The genus *Gloriosa* (Colchicaceae) – ethnobotany, phylogeny and taxonomy

Alfred Maroyi

Thesis committee

Thesis supervisor

Prof. dr. L.J.G. van der Maesen

Professor of Plant Taxonomy and Geography

Wageningen University

Thesis co-supervisor

Dr. L.W. Chatrou

Associate professor, Biosystematics Group

Wageningen University

Other members

Prof. dr. E.F. Smets, Netherlands Centre for Biodiversity and Leiden University

Dr. ir. R.H.M.J. Lemmens, PROTA Network Europe Office, Netherlands

Prof. dr. K.E. Giller, Wageningen University

Dr. M.J.M. Smulders, Wageningen University

This research was conducted under the auspices of the Research School of Biodiversity.

The genus *Gloriosa* (Colchicaceae) – ethnobotany, phylogeny and taxonomy

Alfred Maroyi

Thesis

submitted in fulfillment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. dr. M.J. Kropff,
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Tuesday 29 May 2012
at 11 a.m. in the Aula.

Alfred Maroyi

The genus *Gloriosa* (Colchicaceae) – ethnobotany, phylogeny and taxonomy
194 pages

Thesis, Wageningen University, Wageningen, NL (2012)

With references, with summaries in English and Dutch.

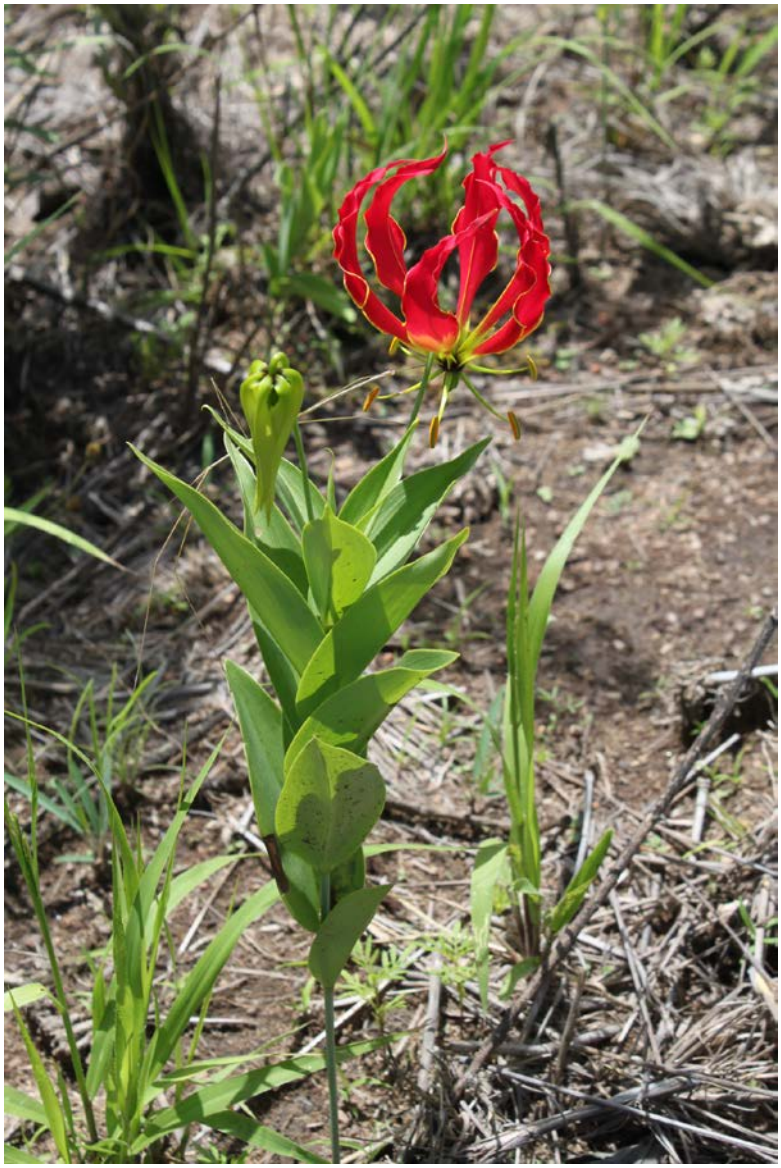
ISBN 978-94-6173-244-6

Dedicated to my beloved soul mate and wife, Vongai Maroyi

Contents

Chapter 1

General introduction



Short, erect, non-climbing *Gloriosa carsonii* Baker, photograph taken by Prof. L.J.G. van der Maesen, 60 km E of Harare, Zimbabwe

INTRODUCTION

In this thesis, the results of morphological and phylogenetic studies on the genus *Gloriosa* L. (family Colchicaceae) are presented. Also included is an extensive review of ethnobotanical, horticultural and commercial uses of *G. superba* L., a commercial source of colchicine. Colchicine is an important pharmaceutical chemical with a wide range of domestic and industrial applications. The overall aim of this study was to revise the genus *Gloriosa* over its distributional range and to evaluate its classification and phylogeny. Documentation of the economic uses of *G. superba*, a valuable medicinal plant in South Africa, tropical Africa and Asia was also perceived to be essential in understanding the biology of the species. Colchicaceae and *Gloriosa* will be introduced briefly, as well as the research questions and research methodology. This introduction is concluded with an outline of the thesis.

Taxonomic history of the family Colchicaceae

The family Colchicaceae has undergone several taxonomic changes since its description by de Candolle in 1805. Baker (1879, 1897, 1898) included Colchicaceae in the family Liliaceae *sensu lato*, a heterogenous group (Dahlgren *et al*. 1985) that included many other distantly related families, in the sense of recent phylogenetic classification such as APG III (2009). In the first comprehensive monographic treatment of Liliaceae, Baker (1879) considered Colchicaceae as one of the three main suborders or divisions of the family Liliaceae based upon variation in structure of fruit, style and anthers. Suborder a included members of the family Liliaceae *sensu stricto* characterised by loculicidal capsule, an undivided style and introrse anthers. Suborder b included members of the family Colchicaceae characterised by septicidal capsule, a tripartite style and extrorse anthers. Suborder c included members of the family Asparagaceae characterised by baccate fruits. Based on these differences, Baker (1897, 1898) treated Colchicaceae, Asparagaceae and Liliaceae *sensu stricto* as suborders or series of the family Liliaceae. He subdivided Colchicaceae into two tribes: Anguillarieae D.Don, characterised by bulbs or corms as its rootstock, a loculicidal to septicidal capsule and perianth segments narrowed into a distinct claw; and Uvularieae A.Gray, characterised by a tuberous rootstock or creeping rhizome and a loculicidal capsule. From its establishment, there were two conflicting opinions: whether to treat Colchicaceae as a subfamily of Liliaceae (Baker 1879, 1897, 1898), or as a separate family (de Candolle 1805; Dahlgren *et al*. 1985). The problem with Colchicaceae at this stage was, therefore, mainly of rank rather than circumscription.

The subdivision of Colchicaceae proposed by Baker (1879, 1897, 1898) was followed by that of Krause (1930) who assembled distant genera such as *Androcymbium* Willd. (now included in *Colchicum* L.), *Angullaria* R.Br. (now included in *Wurmbea* Thunb.), *Baeometra* Salisb. ex Endl., *Burchardia* R.Br., *Dipdax* Laws. ex Salisb. (now included in *Onixotis* Raf.), *Iphigenia* Kunth, *Neodregea* C.H.Wright and *Ornithoglossum* Salisb. into the tribe Anguillarieae. *Colchicum* constituted a tribe of its own, Colchiceae Rchb., and *Gloriosa* was grouped with *Littonia* Hook. (now included in *Gloriosa*) and *Sandersonia* Hook. in Uvularieae tribe. Krause (1930) included these three tribes in a large, heterogenous subfamily Melanthioideae characterised by free styles, capsular fruits and rhizomatous rootstock.

Hutchinson (1934, 1959) restricted the scope of tribe Anguillarieae to comprise only genera with ebracteate inflorescence, i.e. *Angullaria* (now included in *Wurmbea*), *Baeometra*, *Dipdax* (now included in *Onixotis*), *Neodregea*, *Onixotis* and *Wurmbea*. The bracteate genera such as *Androcymbium* (now included in *Colchicum*), *Burchardia*, *Camptorrhiza* Hutch., *Iphigenia* and *Ornithoglossum* were placed in a new tribe, Iphigenieae Hutch. *Colchicum* was retained in the original Colchiceae. *Gloriosa*, *Hexacyrtis* Dinter, *Kreysigia* Rchb. (now a synonym of *Schelhammera* R.Br.), *Littonia* (now included in *Gloriosa*), *Sandersonia*, *Schelhammera, Uvularia* L. and *Walleria* Kirk (now a member of the family Tecophilaeaceae) constituted the tribe Uvularieae.

A further morphological review of the tribes by Buxbaum (1925, 1936, 1937) resulted in the segregation of a new tuberous subfamily Wurmbeoideae from the rest of the rhizomatous Melanthioideae. This was a homogenous group, initially distinguished by possessing a tuberous rootstock. Buxbaum established three more or less hemisyncarpous tribes (Colchiceae, Neodregeae and Wurmbaeae) and three closely related syncarpous tribes (Baeometreae, Glorioseae and Iphigenieae) in this subfamily (Nordenstam 1982, 1986). The segregation of the subfamily Wurmbaeoideae of the Liliaceae received biochemical support showing the occurrence of colchicine and other related alkaloids with a tropolone ring as an exclusive characteristic of genera in this subfamily (Vinnersten & Larsson 2010; Wildman & Pursey 1968). Wurmbaeoideae was later accepted as a separate family Colchicaceae (Dahlgren 1975, 1980; Dahlgren *et al*. 1985; Huber 1969; Nordenstam 1982, 1986, 1998; Schulze 1975). Nordenstam (1982) united, and in some cases renamed Buxbaum's tribes, reducing them to four, viz.: Anguillarieae, Baeometreae, Colchiceae and Iphigenieae. Further studies by Nordenstam (1998) expanded the family Colchicaceae to a larger and heterogeneous assemblage of 19 genera, divided into five tribes (Table 1.1). Molecular and

biochemical analyses (e.g. Chase *et al*. 1993, 1995; Rudall *et al*. 1997; Vinnersten & Larsson 2010; Vinnersten & Manning 2007; Vinnersten & Reeves 2003) have shown the following aberrant genera to belong to family Colchicaceae: *Burchardia*, *Disporum* Salisb., *Kuntheria* J.G.Conran & Cliff., *Schelhammera, Tripladenia* D.Don. and *Uvularia*. Vinnersten & Manning (2007) recognised six morphologically diagnosable, monophyletic clades at tribal level in family Colchicaceae (Table 1.1).

Table 1.1. Two classification systems of family Colchicaceae: (a) based on Nordenstam (1998); (b) based on Vinnersten & Reeves (2003), and Vinnersten & Manning (2007).

a		**b**	
Tribes	**Genera**	**Tribes**	**Genera**
Not placed in any tribe	*Burchardia*	Anguillarieae	*Baeometra*
Anguillarieae	*Neodregea*		*Wurmbea* (= *Neodregea* and *Onixotis*)
	Onixotis	Burchardieae	*Burchardia*
	Wurmbea	Colchiceae	*Colchicum* (= *Androcymbium*)
Baeometreae	*Baeometra*		*Gloriosa* (= *Littonia*)
Colchiceae	*Androcymbium*		*Hexacyrtis*
	Colchicum		*Ornithoglossum*
Iphigenieae	*Camptorrhiza*		*Sandersonia*
	Gloriosa	Iphigenieae	*Camptorrhiza*
	Hexacyrtis		*Iphigenia*
	Iphigenia	Tripladenieae	*Kuntheria*
	Littonia		*Schelhammera*
	Ornithoglossum		*Tripladenia*
	Sandersonia	Uvularieae	*Disporum*
Uvularieae	*Disporum*		*Uvularia*
	Kuntheria		
	Schelhammera		
	Tripladenia		
	Uvularia		

Phylogenetic studies of Colchicaceae by Vinnersten & Reeves (2003), Vinnersten & Manning (2007), and Manning *et al*. (2007) resulted in widening the circumscription of *Wurmbea* to include *Neodregea* and *Onixotis*. The genus *Littonia* is now included within an expanded *Gloriosa*, rendering that genus monophyletic. Phylogenetic relationships within family Colchicaceae (Manning *et al*. 2007; Vinnersten & Reeves 2003), demonstrated that *Colchicum* was not monophyletic unless the closely related *Androcymbium* genus was included to render it monophyletic. But Persson (2007), and Del Hoyo & Pedrola-Monfort (2008), are of the opinion that the taxonomic decision taken by Manning *et al*. (2007) to change the delimitation of the genus *Colchicum* to include *Androcymbium* was premature as morphology and life-history traits of *Androcymbium* favour it as a well-circumscribed genus. In addition to this, the material used to arrive at this conclusion was rather limited, particularly for *Colchicum* (Persson 2007). However, the argument put forward by Persson

(2007) and Del Hoyo & Pedrola-Monfort (2008) that *Androcymbium* is a well circumscribed genus based on its morphology and life-history traits is irrelevant from a classification perspective, as monophyly is the primary principle of phylogenetic classification (Backlund & Bremer 1998). Although several studies have been done on both Liliaceae and Colchicaceae, the taxonomic treatment of several genera within Colchicaceae is still considered to be ambiguous (Manning *et al.* 2007; Persson 2007; Vinnersten & Manning 2007; Vinnersten & Reeves 2003).

Origin and geographical distribution of Colchicaceae

To fully understand and appreciate the biogeographic and evolutionary patterns of Colchicaceae in different continents, a molecular systematic probe into when and where important divergence events happened has recently been advocated (Vinnersten & Bremer 2001). A biogeographical and molecular dating analysis of the phylogeny of the order Liliales indicates that the split between Colchicaceae and its sister families (Alstroemeriaceae and Luzuriagaceae) represents a vicariance event following the disintegration of the Australian-Antarctican-South American link in the early Oligocene, about 34 million years ago (Vinnersten & Bremer 2001). According to this study, Colchicaceae originated in Australia, first reached Asia and North America, and later Africa, from where they expanded to Europe and also dispersed back to Australia.

The investigation of origin and times of diversification of species groups provides useful information of plausible drivers of the events and the speciation process. According to Kahraman & Celep (2010), the large number of *Colchicum* species and endemics in Turkey and the Balkans indicate that these regions are its major centres of diversity and speciation. The genus *Androcymbium* (now included in *Colchicum*) is documented to have originated in the southern tip of Africa and subsequently dispersed northwards through an arid track (Caujapé-Castells *et al*. 1999; Caujapé-Castells *et al*. 2008; Del Hoyo & Pedrola-Monfort 2006; Del Hoyo *et al*. 2009). Molecular dating by Del Hoyo *et al.* (2009), suggests that the genus originated in the middle Miocene (13.4 ± 1.5 mya), diversifying in the late Miocene (9.6 ± 1.7 mya) in the winter-rainfall areas of western South Africa-south of Namibia, and was strongly influenced by the Benguela current. *Wurmbea* is said to have originated in southern Africa and arrived in western Australia via long-distance dispersal (Barrett 1992; Nordenstam 1978; Vinnersten & Bremer 2001). The genus *Wurmbea* has an even African-Australian distribution (Conran 1985; Goldblatt 1978; Nordenstam 1978). The distribution of *Iphigenia* is to some extent comparable, but less widely disjunct with occurrences also in Madagascar, Socotra and India. Interestingly, its close relative *Camptorrhiza* occurs only in southern

Africa and India (Nordenstam 1998). *Disporum*, *Kuntheria*, *Schelhammera*, *Tripladenia* and *Uvularia* are concentrated in forest regions of south-eastern Asia and Australia, with a centre in Australian rainforest areas (Nordenstam 1998). The only genus in the New World, viz. *Uvularia*, is an example of the phytogeographical link between eastern-North America and eastern Australasia, where the related genera occur (Nordenstam 1998). Most of the major diversification within Colchicaceae occurred between the Oligocene and the Miocene when the global climates were putatively undergoing drastic fluctuations (Vinnersten & Bremer 2001). Studies done so far, (e.g. Barrett 1992; Caujapé-Castells *et al*. 1999; Caujapé-Castells *et al*. 2008; Del Hoyo & Pedrola-Monfort 2006; Del Hoyo *et al*. 2009; Nordenstam 1978) suggest that many dispersal rather than vicariance events are responsible for the current geographic distributions of Colchicaceae in Africa, America, Asia, Australia and Europe. The likelihood that vicariance played a significant role in the diversification of Colchicaceae is rather low given that the break-up of Gondwana is known to have occurred about 100 mya (Jokat *et al*. 2003). The earliest rifting within the supercontinent was initiated between South America and Africa, and this happened during the Cretaceous to Paleogene (McLoughlin 2001). New Zealand drifted from the supercontinent about 80 mya (Humphries & Parenti 1999). South America and Australia separated from Antarctica about 35 mya (Bunce *et al.* 2005). Therefore, the historical biogeography of the family Colchicaceae cannot be adequately explained by the break-up of Gondwana, which happened before the diversification of the family.

Economic importance of Colchicaceae

The Colchicaceae family has several members that are of economic importance. Notable among them are *Colchicum autumnale* L., *C. luteum* Baker and *Gloriosa superba* grown as sources of colchicine (Kapadia *et al.* 1972). According to Dounias (2006), *G. superba* is exported by India and Sri Lanka to pharmaceutical industries, and more recently also by a few African companies based in Nigeria, Cameroon and Zimbabwe. Colchicine is an ancient anti-inflammatory drug, has recently been employed for treating an increasing number of disorders characterised by enhanced leukocyte trafficking including Behçet's syndrome, primary biliary cirrhosis, alcohol-induced liver cirrhosis, psoriasis, Sweet's syndrome, scleroderma and sarcoidosis (Cerquaglia *et al.* 2005; Rigante *et al.* 2006). Since 1972 colchicine has become the drug of choice for prophylaxis against Familial Mediterranean Fever (FMF) attacks and risk of amyloidosis (Cerquaglia *et al.* 2005; Rigante *et al.* 2006). The U.S. Food and Drug Administration (FDA) officially approved the oral use of colchicine as a drug for some human disorders in 2009 (Ade & Rai 2010). Moreover, colchicine is well known

for its use in plant and animal genetics because of its property in inducing metaphase arrest (Mukhopadhyay *et al*. 2002), so doubling the chromosome numbers.

Colchicaceae is also a horticulturally well known family. The early botanical exploration of Africa and Asia resulted in a number of genera being taken into cultivation in Europe and United States which have subsequently been used in the horticultural trade across the globe. Examples include species of genera such as *Gloriosa*, *Sandersonia* and *Uvularia*. *Gloriosa* is widely cultivated for the colourful floral display in gardens around the world. Gardeners and horticulturalists have selected different variants for their striking differences in flower colour and shape, both from the wild and in cultivation. Some of the most commonly grown members of Colchicaceae are *Colchicum autumnale, Gloriosa carsonii* Baker*, G. modesta* (Hook.) J.C.Manning & Vinnersten*, G. simplex* L. and *G. superba*, *Sandersonia aurantiaca* Hook. and *Uvularia* spp. Apart from cut flower production, *G. superba* is also grown as a potted plant. The selection known as *G. rothschildiana* O'Brien is cultivated in Europe and the United States for the production of cut flowers (Bunyapratsara & van Valkenburg 1999). There are numerous *Colchicum* cultivars grown throughout Europe for the beauty of their crocus-like flowers. *S. aurantiaca* is native to South Africa, but commercially grown as an ornamental plant in Japan, Israel, New Zealand and South Africa (Burge *et al*. 2008). According to Doreen (1997), the market for *S. aurantiaca* is currently largely untapped, but potentially huge, extending from just tuber and cut-flower production, to the garden plant and pot-plant markets. In 1994 export figures, show *S. aurantiaca* as New Zealand's second largest export flower crop after orchids (Doreen 1997).

Methods of rapid micropropagation of *G. superba, G. modesta*, *Iphigenia indica* (L.) Kunth and *S. aurantiaca* have been developed, using explants from tubers and an auxin-enriched growth medium (see Deroles *et al*. 2010; Doreen 1997; Finnie & Van Staden 1994, 1996; Hassan & Roy 2005; Mukhopadhyay *et al*. 2002; Samarajeewa *et al*. 1993). According to Finnie & Van Staden (1996), there is a wide array of dormancy-breaking techniques practiced by commercial growers of *S. aurantiaca* in New Zealand. Explants from meristematic parts of the tuber are known to yield the highest number of plantlets (Dounias 2006). Techniques used to propagate these species may also be applied to other genera.

