

University of Koblenz-Landau

Systematics and Ecology of *Dracaena* L. (Ruscaceae) in Central, East and Southern Africa

A thesis submitted for the degree of Doctor of Natural Sciences

by

Geoffrey Mwachala

Institute of Biology

June 2005

Abstract

Dracaena L. (Ruscaceae) is a predominantly African genus with a smaller centre of diversity in south-east Asia. The taxonomy of the 29 species occurring in Central, East and Southern Africa was revised through phenetic and phylogenetic analyses of the morphology as well as through herbarium, literature and field studies. An infrageneric classification is proposed, in which four sub-genera are recognised for the first time. A taxonomic account for the study area incorporating an identification key, distribution maps and an IUCN Red List assessment is presented. Analysis of *Dracaena* phytogeography reveals that the Guineo-Congolian centre of endemism is the richest with 21 species while the Maputaland-Pondoland regional mosaic and the Guinea-Congolia/Sudania regional transition zone are the poorest, having only one species each. Investigation of the ecology of *Dracaena* in the Kakamega Forest, Kenya, shows that it plays an important role in the forest ecology and is an indicator of forest quality.

Acknowledgements

I am grateful to the following for their assistance during this study:

In Kenya

The management of the National Museums of Kenya for granting me leave; BIOTA sub-project E04, especially the project leader Prof. Dr. Eberhard Fischer, for funding the study, Ms. Arnhild Althof and Mr. Bonny Dumbo for being there for me both in the field and in the herbarium, and for stimulating discussions that helped shape the study; staff of the East African Herbarium, especially Dr. Muthama Muasya, Dr. Joseph Mutangah and Dr. Beatrice Khayota for support and encouragement; my field assistants in Kakamega, Mr. Alfred Yakhama, Mr. Jackan Mwandoe and Mr. Houston Mwakio; other BIOTA researchers; Fred for producing excellent meals at Udo's Camp and the Kenya Wildlife Service personnel in Kakamega for allowing me unlimited access to all parts of Kakamega Forest I wished to visit.

In Germany

Prof. Dr. Eberhard Fischer, Dr Dorothee Killmann, Ms. Arnhild Althof and their colleagues at the University of Koblenz-Landau for hosting me and making my work in Germany so pleasant; Mr. Fernando Arrau and Ms. Silke Steinert at the Bundesheim Kloster Schönstatt, Vallendar, for managing my accommodation.

In Brussels, Belgium

Prof. Dr. Elmar Robbrecht, The Keeper of the Herbarium at the National Botanic Garden, Meise, and his staff for making me welcome and allowing me to access their collections and library, and for loan material.

In Paris, France

Dr. Thierry Deroin and his colleagues in the Herbarium of the Natural History Museum for allowing me to work in their institution and for loan material.

In Kew, United Kingdom

Dr. Henk Beentje, Dr. Paul Wilkin and Dr. Martin Cheek, all of the Royal Botanic Gardens, Kew, for sharing their knowledge on *Dracaena* systematics; Dr. Henk Beentje for arranging the necessary funding for me to work at Kew; and Ms. Anne Morley-Smith for managing my living arrangements while at Kew

In the Netherlands

The late Dr. Jan Bos for sending me a copy of his book on *Dracaena* in West Africa, thereby convincing me to pursue the subject.

Table of Contents

Title	page i
Abstract	page ii
Acknowledgements	page iii
List of Figures	page vii
List of Tables	page ix
List of Maps	page x
Chapter 1. Introduction, History and Literature review	page 1
1.1. Introduction	page 1
1.2. History and literature review	page 2
1.2.1 Present status of <i>Dracaena</i>	page 3
1.3. Objectives of this study	page 6
Chapter 2. Materials and methods	page 8
2.1. Morphology	page 8
2.1.1. Phenetics	page 8
2.1.2. Phylogeny	page 11
2.1.3. Phytogeography of <i>Dracaena</i>	page 13
2.2. Ecology of <i>Dracaena</i> in Kakamega forest	page 14
2.3. Conservation	page 15
Chapter 3. Results	page 18
3.1. Morphology and Anatomy	page 18
3.1.1. Vegetative morphology and anatomy	page 18
3.1.1.1. Stem	page 18
3.1.1.2. Leaves	page 18
3.1.1.3. Vegetative Anatomy	page 19
3.1.2. Floral morphology and anatomy	page 19
3.1.2.1. Inflorescence	page 19
3.1.2.2. Flowers	page 19
3.1.2.3. Pollen morphology	page 20
3.1.2.4. Fruits and seeds	page 21
3.1.2.5. Reproductive biology	page 22

