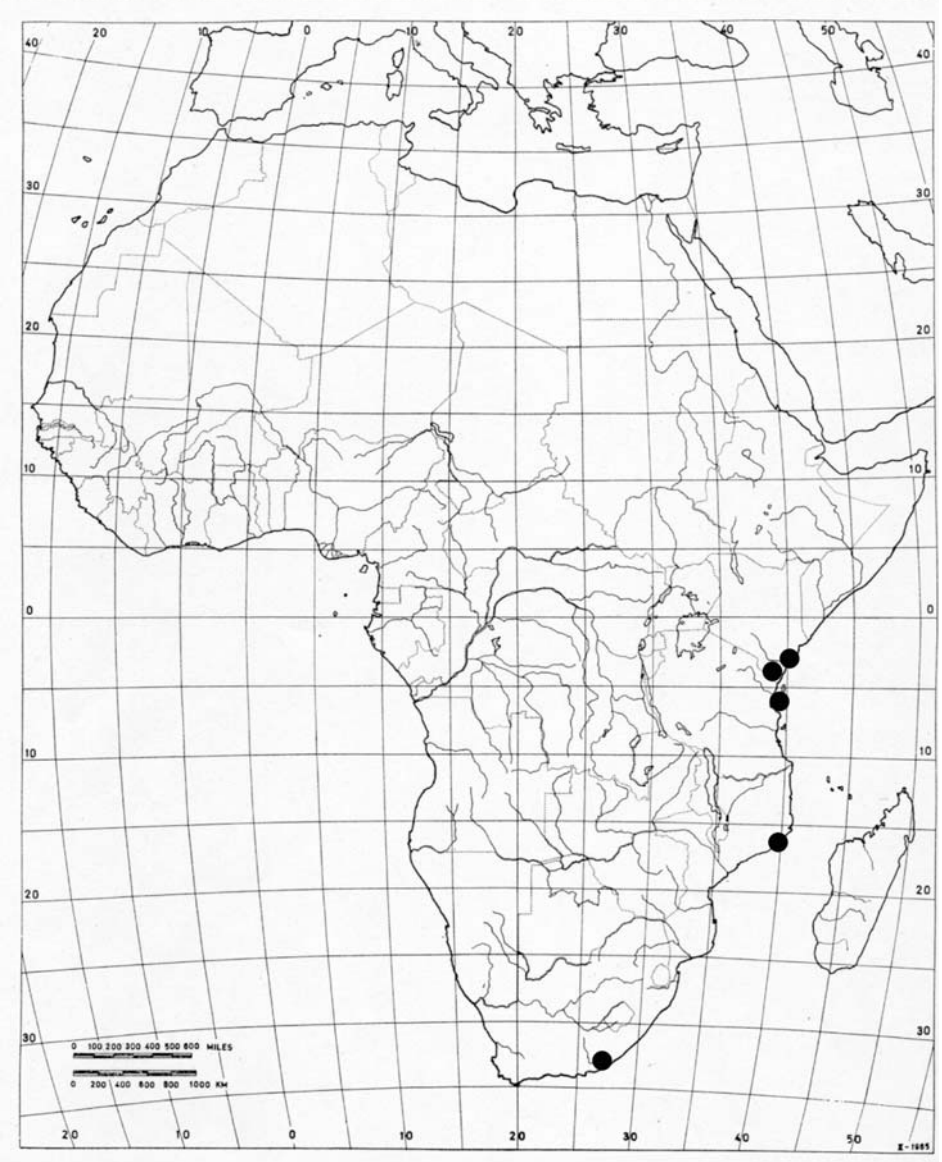
SOUTH AFRICA. Cape, Uitenhage, van Stadens R., *Drège* 4494a (K, P)

TANZANIA. Zanzibar, 1852. *Boivin* s.n.

DISTRIBUTION. Kenya, Tanzania, Mozambique, South Africa

HABITAT. Evergreen or semi-deciduous forest; 50–300 m
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).

Figure 4.6.23. *Draceana aletriformis* (Haw.) Bos.: Fruiting branch



Map 4.6.23. Distribution of *Dracaena aletriformis* (Haw.) Bos

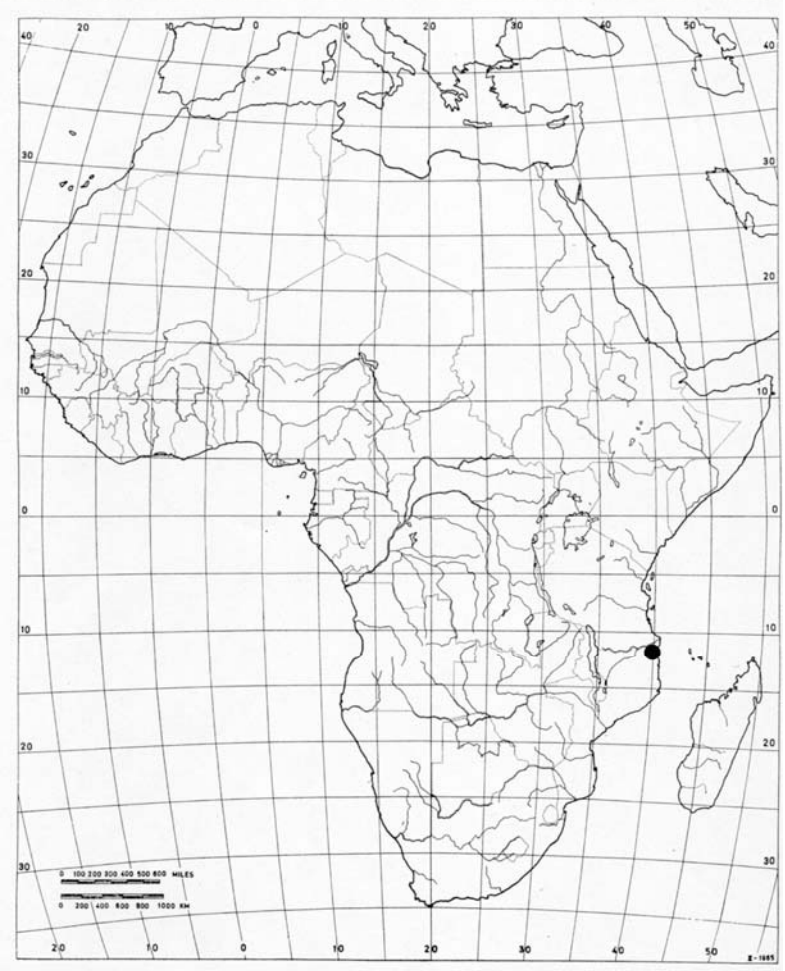
24**. D. reflexa** *Lam*., Encycl. 2: 324 (1786). Baker, Journ. Linn. Soc. 14: 350 (1875); Baker, Fl. Maur.: 375 (1877); H. Perr., Not. Syst. Veg. 2: 90 (1936); H. Perr., Fl. Madag., Fam 40: 8 (1938). Type: Madagascar, *Lamarck* 513 (P).

Small, little branched tree to 3 m tall. Leaves clustered at the ends of the branches, 7–9.5 cm long, 0.5–1.5 cm wide, narrowly oblanceolate, apex acute to acuminate, base cuneate. Inflorescence unbranched or rarely with 1–3 branches, 12–15 cm long. Flowers borne in clusters of 1–2, cream, green at the base; pedicel 3–5 mm long, articulated above the middle, perianth 15–30 mm long, tube shorter than the 10–20 mm long lobes. Fruits 17–22 mm in diameter, globose, 1–3 seeded, orange.

MOZAMBIQUE. Cabo Delgado, Mt. Ancuabe, 7 Feb. 1984, *de Koenig & Groenendijk* 9517 (K); Cabo Delgado, Namatuco, 30 Jan 1984, *Groendijk, Maite & Dungo* 885 (K).

DISTRIBUTION. *D. reflexa* is extremely variable and widespread in Madagascar, Mauritius, the Seychelles, Comores, Reunion and Aldabra.
HABITAT. Forest and bushland on basalt rocks, 350-550 m
USES. None recorded
CONSERVATION NOTES. Least Concern (LC).. On the African continent, only found in the Cabo Delgado province of Mozambique, may be of local conservation interest. It is, however widespread and abundant in Magadascar.

Figure 4.6.24. *D. reflexa* Lam. Flowering branch. Beaujard 108 (P).



Map 4.6.24. Distribution of *Dracaena reflexa* Lam.

25. **D. mannii** *Baker* in J. Bot. 12: 164 (1874) & J. Linn. Soc. Bot. 14: 526 (1875); Fl. Trop. Afr. 7: 438 (1898); Consp. Fl. Africanae: 328 (1895); Enum. Pl. Laurent 1 : 42 (1905) ; Forest Fl. N. Rhodesia: 16 (1962); Fl. W. Trop. Afr. ed. 2, 3 (1): 156 (1968); Bos, *Dracaena* in W Afr.: 69, t. 13, photo. 12 (1984) & in Fl. Southern Afr. 5, 3: 3, t. 9 (1992). Type: Nigeria, Old Calabar, *Mann* 2339 (K!, holo., A, B, K, P, WAG, iso.).

SYNONYMY. *D. usambarensis* Engl. in Abh. Preuss. Akad. Wiss. 1894: 30, nomen (1894) & Die Pflanzw. Ostafrikas und der Nachbargebiete C: 144 (1895); Syll. Fl. Congolanae: 567 (1909) Kenya Trees, Shrubs & Lianas: 640 (1994). Type: Tanzania, Mto wa Simbili between Magila and Sigi R., *Volkens* 65 (B†, syn., K, photo.!) & Shire, 2400 m, gallery forest, *Volkens* 1938 (B†, syn., BR, K, photo!).