Members of the Colchicaceae family are not only appreciated for their natural beauty, but are also widely used as traditional medicines in areas where they occur. *G. superba*, for example, is a well-known non-wood forest product that has long been in regular demand amongst practitioners of

traditional medicine in South Africa, tropical Africa, India and south-eastern Asia. The rootstock of *S. aurantiaca* has traditionally been used by the Zulu people as an aphrodisiac (Roberts 1990). *Ornithoglossum vulgare* B.Nord. is a lily-like plant that has occasionally been incriminated in stock losses, particularly sheep and goats (Botha & Penrith 2008).

The genus *Gloriosa*

Vinnersten & Manning (2007) introduced a broad-based genus concept for *Gloriosa* by sinking *Littonia* into the former, rendering the genus monophyletic. Within this expanded genus, species relationships are poorly understood and there was no modern monograph of the group. This genus is of great commercial, pharmaceutical and ethnobotanical interest because of its colourful flowers and colchicine extracted from the seeds and tubers. On that basis, *Gloriosa* has received growing attention from horticultural, pharmaceutical and ethnobotanical research because of its wide application in horticulture and traditional medicine. Unfortunately, the genus is taxonomically complicated and exhibits a high morphological variability, that in the past has severely hampered the understanding of its diversity. The present thesis attempts to summarise the state of knowledge about *Gloriosa* with a focus on its ethnobotany, phylogeny and taxonomy. This study was prompted by the need to write a monograph of *Gloriosa*. Prior to this study, a major impediment was the uncertainty of *Gloriosa* species, and recently whether *Gloriosa* and *Littonia* are separate genera, after the description of *G. sessiliflora*, which is morphologically intermediate between *Gloriosa* and *Littonia* (Nordal & Bingham 1998). A molecular phylogenetic study of the family Colchicaceae by Vinnersten & Reeves (2003) found strong support for monophyly of genus *Gloriosa* including *Littonia*. Consequently, genus *Gloriosa* has since been expanded and made more coherent by including *Littonia* (Vinnersten & Manning 2007), rendering it monophyletic. These studies have raised questions of relationships at generic and infrageneric levels. Here we use morphological and nucleotide sequence characters to investigate species boundaries and relationships in an attempt to understand the diversity and evolutionary history of the group.

In 1737, Linnaeus established the genus *Gloriosa* based on a specimen collected in south west India (Malabar). During the next 260 or so years a further 40 species of *Gloriosa* were described (IPNI 2011), although the majority was subsequently reduced to synonymy. The most recently described species of *Gloriosa* is *G. sessiliflora* Nordal & Bingham (Nordal & Bingham 1998), a paper where the generic delimitation between *Gloriosa* and *Littonia* was first questioned. The genus *Littonia* was described by Hooker (1853) based on the South African climbing *L. modesta* Hook. and differing

from *Gloriosa* particularly in its straight, not bent style and connivent, not reflexed tepals (Nordal & Bingham 1998). There are many similarities between *Gloriosa* and *Littonia* (Table 1.2). All have tuberous corms (Buxbaum 1937; Dyer 1976; Nordenstam 1998; Sebsebe Demissew 1997; Thulin 1995), their leaves frequently develop tendril-like, cirrhous tips (Dyer 1976; Nordenstam 1998; Queva 1899; Sebsebe Demissew 1997; Thulin 1995) and colchicine occurs in all (Hegnauer 1963; Raffauf 1970; Vinnersten & Larsson 2010; Wildman & Pursey 1968). Queva (1899) also noted that crystals of calcium oxalate were lacking in both *Gloriosa* and *Littonia*. The basic chromosome number is n = 11 for *G. simplex* L.*, G. superba,* and *L. modesta* (now *G. modesta*) (Bell 1958; Cave 1962, 1963).

RESEARCH QUESTIONS

The main objective of this study was to revise *Gloriosa* throughout its distributional range, by documenting its ethnobotany, establishing species delimitations based on morphology and evolutionary relationships. Specific objectives associated with this aim are:

i. To document the ethnobotanical, horticultural and economic significance of *Gloriosa* species (**Chapters 2 & 3**).

ii. To determine the limits, affinities and taxonomic status of poorly defined and problematic *Gloriosa* taxa (**Chapter 4**).

iii. To test the monophyly of the genus *Gloriosa* and determine the circumscription of the genus based on phylogenetic relationships and coherent morphological characteristics (**Chapter 5**)

iv. To produce a modern taxonomic revision of the genus throughout its distributional range (**Chapters 6 & 7**).

Table 1.2. Comparative character states found in *Gloriosa* and *Littonia*

Character	***Gloriosa***	***Littonia***
Habit	Climbing or erect geophytes.	Climbing or erect geophytes.
Tubers	2-pronged, L or V-shaped or globose covered with brown tunics.	3 or 2-pronged, L or V-shaped or globose covered with brown tunics.
Leaves	Cauline, sometimes sheathing the stem, alternate, opposite or irregular; linear to ovate, attenuated into a terminal, recurved tendril.	Cauline, sometimes sheathing the stem, lower leaves often alternate or opposite, but the upper ones often in whorls, linear to lanceolate, apex attenuated into a recurved tendril or aristate.
Perianth segments	Perianth segments usually free, linear to oblanceolate, highly crisped to straight and undulate margins, reflexed, persistent, yellow to red and often bicoloured.	Perianth segments often connate at the base, linear to elliptic, not crisped, not reflexed, persistent, green to orange.
Style	Bent at right angle to the longitudinal axis of the ovary.	Style not bent.
Anthers	Introrse	Extrorse

RESEARCH METHODOLOGY

This work was based on field work, and herbarium collections kept at the National Herbarium of the Netherlands, Wageningen University branch (WAG), the National Herbarium and Botanic Gardens, Harare, Zimbabwe (SRGH). Additional herbarium specimens were received on loan from B, BM, BR, C, COI, F, K, L, P, S, U and UPS (abbreviations follow Holmgren *et al*. 1990). About 1200 herbarium specimens were databased using BRAHMS (Botanical Research and Herbarium Management System) programme and provided the data for the present analysis. In addition, fresh material of *G. superba* complex was studied and field observations made from several localities in Zimbabwe between 2007 and 2011. In order to generate a good phylogenetic hypothesis of species relationships one should have sufficient, good quality leaf material that can be used to extract DNA from. Preferably, this material has to be recently collected and dried in silica gel. As mentioned above, *Gloriosa* is variable and has a wide distributional range. Because time and money were limited, it was impossible to obtain freshly collected leaf material of all *Gloriosa* species variants. Therefore, the ca. 1200 herbarium specimens of *Gloriosa* loaned to Wageningen herbarium (WAG) provided an invaluable source of DNA.

A central component of this research comprised field and taxonomic work aimed at documenting societal significance of *Gloriosa* species; and delimiting, describing and classifying these species. *Gloriosa* has a long history of ethnobotanical use and cultivation; and there is still a lot of scope for continued utilisation as traditional medicine, commercial source of colchicine and the development of horticultural cultivars. Taxonomic revision of the genus combined traditional taxonomic tools with morphometric and molecular methods to resolve taxonomic problems in *Gloriosa*. This study has followed the standard methods for taxonomic revisions (Davis & Heywood 1967). This revision work was based on fresh and herbarium specimens, assessing variation of morphological characters within and between the taxa. Specimens were grouped based on their similarity resulting in the morphologically defined species. This is a common practice among taxonomists as a species is generally regarded as a population that exhibits distinctive morphological characters and a definite geographical range. These groups are then associated with an existing type specimen, which is linked to a particular taxon name. Taxonomists in general often face problems when they adopt this criterion, e.g. to what extent does the amount of morphological difference between two forms reach the crucial point that marks them as species rather than subspecies (Grant 1957). The variation of morphological characters in *Gloriosa* was found to be complicated to handle and hence the need to apply numerical methods to get a more objective definition of taxonomic entities and determination

of taxonomic ranks. When data are sufficiently large and the distributional relationships are so complex that one simply cannot see any meaningful pattern, then computer analyses are extremely valuable in pointing towards the potential useful structure of variation (Stuessy 1990). Therefore, to address the delimitation and identification of the species in this genus, morphological characterisation using Cluster Analysis and Principal Component Analysis have been explored to clarify the taxonomic treatment of *G. superba* complex over its distributional range in South Africa, tropical Africa and Asia. A disadvantage of this concept is that observed traits of specimens are not evidence for their evolutionary connection (Hull 1976) and systematists often do not agree on how to circumscribe a species. The circumscribed species should possess at least one unifying character (apomorphy) not found in other species.

Phylogenetic trees provide us with windows into the past history of organisms, enabling investigation of the long-term significance of evolutionary transitions and ecological processes that otherwise can be observed only on local or instantaneous time frames (Case *et al.* 2008). Thus, phylogenetic studies enable us to generate hypotheses on the evolutionary history of the group being investigated. The phylogeny of *Gloriosa* was investigated using chloroplast DNA (cpDNA), which is non-recombinant, has a relatively conserved gene order and is uni-parentally inherited, making it more useful for parentage and taxonomic studies (Birky 1995). The advantages of using chloroplast DNA for phylogeny reconstruction are that the genome is small, typically between 120 and 200 kb, and most genes in the chloroplast are single-copy, making it easy to examine the entire genome (Soltis *et al.* 1998). Different portions of the chloroplast genome evolve at different rates resulting in a wide range of possibilities for resolving relationships using data from the chloroplast genome from the level of species and genus to family and even higher levels (Soltis *et al.* 1998). Non-coding regions of cpDNA can contain nucleotide substitutions, indels, or inversions that can be used for comparison among individuals in a low-level systematic study (Shaw *et al*. 2005, 2007). The aim of phylogenetic study was to assess the diversification of *Gloriosa* through the sampling of more taxa than in previous studies (Vinnersten & Manning 2007; Vinnersten & Reeves 2003).

THESIS OUTLINE

The thesis is divided into two parts: i. Ethnobotany, and ii. Phylogenetics and taxonomy. **Chapter 1** of the thesis introduces the subject matter and the methodology used in the investigation. **Chapters 2 & 3** explore the ethnobotany of *G. superba*. *Gloriosa* is not only appreciated for its natural beauty, but also for pharmaceutical applications and medicinal uses. **Chapter 2** provides a comparison of

medicinal uses and poisonous properties of *G. superba*. **Chapter 3** provides economic uses and vernacular names of *G. superba*. The systematic part of this thesis focuses on the taxonomic treatment of the genus *Gloriosa* over its distributional range. The generic limit of *Gloriosa* was considered unresolved at the inception of this PhD research. The logical and necessary first step was to undertake this thorough taxonomic revision of the genus in order to have a precise idea of the total number of species, their geographical distribution and ecological preferences, as well as the main features that might have played a role during their evolution. **Chapter 4** provides the numerical study of the *G. superba* complex. Species are deliminated morphologically using numerical methods in addition to normal typological procedures as practised by most taxonomists working in herbaria.

Chapter 5 presents the evolutionary history of genus *Gloriosa*. In this chapter, the phylogenetic relationships among *Gloriosa* species are presented based on cpDNA sequence data. **Chapter 6** provides a monographic treatment of genus *Gloriosa*. Finally, **Chapter 7** summarises and synthesises the taxonomical record of the genus by providing a conspectus of valid names and synonyms of *Gloriosa* species. **Chapter 8** concludes the thesis by providing a summary of the major findings.

Chapter 2

Gloriosa superba L. (family Colchicaceae): remedy or poison?

A. Maroyi & L.J.G. van der Maesen 2011. *Journal of Medicinal Plant Research* 5: 6112-6121. Results of this chapter were also presented during WOCMAP (World conference on medicinal and aromatic plants) conference held in Cape Town, South Africa, 9-14 November 2008. Abstract published as: Maroyi, A. & van der Maesen, L.J.G. 2009. *Gloriosa superba*: remedy or poison? *Afr. J. Trad. CAM*. 6 (Suppl.): 488.

Typical *Gloriosa superba* L., characterised by heavily crisped perianth segments, photograph taken by Prof. L.J.G. van der Maesen, 54 km W of Harare, Zimbabwe

Abstract

This article provides an overview of medicinal uses and poisonous properties of *Gloriosa superba*, and the available literature related to these aspects drawn from studies done in areas where the species is utilised as traditional medicine or reported as poisonous. A list of 45 ethnobotanical applications practiced in 31 subtropical, tropical African and Asian countries was drawn. A considerable convergence in ethnobotanical uses and practices emerged from these data. This comparative analysis strengthens the firm belief that ethnobotanical findings represent not only an important shared heritage, developed over the centuries, but also a considerable mass of data that should be exploited in order to provide new and useful knowledge of plant resources. Further ethnopharmacological studies are required in order to increase our understanding of the links between the documented traditional uses of *G. superba*, public health issues and its phytochemistry and pharmacological properties.

Key words: Colchicine; *Gloriosa superba*; poisonous; toxicity; traditional medicine

Introduction

Gloriosa superba L. (family Colchicaceae) is not only a notorious human and livestock poison, but is also widely used in several indigenous systems of medicine for the treatment of various human ailments. *G. superba* has caused illnesses and even fatalities to humans and animals due to both intentional and accidental poisoning. It is a native to South Africa, tropical Africa, India and south-eastern Asia (Bunyapraphatsara & van Valkenburg 1999), now widely cultivated throughout the world as an ornamental plant. *G. superba* is a tuberous plant with L or V-shaped, finger-like tubers that are pure white when young, becoming brown with age. It is common in forest-savanna boundaries, locally common in thickets, hedges, open forest, grassland and bush land, where it can be seen scrambling through other shrubs (Dounias 2006). *G. superba* is commonly called Glory lily, flame lily, climbing lily, creeping lily in English; Lis de Malabar, lis grimpant, lis glorieux in French; Garras de tigre, aranha de emposse in Portuguese and Mkalamu, kimanja nouchawi in Swahili (Neuwinger 1996). This review is aimed at compiling an up-to-date medicinal uses and poisonous properties of *G. superba* over its distributional range.

Review procedure

The medicinal uses and poisonous properties of *G. superba* were collated over its distributional range. Available references or reports on the species were consulted from published articles, books and book chapters, theses and abstracts available on international online databases such as Web of Science, Scopus and Google Scholar and journals' websites. Suitable books or potential literature sources were identified in online databases of the particular libraries by searching for the terms ethno medicine, traditional medicine, folk medicine, indigenous medicine, ethno botany and botanical medicine, poisonous properties, phytochemistry, pharmacological, toxicological properties of *Gloriosa superba*. References were also identified by searching the extensive library collections of the National Herbarium and Botanic Gardens, Harare, Zimbabwe and Wageningen University, the Netherlands.

Medicinal uses of *G. superba*

G. superba is a well-known medicinal plant in tropical African and Asian countries since antiquity. In India, it is used in Ayurvedic and Unani systems of medicines (Chopra *et al.* 1956; Watt 1972). Herbal medicine recommends *G. superba* for the treatment of urinary and reproductive systems, respiratory ailments, skin diseases, cardiovascular troubles, and many other disorders (Table 2.1). The seeds of *G. superba* are highly priced in the world market as sources of colchicine (Figure 2.1), a chemical that has been used in the past as a remedy against gout, a disease caused by deposits of uric acid in the joints (Sivakumar & Krishnamurthy 2002).

G. superba is used for treating a wide range of human ailments throughout the tropics. In India, the Ayurvedic Pharmacopoeia recommends *G. superba* as an ecbolic in labour, purgative, an anthelminthic and cure against leprosy, colics, chronic ulcers, haemorrhoids, skin-parasites, head lice and tumours (Bunyapraphatsara & van Valkenburg 1999; Geetha *et al.* 2007; Jagtap *et al.* 2006; Jain *et al.* 2004; Katewa *et al.* 2004; Neuwinger 1996; Sandhya *et al.* 2006; Satri 1956; Tiwari & Yadav 2003). The tuberous root stock of *G. superba* is boiled with *Sesamum* oil and applied twice a day on the joints as a remedy against arthritis, and to reduce pain (Singh 1993). The sap from the leaf tip is used as a smoothening agent for pimples and skin eruptions (Hemaiswarya *et al.* 2009). Seeds are used for relieving rheumatic pain and as a muscle relaxant (Nadkarni 2002). Traditionally, the watery extract of *G. superba* tuber has been used as an abortifacient (Burkill 1995; Dounias 2006; Ghani 1998; Haerdi 1964; Jain *et al.* 2004; Manandhar 2002; Neuwinger 1996; Sandhya *et al.* 2006), as a cure against venereal diseases (Dounias 2006; Neuwinger 1996; Yamanda 1999), abdominal and

general body pain (Dounias 2006; Haerdi 1964; Manandhar 2002; Neuwinger 1996). It is also used around doors and windows to repel snakes; and also used as an antidote for snake bite and scorpion sting.

Table 2.1. Medicinal uses of *G. superba* in subtropical, tropical Africa and Asia

Medicinal use(s)	Country practised	Reference(s)
Abdominal and general pain	Ivory Coast; Kenya; Nepal; Thailand	Burkill 1995; Dounias 2006; Manandhar 2002; Neuwinger 1996; Saralamp *et al.* 1996
Abortifacient	Bangladesh; India; Kenya; Nepal; Sri Lanka; Tanzania; Uganda; Zambia	Burkill 1995; Dounias 2006; Fowler 2007; Ghani 1998; Haerdi 1964; Jain *et al.* 2004; Manandhar 2002; Maurya *et al.* 2004; Neuwinger 1996
Anthelminthic and antiparasitic	Guinea, India; South Africa	Dounias 2006; Watt & Breyer-Brandwijk 1962
Anthritis and dislocations	India, Nigeria; Sri Lanka	Burkill 1995; Dounias 2006; Neuwinger 1996; Singh 1993
Aphrodisiac	Ivory Coast; Zimbabwe	Burkill 1995; Gelfand *et al*. 1985; Mavi 1996; Neuwinger 1996
Applied on wounds	India; Tanzania	Bhargava 1983; Burkill 1995; Chopda & Mahajan 2009; Dounias 2006; Haerdi 1964; Katewa *et al*. 2004; Neuwinger 1996
Ascites	South Africa	Watt & Breyer-Brandwijk 1962
Asthma	Bangladesh; Congo; India	Burkill 1995; Dounias 2006; Ghani 1998
Baldness	India	Hemaiswarya *et al*. 2009
Chronic ulcers	India	Hassan & Roy 2005
Colics	India	Ade & Rai 2009; Hassan & Roy 2005
Coughs	Ivory Coast; Sierra Leone	Burkill 1995; Dounias 2006; Neuwinger 1996
Debility	India	Hemaiswarya *et al.* 2009
Decongestant	Burkina Faso; Ivory Coast; Sierra Leone	Burkill 1995; Dounias 2006; Neuwinger 1996
Earache	Tanzania	Burkill 1995; Dounias 2006; Haerdi 1964; Neuwinger 1996
Ecbolic in labour	India	Hemaiswarya *et al.* 2009; Prakash *et al*. 2008
Female sterility	Congo; India; Ivory Coast; South Africa; Zambia	Bryant 1966; Burkill 1995; Dounias 2006; Fowler 2007; Watt & Breyer-Brandwijk 1962
Fever and malaria	Bangladesh; India; Tanzania	Burkill 1995; Dounias 2006; Ghani 1998; Haerdi 1964; Neuwinger 1996
Gout and tumour	Ethiopia; India; Thailand	Hassan & Roy 2005; Kala *et al*. 2004; Saralamp *et al*. 1996; Yineger & Yewhalaw 2007
Haemorrhoids	India	Hassan & Roy 2005; Kala *et al*. 2004; Lather *et al*. 2011; Sahu *et al*. 2010
Head lice killer	Cameroon; Gabon; Ghana; Guinea; Guyana; India; Indonesia; Senegal; South Africa	Burkill 1995; Dalziel 1955; Maradjo 1977; Neuwinger 1996; Watt & Breyer-Brandwijk 1962
Hydrocele	Burundi	Dounias 2006
Hysteria	Nepal	Manandhar 2002
Impotence	India, Iran; Kenya; South Africa; Tanzania; Uganda; Zambia	Burkill 1995; Dounias 2006; Fowler 2007; Haerdi 1964; Neuwinger 1996; Watt & Breyer-Brandwijk 1962
Indigestion	India	Hemaiswarya *et al*. 2009
Inflammations	India	Kala *et al*. 2004
Intestinal worms	India	Bhargava 1983
Leprosy	India; Kenya; Zambia	Dounias 2006; Fowler 2007; Hassan & Roy 2005; Kala *et al*. 2004; Neuwinger 1996
Leucorrhea	Bangladesh	Rahmatullah *et al*. 2009
Mental illness	Burundi	Dounias 2006
Murder poison, suicidal agent and culpable homicide	Burma; Camboidia; India; Kenya; Nigeria; Sri Lanka; Tanzania; Zambia	Bunyapraphatsara & van Valkenburg 1999; Burkill 1995; Dalziel 1955; Dounias 2006; Iwu 1993; Neuwinger 1996
Muscle relaxant	India	Nadkarni 2002
Neuralgia	Guinea; Senegal	Burkill 1995; Dalziel 1955; Neuwinger 1996
Prolapse in cattle	India	Jagtap *et al.* 2006
Purgative	India; Nepal	Ade & Rai 2010; Manandhar 2002

Rheumatism	Bangladesh; Burundi; India	Dounias 2006; Nadkarni 2002; Rahmatullah *et al*. 2009
Scorpion bites	Sri Lanka; Zambia	Burkill 1995; Fowler 2007; Neuwinger 1996
Scrofula	India	Hemaiswarya *et al*. 2009
Skin diseases	Bangladesh; India; Kenya; Nepal; Sri Lanka; Tanzania	Bhargava 1983; Burkill 1995; Dounias 2006; Ghani 1998; Haerdi 1964; Manandhar 2002; Neuwinger 1996; Rahmatullah *et al*. 2009
Snake-bite antidote	India; Kenya; Nigeria; Somalia; Zambia	Bhargava 1983; Burkill 1995; Dounias 2006; Fowler 2007; Jain *et al*. 2009; Mors *et al*. 2000; Neuwinger 1996; Samy *et al*. 2008; Thulin 1995
Sprains	Nigeria; Sri Lanka	Burkill 1995; Dounias 2006; Neuwinger 1996
Stomach-ache	DR Congo; Kenya; Mozambique; Nepal	Dounias 2006; Manandhar 2002; Neuwinger 1996; Watt & Breyer-Brandwijk 1962; Yamanda 1999
Tonic	India; Nepal	Ade & Rai 2009, 2010; Manandhar 2002
Toothache	Zimbabwe	Gelfand *et al*. 1985; Mavi 1996
Ulcers	India	Kala *et al*. 2004
Venereal diseases	DR Congo; India; Zambia	Dounias 2006; Fowler 2007; Jain *et al*. 2009; Neuwinger 1996; Yamanda 1999

Five different plant parts of *G. superba* are cited as important in ethnobotanical applications: leaves, seeds, unripe fruit, the root stock or tuber and the whole plant. The tuber or root stock is the plant part that is most frequently used (Dounias 2006; Neuwinger 1996). Five different pharmaceutical forms were cited: comprising paste, decoction (preparation in hot water), maceration (soaking in cold water), powder and using the whole plant without specific preparation. The decoction and the maceration are used for the majority of internal body ailments, like abdominal pain (Dounias 2006; Haerdi 1964; Manandhar 2002; Neuwinger 1996; Saralamp *et al.* 1996), coughs (Dounias 2006; Haerdi 1964; Neuwinger 1996), fever and malaria (Ghani 1998; Siddique *et al.* 2004), etc. Tuber paste of *G. superba* is applied externally to treat venereal diseases (Dounias 2006; Neuwinger 1996; Yamanda 1999), wounds (Burkill 1995; Dounias 2006; Haerdi 1964; Hassan & Roy 2005; Katewa *et al*. 2004; Neuwinger 1996;), parasitic skin diseases (Dounias 2006; Hassan & Roy 2005; Watt & Breyer-Brandwijk 1962) and head lice (Burkill 1995; Haerdi 1964; Maradjo 1977; Neuwinger 1996; Watt & Breyer-Brandwijk 1962). *G. superba* is often used directly without any specific preparation around doors and windows to repel snakes and scorpions.