3.2.	Phenetics	page 23
3.3.	Phylogeny	page 24
3.4.	Ecology	page 27
3.4.1.	Age structure	page 27
3.4.2.	Phenology	page 28
3.4.3.	Fruit-set observations	page 30
3.5.	Phytogeography	page 34
3.5.1.	Distribution of <i>Dracaena</i> in relation to the major African phytochorological divisions.	page 34

Chapter 4. Discussion and conclusions page 41

4.0.	Overview	page 41
4.1.	Phenetics	page 41
4.2.	Phylogeny	page 43
4.3.	Ecology	page 43
4.4.	Phytogeography	page 44
4.5	Conclusion and perspectives for further work	page 44
4.6.	Taxonomic treatment	page 46

References page 118

Appendices page 123

I.	Details of the phylogenetic analysis
II	Details of the phenetic analysis

List of figures

2.1.	Layout of the transects used for ecological studies	page 15
2.2.	Structure of the IUCN Red List categories	page 16
3.1.2.3	Electron micrographs of the pollen of <i>Dracaena camerooniana</i> Baker	page 20
3.1.2.4.	Electron micrograph of the pollen of <i>Dracaena reflexa</i> Lam.	page 21
3.1.2.4	Electron micrograph of the seed coats of <i>Dracaena arborea</i> (Willd.) Link and <i>Dracaena ombet</i> Kotschy & Peyr. subsp. <i>schizantha</i> (Baker) Bos.	page 22
3.2.1.	Result of the phenetic analysis using the furthest neighbour method	page 23
3.2.2.	Result of the phenetic analysis using the Group Average method	page 24
3.3.1.	One of 100 equally parsimonious trees resulting from the phylogenetic analysis	page 25
3.3.2.	Resolution of the tree generated in terms of morphology	page 26
3.3.3.	Resolution of the tree generated in terms of habit	page 26
3.3.4.	Bootstrap analysis of the tree generated in the analysis	page 27
3.4.1.	Relative <i>Dracaena</i> populations in the forest studied	page 28
3.4.2.	<i>Dracaena</i> population structure in the forest areas studied	page 28
3.4.3.	<i>Dracaena fragrans</i> phenology in October 2002	page 29
3.4.4.	<i>Dracaena fragrans</i> phenology in July 2003	page 30
3.4.5.	<i>Dracaena laxissima</i> phenology in October 2002 and in July 2003	page 30
3.4.6.	<i>Dracaena fragrans</i> exocarp discarded on the forest floor	page 32
3.4.7.	i. <i>Dracaena fragrans</i> seeds in baboon dung	page 33
	ii. Mass of <i>D. fragrans</i> seedlings growing out of baboon dung atop a tree stump.	page 33
3.5.1.	Analysis of the species richness amongst the African phytochorological divisions included in this study	page 40
4.1.1.	<i>Dracaena acutissima</i> Hua.	page 51
4.1.2.	<i>Dracaena aubryana</i> E. Morren	page 53
4.1.3.	<i>Dracaena braunii</i> Engl.	page 56
4.1.4.	<i>Dracaena poggei</i> Engl.	page 58

4.1.5.	<i>Dracaena oddonii</i> De Wild.	page 61
4.1.7.	<i>Dracaena goldieana</i> Mast. & Moore	page 63
4.1.8.	<i>Dracaena phrynioides</i> Hook.	page 65
4.1.10.	<i>Dracaena gabonica</i> Hua.	page 68
4.1.11.	<i>Dracaena bicolor</i> Hook.	page 70
4.1.12.	<i>Dracaena mildbraedii</i> K. Krause	page 72
4.1.13.	<i>Dracaena ovata</i> Ker Gawl.	page 74
4.1.14.	<i>Dracaena viridiflora</i> K. Krause	page 76
4.1.15.	<i>Dracaena rubroaurantiaca</i> De Wild.	page 78
4.1.16.	<i>Dracaena camerooniana</i> Baker	page 80
4.1.17.	<i>Dracaena surculosa</i> Lindl.	page 84
4.1.18.	<i>Dracaena congoensis</i> Hua	page 87
4.1.19.	<i>Dracaena afromontana</i> Mildbr.	page 89
4.1.20.	<i>Dracaena arborea</i> (Willd.) Link	page 92
4.1.21.	<i>Dracaena cerasifera</i> Hua	page 94
4.1.22.	<i>Dracaena laxissima</i> Engl.	page 96
4.1.23.	<i>Dracaena aletriformis</i> (Haw.) Bos	page 99
4.1.24.	<i>Dracaena reflexa</i> Lam.	page 101
4.1.25.	<i>Dracaena mannii</i> Baker.	page 103
4.1.26.	<i>Dracaena ellenbeckiana</i> Engl.	page 107
4.1.27.	<i>Dracaena ombet</i> Kotschy & Peyr. subsp. <i>schizantha</i> (Baker) Bos.	page 109
4.1.28.	<i>Dracaena fragrans</i> (L.) Ker Gawl.	page 112
4.1.29.	<i>Dracaena steudneri</i> Engl.	page 115