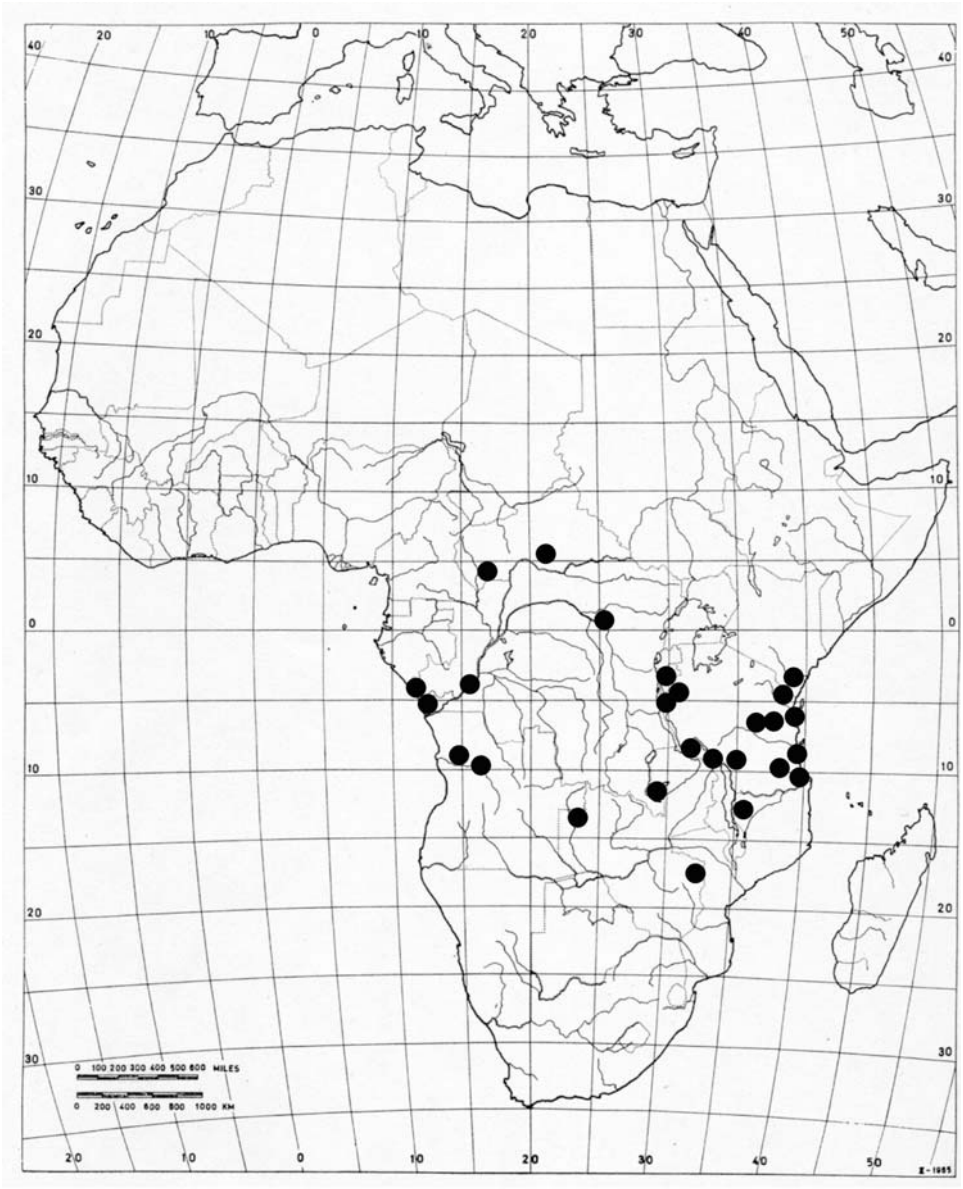
D. usambarensis Engl. var. *longifolia* De Wild. Enum. Pl. Laurent 1 : 42 (1905) ; Syll. Fl. Congolanae : 567 (1909).

D. nitens Baker in Trans. Linn. Soc. ser. 2, Bot. 1: 252 (1898). Type: Angola, Pungo Andongo, *Welwitsch* 3741 (BM, syn.) & 3742 (BM, syn.) & Golungo Alto, *Welwitsch* 3743 (BM, COI, G, K, P, syn.).

D. reflexa Lam. var. *nitens* (Baker) Baker in Fl. Trop. Afr. 7: 441 (1898); Syll. Fl. Congolanae: 566 (1909); Pl. Bequaert.: 39 (1921).

D. pseudoreflexa Mildbr. , Wissenschaflische Ergebnisse der Deutschen Zentral Afrika Expedition, 1907–1908, 2 (botanik), 1914 : 63 t. 5. G–K. (1914); Pl. Bequaert.: 39 (1921).

Figure 4.6.25. *Dracaena mannii* Baker. Fruiting branch. Photo by A.M.Muasya



Map 4.6.25. Distribution of *Dracaena mannii* Baker.

Pleomele mannii (Baker) N.E. Br. in Kew Bull. 1914: 278 (1914). Type: Nigeria, Old Calabar, *Mann* 2339 (K!, holo., A, B, K, P, WAG, iso.).
P. nitens (Baker) N.E. Br. in Kew Bull. 1914: 278 (1914). Type: Angola, Pungo Andongo, *Welwitsch* 3741 (BM, syn.) & 3742 (BM, syn.) & Golungo Alto, *Welwitsch* 3743 (BM, COI, G, K, P, syn.).
P. usambarensis (Engl.) N.E. Br. Kew Bull. 1914: 279 (1914). Type: Tanzania, Mto wa Simbili between Magila and Sigi R., *Volkens* 65 (B†, syn., K, photo.!).

Shrub or tree (2.4–)4.5–30 m high, evergreen, single-stemmed or often multi-stemmed or much branched from near ground level; stem to 2 m in diameter. Leaves clustered near branch ends, narrowly elliptic to narrowly lanceolate or obovate, sessile, (4–)8–40(–50) cm long, (0.3–)0.8–3.8(–4.5) cm wide, base cuneate but the very base half-amplexicaul,

apex acute with a mucro, 'midrib' prominent beneath. Inflorescence, erect, racemose to paniculate; flowers in groups of 2–6, rarely solitary; pedicel 1–4 mm long or up to 9 mm and orange in fruit pedicel articulated above the middle. Flowers creamy white or pure white, yellow-green outside, the tips of lobes greenish to purple, 12–50 mm long, tube 3–25 mm long, lobes 8–24 mm long, 2–3 mm wide. Fruits orange to scarlet, globose or lobed when 2–3-seeded, 10–32 mm in diameter; seeds brown, globose, 10–20 mm in diameter.

ANGOLA. Cabinda District: Sumba, Peco, 25 Sept 1924, *Gossweiler* 8995 (not seen).
CENTRAL AFRICAN REPUBLIC. Haute Sangha District: Route pour le reviere Mossapola, Bayanga, 24 Feb 1976, *Wraber* 49516 (K); Bambari District: 3 km S of Bambari on the Alindao road, 10 Feb 1982, *Fay* 2162 (K).
DEMOCRATIC REPUBLIC OF CONGO. Yangambi District: Yalibwa, 14 March 1937, *Louis* 3589 (K); Kouilou district, 18 Dec 1922, *Sargos* 217 (K).
KENYA. Kwale District: S end of Shimba Hills Reserve, Apr. 1977, *Gillett* 21075 (EA, K)! & Ramisi-Lungalunga road, Oct. 1971, *Archer* 712 (EA, K)!; Kilifi District: Kaya Chonyi, Sep. 1990, *Robertson* 6391 (EA); Kwale District: Buda Forest, Nov. 1936, *Dale* 3577 (EA) & Shimba Hills, Pengo Hill, May 1968, *Magogo & Glover* 1061 (K)
MALAWI. Nkhata Bay District: Mzuzu to Nkhata Bay, 6 Sep. 1975, *Pawek* 10087 (EA)
MOZAMBIQUE. Niassa Province, Macondes Division, between Mueda and Chomba, 23 Sep. 1948, *Pedro & Pedrogao* 5308 (EA).
TANZANIA. Lushoto District: E Usambara Mts, Kiwanda, Oct. 1936, *Greenway* 4698 (EA, K); Kilosa District: Vigude Forest, Kidodi, Nov. 1952, *Semsei* 1006 (K); Njombe District: N of Luilo, Sep. 1970, *Thulin & Mhoro* 1189 (K); Zanzibar: without locality, 1927, *Toms* 13 (K); Kigoma District: Mkuti R., Sep. 1956, *Procter* 512 (EA); Uzaramo District: Mnguvia R. 16 km SE of Dar es Salaam, Sep. 1977, *Wingfield* 4120 (EA); Iringa District: Uzungwa Mts, Sanje, top of waterfall, Oct. 1983, *Lovett* 181 (K); Zanzibar, Mbiji, Dec. 1930, *Greenway* 2628 (EA)
ZAMBIA. Abercorn District, Isoko Valley, 5 Sep. 1960, *Richards* 13199 (K); Mansa District, near Samfya Mission, L. Bangweulu, 20 Aug. 1952, *White* 3095 (K).

DISTRIBUTION. Central Africa east to Kenya, Tanzania; and southwards into Mozambique. widespread in tropical Africa.
HABITAT. Moist forest, often near streams, or riverine forest, forest margins, secondary bushland; may be locally common; 0–1400(–1600) m
USES. Branches used for toothbrushes, young shoots cooked and eaten in Tanzania in times of food shortage.
CONSERVATION NOTES. Least Concern (LC).

Subgenus **Ombet Mwachala,** subgenus nov**. Type:** Ethiopia : Ahl Mts., R Meid. *Hildebrandt* 1472 (K holo., WAG iso)

This subgenus is made up of those species that have ensiform leaves, have their flowers with extremely short perianth tube occurring singly or in clusters of up to four, and occur in the Somali-Masai phytochorion only

26. **D. ellenbeckiana** *Engl.* in Bot. Jahrb. Syst. 32: 95 (1902); Bally, Candollea 22 (2): 255-263 (1967); Forests & Forest Trees of Northeast Africa: 264 (1992); Kenya Trees, Shrubs & Lianas: 639, fig. (1994); Bos in Fl. Ethiopia 6: 77 (1997). Type: Ethiopia, Between Luku and Sheik Hussein, *Ellenbeck* 1232 (B, holo., EA!, K!, photo.).

Shrub or tree 2–8 m high; stems erect, several from a common base, less often solitary, little-branched, up to 8 cm in diameter, longitudinally fissured; branches pale gray with a reticulate pattern of leaf scars. Leaves clustered at branch ends, narrowly lanceolate, sessile, 22–65 cm long, 1–9 cm wide, base clasping, apex acuminate. Inflorescence erect, paniculate, 20–80 cm long with 2–3 branches at each node; flowers in groups of (1–)2–7. Flowers white becoming yellow-green, to 10 mm long, tube 2 mm long, lobes 8 mm long, translucent, 1-ribbed, 0.5–1 mm wide. Fruits orange to scarlet, globose or lobed when several-seeded, 8–14 mm in diameter; seeds brown, globose, 6 mm in diameter.