Poisonous properties of *G. superba*

G. superba is most commonly used as a remedy for skin diseases, as an abortifacient, snake bite or scorpion sting antidote, murder poison, suicidal agent and culpable homicide, head lice killer and as a cure for wounds (Figure 2.2). The dominance of poisoning categories e.g. abortifacient, murder poisoning, head lice killer, treatment of skin diseases (antiparasitic) among the major uses of *G. superba* is not surprising (Figure 2.2). The toxicity effects of *G. superba* are well documented

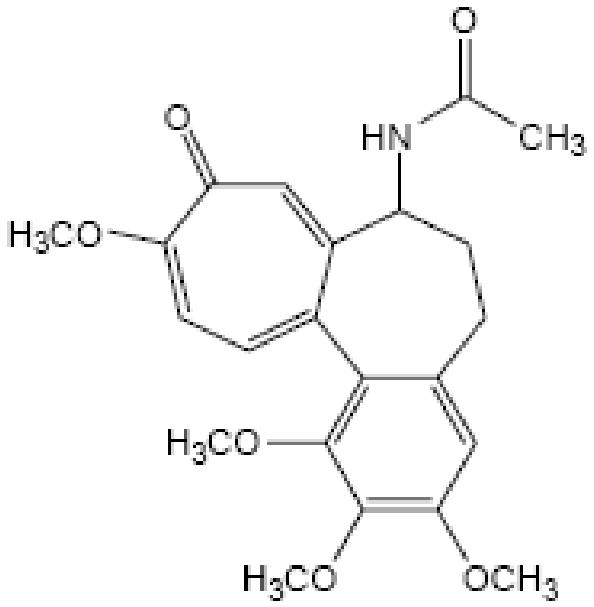


Figure 2.1. Molecular structure of colchicine (Cerquaglia *et al*. 2005**).**

(Aleem 1992; Bunyapraphatsara & van Valkenburg 1999; Dasheiff & Ramirez 1985; Jana & Shekhawat 2011; Neuwinger 1996; Reynolds & Oakley 1984; Sechi *et al*. 2003; Van Wyk *et al*. 2002; Verdcourt & Trump 1969; Watt & Breyer-Brandwijk 1962; Wisniewski & Terry 1967). The experimental use of colchicine on rats and monkeys has been shown to induce epileptic foci in rats, causing generalised seizures and death in both animal species (Dasheiff & Ramirez 1985; Reynolds & Oakley 1984; Sechi *et al*. 2003; Wisniewski & Terry 1967). Its applications in folk medicine over the years seem to exploit its poisonous constituents (Bunyapraphatsara & van Valkenburg 1999; Verdcourt & Trump 1969). Traditional healers seem to be aware of its toxicity as the amounts they prescribe to their patients are such that the toxic symptoms are minimised. Using larger dosages usually result in poisoning and death of the patients. Its poisonous properties are due mainly to colchicine (Figure 2.1), the tropolon alkaloid regarded as the biological hallmark of the family Colchicacae to which *G. superba* belongs (Hegnauer 1963; Raffauf 1970; Vinnersten & Larsson 2010; Wildman & Pursey 1968). Colchicine is documented as one of the seven upavishas (semi-poisonous drugs) in Indian medicine, which cure many ailments but may prove fatal on misuse (Jana & Shekhawat 2011; Joshi 1993; Malpani *et al*. 2011). Other compounds such as colchicoside, gloriosine, lumicolchicine, 3-demethyl-N-deformyl-N-deacetylcolchicine, 3-demethylcolchicine, N-formyl deacetylcolchcine have also been isolated from the plant (Ade & Rai 2009; Suri *et al*. 2001).

A new colchicine glycoside, 3-O-demethylcolchicine-3-O-alpha-D-glucopyranoside from *G. superba* seeds has recently been described (Suri *et al*. 2001).

The use of tubers and seeds of *G. superba* in traditional medicine have caused numerous human deaths in tropical Africa (Van Wyk *et al*. 2002; Verdcourt & Trump 1969; Watt & Breyer-Brandwijk 1962), India and Sri Lanka (Aleem 1992; Eddleston 2000; Fernando & Fernando 1990). *G. superba* has also been used for centuries for homicide, suicide and inducing abortion (Eddleston 2000; Fernando 2001; Modi 1988; Saravanapavananthan 1985). In Nigeria, *G. superba* tuber is added to conventional arrow poisons, e.g., *Strophanthus sarmentosus* DC. and *S. hispidus* DC. (Neuwinger 1996). Both intentional and accidental poisoning with *G. superba* have been reported from Africa and Asia (Agunawella & Fernando 1971; Dunuwille *et al*. 1968; Eddleston 2000; Watt & Breyer - Brandwijk 1962). The tubers of *G. superba* have been documented as dangerous to grazing stock in tropical Africa, causing stock losses in some instances (Burkill 1995; Dalziel 1955; Neuwinger 1996; Watt and Breyer-Brandwijk 1962) and they are used in some cases to poison cattle particularly in India (Satri 1956).

Pharmacological activities of *G. superba*

The traditional and clinical uses of *G. superba* for the treatment of Familial Mediterranean Fever (FMF), gout, tumour and as an antiparasite have been given some validation by modern pharmacological studies. For example, colchicine from the seeds and tubers of *G. superba* have been used for several years against acute attacks of gout arthritis (Bruneton 1999; Harborne *et al*. 1997; Hartung 1954). The U.S. Food and Drug Administration (FDA) officially approved the oral use of colchicine as a drug for some human disorders in 2009 (Ade & Rai 2010). Colchicine is the only drug available for patients with FMF to prevent both acute attacks and long-term complications such as amyloidosis (Cerquaglia *et al*. 2005; Rigante *et al*. 2006). Since 1972 colchicine has become the drug of choice for prophylaxis against FMF attacks and amyloidosis FMF-associated complications (Cerquaglia *et al*. 2005). Colchicine is able to prevent activation of neutrophils, binding β-tubulin and making β-tubulin-colchicine complexes; this way it inhibits assembly of microtubules and mitotic spindle formation (Cerquaglia *et al*. 2005). Colchicine dose in adults is 1 mg daily and in non-responder patients it can be increased to 2 mg until the clinical remission is observed (Rigante *et al.* 2006). In children, the starting dose is adjusted according to their body weight or body surface area, the minimal dose is about 0.25 mg daily until 2 years, but the full daily dose of 1 mg can be

reached at the age of 6-7 years (Rigante *et al.* 2006). In the past it has been shown that children less than 5 years of age might need colchicine doses only as low as 0.07 mg/kg/day (Rigante *et al.* 2006).

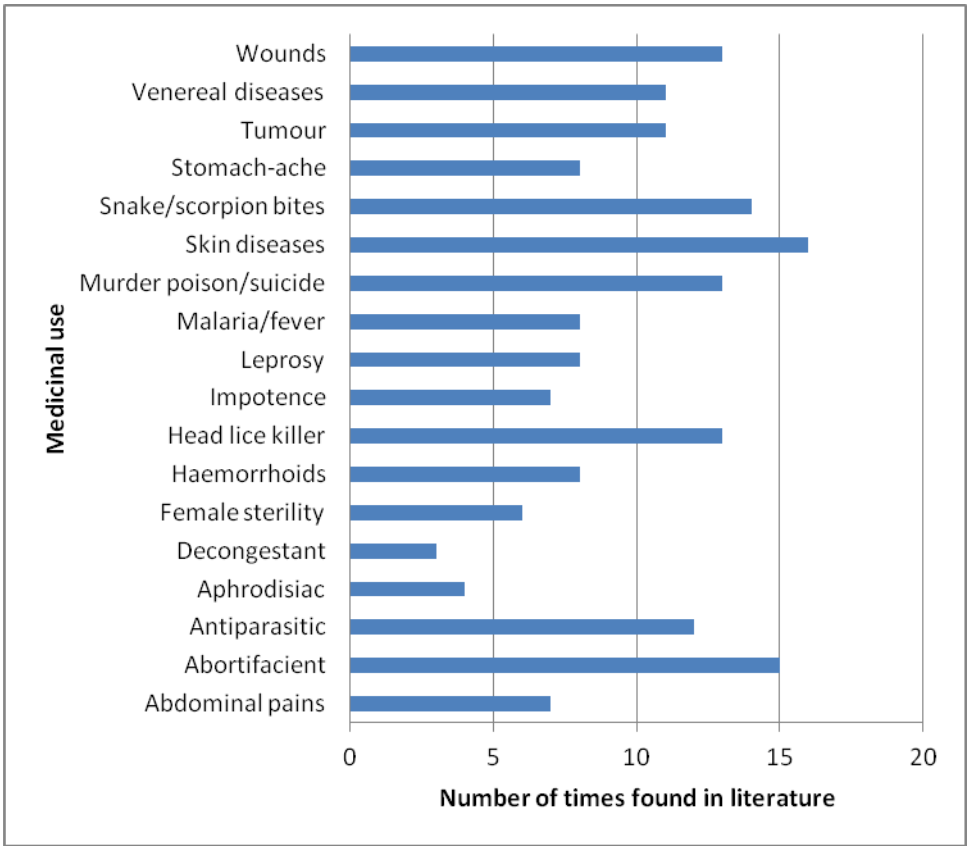


Figure 2.2. Main medicinal applications of *G. superba* in South Africa, tropical Africa and Asia

Anti-inflammatory activity

Colchicine inhibits microtubule polymerisation by binding to tubulin, one of the main constituents of microtubules (Ade & Rai 2010). Availability of tubulin is essential to mitosis, and therefore, colchicine effectively functions as a mitotic or spindle poison. Since one of the defining characteristics of cancer cells is a significantly increased rate of mitosis, this means that cancer cells are significantly more vulnerable to colchicine poisoning than are normal cells (Ade & Rai 2010). Colchicine causes inhibition of the formation of the spindle apparatus during cell division of the cell nucleus in the metaphase, interfering with cell division, for example, blood-forming organs, mucous membranes of the digestive organs, tumour cells, etc (Ade & Rai 2010). Tubers of *G. superba* are known to have mutagenic properties (Agunawella & Fernando 1971). Previous studies on tubers of

G. superba have shown them to possess mutagenic properties when the Ames *Salmonella* mutagenicity test was applied to them (Hemaiswarya *et al.* 2009). The extracts of *G. superba* showed frame shift (TA98) signs of mutagenic activity without exogenous metabolism. In addition, they enhanced the mutagenic activity of the mutagen 2-nitrofluorene used in assays with the TA98 strain without exogenous metabolism (Hemaiswarya *et al*. 2009).

Leaf extracts of *G. superba* displayed anticoagulant properties by inhibiting thrombin-induced clotting with IC_{50} values of 2.97 mg/ml (Kee *et al*. 2008). A "hypercoagulable state" is often associated with cancer (Kee *et al.* 2008). Due to the recognised link between cancer and hypercoagulation, medications able to treat cancer and having antithrombotic or anticoagulant activity would be ideal as chemotherapeutic agents (Kee *et al*. 2008). Alcoholic, hydroalcoholic and aqueous extracts of *G. superba* tubers have been shown to have significant anti-inflammatory activity in male albino rats (Singh *et al*. 2007). According to these investigations, aqueous extract of 250 mg/kg of *G. superba* tubers showed the best anti-inflammatory activity. Oral administration of colchicine at 2, 4 and 6 mg/kg body weight resulted in 48.9%, 68.7% and 79.1% inhibition respectively, while 30.9% inhibition was obtained in the phenylbutazone 100 mg/kg treated group once daily for a period of 4 days (Joshi *et al*. 2010). These results clearly indicate that colchicine is more effective as an anti-inflammatory agent compared with phenylbutazone, the standard drug used in this particular study. Aerial parts of *G. superba* have been found to possess moderate anti-inflammatory effect that was evidenced by the significant reduction in paw edema and cotton pellet granuloma methods (John *et al*. 2009). Analgesic, anti-inflammatory and wound healing action observed in these studies may be attributed to the phytoconstituents present in *G. superba*. These findings suggest that *G. superba* extracts have the potential to be developed as chemotherapeutic agents that can be used to prevent or to inhibit the growth of tumours and cancers, and also to speed up the wound healing process.

Antibacterial activity

Crude petroleum ether, methanol and aqueous extracts of the root tubers of *G. superba* gave fractions that exhibited a broad spectrum of antibacterial activity against the Gram-negative bacteria as determined by both agar well and disc diffusion techniques (Hemaiswarya *et al*. 2009). The Gram-positive bacteria *Bacillus subtilis*, *Staphylococcus aureus* were inhibited by the extracts at concentrations of up to 1 mg/ml as determined by the minimum inhibitory concentration (Hemaiswarya *et al*. 2009). A higher inhibitory activity was observed against *Escherichia coli* than

to the other two Gram-negative microorganisms (Hemaiswarya *et al.* 2009). All the three extracts were significantly more active against *E. coli* and *Proteus vulgaris* (MIC 50 µg/ml) than *Salmonella typhi* (MIC 100 µg/ml) (Hemaiswarya *et al*. 2009). Similar studies also gave mild to moderate antibacterial activities by the crude extract and subsequent fractions of *G. superba* (Khan *et al*. 2008). The chloroform fraction displayed the highest antibacterial sensitivity against *Staphylococcus aureus* (88%) followed by the crude extract (59%) (Khan *et al*. 2008).

Antifungal activity

Methanol extracts of the root tubers and leaves of *G. superba* have been tested for antifungal activity (Hemaiswarya *et al*. 2009). A hundred percent inhibition of *Aspergillus niger* was observed with all the extracts during the first 24 hours of incubation whereas a significant reduction was noted on the next 24 hours of incubation (Hemaiswarya *et al*. 2009). The extracts also inhibited *A. terreus*, *Mucor* sp. and *Rhizopus oryzae* tested at more than 50% which exhibited a lower activity on the next 24 hours of incubation (Hemaiswarya *et al*. 2009). All the fungi were completely inhibited by the positive control, nystatin (Hemaiswarya *et al*. 2009). The results obtained from the spore germination test against *A. niger* (the most sensitive organism tested by the antifungal screening test) revealed a complete inhibition of the fungal spores observed at 500 µg/ml concentration of the petroleum ether extract (Hemaiswarya *et al*. 2009). These findings may justify the use of *G. superba* in the treatment of certain skin infections, infected wounds and also abscesses as shown in Table 2.1. Excellent antifungal sensitivity by *G. superba* have been expressed by the n-butanol fraction against *Candida albicans* and *C. glabrata* (up to 90%) and against *Trichophyton longifusus* (78%) followed by the chloroform fraction against *Microsporum canis* (80%) (Khan *et al.* 2008). These findings may justify the use of *G. superba* in the treatment of skin diseases and its application on infected wounds and also abscesses (Joshi 1993; Singh 1993).

Larvicidal, anthelmintic and nematicidal activities

Methanol extract of the flowers of *G. superba* was found to be toxic against the larvae of cattle tick *Rhipicephalus microplus* (LC_{50} = 153.73 ppm; LC_{90} = 1794.25 ppm) (Zahir *et al*. 2009). Acetone extract of the flowers of *G. superba* was found to be toxic against the adult sheep internal parasite *Paramphistomum cervi* (LC_{50} = 157.61 ppm; LC_{90} = 747.02 ppm) (Zahir *et al*. 2009). In the same study, methanol extract of *G. superba* flowers was found to be toxic against the fourth instar larvae of *Anopheles subpictus* (LC_{50} = 106.77 ppm; LC_{90} = 471.90 ppm) (Zahir *et al*. 2009). It was also

found to be toxic against the larvae of *Culex tritaeniorhynchus* (LC_{50} = 59.51 ppm; LC_{90} = 278.99 ppm) (Zahir *et al*. 2009). These findings suggest that the methanol and acetate extracts of *G. superba* have the potential to be used in the control of *R. microplus, P. cervi, A. subpictus* and *C. tritaeniorhynchus*. Methanol extracts of the leaves of *G. superba* were found to be toxic against the adult cattle tick *Haemaphysalis bispinosa* (LC_{50} = 256.08 ppm) (Bagavan *et al*. 2009). In the same study, methanol extracts of *G. superba* were found to be toxic against sheep fluke *Paramphistomum cervi* (LC_{50} = 60.16 ppm) (Bagavan *et al*. 2009). Acetone extracts of *G. superba* were found to be toxic against the fourth instar larvae of malaria vector, *Anopheles subpictus* (LC_{50} = 18.43 ppm) (Bagavan *et al*. 2009). These results suggest that extracts of *G. superba* may serve to control larvae of cattle ticks, adult sheep internal parasites, sheep fluke and the larvae of the malaria causing vector.

The ethanol and water extract of *G. superba* showed anthelmintic activity against Indian earthworms *Pheretima posthuma* (Pawar *et al*. 2010). Aqueous and ethanol extracts at 20-60 mg mL^{-1} produced significant activity against earthworms when compared with piperazine citrate (15 mg mL^{-1}) which is regarded as the standard reference and as normal saline control (Pawar *et al.* 2010). *G. superba* seeds showed moderate nematicidal activity against the root-knot nematode, *Meloidogyne incognita* (Nidiry *et al*. 1993). The extracts of the shoots and of the tubers of *G. superba* are known to have strong nematicidal activity, which can be attributed mainly to colchicine (Bunyapraphatsara & van Valkenburg 1999). These findings suggest that crude forms of *G. superba* can be used to control nematodes and other related organisms.

Other activities

Other studies have evaluated the enzyme inhibition activities of *G. superba* rhizome extract against lipoxygenase, actylcholinesterase, butyrycholinesterase and urease in which wonderful inhibition was observed on lipoxygenease (Khan *et al*. 2007). The aqueous extract of *G. superba* root showed oxytocic activity and early abortifacient activity on the female reproductive system of rats (Malpani *et al*. 2011). These findings provide justification for the use of *G. superba* as an abortifacient and other ethnobotanical uses as shown in Table 2.1.