List of tables.

1.0.	Distinction between <i>Dracaena</i> and <i>Sansevieria</i> according to Phillips (1951)	page 4
2.1.	Characters used in the phenetic analysis and their states.	page 11
2.2.	Characters used in the phylogenetic analysis and theirs states	page 12
3.3.1.	The morphological matrix used in the phylogenetic analysis	page 25
3.4.3.1.	<i>D. fragrans</i> fruit set observations.	page 31

List of Maps

3.5.1.	The major phytochoria of Africa and Madagascar (after White, 1983, and Clarke, 1998).	page 37
4.1.1.	Distribution of <i>Dracaena acutissima</i> Hua	page 52
4.1.2.	Distribution of <i>Dracaena aubryana</i> E. Morren	page 54
4.1.3.	Distribution of <i>Dracaena braunii</i> Engl.	page 57
4.1.4.	Distribution of <i>Dracacena poggei</i> Engl.	page 59
4.1.5.	Distribution of <i>Dracaena vanderystii</i> De Wild.	page 60
4.1.6.	Distribution of <i>Dracaena oddonii</i> De Wild.	page 62
4.1.7.	Distribution of <i>Dracaena goldieana</i> Mast. & Moore	page 64
4.1.8.	Distribution of <i>Dracaena phrynioides</i> Hook.	page 66
4.1.9.	Distribution of <i>Dracaena phanerophlebia</i> Baker	page 67
4.1.10.	Distribution of <i>Dracaena gabonica</i> Hua.	page 69
4.1.11.	Distribution of <i>Dracaena bicolor</i> Hook.	page 71
4.1.12.	Distribution of <i>Dracaena mildbraedii</i> K. Krause	page 73
4.1.13.	Distribution of <i>Dracaena ovata</i> Ker Gawl.	page 75
4.1.14.	Distribution of <i>Dracaena viridiflora</i> K. Krause	page 77
4.1.15.	Distribution of <i>Dracaena rubroaurantiaca</i> De Wild.	page 79
4.1.16.	Distribution of <i>Dracaena camerooniana</i> Baker	page 81
4.1.17 i.	Distribution of <i>Dracaena surculosa</i> Lindl. var. <i>maculata</i> Hook.f.	page 85
4.1.17 ii.	Distribution of <i>Dracaena surculosa</i> Lindl. var <i>surculosa</i>	page 85
4.1.18.	Distribution of <i>Dracaena congoensis</i> Hua.	page 88
4.1.19.	Distribution of <i>Dracaena afromontana</i> Mildbr.	page 90
4.1.20.	Distribution of <i>Dracaena arborea</i> (Willd.) Link	page 93
4.1.21.	Distribution of <i>Dracaena cerasifera</i> Hua	page 95
4.1.22.	Distribution of <i>Dracaena laxissima</i> Engl.	page 97
4.1.23.	Distribution of <i>Dracaena aletriformis</i> (Haw.) Bos	page 100
4.1.24.	Distribution of <i>Dracaena reflexa</i> Lam.	page 102
4.1.25.	Distribution of <i>Dracaena mannii</i> Baker	page 104
4.1.26.	Distribution of <i>Dracaena ellenbeckiana</i> Engl.	page 108
4.1.27.	Distribution of <i>Dracaena ombet</i> Kotschy & Peyr. subsp. <i>schizantha</i> (Baker) Bos	page 110
4.1.28.	Distribution of <i>Dracaena fragrans</i> (L.) Ker Gawl.	page 113