KENYA. Turkana District: Kachagalau, E slope of Kalapata Mts, Jan. 1959, *Langdale Brown* 95 (K); Laikipia District: 30 km N of Rumuruti, Kisima Farm, Apr. 1975, *Hepper & Field* 5078 (K); Kiambu District: Kikuyu Escarpment just below loer Lari Forest guard post, Dec. 1966, *Perdue & Kibuwa* 8259 (EA)
UGANDA. Karamoja District: Kamion, Nov. 1939. *A.S. Thomas* 3254 K); & NE Karamoja, Jun., 1945, *Dale* 432 (EA)
Ethiopia. Between Luku and Sheik Hussein, *Ellenbeck* 1232 (Type, EA); Galla Sidamo Province, Asile, SE of Hummu Mt., Jul. 1939, *Corradi* 4586 (K).
DISTRIBUTION. Kenya, Uganda, Ethiopia.
HABITAT. Semi-evergreen bushland or open dry forest on rocky slopes; may be locally common; 1050–2100 m
USES. Stems used for arrow quivers
CONSERVATION NOTES. Least Concern (LC).

27**.** **Dracaena ombet** *Kotschy & Peyr*. subsp. **schizantha** (Baker) Bos, Sinet :20 (1997); Bos & Teketay in Fl. Ethiopia & Eritrea 6: 77–79 (1997); Pl. Tinn. 47 (1867). Type : Ethiopia : Ahl Mts., R Meid. *Hildebrandt* 1472 (K ! holo., WAG iso).

SYNONYMY
D. schizantha Baker. Type : Ethiopia : Ahl Mts., R Meid. *Hildebrandt* 1472 (K ! holo., WAG iso)

Tree to 5 (–8) m high, trunk 15–40 cm diameter, branching into an umbrella-like crown Leaves tough and thick, linear, crowded at the tips of branches, 40–50 cm long, 0.5–0.8 cm wide,widened abruptly into a , semi-amplexicaule, apex acute. Petiole non existent. Inflorescence paniculate up to 70 cm long and 30 cm wide; lower branches of inflorescence branched, the upper ones unbranched, ultimate inflorescence branches pubescent. Flowers white, 6 mm long, of which the tube

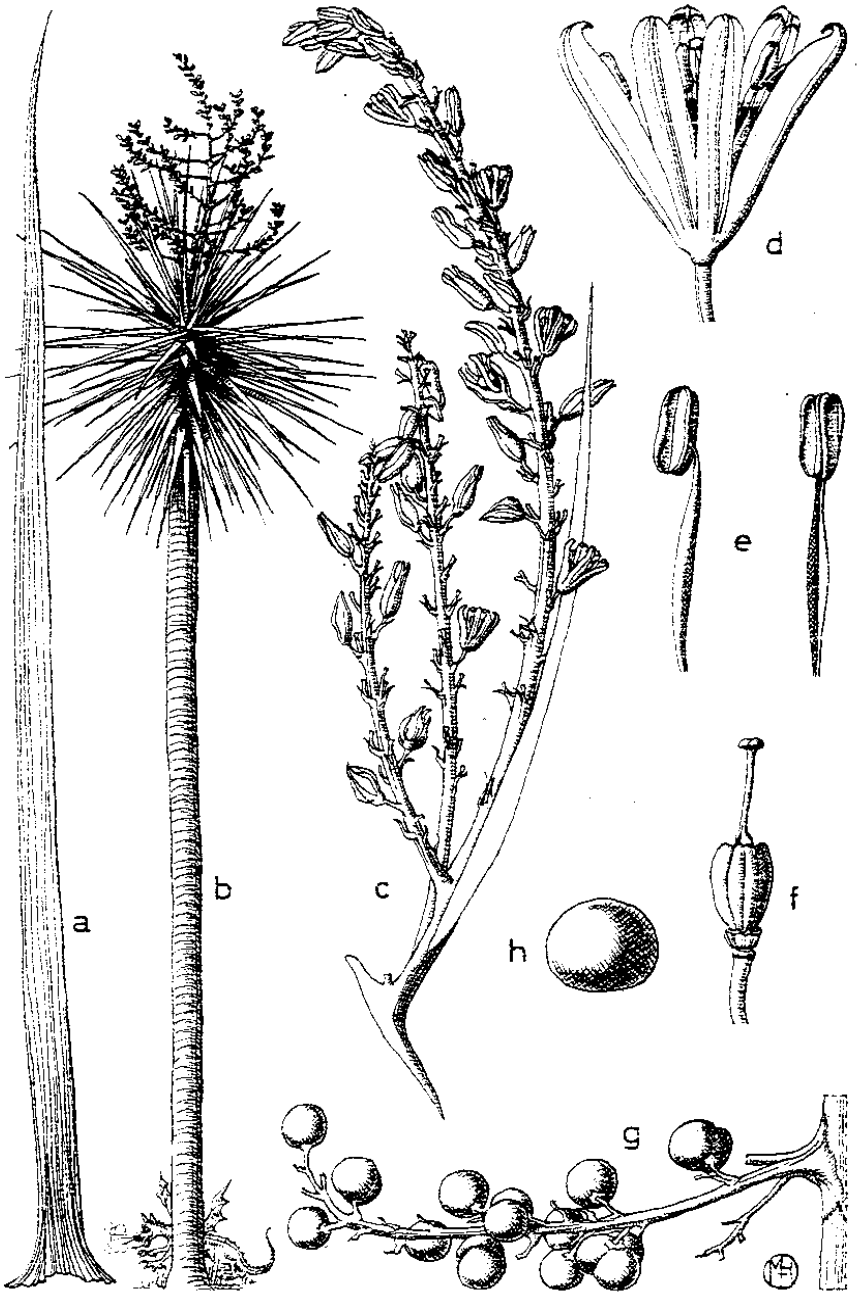
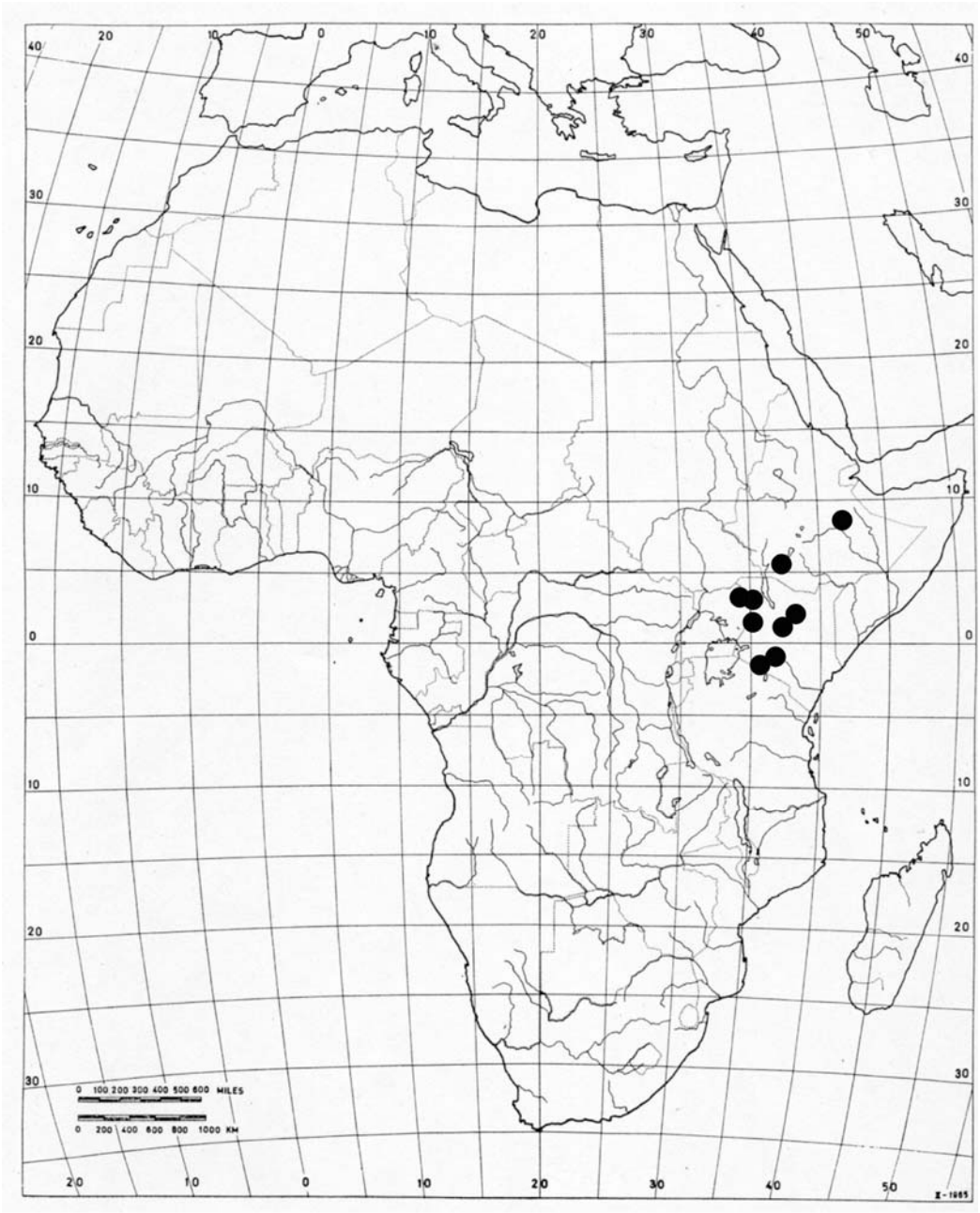


Figure 4.6.26. *Dracaena ellenbeckiana* Engl.: a. whole plant; b. leaf; c. inflorescence; d. flower; e. stamens; f. pistil; g. fruit; h. seed. (from Bally, 1967).