Toxicity and adverse effects

10 mg of colchicine has been documented as the toxic dose which may cause a lethal effect in humans (Rigante *et al*. 2006). According to this research, colchicine is not associated with a reduced

fertility rate in women or with a higher miscarriage rate and stillbirths; on the contrary colchicine might improve female fertility and pregnancy outcome. This is an observation that contradicts the findings of Malpani *et al.* (2011), who found colchicine to have oxytocic activity and early abortifacient activity on the reproductive system of female rats. More than 40 mg of colchicine in humans is invariably fatal within three days of ingestion (Bruneton 1999). Side effects associated with the use of *G. superba* as a cure for FMF are listed in Table 2.2. Side effects increase in older patients or in those affected by liver or kidney failure (Rigante *et al*. 2006). Just after ingestion of toxic levels of colchicine, the symptoms develop within two hours (Table 2.3). The first signs of toxicity include vomiting, numbness and severe effects on throat as well as diarrhea leading to dehydration (Table 2.3). Alopecia and dermatitis are the major symptoms that develop after two to three weeks after poisoning (Cerquaglia *et al.* 2005; Maxwell *et al*. 2002; Rigante *et al*. 2006). Multi-organ failure can develop 24 to 72 hours after ingestion. These include bone marrow depression, hemolytic anemia, liver damage, renal failure, respiratory distress syndrome, arrhythmias, neuromuscular disturbances, paralysis and disseminated intravascular coagulation (Cerquaglia *et al*. 2005; Maxwell *et al*. 2002; Rigante *et al*. 2006). Over-dosage may frequently lead to a cholera-like syndrome associated with dehydration, shock, acute renal failure, alopecia, hyperthermia, hepatocellular failure, epileptic seizures, coma and death (Rigante *et al*. 2006).

Table 2.2. Colchicine side effects (after Rigante *et al.* 2006)

Affected body part	Side effects
Gastrointestinal tube	Abdominal pain, nausea, vomiting, diarrhea, cholera-like gastroenteritis, abdominal distension, malabsorption syndrome, secondary lactose intolerance
Muscular apparatus	Myopathy, proximal muscular weakness, rhabdomyolysis, elevation in serum creatine kinase concentration
Peripheral nerves	Axonal neuropathy, ascending polyneuritis, hyporeflexia
Blood	Bone marrow depression (leukopenia, thrombocytopenia, aplastic anemia)
Gonads	Reversible azoospermia
Skin	Alopecia, skin reactions
Heart	Arrhythmias

Conclusions

The pharmacological studies conducted on *G. superba* indicate the immense potential of this plant species in the treatment of inflammatory, parasitic and bacterial ailments. Different pharmacological studies in a number of experiments have convincingly demonstrated the ability of *G. superba* to

exhibit a wide range of pharmacological activities lending support to the rationale behind several of its traditional ethnobotanical uses as detailed in Table 2.1. These results may justify the use of *G. superba* as an anti-inflammatory and anti-microbial medicine in a couple of African and Asian countries. Correlation between the ethnomedicinal employment and the pharmacological activities has been duly observed and described in the present review. In fact, these findings suggest that *G. superba* has the potential to be developed as a chemotherapeutic agent to prevent or to inhibit the growth of tumours and cancers. While there are still gaps in the clinical studies conducted so far, which need to be bridged in order to exploit the full medicinal potential of *G. superba*, it is still very clear that this widespread plant species has tremendous potential for the future. There is need for further research, clinical trials and product development. This should include the study of the acute toxicity, sub-acute toxicity, chronic toxicity and pharmacological safety associated with the use of *G. superba* as medicine. Detailed animal and human acute and chronic toxicity studies of colchicine and its derivatives are required prior to clinical testing. Traditional healers seem to be aware of its toxicity as the amounts they prescribe are such that toxic symptoms are minimised. Using larger dosages usually result in human poisoning. On the basis of current information and evidence, *G. superba* extracts are characterised by instances of toxicity and it should be used under supervision of a physician.

Table 2.3. Sequential and overlapping stages of colchicine toxicity (after Maxwell *et al.* 2002; Cerquaglia *et al.* 2005)

Phase	Symptoms
0-24 hours	Nausea, vomiting, diarrhoea, abdominal pain and anorexia. Electrolyte imbalance and hypovolaemia. Peripheral leucocytosis
2-7 days	Bone marrow hypoplasia, profound leucopenia, and thrombocytopenia. Cardiac arrythmias and cardiovascular collapse. Respiratory distress, hypoxia and pulmonary oedema. Oliguric renal failure. Rhabdomyolysis. Electrolyte derangements. Metabolic acidosis. Mental state changes. Seizures. Peripheral neuropathy and ascending paralysis
7th day onwards	Rebound leucocytosis. Transient alopecia

Chapter 3

Gloriosa superba L. (Colchicaceae): ethnobotany and economic importance

A. Maroyi and L.J.G. van der Maesen. In press. XIXth AETFAT Proceedings/Plant Ecology and Evolution

Gloriosa superba **L., characterised by yellow, heavily crisped perianth segments, photograph taken by Prof. L.J.G. van der Maesen, outside Great Zimbabwe Hotel, Great Zimbabwe, Masvingo, Zimbabwe**

Chapter 3: *G. superba* L.: ethnobotany and economic importance

Abstract

The present study is a comprehensive analysis of traditional, folkloristic and economic uses of *Gloriosa superba* L. (Colchicaceae) over its distributional range. Herbarium, field and ethnobotanical studies were supplemented by a detailed literature review. Data on vernacular names and how *G. superba* is used in the countries where it occurs were assembled together with linguistic aspects. Although the relative importance of *G. superba* varies by location, it is one of the most widely used plant species in the tropics, and is used in strikingly similar ways throughout its geographical range. The plant has escaped in several localities becoming naturalised, even a weed in some places; but it continues to be sold as an ornament even in those areas where it is naturalised. In some parts of India, it is considered threatened due to over-harvesting by the pharmaceutical trade.

Key Words: Ethnobotany; folkloristic uses; *Gloriosa superba*; horticulture; weed

Introduction

Gloriosa L. belongs to the family Colchicaceae, a horticulturally well known family of common garden ornamental herbs such as Bellworts (*Uvularia* spp.) and Naked Ladies (*Colchicum* spp.). The phylogeny and classification of the family Colchicaceae was recently investigated using cpDNA sequence data (Vinnersten & Manning 2007; Vinnersten & Reeves 2003). This study established the monophyly of the family as defined by Nordenstam (1998), composed of species with rhizomes, non-sheathing leaves, reticulate venation and berries. Members of Colchicaceae are known to contain the alkaloid colchicine, regarded as the biological hallmark of the family (Hegnauer 1963; Raffauf 1970; Vinnersten & Larsson 2010; Wildman & Pursey 1968). Colchicine is today commercially extracted from *Gloriosa* and *Colchicum*.

More than 40 species names of *Gloriosa* have been listed (IPNI 2011), although other authors (e.g. Dyer *et al.* 1962; Field 1971, 1972; Geerinck 2010; Hoenselaar 2005; Maroyi 2002; Thulin 1995; Wild 1965) regard *Gloriosa* as a monotypic genus, consisting of a single highly variable species, *G. superba*. The major variations in genus *Gloriosa* mainly involve plant height, shape, size and flower colour. Plant height varies from short and erect to long, slender, climbing on the surrounding vegetation to which it clings for support. The leaf tips are elongated into curling, twisting tendrils which twine around other vegetation and there are also plants without leaf tendrils, others with short

or inconspicuous leaf tendrils. Leaves in *Gloriosa* may be uniformly linear-lanceolate, lanceolate or broadly ovate. The short form normally has a single flower at the apex, while taller forms can carry many flowers, one in each of the upper leaf axils. Leaf arrangement is normally alternate, opposite, whorled or irregular or different combinations of phyllotaxis may exist on one plant. *Gloriosa* shows considerable amount of variation in its appearance, the perianth segments attain a full colour of either pure yellow or bi-coloured: red and yellow or purple and yellow. Plants with bi-coloured perianth segments tend to lose the yellow colour and turn either red or purple but the yellow tinge does not completely fade especially from the adaxial side. The perianth segments are variable in shape and size. There are two extreme forms of perianth segments: one which is heavily crisped and narrowly uniform throughout its entire length and broader, plane-margined perianth segments. With a large number of forms available for examination in one place, the differences are sometimes startling (Wild 1965). Variation is endless and one gets the impression that more than one species is involved (Wild 1965). The present authors are currently employing field investigations, biogeographical, morphological and molecular studies aimed at resolving the taxonomy of genus *Gloriosa.* It is clear that the genus needs taxonomical revision, given its traditional, present day and potential domestic and industrial uses. As the pharmaceutical industry research progresses, wide use of unpublished and doubtful names is creating problems and considerable taxonomic confusion. Therefore, this investigation is aimed at documenting traditional, folkloristic and economic uses of *G. superba* over its distributional range.

Materials and Methods

Literature review on traditional, folkloristic and economic uses of *G. superba*

The study was conducted from 2007 to 2011. We began the present study by a literature review, in order to document traditional, folkloristic and economic uses of *G. superba*. Records of uses of *G. superba* over its distributional range were identified during a review of over 200 multidisciplinary, mostly English language publications. Sources of information included: Bunyapraphatsara & van Valkenburg 1999; Burkill 1995; Dalziel 1955; Dounias 2006; Ganesan *et al*. 2007; Geetha *et al.* 2007; Gelfand *et al.* 1985; Ghani 1998; Haerdi 1964; Jagtap *et al*. 2006; Jain *et al*. 2004; Katewa *et al*. 2004; Neuwinger 1996; Prayoonrat 2005; Sandhya *et al.* 2006; Saralamp *et al.* 1996; Satri 1956; Sivakumar & Krishnamurthy 2002; Tiwari & Yadav 2003; Van Duong 1993; Van Steenis-Kruseman 1953; Watt & Breyer-Brandwijk 1962; Williams 1949; Yamanda 1999; Yineger & Yewhalaw 2007 and various Floras. An online literature search was also conducted using BioMed Central (www.biomedcentral.com), Blackwell Synergy (www.blackwell-synergy.com), CAB Abstracts

(www.cabi.org), Elsevier ScienceDirect (www.sciencedirect.com), Ingenta Connect (www.ingentaconnect.com), ISI Web of knowledge (www.isiknowledge.com), intute (www.intute.ac.uk) and JSTOR (www.jstor.org) for scientific articles published before June 2011. References were also identified by searching the extensive library collections of the National Herbarium and Botanic Gardens, Harare and Wageningen University, the Netherlands. Data collected from the literature included: use(s), mode of preparation, administration, and cultural uses of the species, if mentioned. Suitable books or potential literature sources were identified in online databases of the particular libraries by searching for the terms botanical medicine, cultural uses, economic uses, ethno botany, ethno medicine, folk medicine, folkloristic uses, horticultural uses, indigenous medicine, traditional medicine of *Gloriosa superba*.

Herbarium and field studies

Over 1 200 herbarium specimens of *Gloriosa* on loan to the National Herbarium of the Netherlands, Wageningen branch (WAG) from the following herbaria: B, BM, BR, C, COI, F, K, L, P, S, U, UPS and collections kept in the following herbaria: SRGH and WAG (abbreviations follow Holmgren *et al.* 1990) were examined. Field studies were conducted in Zimbabwe between November 2007 to January 2011. Specific localities visited were determined from labels on herbarium specimens at the National Herbarium and Botanic Garden (SRGH) in Harare. These herbarium specimens were studied prior to field studies and during the course of the field work to obtain information on geographical distribution of *Gloriosa*, habitat, ecology, growth habit and determining its range of variation. As deduced from information given on herbarium labels and literature, *Gloriosa* in Zimbabwe tends to flower and/or fruit between November and May. Thus, fieldwork was conducted during this period.

Documentation of *G. superba* uses by both the rural and urban communities in Zimbabwe was also undertaken during field studies. This study utilised Participatory Rural Appraisal (PRA) (Chambers 1992; FAO 1989). This participatory approach provides a valuable insight into the multiple meanings, dimensions and experiences of local people with plant resources. It captures information that standard plant use methods are likely to miss. Use of open-ended methods, such as unstructured interviews and discussion groups allowed the emergence of issues and dimensions that are important to the community but not necessarily known to the researcher, thus allowing unanticipated themes to be explored by the interviewer (Miles & Huberman 1994). Prior informed consent was obtained orally before the start of each interview. All interviews were conducted in Shona, since the first author is a native speaker of the language. The process involved close consultation with the

community in information sharing, data gathering and compilation. It involved visiting several villages, communities and discussing with many individuals the uses and cultural importance of *G. superba*. Purposive sampling was used in the selection of participants in order to allow us to have an in-depth focus on the issues important to the study (Cohen & Manion 1989).

Results and Discussion

Geographical distribution

G. superba occurs naturally in subtropical, tropical Africa and Asia, and it is now naturalised in Fiji (Wright *et al*. 2005), the Réunion-Mascarene Archipelago (Tassin *et al.* 2007) and along parts of the Australian coast from north of Sydney to south-east Queensland (Grove *et al.* 2005). It is now invasive on Moreton Island and along the north coast of New South Wales (Grove *et al.* 2005; Le Cussan 2006), Lord Howe Island (Orchard 1994), French Polynesia Society Islands (Welsh 1998), Karibati Line Islands (Wester 1985), and Solomon Islands (Hancork & Henderson 1988). *G. superba* is cultivated throughout the world in many botanical and private gardens as an ornamental plant.

G. superba is important to people over the globe since 1600s or earlier, since it was included in some early floristic accounts (e.g. Adanson 1763; Crantz 1766; Herman 1687; Lamarck 1796). Miller (1768), in his Gardeners Dictionary, gave a hint on the deadly nature of *G. superba*, noting that "the root and every part of this plant is very poisonous, so should not be put in the way of the children". By Miller's time, *G. superba* was probably already a popular garden plant. The fact that both generic and specific names (i.e. *Gloriosa superba)* assigned by Linnaeus, describe the superb nature of the plant species means that we are dealing here with a beautiful ornamental plant of considerable antiquity. Explorers from Europe and Great Britain displayed some morphological forms of *G. superba* in the famous gardens at Kew, Chelsea Physic Garden in London and Amsterdam Botanic Gardens (Hoog 1950; O'Brien 1903, 1904). British, continental European and American nurserymen popularised and commercialised many colourful forms in the 18th and 19th centuries. Hundreds of cultivars (e.g. Boom 1953, Bracelin 1942; Brumbash 1971; Hoog 1950; O'Brien 1903, 1904) have been developed as ornamentals for temperate climates. They are widely cultivated in America, Europe and Australia as garden flowers. It was introduced in Hawaiian Islands in the 19th century (Hillebrand 1888) and several forms from Central African countries and Equatorial Guinea (Fernando Póo, now Bioko) were also introduced at Kew (O'Brien 1903, 1904). Quisumbing (1978) recorded *G. superba* as a recent introduction in the Philippines, where it is cultivated as an ornamental garden plant. The abundance of *G. superba* is recorded on herbarium labels as ranging

from rare, occasional, and common to abundant. Where we have seen the plants in the field, for example in Malawi, South Africa, Zambia and Zimbabwe, they are in small patches, counting one to several individuals. *G. superba* is found from sea level to 2400 m altitude, growing in natural forests, thickets, savanna, and secondary or disturbed vegetation, hedgerows in which the lower part of the plant is shaded and the upper flower-bearing stems reach out for the sun.

Folkloristic uses of *G. superba*

G. superba is known by a multiple of vernacular names (Table 3.1), which are not specific to any particular morphological type, form or any of the previously described species, but rather refer to *G. superba* sensu lato. Vernacular or common names of plants in some cases may indicate morphological features or may point to certain resemblances to other plants or to the agent of introduction or some cultural aspect. The introduction of *G. superba* to new localities, e.g. Australia resulted also in passing on of common names particularly English common names. These names may also aid in identifying the geographical origin of the species and the pathways of diffusion. Such informative names include Rhodesian Flame Lily, an English name widely used in Australia. This common name is describing the plant and at the same time the native country of the species (Rhodesia, now Zimbabwe), where it is the country's national flower. *G. superba* was selected as the national flower of Southern Rhodesia (now Zimbabwe) in 1953, during the federation of Northern Rhodesia (now Zambia), Southern Rhodesia and Nyasaland (now Malawi). The design was chosen by Lord Llewellin, the first Governor General of the Federation of Rhodesia and Nyasaland "I have decided to use an African Flame Lily (*G. superba*) as the emblem, a flower of great beauty which grows naturally in each of the three territories"[1] (i.e. present-day Malawi, Zambia and Zimbabwe), which comprised the Federal area.

Table 3.1. Vernacular names of *Gloriosa superba*

Common name	Language / Region / Country	Source / Notes
Adavi-nabhi	Telugu, India	Ambasta 1986
Add'aawa	Borana, Kenya	Neuwinger 1996
Adin tuki	Warrangeleh, Northern Somalia	*Adin tuki* = crow's leg (Collenette 1929); Thulin 1995
Agananmoigbo	Nigeria	Millen 1892
Aganèribgo	Nago / Yoruba, Benin	Van der Burg 2006
Aganĕrigbo	Yoruba, Nigeria	Burkill 1995; Dalziel 1955

[1] National Archives of Zimbabwe (Reference F201/GG24)

Agnimukhi	Sanskrit, India	Ambasta 1986
Agnishike	Kannada, India	Farooqi & Sreeramu 2001
Agnishikha	Sanskrit, India	Ambasta 1986; Jain *et al.* 2004
Agnisikhe	Kanari, India	Ambasta 1986
Ailni	Sanskrit, India	Ambasta 1986
Ajoma	Gun / Goun, Benin	Van der Burg 2006
Akanyamarenge	Kirundi, Burundi	Neuwinger 1996
Akáwamóigbó	Yoruba, Nigeria	Burkill 1995
Akkinichilam	Tamil, India	Ambasta 1986
Akkatangiballi	Kanari, Kannada, India	Ambasta 1986; Farooqi & Sreeramu 2001
Akwèma	Goun / Gun, Benin	Van der Burg 2006
Akwe masi	Fon, Benin	Van der Burg 2006
Alo-ngu	Fang, Gabon	Neuwinger 1996
Amagugulume	Ndebele, South Africa	*Amagugulume* = denotes the flower's resemblance to the cock's head, Neuwinger 1996
Amakukhulume	Ndebele, Zimbabwe	*Amakukhulume* = denotes the flower's resemblance to the cock's head (Wild *et al.* 1972); Neuwinger 1996
Aramandewa	Addis Ababa, Ethiopia	Neuwinger 1996
Archmandawa	Galla, Ethiopia	Mooney 1962
Asase foro	Twi, Ghana	Burkill 1995; Dalziel 1955; Neuwinger 1996
Atandi bihil	Basari, Senegal	Burkill 1995
Atandi bihil kuta	Basari, Senegal	Burkill 1995
A-tiándiwù	Basari, Guinea	*A-tiándiwù* = rainbow in the sky, Burkill 1995
Ayanan moigbo	Goun / Gun, Benin	Van der Burg 2006
Ayanan-moigbo	Yoruba, Nigeria	Dalziel 1955
Babukanjuju	Nyindu, DR Congo	Neuwinger 1996
Bachnag	Bombay/Mumbai, India	Ambasta 1986
Balajejo	Kisi, Sierra Leone	Neuwinger 1996
Balayeo	Kissi, Sierra Leone	Burkill 1995
Basongo	Banda, Central African Republic	Neuwinger 1996
Baurere	Hausa, Nigeria	Burkill 1995; Dalziel 1955; Neuwinger 1996
Bavdi tévédi	Pulaar, Senegal	Burkill 1995
Bere gyimlo	Dogon, Mali	Burkill 1995; Neuwinger 1996
Bishalanguli	Bengali, India	Ambasta 1986
Boboydié	Guere / Shien, Ivory Coast	Burkill 1995; Neuwinger 1996
Borompa	Gurma, Burkina Faso	Neuwinger 1996
Brĕbia	Fant, Ghana	Burkill 1995; Dalziel 1955; Neuwinger 1996
Cây ngót nghẽo	Vietnamese, Vietnam	Van Duong 1993
Cây nhú nhoái	Vietnamese, Vietnam	Van Duong 1993
Chikongoromandianga	Kimwera, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Citambala	Nyanga / Cewa / Ngoni / Nsenga / Tonga, Zambia	Fowler 2007
Cubisseque	Guinea	Espirito Santo 1945
Cumarô-túrô	Manding-Mandinka, Guinea-Bissau	Burkill 1995
Dabalole	Somalia North, Somalia	Thulin 1995
Da favo	Borana, Kenya	Wall s.n.
Dao dung	Thailand	Sangkhachand & Smitinand 1964
Dawaurahman	Jimma, Ethiopia	Yineger & Yewhalaw 2007
Déléngor	Serer, Senegal	Burkill 1995
Dema-dema	Mende, Sierra Leone	Burkill 1995
Deman-dema	Kono, Sierra Leone	Burkill 1995, Neuwinger 1996
Demnal nagge	Fulani, Nigeria	*Demnal nagge* = cow's tongue, Burkill 1995; Dalziel 1955
Dene dana	Dogon, Mali	Neuwinger 1996
Diélingor	Serer, Senegal	Burkill 1995
Djambel gak	Fulani, Cameroon	Neuwinger 1996
Dokomerabo	Sierra Leone	Thomas 1914
Dondo ngolo	Manding-Bambara, Senegal	Burkill 1995