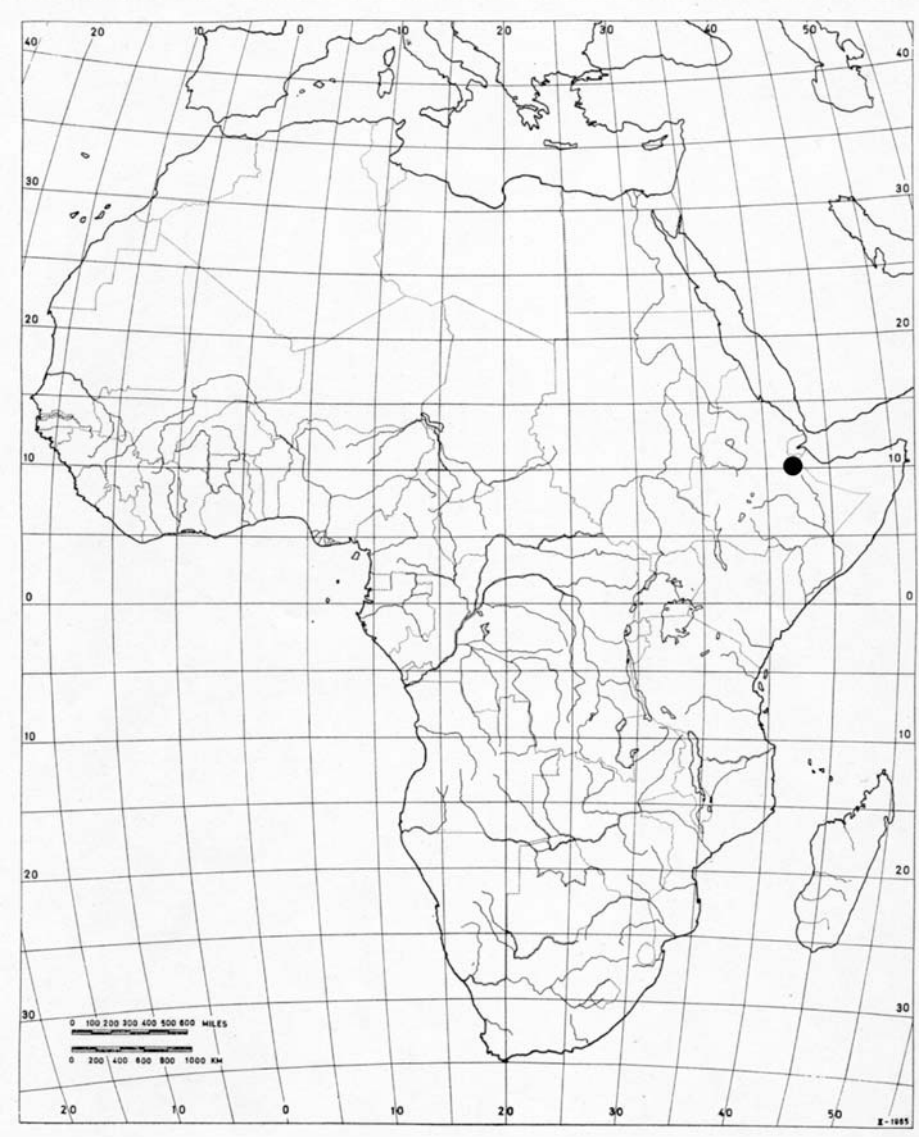


Map 4.6.26. Distribution of *Dracaena ellenbeckiana* Engl.

0.5 mm long, lobes 4.5–5.5 mm long, 1.5 mm wide. Fruits globular, brown, 0.5–0.8 cm long, 0.5–0.8 mm wide, 1-3 seeded. Seeds near-spherical, the side facing the other seed flattened, chest-nut brown, with a conical protruberance at the distal end. 0.6 cm long, 0.5 cm wide

ETHIOPIA, 14 km SE of DireDawa on road to Harrar. 30 Nov 1968. *De Wilde.* 4105 (BR) ;
DISTRIBUTION. Ethiopia, Somalia, Sudan
HABITAT. *Acacia -Commiphora* bushland on limestone, 1450–1750 m
USES. Fodder for Camels.
CONSERVATION NOTES. Least Concern (LC).

Figure 4.6.27. *Dracaena ombet* Kotschy & Peyr. subsp. *schizantha* (Baker) Bos. Burger 3714 in EA.



Map 4.6.7. Distribution of *Dracaena ombet* Kotschy & Peyr. subsp. *schizantha* (Baker) Bos

Subgenus **fragrans** Mwachala **subgenus nov.** Type: Mag.: t.1081 (1808). Trees and shrubs with sword-shaped leaves and paniculate inflorescences. Flower borne in dense glomerules; the perianth tube shorter than the lobes. The distribution of this sub-genus is pan-African.

28. **D. fragrans** (*L.*) *Ker Gawl.* in Bot. Mag.: t. 1081 (1808); Baker in J. Bot. 12: 165 (1874) & J. Linn. Soc. Bot. 14: 529 (1875) ; Fl. Trop. Afr. 7: 440 (1898); Consp. Fl. Africanae : 327 (1895) ; Enum. Pl. Laurent 1 : 42 (1905) ; Syll. Fl. Congolanae : 565 (1909) ; Pl. Bequaert. : 38 (1921) ; Fl. W. Trop. Afr. ed. 2, 3 (1): 157 (1968); Bos, *Dracaena* in W Afr.: 69, t. 13, photo. 12 (1984); Forests & Forest Trees of Northeast Africa: 265 (1992); Kenya Trees, Shrubs & Lianas: 639 (1994); Bos in Fl. Ethiopia 6: 77 (1997). Type: *Commelin*, Hort. Med. Amst. 2: t. 4 f. 2 (1701).

SYNONYMY. *Aletris fragrans* L., Sp. Pl. ed. 2: 456 (1762). Type: *Commelin*, Hort. Med. Amst. 2: t. 4 f. 2 (1701).

Pleomele fragrans (L.) Salisb., Prodr.: 245 (1796); Brown in Kew Bull. 1914: 276, 278 (1914) Type: *Commelin*, Hort. Med. Amst. 2: t. 4 f. 2 (1701).

D. smithii Hook. f. in Bot. Mag.: t. 6169 (1875); Baker in Fl. Trop. Afr. 7: 440 (1898); Fl. W. Trop. Afr. ed. 2, 3 (1): 156 (1968). Type: specimen cultivated in Kew Gardens jan. 1874 (K!, lecto., chosen by Bos).

D. steudneri Engl. var. *kilimandscharica* Engl. in Die Pflanzw. Ostafrikas und der Nachbargebiete: 143 (1895). Type: Tanzania, Marangu, 1580 m, *Volkens* 1416 (B, holo., K!, iso.).

D. ugandensis Baker in Fl. Trop. Afr. 7: 445 (1898). Type: Uganda, common in hedges, *Scott Elliot* 7264 (K!, holo.).

D. deremensis Engl. in Bot. Jahrb. Syst. 32: 95 (1903); Kenya Trees, Shrubs & Lianas: 639 (1994). Type: Tanzania, Lushoto District, Usambara, Handei, Nguelo, *Scheffler* 67 (B†, holo., K, photo!).

Shrub or tree, 1.5–15 m high; stem single, up to 30 cm in diameter, or in forest often with a mass of horizontal stems near the ground from which vertical stems arise. Leaves strap-shaped to oblanceolate, sessile, (7–)20–150 cm long, 2–12 cm wide, base attenuate, widening for 2–5 cm and sheathing the stem, apex acute with subulate mucro. Inflorescence, erect rarely pendent, paniculate, 15–160 cm long; flowers in multiflowered glomerules; pedicels 2–6 mm long, articulated above the middle. Buds purple or pink, flowers with tube white, the lobes white with a fine red to purple line down the centre, darker outside, (15–)17–22(–25) mm long, tube 5–11 mm long, lobes 7–12 mm long, up to 3 mm wide. Fruits bright orange, depressed globose, 11–19 mm in diameter, lobed when several-seeded; seeds white turning brown, globose to bean-shaped, 4–14 mm in diameter.

CAMEROON. N.West Province, Bambui Experimental Farm, Bamenda, Feb. 1963, *Brunt* 965 (K); Southwest province: Mt. Cameroon, 18 Feb 1927, *Armour* 8348 (K)

DEMOCRATIC REPUBLIC OF CONGO. Katanga District: 43 km a l'ESE de Lukeka, 20 Jun 1966, *Malaisse* 4264 (K); Kivu Nord District: Virunga Vulkane, südliches lavavorland der Westgruppe, 14 Aug 1954, *Stauffer* 99 (K); Haut-Katanga District: Kilimbwe, collective Luindi, zone de Mwenga, 21 Nov 1977, *Yamada* 191 (K).

EQUATORIAL GUINEA. Bioco District: Moca, camino de Ureca, 18 Feb 1989, *Casas* 11791 (K)

GABON.: Bord du layon no. 20 a 900 m de la route Cap Esteria, 3 Dec 1970, *Gavage* 7 (K).

KENYA. N Kavirondo District: near Kakamega Forest Station, Dec, 1967, *Perdue & Kibuwa* 9400 (EA, K); Kericho District: Sotik, Kibajet Estate, Dec. 1947, *Bally* 5720 (K)!; Teita District: Kasigau, Rukanga route, Nov. 1974, *Luke & Luke* 4166 (EA, K)

MALAWI. Chitipa District, Misuku Hills, Mugesse Forest, 7 Jul. 1973, *Pawek* 7065 (K); Ntchisi Forest Reserve, 25 Mar. 1970, *Brummit & Evans* 9388 (K).

MOZAMBIQUE. Maputo, Jardin Vasco da Gama, 16 Feb 1972, *Balsinhas* 2388 (K); Mt. Gorongosa, May, *Torre & Paiva* 12297 (K).

TANZANIA. Bukoba District: Kagera, Minziro, Feb. 1995, *Congdon* 413 (K); Tanga District: Potwe Forest, Dec. 1960, *Semsei* 3187 (EA, K); Morogoro District: Kanga Mts 90 km N of Morogoro, Dec. 1987, *Mwasumbi & Munyenyembe* 13875 (K)

UGANDA. Ankole District: Igara, Mar. 1939, *Purseglove* 637 (K); Toro District: Kibale Forest, Sebutole, Feb. 1953, *Osmaston* 2812 (K); Mengo District: 14 km on Masaka road, Oct. 1937, *Chandler* 1942 (K)!

ZAMBIA. Lumangwe, 14 Nov. 1957, *Fanshawe* 4020 (K).

ZIMBABWE. Chirinda Forest, Dec 1908, *Swynnerton* 6520 (K).

DISTRIBUTION. Throughout tropical Africa

HABITAT. Undergrowth of medium altitude and montane forest, 600–2250 m

USES. Used for hedges/living fences, and as a foliage ornamental.

CONSERVATION NOTES. Least Concern (LC).

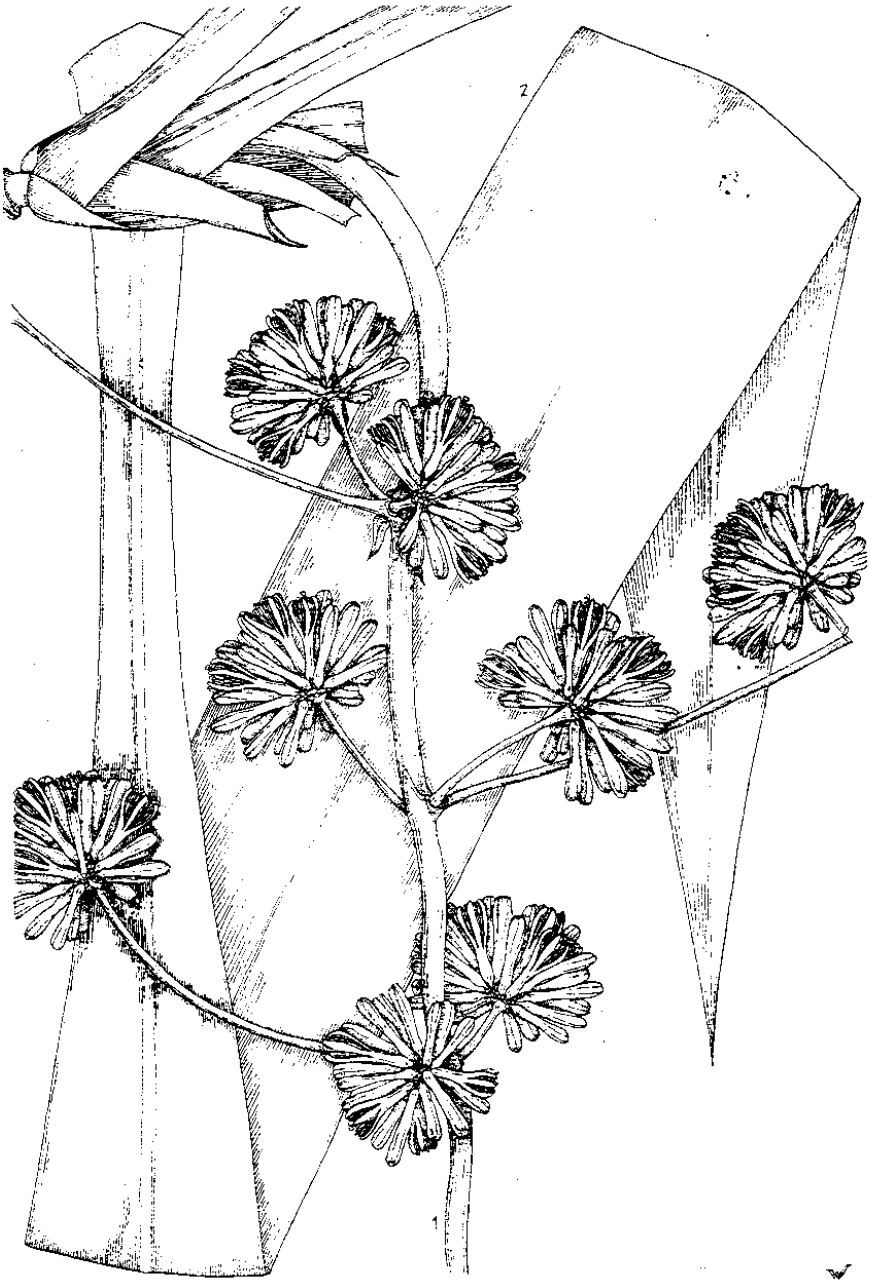
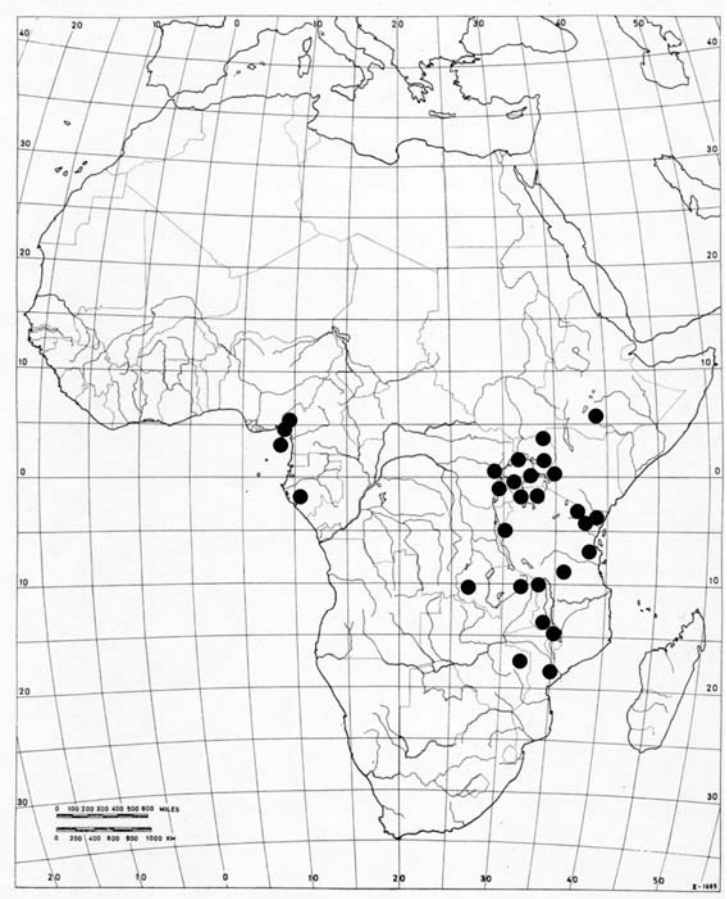


Figure 4.6.28. *Dracaena fragrans* (L.) Ker Gawl.: 1. leaf; 2: leaf. (from Bos, 1984).



Map 4.6.28. Distribution of *Dracaena fragrans* (L.) Ker Gawl

29. **D. steudneri** *Engl*. in Die Pflanzw. Ostafrikas und der Nachbargebiete C: 143 (1895); Fl. Trop. Afr. 7: 441 (1898); Troupin, Fl. Pl. Lign. Rwanda: 68 (1982); Forests & Forest Trees of Northeast Africa: 226 (1992); Kenya Trees, Shrubs & Lianas: 640 (1994); Bos in Fl. Ethiopia 6: 79, t. 187/5 (1997). Type: Ethiopia, Gondar, Dschibba, *Steudner* 477 (B†, holo., BR, K!, photo)

SYNONYMY. *Dracaena. papahu* Engl., Die Pflanzw. Ostafrikas und der Nachbargebiete C: 143 (1895). Type: Tanzania, Lushoto District, Usambara, Lutindi, *Holst* 3260 (B, holo., K!, iso. & photo of holo.)

Pleomele papahu N.E. Br. in Kew Bull. 1914: 278 (1914). Type Tanzania, Lushoto District, Usambara, Lutindi, *Holst* 3260 (B, holo., K!, iso. & photo of holo.)

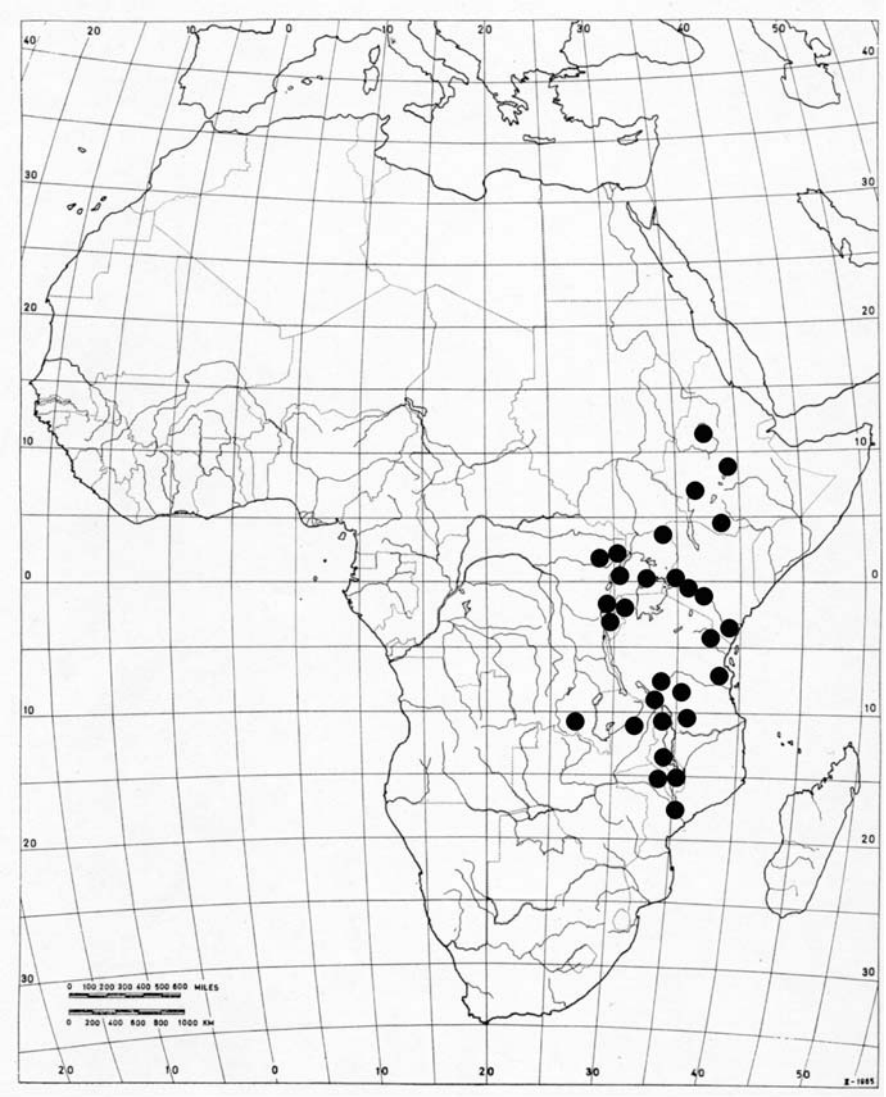
Tree (3–)6–15(–25) m high; stem single, to 45 cm in diameter; crown freely branched. Leaves clustered at branch ends, leathery, narrowly lanceolate, sessile, 40–130 cm long, 4–16 cm wide, base narrowed and clasping, apex attenuate towards acute tip. Inflorescence erect becoming pendulous in fruit, paniculate, 0.3–1(–2) m long and up to 1.5 m wide; flowers in almost globose groups of 25 or more; pedicels 2.5 mm long, articulated above the middle. Flowers white, cream or greenish white, 11–15 mm long, tube 4–5 mm long, lobe 10–11 mm long, and 0.5–1 mm wide, lobes translucent, 1-ribbed.