Donon tulu	Manding-Bambara, Senegal	*Donon tulu* = comb of the cock, Burkill 1995
Dongkèl sungsang	Javanese, Indonesia	Maradjo 1977
Dong Dueng	General, Thailand	Bunyapraphatsara & Van Valkenburg 1999; Saralamp *et al.* 1996
Dudhiovachnag	Gujrati, India	Ambasta 1986
Dumun tulo	Mandinka, Senegal	Burkill 1995
Dunun tulu	Manding-Bambara, Senegal	Burkill 1995
Egwarere	Benin, Nigeria	Dalziel 1955; Farquhar 1908
Emmere yannamunye	Ganda, Uganda	Neuwinger 1996
Enatba	Dawan, Lesser Sunda Island, Indonesia	Jessop 1983
Enyamukonora	Langaunkole, Uganda	Purseglove 1938
Erimbi	Kisonjo, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Eshi	Bambindjere, Central African Republic	Harris & Fay 1988
Ewe ajè	Nago / Yoruba, Benin	Van der Burg 2006
Ewé-ajě	Yoruba, Nigeria	*Ewé-ajě* = sorcerer's leaf, Burkill 1995; Dalziel 1955; Farquhar 1908; Millen 1892
Faraji diil	Saakow, Somalia	Synnott 1987; Thulin 1995
Gaal waaqa	Boran, Kenya	Neuwinger 1996
Ganjeri	Telugu, India	Ambasta 1986
Garbhaghatini	Sanskrit, India	Ambasta 1986
Garbhhogh-hatono panjangulia	Oriya, India	Ambasta 1986
Gatarin kurege	Hausa, Nigeria	*Gatarin kurege* = ground squirrel's hatchet, describing the shape of the tuber which is occasionally like an axe-head, Burkill 1995; Dalziel 1955; Neuwinger 1996
Gheloac	Somalia South, Somalia	Thulin 1995
Gombogombo	Kiliguru, Tanzania	Anatoli 1955; Neuwinger 1996; Verdcourt & Trump 1969
Gowrihoo	Kannada, India	Farooqi & Sreeramu 2001
Gùdúmàr zóómóó	Kano and East Hausa, Nigeria	Gùdúmàr zóómóó literally means "hare's hammer", describing the anthers which resemble a hammer-shaped weapon used to throw at hares, etc., Burkill 1995; Dalziel 1955; Neuwinger 1996
Haduihaku	Ewe, Ghana	*Haduihaku* means if a pig eats it he will die, Burkill 1995; Dalziel 1955; Neuwinger 1996
Hamo	Boran, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Hankun	Fon, Benin	Van der Burg 2006
Harital phul	Nepali, Nepal	Manandhar 2002
Hawola	DR Congo	Louis 1937
Homa	Boran, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Ihlamvu	Zulu, South Africa	Finnie & van Staden 1994; Neuwinger 1996
Ihlamvu-lomfana-nentombazana	Ndebele, South Africa	Neuwinger 1996
Iliga ya kashishi	DR Congo	Yamanda 1999
Ikwa chia nduru	Kikuyu, Kenya	Kibue 1972
Indai	Marathi, India	Ambasta 1986
Intaremarungu	Kinyaruanda, Rwanda	Troupin 1959
Inya-orere	Benin, Nigeria	Dalziel 1955
Iriga ya kashishi	Nyindu, DR Congo	Neuwinger 1996
Itawola	Kundu, DR Congo	Louis 1936
Iyán-orere	Edo, Nigeria	Burkill 1995
Jambere jire	Fulani, Nigeria	Burkill 1995; Dalziel 1955; Neuwinger 1996
Jat-tut	Loango, Uganda	Neuwinger 1996
Jengaluwo - ngako	Nyamwezi / Sukuma, Zambia	Fowler 2007
Jinkenya	Pogoro, Tanzania	Neuwinger 1996
Khadyanag	Bombay / Mumbai, India	Ambasta 1986
Kajongwe	Shona, Zimbabwe	*Kajongwe* = denotes the flower's resemblance to the cock's head, Wild *et al.* 1972

Kalamu	Swahili, Zanzibar	*Kalamu* = pen or pencil, stem is cut and used in villages as a rough pen, Williams 1949
Kalapai	South India	Geetha *et al*. 2007; Sandhaya *et al.* 2006
Kalappagadda	Telugu, India	Ambasta 1986
Kalappaikkilanku	Tamil, India	Farooqi & Sreeramu 2001
Kalaippaik-kishangu	Tamil, India	Ambasta 1986
Kalgari	Hindi, India	Katewa *et al.* 2004
Kalihari	Sanskrit, India	Ambasta 1986; Jain *et al.* 2004; Raina & Gupta 1999; Tiwari & Yadav 2003
Kallavi	Marathi, India	Ambasta 1986
Kalume ka imbila liakanzinzi	Lega, DR Congo	Neuwinger 1996
Kalume - kandiya	Kunda, Zambia	Fowler 2007
Kandahi	Kingoni, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Kanéhi	Pulaar, Senegal	Burkill 1995
Kanuvalikodi	South India	Ganesan *et al.* 2007; Geetha *et al.* 2007
Karadikanninagadde	Kanari, India	Ambasta 1986
Kariannag	Marathi, India	Ambasta 1986
Karianag	Bombay / Mumbai, India	Ambasta 1986
Kariari	Punjab, India	Ambasta 1986
Karihari	Hindi, India	Ambasta 1986; Farooqi & Sreeramu 2001
Kasaura	Bemba, Zambia	Lees 1951
Katongkat	Sundanese, Indonesia	Bunyapraphatsara & van Valkenburg 1999; Jessop 1983; Maradjo 1977; van Steenis-Kruseman 1953
Kembang djonggrang	Malaysia, Indonesia	Jessop 1983
Kembang kuku matjan	Malaysia, Indonesia	Jessop 1983
Kembang sungsang	Malaysia, Indonesia	Jessop 1983; Maradjo 1977
Kewari	Nepali, Nepal	Manandhar 2002
Kimagugu	Marakwet, Kenya	Lindsay 1958; Neuwinger 1996; Verdcourt & Trump 1969
Kimanja nouchawi	Swahili, Kenya	Dounias 2006
Kinyagatwa	Tanzania	Frontier-Tanzania Coastal Forest Research Programme 1990
Kisukuma	Ngoko, Tanzania	Tanner 1953
Kitooke kyanyamunya	Nyoro, Uganda	Neuwinger 1996
Kizhangu	South India	Geetha *et al.* 2007; Sandhaya *et al.* 2006
Kliélélo	Kweni, Ivory Coast	Burkill 1995; Neuwinger 1996
Krilélo	Kweni, Ivory Coast	Burkill 1995; Neuwinger 1996
Kumaro turo	Mandinka, Senegal	Burkill 1995
Laenda	Bangala, DR Congo	Neuwinger 1996
Langali	Sanskrit, India	Farooqi & Sreeramu 2001; Raina & Gupta 1999
Languli	Hindi, India	Ambasta 1986; Farooqi & Sreeramu 2001
Langli	Sanskrit, India	Ambasta 1986
Léb	Wolof, Senegal	Burkill 1995
Lelema-buli	Mende, Sierra Leone	Burkill 1995; Dalziel 1955
Lelemĕ	Mende, Sierra Leone	Burkill 1995; Dalziel 1955; Neuwinger 1996
Like	Borana, Kenya	Neuwinger 1996
Likolekole	Turumbu, DR Congo	Louis 1937
Lili	Creole, Sierra Leone	Burkill 1995; Neuwinger 1996
Liqude	Ndebele, South Africa	Neuwinger 1996
Litaola	Mongo, DR Congo	Neuwinger 1996
Loriochimala sakùteri	Samburu, Kenya	Neuwinger 1996
Lontinta	Koranko, Sierra Leone	Burkill 1995
Majabe	Somali, Somalia	Neuwinger 1996
Ma khaa kong	Northern Thailand	Bunyapraphatsara & Van Valkenburg 1999
Makuwa - kuwa	Lozi / Kwangwa / Simaa / Totela, Zambia	Fowler 2007
Malabar Glory Lily	English, India	Ambasta 1986
Malattamara	Malayalam, India	Ambasta 1986
Malomenqui	Equatorial Guinea	Tessmann 1908
Mandalika	Javanese, Indonesia	Jessop 1983; Maradjo 1977

Mand(h)alika	Madurese, Indonesia	Jessop 1983
Mansa debonyaro	Manding-Mandinka, Gambia	Burkill 1995
Marau	Maasai, Purko, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Masaran machiji	Hausa, Nigeria	*Masaran machiji* = snake's maize, Burkill 1995; Dalziel 1955
Mbegebege	Kishambaa, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Mbegembege mhenzilani	Sambaa, Tanzania	Tanner 1957
Mberewere	Kisagala, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Mburiru	Kikuyu, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Mburiu	Kikuyu, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Medoni	Malayalam, India	Ambasta 1986
Meheriaphulo	Oriya, India	Ambasta 1986
Mere ganamunji	Ganda, Uganda	Neuwinger 1996
Mereganamunyi	Luganda, Uganda	Verdcourt & Trump 1969
Mettonni	Malayalam, India	Ambasta 1986
Mkalamu	Swahili, Tanzania	*Mkalamu* = pen, Dounias 2006; Neuwinger 1996
Mkalumu	Swahili, Kenya	*Mkalamu* = pen, Neuwinger 1996; Verdcourt & Trump 1969
Mkolwe	Chifipa, Chimambwe, Musa, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Mlialamu	Zanzibar	Williams 1950
Mmaatia kye	Ghana	Lamptey 1932
Molok	Maasai South, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Molong	Maasai South, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Mondaliko	Lombok Island, Indonesia	Prawiroatmodjo 1976
Mora	Nago / Yoruba, Benin	Van der Burg 2006
Morá	Yoruba, Nigeria	Burkill 1995; Dalziel 1955; Neuwinger 1996
Movi-movi	Apindji, Gabon	Neuwinger 1996
Msele	Nyanga / Cewa / Ngoni / Nsenga / Tonga, Zambia	Fowler 2007
Muatikima	Mozambique	Faulkner 1944
Mugobogobo	Kihehe, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Mulim	Punjabi, India	Ambasta 1986
Mwana funzi	Swahili, Kenya	Neuwinger 1996; Verdcourt & Trump 1969
Nabhikkodi	Tamil, India	Farooqi & Sreeramu 2001
Nagkaria	Marathi, India	Ambasta 1986
Nansa debonyaro	Genieri, Gambia	Fox 1949
Narge	Sierra Leone	Thomas 1914
Ndiollâg	Serer, Senegal	Burkill 1995
Ndol lâg	Serer, Senegal	Burkill 1995
Ngkúkún	Efik, Nigeria	Burkill 1995
Ngobop	Konyagi, Senegal	Burkill 1995
Nkufukun	Ibibio, Nigeria	Burkill 1995; Dalziel 1955
Nni nlili	Igbo, Nigeria	Burkill 1995
Nomgbache	Tivi, Nigeria	Burkill 1995; Dalziel 1955; Neuwinger 1996
Noto-a-ndu	Bafia, Cameroon	Neuwinger 1996
Nwuloko	Igbo, Nigeria	Burkill 1995; Thomas 1911
Nyaka - jongwe	Tumbuka cluster: Fungwe / Henga / Kamanga / Lambya / Nyika / Poka / Senga / Tambo / Wandya / Wenya / Yombe, Zambia	Fowler 2007
Nyamahlokane	Tonga, Mozambique	Neuwinger 1996
Nya - malokane	Nyanga / Cewa / Ngoni / Nsenga / Tonga, Zambia	Fowler 2007
Nyamukonora	Nyankere, Kiga, Uganda	Neuwinger 1996
Nyamukonora	Kinyaruanda, Rwanda	Troupin 1957, 1958
Ŏbara ŏkpa	Ibo, Nigeria	Burkill 1995; Dalziel 1955
Ognisikha	Oriya, India	Ambasta 1986
Okĕ ubŏgu	Owerri, Nigeria	Burkill 1995; Dalziel 1955

Òkòri òkónèyò	Efik, Nigeria	Òkòri òkónèyò = it develops in a night, Burkill 1995
Olodi	Aguku, Nigeria	Burkill 1995; Dalziel 1955
Ompilu	Kwanyama-Ovambo, Namibia	Neuwinger 1996
Ooma	Borana, Kenya	Neuwinger 1996
Otjinatjo	Herero, Namibia	Neuwinger 1996
Pacing tawa	Javanese, Indonesia	Bunyapraphatsara & van Valkenburg 1999; Maradjo 1977
Paiunco	Guinea	Espirito Santo 1945
Pamusele	Tumbuka cluster: Fungwe / Henga / Kamanga / Lambya / Nyika / Poka / Senga / Tambo / Wandya / Wenya / Yombe, Zambia	Fowler 2007
Pa(n)tjing towo	Javanese, Indonesia	Jessop 1983
Pate-kodzo	Adangme, Ghana	*Pate-kodzo* = bunting, Dalziel 1955; Neuwinger 1996
Phan ma ha	Lao, Laos	Bunyapraphatsara & van Valkenburg 1999; Van Duong 1993
Pipadoro	Ngowe, Gabon	Neuwinger 1996
Pipedoro	Nkomi, Gabon	Neuwinger 1996
Pipidori	Lumba, Gabon	Neuwinger 1996
Portiga	Gurma, Burkina Faso	Neuwinger 1996
Rahmaldawa	Jimma, Ethiopia	Yineger & Yewhalaw 2007
Roheratin	Karamoja, Kenya	Verdcourt & Trump 1969
Roheratin	Karamoja, Uganda	Neuwinger 1996
Sáda urio	Dogon, Mali	Burkill 1995
Sakosi	Zande, DR Congo	Neuwinger 1996
Samankantan	Twi, Ghana	*Samankantan* = bunting, Dalziel 1955; Neuwinger 1996
Sasa	Dogon, Mali	Neuwinger 1996
Sémègne ou buki	Wolof, Senegal	*Sémègne ou buki* = hyena's axe, Burkill 1995; Dalziel 1955; Neuwinger 1996
Sémèñ i buki	Wolof, Senegal	Burkill 1995
Sémèñ i gob	Wolof, Senegal	Burkill 1995
Semin buké	Wolof, Senegal	Neuwinger 1996
Sémiń buku	Wolof, Senegal	Burkill 1995
Sémingolo	Lebou, Wolof, Senegal	*Semingolo* = hatchet of the lion, in allusion to the shape of the tubercule, Burkill 1995; Neuwinger 1996
Semiñ u buki	Wolof, Senegal	Semiñ u buki = hatchet of the hyena, Burkill 1995
Sémiń u buki	Wolof, Senegal	Sémiń u buki = axe of the hyena, Burkill 1995
Séniń buku	Wolof, Senegal	Burkill 1995
Shambiroyoldi	Ethiopia	Simmons 1956
Sikal enatba	Dawan, Lesser Sunda Islands, Indonesia	Jessop 1983
Simbair	Arabic, Sudan	Wickens 1964
Simuzingili	Toka, Zambia	Fowler 2007
Siricsamano	Santal, India	Ambasta 1986
Sodi bate	Akye, Ivory Coast	Burkill 1995
Spinnebloem	Dutch, Paramaribo, Suriname	Ramsahai 2008
Táiorgo	Sierra Leone	Thomas 1914
Tamaior	Somalia North, Somalia	Thulin 1995
Tamabala	Nyanga / Cewa / Ngoni / Nsenga / Tonga, Zambia	Fowler 2007
Tengaluangoko	Kisukuma, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Tindise	Koranko, Sierra Leone	Burkill 1995
Tititambá	Fula-Pulaar, Guinea-Bissau	Burkill 1995
Tititămba	Fula-Pulaar, Senegal	Burkill 1995
Ugaele	Ibo, Nigeria	Neuwinger 1996
Ugu ele	Ibo, Nigeria	*Ugu ele* = antelope's ugu, Dalziel 1955; Neuwinger

		1996
Ulatchandal	Bengali, India	Ambasta 1986
Ulat kambal	Bengali, Bangladesh	Siddique *et al*. 2004
Umakbu	Aguku, Nigeria	Burkill 1995; Dalziel 1955
Umukonoro	Kinyarwanda, Rwanda	Michel 1959
Umwambaza	Kirundi, Burundi	Neuwinger 1996
Urio	Dogon, Mali	Neuwinger 1996
Vaeha taan	Maldives	Munch-Petersen 1977
Varhvardi	Gujrati, India	Ambasta 1986
Var sleng dong dang	Cambodian, Cambodia	Bunyapraphatsara & van Valkenburg 1999; Van Duong 1993
Vihalagon'di	Dhivehi, Maldives	Schmelzer 1991
Visalya	Sanskrit, India	Farooqi & Sreeramu 2001
Vitosambili	Kihehe, Tanzania	Neuwinger 1996; Verdcourt & Trump 1969
Waan kaam puu	Thai, Central, Thailand	Bunyapraphatsara & van Valkenburg 1999
Wigitaru	Fula, Nigeria	Burkill 1995
Wubaru	Fula, Nigeria	Burkill 1995
Zagdaili	Korku tribe, India	Jagtap *et al*. 2006
Zakoronédié	Kru-Guere, Shien, Ivory Coast	Burkill 1995; Neuwinger 1996
Zango de ekole	Aka pygmies, Central African Republic	Neuwinger 1996
Zmiadiam	Kru-Guere, Ivory Coast	Burkill 1995

Insight into the societal value of *G. superba* may be gained by examining the vernacular names of the species. People rarely name plant species that they do not use. A survey of herbarium specimens and the literature shows no fewer than 279 vernacular names for *G. superba* (Table 3.1; Figure 3.1). India, Nigeria, Kenya and Senegal appear to have the highest number of vernacular names (Figure 3.1). This long list of names indicates that local people in these countries have an active interest in *G. superba*. The plant is a well-known non-timber forest product that has long been in regular demand amongst local communities and practitioners of traditional medicines in different countries. In India, it is a much used plant in Ayurvedic and Unani systems of medicines (Chopra *et al.* 1956; Watt 1972), it is used either as a single drug or in combination with other drugs. Although there are comments to the contrary, for example, reports from Vietnam indicating no known uses for the species (Van Duong 1993). This lack of ethnobotanical information from Vietnam may reflect no usage or that no one has studied or reported the usage of *G. superba* in that country.

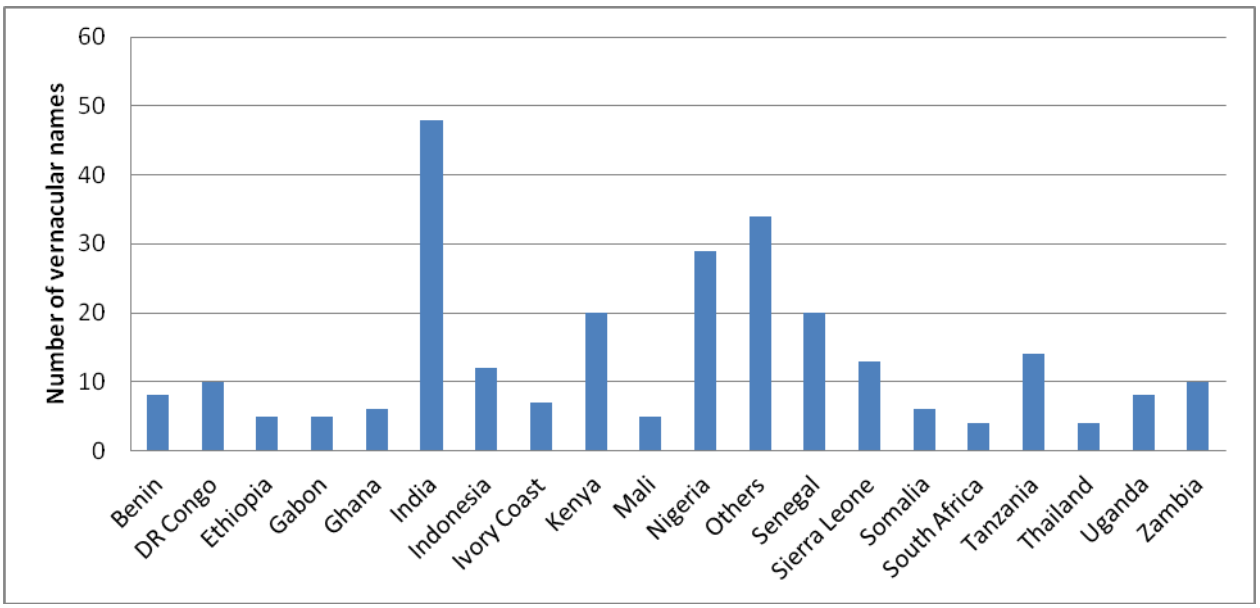


Figure 3.1. Vernacular names of *G. superba*. Other countries with less than 4 vernacular names include: Bangladesh (1); Burkina Faso (2); Burundi (2), Cambodia (1); Cameroon (2); Central African Republic (3); Equatorial Guinea (1); Gambia (2); Guinea (1); Guinea Bissau (2); Laos (1); Maldives (1); Mozambique (2); Namibia (2); Nepal (2); Rwanda (3); Sudan (1); Vietnam (2); Zanzibar (2) and Zimbabwe (2).