Fruits bronze to dark purple to blackish red, 12–30 mm in diameter; pulp orange; seeds white, globose, 10 mm in diameter.

BURUNDI. Muramvya, sacred forest of Mpotsa, 9 June 1979, *Reekmans* 8238 (EA); Muramvya, route Bekeye, 28 Jan 1967, *Lewalle* 1533 (K).
DEMOCRATIC REPUBLIC OF CONGO. Mahagi District: Djalasinda, 23 Jul 1945, *Germain* 4054 (K); Ituri District: Entre Kalindi et Lubango (Kibale-Ituri), Jan. 1932, *Lebrun* 4790 (K); Katanga District: Pres de Lukafu, Aug. 1937, *Brande* 4948 (K); Nioka, Mahagi, *Froment* 784 (K).
ETHIOPIA. Kaffa Province, Jimma Agric. High School, 10 Feb. 1965, *Burger* 3642 (EA); Sidamo Province, Mogada, Jun. 1976, *Haile* 836 (EA).
KENYA. Trans Nzoia District: Mt. Elgon, 15 Mar 1933, *Jack* 427 (EA); Kiambu District: Karura Forest, 14 Dec 1966, *Perdue & Kibuwa* 8239 (EA, K); Teita District: Mt. Kasigau, path from Rukanga up the mountain, 5 Apr 1969, *Faden et al.* 459 (EA)
MALAWI. Chitipa District, Misuku Hills, Mugesse Forest, 1 Jan. 1977, *Pawek* 12172 (EA); Ntchisi Mountain, road from Forest station to mountain, 2 May 1980, *Blackmore* 1372A (K); Mt. Soche, on NE slopes, by rock outcrop in sub-montane forest, 26 Aug 1982, *Chapman & Tawakali* 6390 (K).
MOZAMBIQUE. Angonia, Monte Domue, 9 Mar 1964, *Torre & Paiva* 11094 (K); Mt. Marumo, 11 Sep. 1906, *Swynnerton* 725 (K).
RWANDA. Ruhengeri District, Lac Bulera, riv. Kabaga, 15 Feb 1972, *Bamps* 3146 (EA); Kibungo District: Marais Cyunuzi-Bigogo, 15 Jul 1978, *Runyinya* 675 (K).
TANZANIA. Lushoto District: Lushoto, Oct. 1963, *Semsei* 3644 (EA); Ulanga District: Ujiji near Mahenge, Oct. 1960, *Haerdi* 595/0(K); Songea District: Luwira-Kitega Forest Reserve, Oct. 1956, *Semsei* 2536(EA, K)
UGANDA. Kigezi District: Kachwekano Farm, Sep. 1949, *Purseglove* 3119(EA, K); Mengo District: Mengo, Kampala, Sep. 1930, *Snowden* 1821 (EA, K); Karamoja District: Mt. Lonyili, Kidepo National Park, 16 May 1972, *Synnott* 1022 (EA).
ZAMBIA. Chinsali District, Shiwa Ngandu, 29 Nov. 1952, *White* 3777 (K)
ZIMBABWE. Vumba Mts, eastern slopes of forest, 1 Nov. 1946, *Wild* 1597 (K).

DISTRIBUTION. Uganda, Kenya, Tanzania, Democratic Republic of Congo, Ethiopia, S to Mozambique, Zimbabwe
HABITAT. Moist or dry forest or forest margins, sometimes planted as a boundary in fields; (0–300–)850–2300 m
USES. Leaves sometimes used as wrapping material; leaves and root in minor medicine in Kenya and Tanzania
CONSERVATION NOTES. Least Concern (LC)..

Figure 4.6.29. *Dracaena steudneri* Engl.: clockwise – Whole plant; glomerulus; flower; portion of infructescence; whole inflorescence (drawn by Andrew Kamiti).



Map 4.6.29. Distribution of *Dracaena steudneri* Engl.

Species Incerta Sedis

The following names have been used in the literature, but due to specimens from our area not being cited or being unavailable to me, their meaning has not been resolved

D. buettneri *Engl.* Bot. Jahrb. Syst. 15: 479 (1892); Consp. Fl. Africanae: 326 (1895). Type: Gabon

Habit unknown [Inadequate note on specimen.]. Leaves lanceolate, evenly spaced along the shoot, 14– 21 cm long, 5.5–6.5 cm wide, base rounded, apex acuminate, Petiole 5–9 cm long with an amplexicaule base. Inflorescence ?paniculate 7 cm long, borne on a 7 cm long peduncle. Flowers 1.9–2 cm long, lobes 0.4–0.5 cm long, tube 1.5–1.6 cm long. Fruits unknown. Seeds unknown.

DEMOCRATIC REPUBLIC OF CONGO. Sangi, Kinshasa 11 Feb 1960, Compere 1434; Entre Selenge et Lukoka, 1 Jul 1933, Goossens 4973 ; Panzi 1925, Vanderyst 1933

DISTRIBUTION. Gabon and Democratic Republic of Congo

HABITAT. Riverine vegetation.

Very like *D. braunii*, but not littoral. More material needed.

D. glomerata *Baker* in Journ. Bot. 1874: 166

Shrub to 8 2.5 m tall. Leaves 10–15 cm long, 6–7.5 cm wide, base deltoid, apex cuspidate. Petiole 10–12 cm long. Inflorescence paniculate, 30 cm long. Flowers in dense glomerules, colour, perianth tube 1.5 cm long, lobes c 0.5 cm long. Fruit unknown; seed unknown.

DISTRIBUTION. Gabon.

I think that this species is closely related to *D. fragrans* on basis of inflorescence architecture, but differs from it in the pedicelled elliptic leaves. Until I examine more herbarium as well as living material, I prefer to leave it out of the current treatment.

D. parviflora Baker, Trans. Linn. Soc. Ser. II, I: 252(1878); Fl. Trop. Afr. 7: 400 (1898)

D. acaulis Baker, Trans. Linn. Soc. Ser. II, I: 252 (1878); Fl. Trop. Afr. 7: 444 (1898)

D. bueana Engl. Bot. Jahrb. Syst. 59: 131 (1924). Fl. Trop. Afr.

D. fischeri Baker Bot. Jahrb. Syst. 15: 477 (1898); Fl. Trop. Afr. 7: 441 (1898).

D. nyangensis Pellegr., Bull. Mus. Hist. Nat. Paris, Ser II, ii: 571 (1930); Bos, *Dracaena* in W Afr.: 41(1984);

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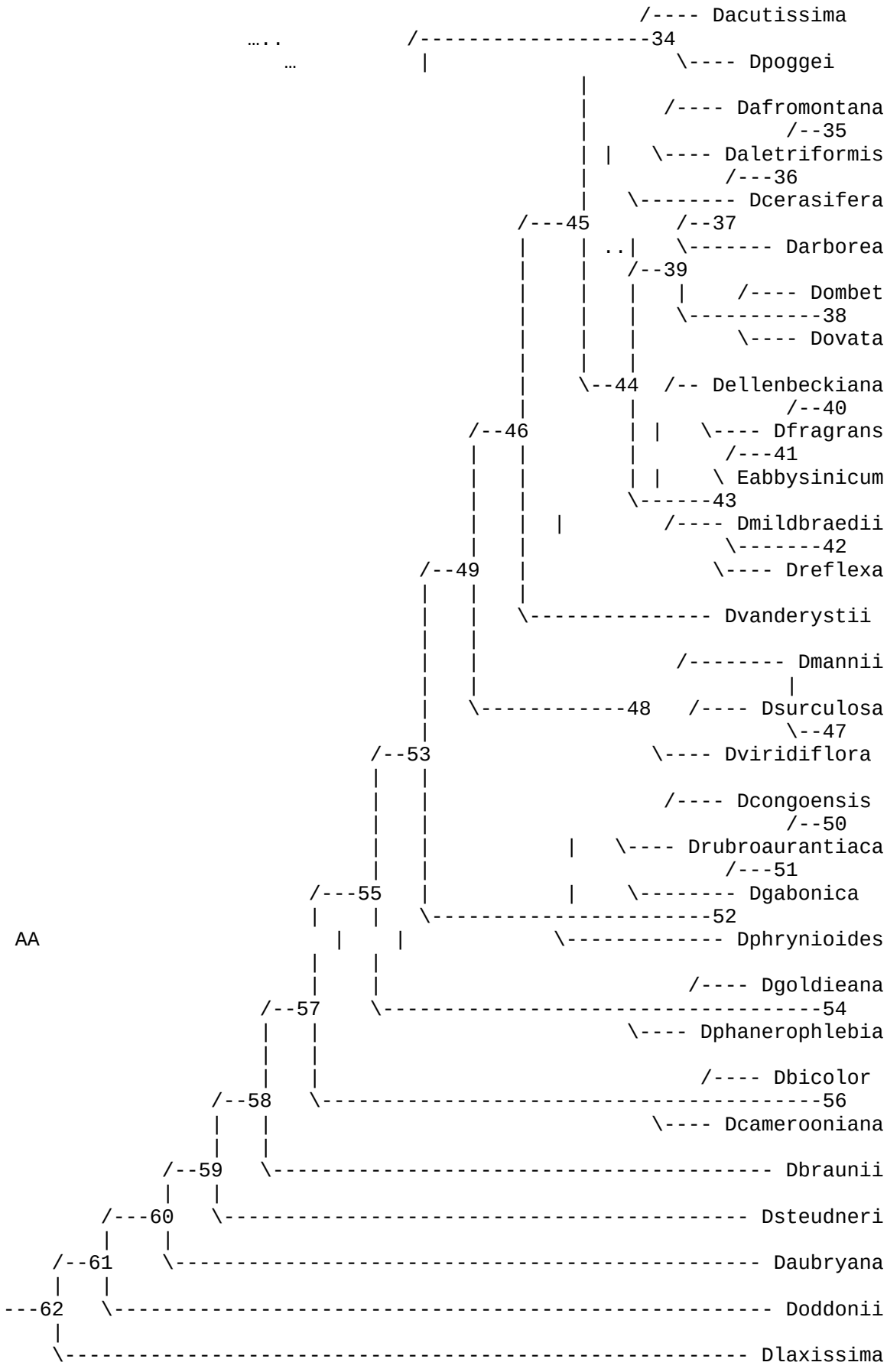
Appendices

Appendix 1.