Several of the plant's common names refer to the structure of the flowers, stems and tubers (Table 3.1). The indigenous people in Indonesia were inventive and imaginative; they recognised the reflexed nature of the flowers of *G. superba*, an invaluable diagnostic feature of the species. They described the flower shape and arrangement as unusual, hence the vernacular name *kembang sungsang*, which translates into "an upside down flower" (Maradjo 1977). The structure of the flower and flower colouration of red or purple and yellow resulted in *G. superba* being compared to a cow's tongue, rainbow, a crow's foot and a cock by local people in a couple of African countries. The Manding-Bambara people of Senegal call the species *donon tulu*, the Ndebele people of South Africa call it *amagugulume*, and the Ndebele and Shona people of Zimbabwe call it *amakukhulume* and *kajongwe* respectively. The common feature uniting all these vernacular names is their description of the colourful nature of *G. superba* resembling a cock's head. Other examples of vernacular names alluding to the plant's structure are those of the Somalis, the Basari of Guinea, the Fulani and Hausa of Nigeria. The Hausa people of northern Nigeria call *G. superba gatarin kurege* which translates into "ground squirrel's hatchet". *Adin tuki* is the name of the species in Northern Somalia,

Warrangeleh, which appears to simply mean a "crow's leg" (Collenette 1929). In Guinea, the local name is *a-tiándiwú* which translates to "the rainbow in the sky" (Burkill 1995). The Fulani of Nigeria call the species *demnal nagge*, which translates into "cow's tongue". The last two names appear to be focusing more on flower colour than other characteristics of the inflorescence.

The flowers of *G. superba* have a long history of involvement with humans, throughout the distributional range of the species. Figure 3.2 shows a series of postage stamps issued by the national governments of Democratic Republic of Congo, India, Indonesia, Namibia, Uganda, Vietnam and Zimbabwe. Although the use of postage stamps is slowly fading away, it leaves an important historical cultural account of *G. superba* in both tropical Africa and Asia. The remarkable shape of the flowers evoke use as personal adornment; widely used in Kenya and Nigeria by placing over the ears (Burkill 1995). The flowers are also used by the Hindus in the worship of Siva and Lingam, whilst roots and tubers are reputed to possess medicinal properties and were included by the Sanskrit writers in the seven minor poisons of India; see the Pharmacographia Indica (Clewer *et al.* 1915). Lowrie (1903) wrote the following account on the attitude of Indians towards the plant "In hoeing the coffee, no Hindoo would root up or otherwise destroy this, to them, its a favourite plant and they (men and women) being passionately fond of flowers, might be seen working with their heads adorned with the beautiful bloom". *G. superba* is used in a similar way in Ghana, where two vernacular names, *pate-kodzo* and *samankantan*, allude to the use of the species as an adornment or bunting. Several vernacular names for *G. superba* in African and Asian countries indicate a long history of human use in these regions. These names include those recorded by Farquhar (1908) in Nigeria and Tessman (1908) in Equatorial Guinea.

Traditional uses of *G. superba*

G. superba is used for various ethnobotanical applications in many parts of the subtropics and tropics (Table 3.2). Many similarities can be recognised when the uses of *G. superba* are considered in totality over its distributional range (Table 3.2). This may be ascribed to shared cultural heritage about *G. superba* through exchange of its ethnobotanical information. The relations of people to their indigenous plants and that of other regions near or further away aids in measuring their cultural status and their contacts with each other (Gilmore 1932). By carrying out such studies we gain knowledge of the pattern of their life customs and habits of life; and we also obtain suggestions for additional uses of plants besides those now employed by the local people. For example, in the past people may have depended on *G. superba* for a couple of medicinal uses, before better remedies

from other plant products became readily available on the market. The development of the human race has meant that some of the uses of *G. superba* are no longer appreciated and such knowledge is in danger of being lost. So when such information is recorded, it does not mean that it is current practice, but reminds people of the potential of the species in their daily lives. The purposes for which people grow, nurture and move *G. superba* are varied; with even some reports of the tubers being eaten in Maldives (Munch-Petersen 1977; Schmelzer 1991). Tubers are said to be eaten when fried with sugar added to them (Schmelzer 1991).

Figure 3.2: *G. superba* on postage stamps from Democratic Republic of Congo, India, Indonesia, Namibia, Uganda, Vietnam and Zimbabwe.

Table 3.2. Traditional uses of *G. superba*

Country	Part used and recipe	References
Bangladesh	Tuber paste applied externally for parasitic skin diseases. Also used as an abortifacient, remedy for fever and asthma.	Ghani 1998; Hassan & Roy 2005; Siddique *et al.* 2004
Burkina Faso	Leaves administered in enema as a decongestant.	Dounias 2006
Burma (Myanmar)	Tuber used as a murder poison and to commit suicide.	Bunyapraphatsara & van Valkenburg 1999;

		Dalziel 1955; Neuwinger 1996
Burundi	Leaf decoction prescribed for hydrocele (dropsy of the scrotum), while the leaf pulp serves against rheumatism and mental patients are given a leaf decoction in a drink.	Dounias 2006
Cambodia	Used as a poison.	Bunyapraphatsara & van Valkenburg 1999
Cameroon	The unripe fruit in butter used in north Cameroon to kill head lice.	Neuwinger 1996
Congo (Brazzaville)	Soup of leaves with a kid's heart is administered for female sterility or for delayed child-birth, and crushed leaves applied to the chest for asthma together with charred roots taken internally.	Burkill 1995; Dounias 2006
DR Congo (Kinshasa)	Rasped and washed tuber used externally to treat venereal diseases and stomach ache. *G. superba* cause losses among grazing animals every year in the Shaba province between dry and rainy seasons (October to December). Local people discouraged to eat buds of the species since it is poisonous.	Dounias 2006; Neuwinger 1996; Yamanda 1999
Ethiopia	Dried powdered root administered with tea or coffee as remedy for tumour.	Yineger & Yewhalaw 2007
Gabon	*G. superba* generally regarded as poisonous. Fang hunters are reported to eat the leaves chopped up with seeds of a small pumpkin and meat of a pig as an exercise in magic to bring luck in hunting warthog. Tuber macerate used to kill head lice.	Burkill 1995; Neuwinger 1996
Ghana	*G. superba* regarded as a danger to grazing stock and the Gbe-Vhe name is *haduihaku*: if a pig eats it, he will die. Grazers in Kordofan are reported to pull up the plant and burn the tubers to keep down the plant population. Juice of crushed leaves is used to kill head-lice.	Burkill 1995; Dalziel 1955
Guinea	*G. superba* regarded as poisonous but people make poultices of them to relieve neuralgias; and juice of crushed leaves is used to kill head-lice.	Dalziel 1955; Neuwinger 1996
Guyana	Leaf extract used against head lice.	Maradjo 1977
India	Tuber paste used as an abortifacient and as an ecbolic in labour. Paste of dried tuber applied on wounds. Tuber generally regarded as a purgative, an anthelminthic and used to cure leprosy. Root found useful against colics, chronic ulcers and haemorrhoids and the white starchy powder obtained after repeated grinding and washing given for gonorrhoea. Commonly put on windows to keep snakes away. Macerated root used in lotion form to kill skin-parasites and head lice. Tuber paste applied externally to cure tumours and the root crushed and applied on Mayang cattle to treat prolapse. Tubers used as a murder poison, regarded as dangerous to grazing stock and used to poison cattle.	Dalziel 1955; Geetha *et al.* 2007; Jagtap *et al.* 2006; Jain *et al*. 2004; Katewa *et al*. 2004; Neuwinger 1996; Sandhya *et al*. 2006; Satri 1956; Tiwari & Yadar 2003
Indonesia	Often planted as an ornamental or hedge. Also used against head lice.	Maradjo 1977
Iran	Used for impotence and nocturnal seminal emission.	Burkill 1995
Ivory Coast	Tuber used against female sterility and as an aphrodisiac. Leaf decoction used as a liniment to ease coughs and general pain. Leaf juice inserted into the nose as a remedy for fainting fits. Pulped leaves administered as enema for pelvic decongestant. Believed to have magical properties as it is credited with the ability to cause poisoning at a distance.	Burkill 1995; Neuwinger 1996
Kenya	The Marakwet people take tuber decoction against abdominal disorders and to induce abortion. Root boiled and taken as medicinal tea against stomachache. Macerated tuber also taken against smallpox, leprosy, eczema, itch and ringworm. Powdered tuber used as a suicidal agent and to commit homicide. Tuber used for impotence and as an abortifacient. Cattle bitten by snake made to inhale the vapour of stewed roots.	Dounias 2006; Neuwinger 1996
Maldives	Washed root is eaten, fried with sugar.	Munch-Petersen 1977; Schmelzer 1991
Mozambique	Tubers regarded as poisonous. Roots boiled and given to nursing babies when they have stomach pains.	Faulkner 1944; Watt & Breyer-Brandwijk 1962
Nepal	Tuber is tonic, antiperiodic, laxative, purgative and stomachic. Tuber juice given for hysteria and abdominal disorders. Root considered arbortifacient. Leaf juice and tubers used to treat skin diseases and bowel complaints.	Manandhar 2002

Nigeria	Tuber added to arrow poison, used as suicidal agent and to commit homicide. Yoruba name, ewé-ajé, means "leaf of the sorcerer", and used to prevent one from being poisoned. The Igbo in southeast Nigeria drink tuber extract against anthritis. The pulped root is used in topical application for arthritic conditions, sprains and dislocations. The root is used as an antidotal to snake-bite.	Burkill 1995; Dounias 2006; Neuwinger 1996,
Senegal	*G. superba* regarded as poisonous, leaf-sap used in arrow-poisons. But people make poultices of the leaves to relieve neuralgias and leaf juice used to kill head-lice.	Burkill 1995; Dalziel 1955
Sierra Leone	Leaf decoction applied as liniment to ease cough and general pain. Leaf juice instilled into the nose in case of fainting and also administered in enema as a decongestant.	Dounias 2006
Somalia	Used as remedy against snake bites.	Burkill 1995; Synnott 1987; Thulin 1995
South Africa	Tubers regarded as poisonous, but used as a cure for impotence and barrenness. Also used as an antiparasitic and a remedy for ascites, skin eruptions, charm, lice killer; tick infections and screw-worm on cattle; and to determine the desired sex of a child.	McGaw & Eloff 2008; Roberts 1990; Watt & Breyer-Brandwijk 1962
Sri Lanka	Tuber paste used as an abortifacient, applied for skin disorders such as warts or blackheads, scorpion bites, sprains and dislocations. Tuber used as a murder poison.	Burkill 1995; Neuwinger 1996
Sudan	Tuber sap used as an ingredient of a drink that induces sleep.	Dounias 2006
Tanzania	Plant sap drunk as a remedy for malaria, impotence and abortifacient. The Ulanga people burn the herb and apply ash on wounds to promote healing. The Ulanga people also use tuber juice for ear drops to treat earache. Powdered tuber commonly used as a suicidal agent and to commit homicide. Roots put in water with leaves and taken orally as treatment for small pox and swelling of the joints. Sukuma people also remove *G. superba* plant appearing near to their houses as it is believed to attract lightning.	Burkill 1995; Dounias 2006; Haerdi 1964; Neuwinger 1996; Tanner 1953
Thailand	Root is a popular medicine for cancer, analgesic and treatment of acute gout. But not recommended as herbal medicine due to low therapeutic dose which is close to toxic dose .	Saralamp *et al.* 1996
Uganda.	Banyankole girls apply root-pulp of *G. superba* to their breasts to make them larger. Rhizome preparation used to treat for impotence and as an abortifacient.	Haerdi 1964; Purseglove 1938
Vietnam	Not used medicinally in folk medicine, perhaps because of its high toxicity	Van Duong 1993
Zambia	Tuber is part of a preparation to cure impotence and used as an abortifacient. Powdered tuber is a criminal poison and suicide poison in south Zambia. G. superba is also used against gonorrhoea and snake bite.	Dounias 2006; Fowler 2007; Neuwinger 1996
Zanzibar	Stem cut and used in villages as a rough pen, hence a Swahili name for the plant *kalamu*: a pen or pencil	Williams 1949
Zimbabwe	Well-known poisonous plant. Used as a remedy for toothache by the Shona people. Tuber used as an aphrodisiac. Sold along major highways as a cut flower.	Gelfand *et al.* 1985; Mavi 1996

G. superba as a commercial source of colchicine

Clewer *et al.* (1915) isolated a mixture of alkaloids consisting mainly of colchicine from dried tubers of *G. superba*. Colchicine yield from *Colchicum* and *Gloriosa* has been compared (Bunyapraphatsara & van Valkenburg 1999; Jha *et al.* 2005). On dry mass basis, *Colchicum* yielded 0.62% colchicine and 0.39% colchicoside, while *Gloriosa* yielded 0.9% and 0.82% respectively (Jha *et al.* 2005). The seeds are valued as a commercial source of colchicine. The tubers also contain colchicine, but the

content in seeds is reported to be up to ten times higher, hence the importance attached to good seed set when the plant is grown for colchicine production (Bunyapraphatsara & van Valkenburg 1999). A report from Rwanda claims that the highest colchicine content is present in the young leaves (Neuwinger 1996). The seeds of *G. superba* are highly priced in the world market as they are the main sources of colchicine (Sivakumar & Krishnamurthy 2002).

G. superba as a weed

G. superba has been recorded as a farmland weed in West Africa (Burkill 1995) and also as an agricultural weed in Thailand (Prayoonrat 2005). It was identified as naturalised at Caloundra in south-east Queensland in 1950 and in New South Wales in 1972 (Grove *et al.* 2005). Other publications list it as an ornamental plant, garden escape, naturalised, weed or environmental weed in Australia (e.g. Conran 1987, Le Cussan 2006) and Fiji (Wright *et al.* 2005). Farmers in Kordofan, Sudan are reported to pull up the plant and burn the tubers to keep down the population (Burkill 1995). *G. superba* seems to be invasive in coastal areas of Australia. It reproduces vegetatively by persistent tubers which re-shoot even when the foliage has been removed. It forms dense infestations in coastal areas, excluding or displacing native plants. It has been declared a noxious weed in some parts of Australia, e.g. Lord Lowe Islands, where severe infestations of 100 stems/m^2 have been recorded (www.northcoastweeds.org.au). Due to the invasive ability of *G. superba*, range management procedures have been initiated which now include the monitoring and control of the species. It is one of the most difficult coastal weeds to control. The most effective control in Australia has been achieved using foliar spray application with glyphosate and metsulfuron-methyl in late November or December (depending on the season) when the new annual stems first appear (www.northcoastweeds.org.au). A follow up application in February or March, has also proved effective. Home-owners in Australia are under pressure from the local authorities to use all manual, mechanical and chemical means to eradicate it for the safety of children. Those with *G. superba* growing in their gardens are urged to dig up the tubers and destroy the plants.

Horticultural potential of *G. superba*

G. superba is an increasingly important species for its horticultural and floricultural uses. In recent years, a number of cultivars have been used as ornamentals in the USA and Europe (Bose *et al.* 2003). *G. superba* can be grown as a house or outdoor plant; but it is unlikely to flower outside in Europe. It dies down when the weather gets cold. *G. rothschildiana* is one of the prettiest cultivars of

G. superba. This cultivar was named after Baron Z.W. Rothschild, an authority on birds, who bought the flower from Africa and entered it at an exhibition of the English Horticultural Society at the turn of the previous century (Bose *et al.* 2003). It was first cultivated in the United Kingdom in 1902 (O'Brien 1903), now mainly grown in Belgium (Boom 1953), Denmark (Botanical Garden of Coperhagen 1967), the Netherlands (Boom 1953) and the United States of America (Bracelin 1942; Brumbach 1971; Schallert 1958).

G. superba is characterised by poor seed germination, susceptibility towards many pests and excessive collection in habitats for both medicinal uses and pharmaceutical trade (Dounias 2006). Therefore, in order to provide enough plant material for commercial exploitation, cultivation of the species at a large scale is necessary. In horticultural practice, vegetative propagation of *G. superba* is commonly used but the growth is very slow (Krause 1986), multiplication rate is low as only two plants are produced per corm per year. It takes four or five vegetative cycles to complete a reproductive phase (Samarajeewa *et al.* 1993). The effect of different growth regulators on initiation and multiplication of *G. superba* shoots in tissue culture have been studied by many researchers (Finnie & Van Staden 1991, 1994; Sivakumar & Krishnamurthy 2002). The tissue culture production of resting organs such as tubers is very important as they adapt easily after they have been transplanted to soil (Kozak 2002). In-vitro tubers have several advantages, they are hardier, easier to handle, can be transported dry and there is no dormancy period (Jha *et al.* 2005), thereby making year-round cultivation possible.

Conservation status of *G. superba*

Due to its multiple uses, the demand for *G. superba* is constantly on the rise, particularly in India. India is a major exporter of raw medicinal and aromatic plants (MAPs) as well as processed plant-based drugs (Lambert *et al.* 1997). This boom in export trade, involving *G. superba* and other plant species is depleting these resources from the wild, bringing some to the edge of extinction. Current harvesting practices in Bangladesh (Ghani 1998, Siddique *et al.* 2005) and India (Jha *et al.* 2005; Raina & Gupta 1999) are unsustainable and have resulted in depletion of the plant resource base. Earlier, the medicinal properties of *G. superba* were thought to be present only in the tubers (Raina & Gupta 1999) and these were ruthlessly extracted. As a result of scarcity and increased demand for its crude and processed products, *G. superba* has been placed on the negative list of exports by the Ministry of Commerce, Government of India (Raina & Gupta 1999).

Zimbabwe is the other country where *G. superba* is protected. It is the country's national flower and is protected under the Parks and Wildlife Act enacted in 1975, therefore, it cannot be collected from the wild without a permit from the Department of National Parks and Wildlife Management. This is a precautionary measure, as *G. superba* is not threatened, but plant collectors and flower vendors, poach *G. superba* flowers from national parks, private and state land. These intermediaries sell the flowers in the city streets and along major highways.

Conclusions

This study resulted in the collection and documentation of scattered information on traditional, folkloristic and economic importance of *G. superba* over its distributional range. Useful information was generated as a result of linking modern ethnobotanical studies with traditional or historical ethnobotanical approaches. This species is not only used for cultural purposes and as herbal medicine but it is also a notorious human and livestock poison. Its tubers have been used for centuries for homicide, suicide and inducing abortion. There is no doubt, however, that *G. superba* can constitute an important source of active molecules useful as raw material for the pharmaceutical industry.

Chapter 4

Systematic studies in the *Gloriosa superba* L. complex (Colchicaceae): a re-assessment of species boundaries

A. Maroyi, R.G. van den Berg and L.J.G. van der Maesen. Submitted to Plant Ecology and Evolution

Gloriosa superba **L., characterised by yellow, heavily crisped perianth segments, photograph taken by Prof. L.J.G. van der Maesen, outside Great Zimbabwe Hotel, Great Zimbabwe, Masvingo, Zimbabwe**

Chapter 4: *G. superba* L.: reassessment of species boundaries

Abstract

Gloriosa superba L. is a highly variable species occurring in a wide range of ecological habitats in South Africa, tropical Africa and Asia. A morphological study of 79 herbarium specimens covering the entire geographical range of the species, using multivariate and univariate techniques, has revealed the existence of four phenetic species in the group. Recognition of these species is based on habit, inflorescence characters and distribution patterns. It is proposed here that four species should be recognised in the *G. superba* L. complex: *G. baudii* (Terracc.) Chiov., *G. carsonii* Baker, *G. simplex* L. and *G. superba* L. *G. superba* is the most widespread taxon, occurring in South Africa, tropical Africa and Asia. *G. simplex*, *G. carsonii* and *G. baudii* are confined to the African continent; with *G. baudii* having the most restricted range, confined to the arid regions of northern Kenya, Ethiopia and Somalia. Results of morphological analysis, diagnostic features and a dichotomous key of the recognised species are provided.