Detail of the phylogenetic analysis

```
                        P A U P *
                   Version 4.0b4a for Macintosh
                 Tuesday, March 14, 2005  8:41 am

               This copy registered to: Eric Knox
                       Rutgers University
                   (serial number = B413749)

Processing of file "dracaena05z.paup" begins...

Warning: File does not begin with '#NEXUS'.

Data matrix has 30 taxa, 14 characters
Valid character-state symbols: 0123456789
Missing data identified by '?'
Gaps identified by '-'

Processing of file "dracaena05z.paup" completed.

T
Generating 100 (rooted) random trees:
   Model = equiprobable
   Starting seed = 847659188
   Trees stored in tree buffer

Logging output to file "dracaena05z.paup.log".

Tree description:

   Optimality criterion = maximum parsimony
   Character-status summary:
     Of 14 total characters:
       All characters are of type 'unord'
       All characters have equal weight
       4 characters are constant
       4 variable characters are parsimony-uninformative
       Number of parsimony-informative characters = 6
   Gaps are treated as "missing"
   Character-state optimization: Accelerated transformation (ACCTRAN)
                                 AncStates = "standard"

Tree number 38:

Tree length = 47
Consistency index (CI) = 0.2766
Homoplasy index (HI) = 0.7234
CI excluding uninformative characters = 0.2093
HI excluding uninformative characters = 0.7907
Retention index (RI) = 0.2273
Rescaled consistency index (RC) = 0.0629
```



Character change lists:

Character	CI	Steps	Changes

```
-------------------------------------------------------------------
1         1.000      1          node_41 1 ==> 0 Eabbysinicum
5         1.000      1          node_38 1 ==> 0 Dombet
6         0.143      1          node_44 1 --> 2 node_39
                     1          node_38 2 --> 1 Dovata
                     1          node_41 1 ==> 2 node_40
                     1          node_48 1 ==> 2 Dmannii
                     1          node_50 1 ==> 2 Dcongoensis
                     1          node_59 1 ==> 2 Dsteudneri
                     1          node_62 1 --> 2 Dlaxissima
7         1.000      1          node_51 1 ==> 0 Dgabonica
8         0.154      1          node_58 1 --> 0 node_57
                     1          node_55 0 --> 1 node_53
                     1          node_45 1 --> 2 node_44
                     1          node_38 2 --> 1 Dovata
                     1          node_41 2 --> 1 Eabbysinicum
                     1          node_42 2 --> 1 Dmildbraedii
                     1          node_49 1 --> 2 node_48
                     1          node_47 2 --> 1 Dsurculosa
                     1          node_50 1 ==> 2 Drubroaurantiaca
                     1          node_52 1 --> 0 Dphrynioides
                     1          node_56 0 --> 2 Dcamerooniana
                     1          node_59 1 ==> 2 Dsteudneri
                     1          node_62 1 --> 2 Dlaxissima
9         0.500      1          node_34 0 ==> 1 Dacutissima
                     1          node_38 0 ==> 1 Dombet
10        0.286      1          node_49 0 --> 1 node_46
                     1          node_45 1 --> 0 node_44
                     1          node_41 0 ==> 2 Eabbysinicum
                     1          node_50 0 ==> 1 Drubroaurantiaca
                     1          node_52 0 ==> 1 Dphrynioides
                     1          node_58 0 ==> 1 Dbraunii
                     1          node_60 0 ==> 1 Daubryana
11        0.250      1          node_45 0 ==> 1 node_34
                     1          node_50 0 ==> 1 Drubroaurantiaca
                     1          node_52 0 ==> 1 Dphrynioides
                     1          node_60 0 ==> 1 Daubryana
12        0.200      1          node_58 2 --> 0 node_57
                     1          node_55 0 --> 2 node_53
                     1          node_45 2 --> 1 node_34
                     1          node_38 2 ==> 0 Dovata
                     1          node_42 2 ==> 0 Dmildbraedii
                     1          node_48 2 --> 0 node_47
                     1          node_47 0 --> 1 Dsurculosa
                     1          node_50 2 --> 0 Dcongoensis
                     1          node_52 2 --> 0 Dphrynioides
                     1          node_61 2 ==> 0 Doddonii
13        1.000      1          node_41 0 ==> 1 Eabbysinicum
```

Apomorphy lists:

```
               Branch                 Character  Steps     CI   Change
-------------------------------------------------------------------------
         node_58 --> node_57          8              1  0.154  1 --> 0
                                      12             1  0.200  2 --> 0
         node_55 --> node_53          8              1  0.154  0 --> 1
                                      12             1  0.200  0 --> 2
         node_49 --> node_46          10             1  0.286  0 --> 1
         node_45 --> node_34          11             1  0.250  0 ==> 1
                                      12             1  0.200  2 --> 1
         node_34 --> Dacutissima      9              1  0.500  0 ==> 1
         node_45 --> node_44          8              1  0.154  1 --> 2
                                      10             1  0.286  1 --> 0
         node_44 --> node_39          6              1  0.143  1 --> 2
```

```
          node_38 --> Dombet           5              1  1.000  1 ==> 0
                                       9              1  0.500  0 ==> 1
          node_38 --> Dovata           6              1  0.143  2 --> 1
                                       8              1  0.154  2 --> 1
                                       12             1  0.200  2 ==> 0
          node_41 --> node_40          6              1  0.143  1 ==> 2
          node_41 --> Eabbysinicum     1              1  1.000  1 ==> 0
                                       8              1  0.154  2 --> 1
                                       10             1  0.286  0 ==> 2
                                       13             1  1.000  0 ==> 1
          node_42 --> Dmildbraedii     8              1  0.154  2 --> 1
                                       12             1  0.200  2 ==> 0
          node_49 --> node_48          8              1  0.154  1 --> 2
          node_48 --> Dmannii          6              1  0.143  1 ==> 2
          node_48 --> node_47          12             1  0.200  2 --> 0
          node_47 --> Dsurculosa       8              1  0.154  2 --> 1
                                       12             1  0.200  0 --> 1
          node_50 --> Dcongoensis      6              1  0.143  1 ==> 2
                                       12             1  0.200  2 --> 0
          node_50 --> Drubroaurantiaca 8              1  0.154  1 ==> 2
                                       10             1  0.286  0 ==> 1
                                       11             1  0.250  0 ==> 1
          node_51 --> Dgabonica        7              1  1.000  1 ==> 0
          node_52 --> Dphrynioides     8              1  0.154  1 --> 0
                                       10             1  0.286  0 ==> 1
                                       11             1  0.250  0 ==> 1
                                       12             1  0.200  2 --> 0
          node_56 --> Dcamerooniana    8              1  0.154  0 --> 2
          node_58 --> Dbraunii         10             1  0.286  0 ==> 1
          node_59 --> Dsteudneri       6              1  0.143  1 ==> 2
                                       8              1  0.154  1 ==> 2
          node_60 --> Daubryana        10             1  0.286  0 ==> 1
                                       11             1  0.250  0 ==> 1
          node_61 --> Doddonii         12             1  0.200  2 ==> 0
          node_62 --> Dlaxissima       6              1  0.143  1 --> 2
                                       8              1  0.154  1 --> 2
```

Character diagnostics:

Character	Range	Min steps	Tree steps	Max steps	CI	RI	RC	HI	G-fit
1	1	1	1	1	1.000	0/0	0/0	0.000	1.000
5	1	1	1	1	1.000	0/0	0/0	0.000	1.000
6	1	1	7	11	0.143	0.400	0.057	0.857	0.333
7	1	1	1	1	1.000	0/0	0/0	0.000	1.000
8	2	2	13	16	0.154	0.214	0.033	0.846	0.214
9	1	1	2	2	0.500	0.000	0.000	0.500	0.750
10	2	2	7	8	0.286	0.167	0.048	0.714	0.375
11	1	1	4	5	0.250	0.250	0.062	0.750	0.500
12	2	2	10	11	0.200	0.111	0.022	0.800	0.273
13	1	1	1	1	1.000	0/0	0/0	0.000	1.000

(4 constant characters not shown)

Appendix II
Detail of the phenetic analysis

a. The morphological character matrix used in the phenetic analysis

	character																												
species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
acutissima	0	1	0	1	0	0	1	*	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0
afromontana	0	1	1	1	0	0	0	1	0	0	2	1	2	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0
aletriformis	0	1	1	1	0	0	1	1	0	0	2	1	2	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0
arborea	0	1	1	1	*	0	0	1	0	0	2	1	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
aubryana	0	0	0	1	0	1	1	0	0	0	1	1	1	0	1	1	2	1	0	0	0	0	1	0	0	0	0	0	1	0
bicolor	0	1	2	1	0	0	1	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
braunii	1	0	1	1	0	1	1	0	0	0	1	1	1	0	1	*	2	1	0	0	0	0	0	0	0	0	0	0	0	0
cameroon	0	0	1	1	1	0	1	0	0	0	1	1	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0
cerasifera	0	1	1	1	1	0	0	1	0	0	2	1	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1
congoensis	0	1	1	1	0	0	1	0	0	0	2	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
ellenbeckia	0	2	0	1	0	0	1	1	0	0	2	1	2	0	0	0	2	0	0	1	1	0	0	0	0	0	0	0	0	0
fragrans	0	1	2	1	0	0	1	0	1	0	2	1	2	0	0	0	2	1	1	1	1	1	1	1	1	0	0	0	1	0
gabonica	0	0	1	1	0	1	1	*	0	0	1	0	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
goldieana	0	0	1	1	0	1	1	*	*	0	1	1	0	*	*	*	*	1	0	0	0	0	0	0	0	0	0	0	0	0
laxissima	0	0	1	1	1	0	0	1	0	0	2	1	2	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0
mannii	0	1	1	1	1	0	1	1	0	0	2	1	2	0	0	0	2	1	1	0	0	0	0	1	0	0	0	0	1	1
mildbraedii	0	1	1	1	0	0	1	1	1	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
oddonii	0	0	1	1	1	0	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
ombet	0	1	0	0	0	0	1	0	0	0	2	1	2	1	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0
ovata	0	0	2	1	0	0	0	1	1	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
phanerophlebia	1	0	0	1	0	1	1	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
phrynioides	1	0	0	1	0	1	1	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
poggei	1	1	1	1	0	0	1	0	0	0	1	1	1	0	1	1	*	1	0	0	0	0	0	0	0	0	0	0	0	0
reflexa	0	1	1	1	1	0	1	1	1	0	*	1	2	0	*	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0
rubroaurantiaca	0	1	1	1	0	0	1	1	1	0	1	*	2	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
steudneri	0	1	1	1	0	0	1	1	1	0	2	1	2	0	0	0	2	1	1	1	1	1	1	1	0	0	0	0	0	0
surculosa	0	0	1	1	1	0	1	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0

vanderystii	1	1	*	1	*	0	1	*	*	0	1	1	1	0	1	*	*	1	0	0	0	0	0	0	0	0	0	0	0	0
viridiflora	0	1	1	1	1	0	1	1	1	0	*	1	2	0	*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