Introduction

Gloriosa superba L. was first described by Linnaeus in 1737, based on material from south west India (Malabar) and the name was validated in 1753 (Linnaeus 1753). It is a native of South Africa, tropical Africa, Asia and south-eastern Asia. *G. superba* complex occupies a wide range of ecological habitats; it is common in forest-savanna boundaries, thickets, hedges, open forest, grassland and bush land, where it can be seen scrambling through shrubs (Dounias 2006). The genus *Gloriosa* L. (including *Littonia* Hook.) is classified as a member of the tribe Colchiceae in the Colchicaceae family (Vinnersten & Manning 2007). There is a close relationship between *Gloriosa* and *Littonia* Hook. (now synonymised under *Gloriosa*), found in South Africa, south-central Africa, north to Djibouti, Ethiopia, Somalia and south Yemen. The genus *Littonia* was described by Hooker (1853) based on the South African climbing *L. modesta* Hook. and differing from *Gloriosa* particularly in its straight, not bent style and connivent, not reflexed tepals. Several similarities have been known to exist between these two genera. All have tuberous corms (Buxbaum 1937; Dyer 1976; Nordenstam 1998; Sebsebe Demissew 1997; Thulin 1995), their leaves frequently develop tendril-like cirrhose tips (Dyer 1976; Nordenstam 1998; Queva 1899; Sebsebe Demissew 1997; Thulin 1995) and colchicine occurs in all (Hegnauer 1963; Raffauf 1970; Vinnersten & Larsson 2010; Wildeman & Pursey 1968). Queva (1899) also noted that crystals of calcium oxalate

were lacking in both *Gloriosa* and *Littonia*. The pistils of *Gloriosa* and *Littonia* are generally tricarpellate and alike (Sterling 1975). Because of such a series of resemblances, most investigators have been inclined to treat these genera as being closely related and have placed them in the same tribal affinity (e.g. Buxbaum 1936; Hutchinson 1934, 1959; Krause 1930; Nordenstam 1982, 1998). Nordal & Bingham (1998) were the first to question the generic delimitation between *Gloriosa* and *Littonia* basing their arguments on diagnostic features of *G. sessiliflora* Nordal & Bingham; characterised by the presence of connivent tepals bridging the postulated gap in floral morphology between *Gloriosa* and *Littonia*. The flowers of *G. sessiliflora* characterised by connivent tepals are similar to those of *Littonia*, although the colour, shape and undulation of the tepals strongly resemble those of some forms of *G. superba* (Nordal & Bingham 1998). The slightly bent style of *G. sessiliflora* also appears to be an intermediate trait.

Different forms of *G. superba* have been recognised as species or varieties (Table 4.1). Maybe, the recognition of these forms considered as variation resulting from geographic isolation and ecological specialisation is justified given the wide distribution of *G. superba*. But, most recent accounts lump these described species under an inclusive and variable *G. superba* (e.g. Dyer *et al.* 1962; Field 1971, 1972; Geerinck 2010; Hoenselaar 2005; Maroyi 2002; Thulin 1995; Wild 1965). Sebsebe Demissew (1997) recognised two species in the Flora of Ethiopia and Eritrea, *G. superba* and *G. baudii* (Terracc.) Chiov.; recommending the need for further study to resolve taxonomic problems in the group. Hepper (1968) and Van der Burg (2006) recognised *G. superba* and *G. simplex* L. in the Flora of West Tropical Africa and Flora of Benin respectively. Three *Gloriosa* names appear to have been widely used (Table 4.1), these are: *G. baudii*, *G. simplex* and *G. superba*. The present paper focuses on the delimitation of taxa within this group. Plants from western Zambia, the Bulozi flood plain, though similar to *G. superba* complex in some morphological and floral characteristics, are here recognised as distinct belonging to *G. sessiliflora*. According to Baker (1898), *G. superba* and *G. virescens* Lindl. (synonym of *G. simplex* L.) can be distinguished by the former having perianth segment that are crisped. *G. simplex* and *G. superba* have been confused in the past (Dyer *et al.* 1962; Field 1972; Polhill 1962; Wild 1965) and this has resulted in nomenclatural confusion and numerous misidentifications in several herbaria. According to Baker (1897, 1898), *G. virescens* (= *G. simplex* L.) is confined to South Africa, tropical Africa, while *G. superba* has been recorded in South Africa, tropical Africa, India and south-eastern Asia. Based on Baker's synopsis (1898), it can also be deduced that *G.*

virescens (= *G. simplex* L.) is more variable than *G. superba*; hence he described an infraspecific taxon, *G. virescens* Lindl. var. *grandiflora* (Hook.) Baker from the Niger Delta.

Table 4.1. Taxonomy of *Gloriosa superba* L.

Previously described species and author	Baker (1898)	Hepper (1968)	Thulin (1995)	Sebsebe Demissew (1997)	Maroyi (2002)	Hoenselaar (2005)	Van der Burg (2006)	Geerinck (2010)
Clinostylis speciosa Hochst. (1844)	*G. abyssinica* A. Rich.	-	-	*G. superba* L.	-	-	-	-
Gloriosa abyssinica A.Rich. (1851)	*G. abyssinica* A. Rich.	-	-	*G. superba* L.	-	*G. superba* L. var. *superba*	-	-
G. abyssinica A.Rich. var. *graminifolia* Franch. (1882)	*G. abyssinica* A.Rich. var. *graminifolia* Franch.	-	*G. superba* L.	*G. baudii* (Terracc.) Chiov.	-	*G. superba* L. var. *graminifolia* (Franch.) Hoenselaar	-	-
G. angulata Schum. & Thonn. (1827)	*G. superba* L.	-	-	-	-	-	-	-
G. aurea Chiov. (1928)	-	-	*G. superba* L.	-	-	-	-	-
G. baudii (Terracc.) Chiov. (1916)	-	-	*G. superba* L.	*G. baudii* (Terracc.) Chiov.	-	*G. superba* L. var. *graminifolia* (Franch.) Hoenselaar	-	-
G. caerulea Mill. (1768)	*G. virescens* Lindl.	*G. simplex* L.	-	-	-	-	-	-
G. carsonii Baker (1895)	*G. carsonii* Baker	*G. simplex* L.	-	-	-	*G. superba* L. var. *superba*	-	-
G. doniana Roem. & Schult. (1829)	*G. superba* L.	-	-	-	-	-		
G. graminifolia (Franch.) Chiov. (1916)	-	-	*G. superba* L.	*G. baudii* (Terracc.) Chiov.	-	*G. superba* L. var. *graminifolia* (Franch.) Hoenselaar	-	-
G. graminifolia (Franch.) Chiov. var. *heterophylla* Chiov. (1916)	-	-	*G. superba* L.	-	-	-	-	-
G. minor Rendle (1896)	*G. minor* Rendle	-	*G. superba* L.	*G. baudii* (Terracc.) Chiov.	-	*G. superba* L. var. *graminifolia* (Franch.) Hoenselaar	-	-
G. simplex L. (1767)	*G. virescens* Lindl.	*G. simplex* L.	*G. superba* L.	*G. superba* L.	*G. superba* L.	*G. superba* L. var. *superba*	*G. simplex* L.	-
G. speciosa (Hochst.) Engl. (1892)	*G. abyssinica* A. Rich.	-	-	*G. superba* L.	-	-	-	-
G. superba L. (1753)	*G. superba* L.	*G. superba* L.	*G. superba* L.	*G. superba* L.	*G. superba* L.	*G. superba* L. var. *superba*	*G. superba* L.	*G. superba* L.
G. superba L. var *angustifolia* Baker (1879)	*G. superba* L. var *angustifolia* Baker	-	-	-	-	*G. superba* L. var. *superba*	-	-
G. superba L. var. *graminifolia* (Franch.) Hoenselaar (2005)	-	-	-	-	-	*G. superba* L. var. *graminifolia* (Franch.) Hoenselaar	-	-
G. superba L. var. *superba* (Hoenselaar 2005)	-	-	-	-	-	*G. superba* L. var. *superba*	-	-
G. virescens Lindl. (1825)	*G. virescens* Lindl.	*G. simplex* L.	-	-	*G. superba* L.	*G. superba* L. var. *superba*	-	-
G. virescens Lindl. var. *grandiflora*	*G. virescens* Lindl. var.	*G. simplex*	-	-	-	*G. superba* L. var. *superba*	-	-

(Hook.) Baker (1879)	*grandiflora* (Hook.) Baker	L.						
Methonica abyssinica (A.Rich.) Walpers (1852)	-	-	-	*G. superba* L.	-	-	-	-
M. doniana Kunth (1843)	*G. superba* L.	-	-	-	-	-	-	-
M. grandiflora Hook. (1860)	*G. virescens* Lindl. var. *grandiflora* (Hook.) Baker	-	-	-	-	*G. superba* L. var. *superba*	-	-
M. leopoldii Lemaire (1846)	*G. virescens* Lindl. var. grandiflora (Hook.) Baker	-	-	-	-	-	-	-
M. petersiana Klotzsch (1863)	*G. virescens* Lindl.	-	-	-	-	-	-	-
M. platyphylla Klotzsch (1863)	*G. virescens* Lindl.	-	-	-	-	-	-	-
M. superba (L.) Crantz (1766)	*G. superba* L.	-	-	-	-	-	-	-
M. virescens (Lindl.) Kunth (1843)	*G. virescens* Lindl.	-	-	-	-	-	-	-
M. virescens (Lindl.) Kunth var. *plantii* Planch. (1854)	*G. virescens* Lindl.	-	-	-	-	-	-	-

The major variations in *G. superba* complex mainly involve plant habit, perianth segment colour and shape. *G. superba* is found as short, stocky and self-supporting plants, and as tall slender scramblers, clinging to other plants by means of leaf tendrils. According to Baker (1898), *G. abyssinica* A.Rich., *G. carsonii* Baker and *G. minor* Rendle are non-climbing while *G. virescens* (= *G. simplex* L.) and *G. superba* are climbing. *G. minor* was said to have small and solitary flowers; while *G. abyssinica* and *G. carsonii* were said to have several and larger flowers. *G. abyssinica* is now generally regarded as a synonym of *G. superba* (Hoenselaar 2005; Sebsebe Demissew 1997). *G. carsonii* was sunk into *G. simplex* by Hepper (1968), and *G. superba* L. var. *superba* by Hoenselaar (2005). *G. minor* was treated as a synonym of *G. superba* by Thulin (1995); of *G. baudii* (Sebsebe Demissew 1997) and of *G. superba* L. var. *graminifolia* L. (Franch.) Hoenselaar (Hoenselaar 2005). Baker's delimitation (1897, 1898) was adopted by Hepper (1968) and Van der Burg (2006), who recognised two climbing species of *Gloriosa*, *G. superba* and *G. simplex*. The taxonomic revisions of *Gloriosa* by Sebsebe Demissew (1997) and Hoenselaar (2005) acknowledge the need to separate the more compact form of *G. superba* that has been recorded from arid regions of northern Kenya, Ethiopia and Somalia from the widespread, climbing *G. superba*. Sebsebe Demissew (1997) recognised *G. superba* and *G. baudii* while Hoenselaar (2005) recognised two varieties, *G. superba* var. *superba* and *G. superba* var. *graminifolia*. The species delimitation in *G. superba* complex is clearly controversial; this is also reflected in the high number of synonyms (Table 4.1). This shows a poor understanding of the taxonomy and evolutionary relationships of the group, hence the need for a major revision. To delimit

species, it is important to first determine what a species is and how it is to be recognised in nature. In this systematic study of *G. superba* complex, we follow both the phenetic (Sneath & Sokal 1973) and phylogenetic species concepts (Cracraft 1983; Nixon & Wheeler 1990).

The phenetic species concept (Sneath & Sokal 1973) is an empirical approach that considers distinct phenetic clusters as species without making assumptions about speciation. The clustering and ordination methods will help to circumscribe morphological species and determine species boundaries as objectively as possible by determining gaps in morphological variation of the species within the *G. superba* complex. According to Hill & Crane (1982), classification is aimed at dividing organisms into different groups in which more similar organisms come together and separating those with more disimilarities. The primary basis for delimiting taxa in a "complex species" is the recognition of discontinuities in character states. In this regard, multivariate and univariate analyses have proven helpful to studies on similarities and differences in "complex species" (e.g. Brunell & Whitkus 1999; Cron *et al.* 2007; Downing *et al.* 2004; Ehrhart 2005; Matos 1995; Otieno *et al.* 2006; Pinheiro & De Barros 2009; Tyteca & Dufrene 1994; Wilkin 1999). Under the phylogenetic species concept, distinct clusters accompanied by autapomorphy are recognised as species while those lacking autapomorphies are considered metaspecies. Under this species concept, a species is defined as the smallest aggregation of populations (sexual) or lineages (asexual) diagnosable by a unique combination of character states in comparable individuals (Nixon & Wheeler 1990). Snow (1997) emphasised the need of recognising phylogenetic species by "ordinary morphological means" as represented on herbarium specimens. The current study deals principally with monographic work involving grouping herbarium specimens into taxonomic units. These groups are then either associated with an existing type specimen, which is linked to a particular taxon name or described as a new species. The fixed diagnostic character state across individuals of the same species is generally regarded and interpreted as reliable and indicative of the existence of common history shared by the species (Luckow 1995; Snow 1997). In addition, a phylogenetic species is expected to be monophyletic (De Queiroz & Donoghue 1988; Donoghue 1985; Mishler & Donoghue 1982) characterised by at least one autapomorphy; and its apparent relationship to others is established by synapomorphy. The use of both the phenetic and phylogenetic species concepts is feasible and often used by practising taxonomists since their studies are based on observed patterns of character variation to recognise taxa as distinct species. In this study multivariate and univariate techniques were applied in order to elucidate morphological variation within *G.*

superba complex; to find out whether those diagnostic characters previously used are sufficiently distinctive for the reasonable delimitation of those taxa and finally to get a more objective classification of the *G. superba* complex. A complete taxonomic account of the genus *Gloriosa* will be published separately.

Materials and methods

Plant material

The present study is largely based on herbarium material received on loan from B, BM, BR, C, COI, F, K, L, P, S, U and UPS and collections kept in the following herbaria: SRGH and WAG (abbreviations follow Holmgren *et al.* 1990). In addition, herbarium specimens were augmented with field observations and fresh material collected in the field during 2007-2009 in several localities of Zimbabwe. Of the 1200 specimens examined, 79 were included in this analysis. As far as possible herbarium specimens were selected to represent the entire geographical range of the *G. superba* complex in South Africa, tropical Africa and Asia and to reflect the morphological variability present within the taxa. As far as possible, herbarium specimens were selected to include specimens matching descriptions of *G. baudii* (Terracc.) Chiov., *G. carsonii* Baker, *G. superba* L. and *G. simplex* L. / *G. virescens* Lindl. (after Baker 1897, 1898; Hepper 1968; Hoenselaar 2005; Sebsebe Demissew 1997; van der Burg 2006). All original descriptions of the taxa were obtained and an attempt was made to locate all extant type specimens. Images of type specimens were obtained from K. Only those specimens with fully open flowers were included in the study in order to allow standardised measurements to be made. Sterile and incomplete specimens were excluded from this study. Field studies also clarified character states such as leaf arrangement, leaf shape, perianth segment shape and colour for the analyses. Published keys and descriptions of species (e.g. Baker 1897, 1898; Berhaut 1967; Dassanayake 2000; Geerinck 2010; Hepper 1968; Hoenselaar 2005; Hooker 1894; Jessop 1983; Maroyi 2002; Sebsebe Demissew 1997; Thulin 1995; Trimen 1894; Van der Burg 2006) were consulted to establish characters that had previously been considered to be of taxonomic importance. Each specimen measured was treated as an independent operational taxonomic unit (OTU) for all the statistical tests. Data on all characters were entered in a data matrix, which is available from the corresponding author on request. A review of floristic treatments was conducted to produce an initial list of qualitative characters used to distinguish the species. Quantitative characters were counted or measured with a ruler and digital callipers. A total of twenty-one vegetative and floral

characters were recorded for each specimen. Sixteen of these characters were measured quantitatively and three qualitatively (Table 4.2). Two ratios were used, and stem diameter and leaf length were excluded from the analysis to avoid weighing of characters. Most of the floral measurements were done on material soaked in tap water with a little detergent overnight or directly on samples in 70% ethanol.

Multivariate analysis

Data were entered in Excel. Prior to doing Cluster Analysis (CA) and Principal Components Analysis (PCA), the data were standardised to remove the effects of characters with large variances. CA and PCA were performed using NTSYS package version 2.11a (Rohlf 2002) to verify morphological discontinuities among the taxa. PCA was carried out to examine the pattern of relationships between specimens or OTUs as well as the relative importance of the characters employed. This technique projects samples in multivariate space so that maximum variances which are not correlated are extracted along different axes. CA based on unweighted pair group method using arithmetic averages (UPGMA) was used to generate phenograms.

Univariate analysis

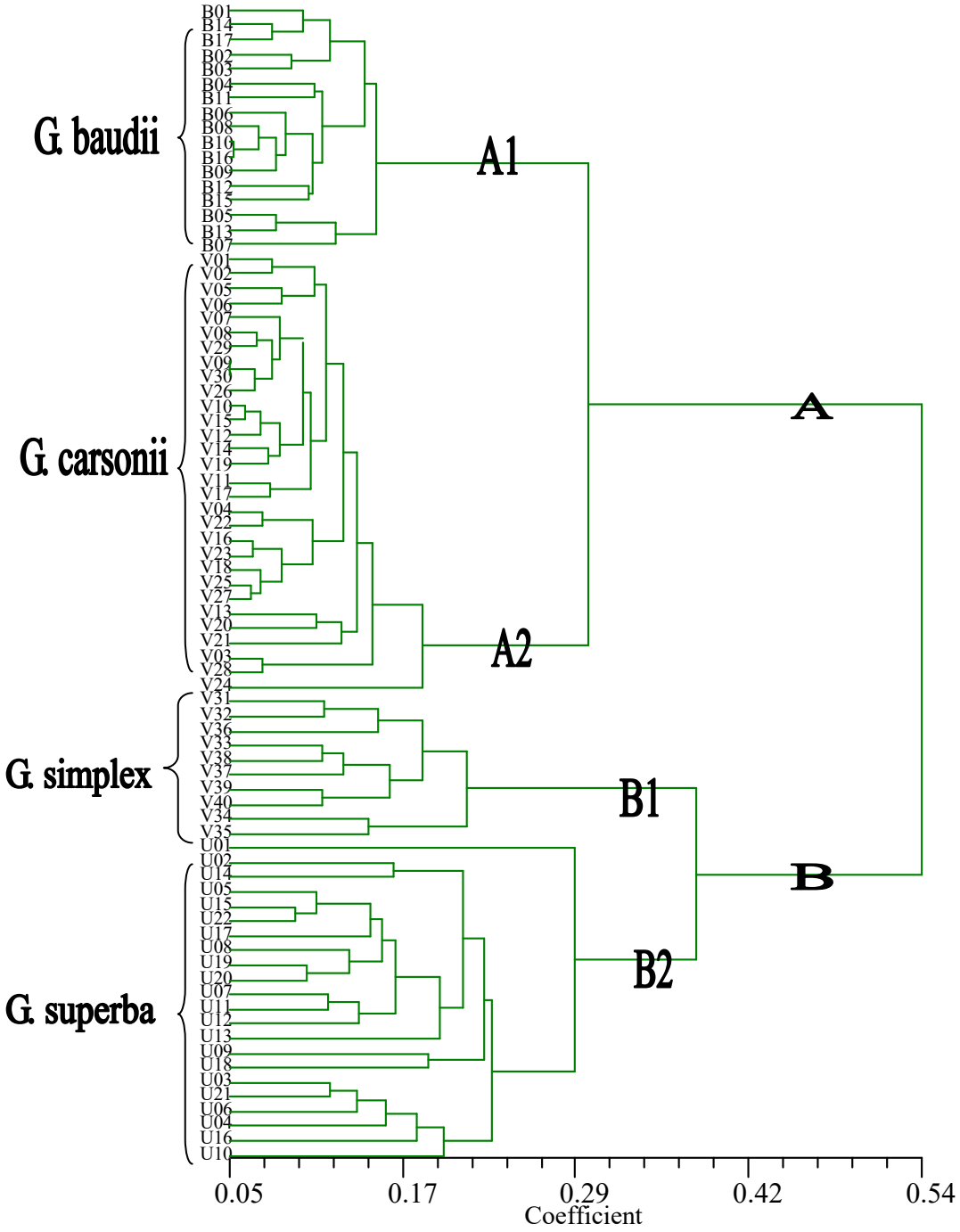
The variability of quantitative characters was evaluated by box-plots using SPSS Statistics 17.0 (Field 2009). Box plots featuring medians, first and third quartiles and a range of selected characters were drawn. These plots allowed individual characters to be evaluated to determine the extent of overlap between the specimens detected in the phenetic analysis. The groupings used for box-plots follow the phenetic results of CA and PCA.