The phenetic analysis of the matrix used in the study

```
GenStat Release 4.23DE  (PC/Windows 98)             14 March 2005
17:21:39
Copyright 2003, Lawes Agricultural Trust (Rothamsted Experimental
Station)

                 ____________________________________________

                 GenStat Discovery Edition 1
                 GenStat Procedure Library Release PL12.2
                 ____________________________________________

   1  %CD 'C:/My Documents/BIOTA October 2004/Dracaena species data
analysis'
   2  "Data taken from File: \
  -3  C:/My Documents/BIOTA October 2004/Dracaena species data
analysis/Morphological matrix for phenetic analysis 2005.xls\
  -4  "
   5  DELETE [Redefine=yes] _stitle_: TEXT _stitle_
   6  READ [print=*;SETNVALUES=yes] _stitle_
  10  PRINT [IPrint=*] _stitle_; Just=Left

 Data imported from Excel file: C:\My Documents\BIOTA October
2004\Dracaena
species data analysis\Morphological matrix for phenetic
  on: 14-Mar-2005 17:22:19

  taken from sheet "Sheet2", cells A2:AE30


  11  DELETE [redefine=yes]
%3[1],%1,%2,%3_1,%4,%5,%6,%7,%8,%9,%10,%11,%12,%13,%14\
  12  ,%15,%16,%17,%18,%19,%20,%21,%22,%23,%24,%25,%26,%27,%28,%29,%30_1
  13  TEXT [nvalues=29] %3[1]
  14  READ %3[1]

    Identifier   Minimum      Mean   Maximum    Values   Missing
         %3[1]                                      29         0

  20  VARIATE [nvalues=29] %1
  21  READ %1

    Identifier   Minimum      Mean   Maximum    Values   Missing
            %1    0.0000    0.1724     1.000        29         0    Skew

  23  VARIATE [nvalues=29] %2
  24  READ %2

    Identifier   Minimum      Mean   Maximum    Values   Missing
            %2    0.0000    0.6552     2.000        29         0

  26  VARIATE [nvalues=29] %3_1; extra=' %3'
  27  READ %3_1

    Identifier   Minimum      Mean   Maximum    Values   Missing
          %3_1    0.0000    0.8929     2.000        29         1

  29  VARIATE [nvalues=29] %4
  30  READ %4

    Identifier   Minimum      Mean   Maximum    Values   Missing
```

```
          %4    0.0000    0.9655     1.000        29          0    Skew

32  VARIATE [nvalues=29] %5
33  READ %5

  Identifier   Minimum      Mean   Maximum    Values   Missing
          %5    0.0000    0.2963     1.000        29          2

35  VARIATE [nvalues=29] %6
36  READ %6

  Identifier   Minimum      Mean   Maximum    Values   Missing
          %6    0.0000    0.2069     1.000        29          0    Skew

38  VARIATE [nvalues=29] %7
39  READ %7

  Identifier   Minimum      Mean   Maximum    Values   Missing
          %7    0.0000    0.8276     1.000        29          0    Skew

41  VARIATE [nvalues=29] %8
42  READ %8

  Identifier   Minimum      Mean   Maximum    Values   Missing
          %8    0.0000    0.6400     1.000        29          4

44  VARIATE [nvalues=29] %9
45  READ %9

  Identifier   Minimum      Mean   Maximum    Values   Missing
          %9    0.0000    0.2963     1.000        29          2

47  VARIATE [nvalues=29] %10
48  READ %10

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %10    0.0000    0.0000    0.0000        29          0

50  VARIATE [nvalues=29] %11
51  READ %11

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %11     1.000     1.407     2.000        29          2

53  VARIATE [nvalues=29] %12
54  READ %12

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %12    0.0000    0.9643     1.000        29          1    Skew

56  VARIATE [nvalues=29] %13
57  READ %13

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %13    0.0000     1.345     2.000        29          0

59  VARIATE [nvalues=29] %14
60  READ %14

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %14    0.0000   0.07143     1.000        29          1    Skew

62  VARIATE [nvalues=29] %15
63  READ %15
```

```
  Identifier   Minimum      Mean   Maximum    Values   Missing
         %15    0.0000    0.3077     1.000        29         3

65  VARIATE [nvalues=29] %16
66  READ %16

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %16    0.0000    0.2308     1.000        29         3    Skew

68  VARIATE [nvalues=29] %17
69  READ %17

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %17    0.0000     1.231     2.000        29         3

71  VARIATE [nvalues=29] %18
72  READ %18

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %18    0.0000    0.8276     1.000        29         0    Skew

74  VARIATE [nvalues=29] %19
75  READ %19

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %19    0.0000    0.1379     1.000        29         0    Skew

77  VARIATE [nvalues=29] %20
78  READ %20

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %20    0.0000    0.1034     1.000        29         0    Skew

80  VARIATE [nvalues=29] %21
81  READ %21

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %21    0.0000    0.1379     1.000        29         0    Skew

83  VARIATE [nvalues=29] %22
84  READ %22

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %22    0.0000    0.1379     1.000        29         0    Skew

86  VARIATE [nvalues=29] %23
87  READ %23

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %23    0.0000    0.1034     1.000        29         0    Skew

89  VARIATE [nvalues=29] %24
90  READ %24

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %24    0.0000    0.1724     1.000        29         0    Skew

92  VARIATE [nvalues=29] %25
93  READ %25

  Identifier   Minimum      Mean   Maximum    Values   Missing
         %25    0.0000   0.06897     1.000        29         0    Skew
```

```
 95  VARIATE [nvalues=29] %26
 96  READ %26

   Identifier   Minimum      Mean   Maximum    Values   Missing
          %26    0.0000    0.0000    0.0000        29         0

 98  VARIATE [nvalues=29] %27
 99  READ %27

   Identifier   Minimum      Mean   Maximum    Values   Missing
          %27    0.0000    0.0000    0.0000        29         0

101  VARIATE [nvalues=29] %28
102  READ %28

   Identifier   Minimum      Mean   Maximum    Values   Missing
          %28    0.0000    0.0000    0.0000        29         0

104  VARIATE [nvalues=29] %29
105  READ %29

   Identifier   Minimum      Mean   Maximum    Values   Missing
          %29    0.0000    0.2414     1.000        29         0    Skew

107  VARIATE [nvalues=29] %30_1; extra=' %30'
108  READ %30_1

   Identifier   Minimum      Mean   Maximum    Values   Missing
        %30_1    0.0000   0.06897     1.000        29         0    Skew

110  RESTRICT
%3[1],%1,%2,%3_1,%4,%5,%6,%7,%8,%9,%10,%11,%12,%13,%14,%15,%16,%17,\
111  %18,%19,%20,%21,%22,%23,%24,%25,%26,%27,%28,%29,%30_1
112
113  DELETE [Redefine=yes] koshi_ifue
114  FSIMILARITY [SIMILARITY=koshi_ifue]
%1,%10,%11,%12,%13,%14,%15,%16,%17,%18,%19,%2,\
115
%20,%21,%22,%23,%24,%25,%26,%27,%28,%29,%30_1,%3_1,%4,%5,%6,%7,%8,%9;
TEST=euclidean
116  HCLUSTER [PRINT=dendrogram; METHOD=furthestneighbour] koshi_ifue;
AMALGAMATIONS=_amal;\
117   PERMUTATION=_perm

**** Furthest neighbour cluster analysis ****

**** Dendrogram ****
** Levels   100.0  90.0  80.0  70.0  60.0  50.0  40.0

           1  ........
           5  ........)..
           7  .....      )
          23  ..   )     )
          28  ..)..)..   )
          18  ........)..)..
          14  .....         )
          22  .....)        )
          21  .....).......).........
           2  ........                )
           4  ..      )               )
           9  ..)..   )               )
          15  .....)..).....          )
           6  ..            )         )
          17  ..)           )         )
```

```
            20  ..)..         )          )
            29  .....)........)          )
            13  ...........   )          )
            25  ...........)..).....     )
             3  ........            )     )
            24  ........)..         )     )
            16  ...........)........)     )
             8  ..                  )     )
            27  ..).....           )     )
            10  ........)...........)     )
            11  ........           )     )
            19  ........)...........).....)...........
            12  ........                              )
            26  ........)............................)........

 118  GETATTRIBUTE [ATTRIBUTE=rows] koshi_ifue; _ps
 119  LRV [ROWS=_ps[1]; COLUMNS=2] _lrv
 120  PCO koshi_ifue; LRV=_lrv
 121  DMST [TITLE='Minimum Spanning Tree'] _lrv[1];
SIMILARITY=koshi_ifue
 122  DDENDROGRAM [order=given] DATA=_amal; PERM=_perm
 123  HCLUSTER [PRINT=dendrogram; METHOD=groupaverage] koshi_ifue;
AMALGAMATIONS=_amal; PERMUTATION=_perm

 **** Group average cluster analysis ****

 **** Dendrogram ****
 ** Levels   100.0  90.0  80.0  70.0  60.0

             1  ........
             5  ........)..
             7  ..          )
            23  ..)         )
            28  ..)..       )
            18  .....)..    )
            14  .....   )   )
            22  .....)  )   )
            21  .....)..)   )
            13  ........)..)
             6  ..          )
            17  ..)         )
            20  ..)..       )
            29  .....)..    )
            25  ........)..)
             8  ..          )
            27  ..)..       )
            10  .....).....).....
             2  .....             )
             4  ..   )            )
             9  ..)..)            )
            15  .....).....       )
             3  ........   )      )
            24  ........)..)      )
            16  ...........)..    )
            11  ........       )  )
            19  ........).....)..).....
            12  ........                 )
            26  ........)..............)...........

 124  GETATTRIBUTE [ATTRIBUTE=rows] koshi_ifue; _ps
 125  LRV [ROWS=_ps[1]; COLUMNS=2] _lrv
 126  PCO koshi_ifue; LRV=_lrv
 127  DMST [TITLE='Minimum Spanning Tree'] _lrv[1];
SIMILARITY=koshi_ifue
```

```
128  DDENDROGRAM [order=given] DATA=_amal; PERM=_perm
```