Results

Cluster analysis of 79 specimens revealed two main groups A and B (Figure 4.1). Group A consists of dwarf to short non-climbing plants, rarely exceeding 80 cm in height. Group B has noticeably tall and climbing plants, averaging 250 cm in height. Within both Groups A and B, two subgroups are evident (Figure 4.1). Each subgroup or cluster was given the name of the type specimen found within it. Subgroup A1 is made up of seventeen specimens matching the description of *G. baudii*. These are the dwarf plants found in the arid regions of northern Kenya, Ethiopia and Somalia, which rarely exceed 40 cm in height. Subgroup A2 matches the description of *G. carsonii*. These are short, erect and non-climbing plants, averaging 60

cm in height, widespread in southern and east Africa. Specimens of subgroup B1 have wide perianth segments, which are not crisped, but straight or slightly undulate edges or margins,

Figure 4.1. Phenogram depicting the groups within the *G. superba* complex based on vegetative and floral characters. Four clusters corresponding to: *G. baudii* (A1); *G. carsonii (*A2); *G. simplex* (B1) and *G. superba* (B2) are indicated. OTUs are numbered as in Appendix 1.



corresponding to *G. simplex*. *G. simplex* occurs in South Africa and tropical Africa. Specimens of subgroup B2 matches the description of *G. superba*, the only species of *Gloriosa* that naturally occurs in tropical Asia. Its perianth segments are narrower than those of *G. simplex* and are crisped to heavily crisped.

Principal components analysis of the data revealed similar groupings as obtained by cluster analysis (Figure 4.2). Figure 4.3 presents an alternative view of the 3-dimensional ordination. The 3D plot confirmed the distinctiveness of the four clusters, with *G. baudii* and *G. superba* on the extremes and *G. carsonii* and *G. simplex* in the middle of the 3D space. In the PCA run using the characters shown in Table 4.2, the first three principal components explain 83.6% of the total character variation, with 60.8%, 16.4% and 6.4% for the respective axes (Table 4.3). In the case of PC1, fourteen characters had loadings with an absolute value greater than 0.6. PC2 had four characters with such an absolute value while PC3 has only TW as the major variable (Table 4.3). These characters with the highest loadings (both quantitative and qualitative characters), can be considered as taxonomically useful for partitioning the *G. superba* complex into subgroups.

Univariate analyses using box plots (Figure 4.4) indicate that plant height, ratio of plant height to stem diameter, filament length, anther length and width contribute most to the separation of the two major clusters, Group A and B. The discontinuities obtained in these vegetative and floral characters were used in the key to delineate different species in the complex. Plant height, ratio of plant height to stem diameter, leaf width, distance from leaf base to the widest point of the leaf, ratio of leaf length to width and anther width can be used to separate Group A into *G. baudii* (Group A1) and *G. carsonii* (Group A2). Plants forming the Group B cluster are long, have sarmentose stems, and are collected from South Africa, tropical Africa and Asia. Floral characters (Figure 4.4J, K, O) convincingly separate *G. simplex* (Group B1) from *G. superba* (Group B2). *G. simplex* has been collected from South Africa, tropical Africa, while *G. superba* has been collected from South Africa, tropical Africa and Asia.

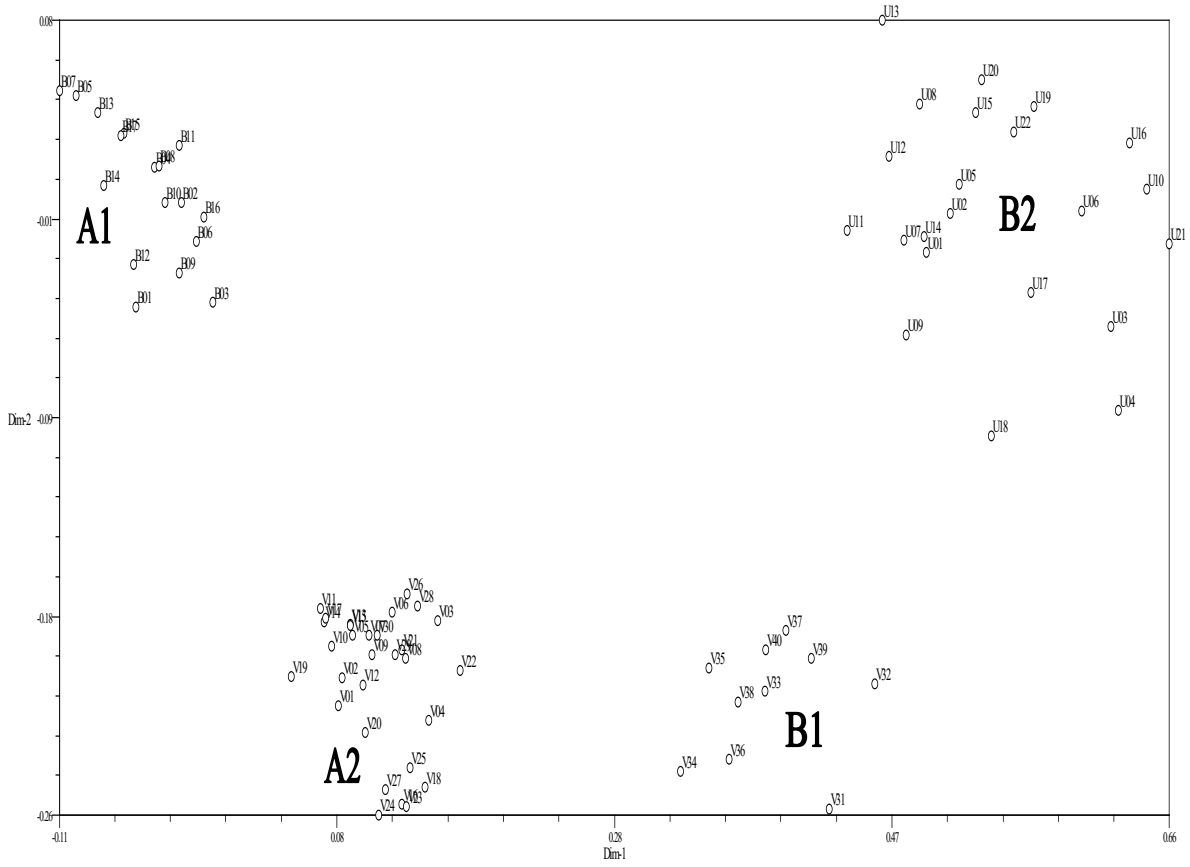


Figure 4.2. An ordination of the principal components reveals four discrete groupings: A1 = *G. baudii*; A2 = *G. carsonii*; B1 = *G. simplex* and B2 = *G. superba*. OTUs are numbered as in Appendix 1.

Figure 4.3. The 3-dimensional plot of vegetative and floral characters reveals four discrete groupings: A1 = *G. baudii*; A2 = *G. carsonii*; B1 = *G. simplex* and B2 = *G. superba*. OTUs are numbered as in Appendix 1.

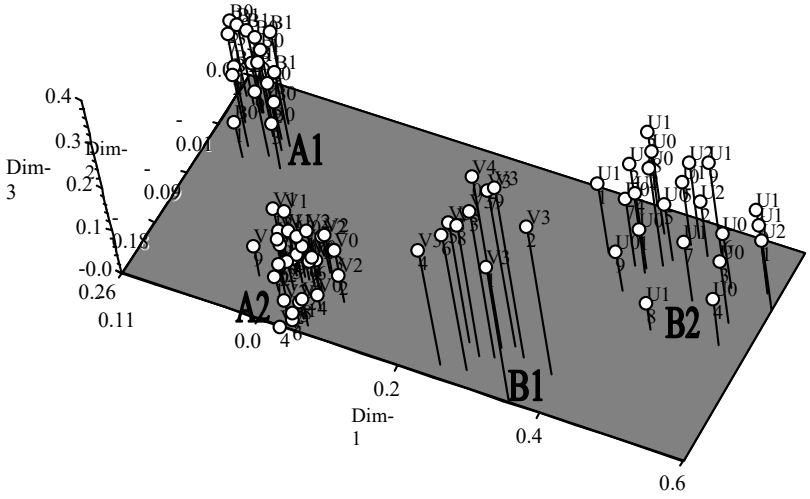


Table 4.2. Qualitative and quantitative characters used for multivariate analysis of *G. superba* complex. Characters used in the final CA and PCA are marked with an asterisk.

Acronym	Character state
PH*	Plant height (mm)
SD	Stem diameter at the widest point (mm)
HS*	Ratio of plant height to stem diameter
ST*	Stem type: 1=simple; 2=branched
SF*	Stem form: 1=erect; 2=climbing
LL	Length of leaf from base to tip (including tendril if present) (mm)
LW*	Width of leaf at widest point (mm)
LWR*	Leaf length to width ratio
DW*	Distance from leaf base to the widest point of the leaf (mm)
PL*	Pedicel length (mm)
TL*	Tepal length (mm)
TW*	Tepal width at the widest point, excluding serrations (mm)
TS*	Tepal shape: 1 = linear and crisped; 2 = oblanceolate / oblong and entire, flat
DL*	Distance from tepal base to the widest point of the tepal (mm)
TT*	Length of tepal tube (mm)
BW*	Basal tepal width (mm)
SL*	Style length (mm)
SLL*	Style lobe length (mm)
FL*	Filament length (mm)
AL*	Anther length (mm)
AW*	Anther width (mm)

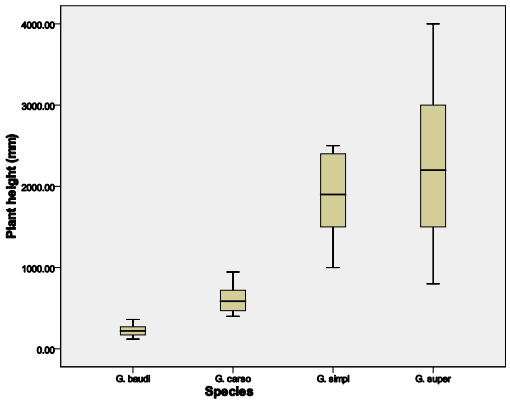
Table 4.3. Factor loadings on the first three principal components for quantitative and qualitative characters used in the final PCA. Qualitative characters are marked with an asterisk.

Character	PC1	PC2	PC3
1. PH	0.884	0.084	0.122
2. HS	0.844	0.044	0.09
3. LW	0.548	-0.756	-0.221
4. LWR	-0.533	0.725	0.308
5. DW	0.52	0.712	-0.206
6. PL	0.857	-0.05	-0.149
7. TL	0.872	-0.008	0.057
8. TW	0.056	-0.671	0.658
9. DL	-0.531	-0.511	0.416
10. TT	-0.689	0.52	0.26
11. BW	0.826	0.0004	0.1
12. SL	0.882	0.329	-0.006
13. SLL	0.864	-0.016	-0.043
14. FL	0.877	0.359	-0.022
15. AL	0.908	0.116	0.175
16. AW	0.942	-0.081	0.129
17. SF*	0.878	0.117	0.314
18. ST*	0.905	0.133	0.298
19. TS*	-0.819	-0.477	0.243

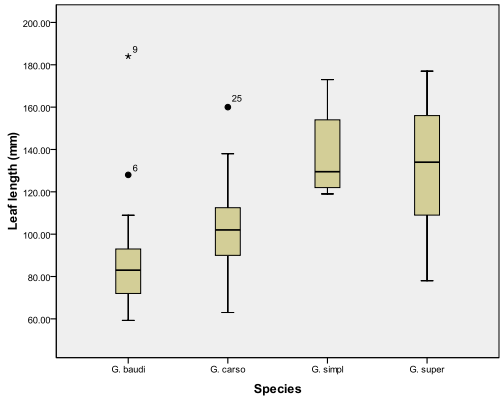
Discussion

In this study CA, PCA and univariate analysis of morphological characters strongly suggest the existence of two assemblages of species in *G. superba* complex: one comprising *G. baudii* and *G. carsonii* and the other *G. superba* and *G. simplex*. CA and PCA were able to discriminate between *G. baudii* and *G. superba* placing them on two extremes. *G. carsonii* appears to be phenetically closer to *G. baudii*; and *G. simplex* is phenetically closer to *G. superba*. These findings are consistent with the habit and floral characters used by Baker (1898) to differentiate *Gloriosa* species. Baker (1898) divided *Gloriosa* species into two groups depending on whether they are climbing or erect. Of the two climbing species, *G. superba* and *G. simplex* are separated by the former having crisped perianth segments. These taller species are more or less regularly branched with numerous flowers, climbing on other plants. In addition to these observations, *G. superba* is more widespread than the other *Gloriosa* species. It occurs in South Africa, tropical Africa and Asia, while *G. simplex* is confined to South Africa and tropical Africa. On the other hand, *G. baudii* is a short, erect herb confined to the stony, sandy soils of the arid regions of northern Kenya, Ethiopia and Somalia (Field 1972; Sebsebe Demissew 1997). *G. carsonii* is another short and erect species widespread in tropical Africa, particularly south east and east tropical Africa. It is therefore, not surprising that in CA and PCA, these species clustered together as a phenetic group. In light of the data presented here, it is evident that the four clusters should probably be treated as separate species. Taxonomic implications of this study are as detailed below.

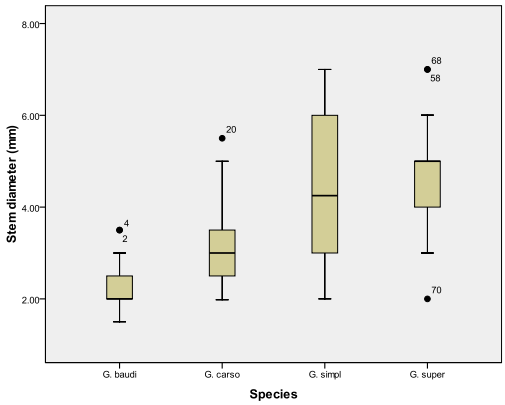
Figure 4.4. Boxplots of selected vegetative and floral characters. G. baudi = *G. baudii* (Group A1); G. carso = *G. carsonii* (Group A2); G. simpl = *G. simplex*) (Group B1); G. super = *G. superba* (Group B2). Box = standard error; whisker = standard deviation; line in box = mean; • = outlier; * = extremes.


Plant height (mm)
4000.00
3000.00
2000.00
1000.00
0.00
G. baudi
G. carso
G. simpl
G. super
Species

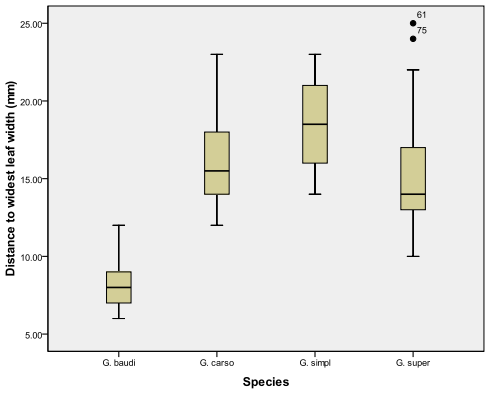
A


Leaf length (mm)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
9
25
6
G. baudi
G. carso
G. simpl
G. super
Species

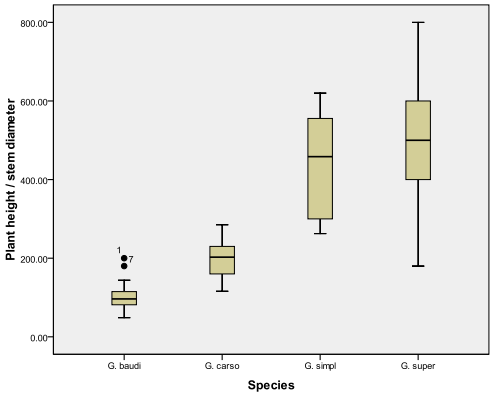
E


Stem diameter (mm)
8.00
6.00
4.00
2.00
68
58
20
4
2
70
G. baudi
G. carso
G. simpl
G. super
Species

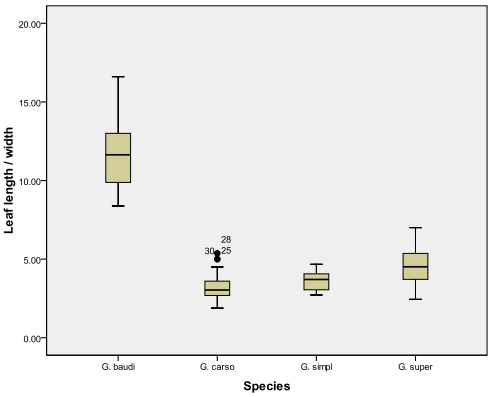
B


Distance to widest leaf width (mm)
25.00
20.00
15.00
10.00
5.00
61
75
G. baudi
G. carso
G. simpl
G. super
Species

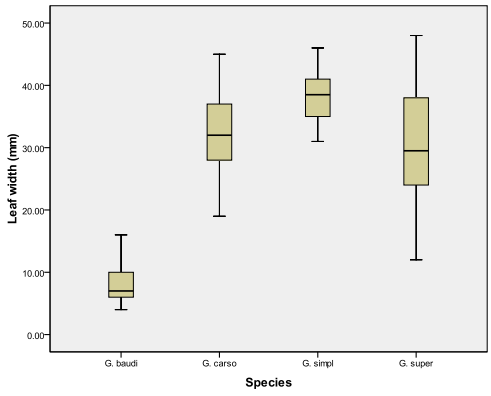
F


Plant height / stem diameter
800.00
600.00
400.00
200.00
0.00
1
7
G. baudi
G. carso
G. simpl
G. super
Species

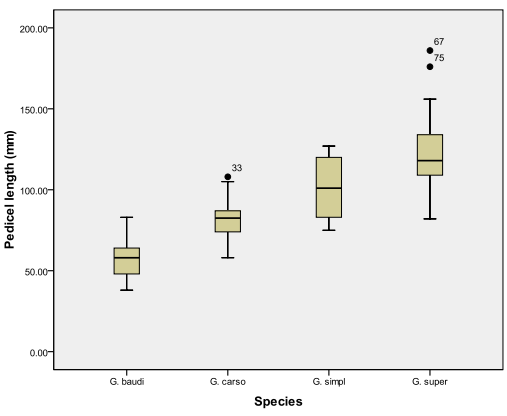
C


Leaf length / width
20.00
15.00
10.00
5.00
0.00
28
30
25
G. baudi
G. carso
G. simpl
G. super
Species

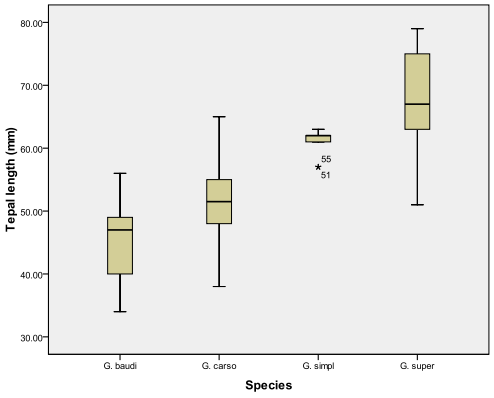
G


Leaf width (mm)
50.00
40.00
30.00
20.00
10.00
0.00
G. baudi
G. carso
G. simpl
G. super
Species

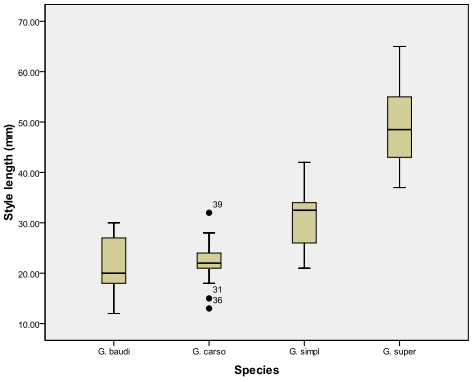
D


Pedicel length (mm)
200.00
150.00
100.00
50.00
0.00
67
75
33
G. baudi
G. carso
G. simpl
G. super
Species

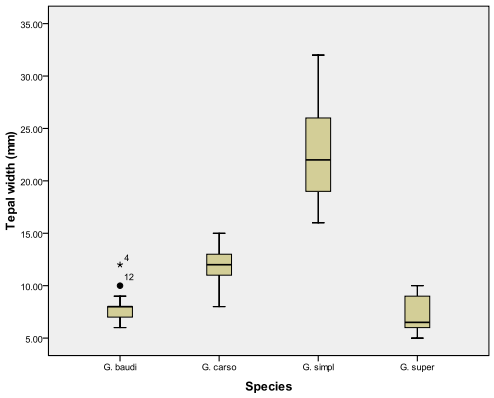
H


Tepal length (mm)
80.00
70.00
60.00
50.00
40.00
30.00
55
51
G. baudi
G. carso
G. simpl
G. super
Species

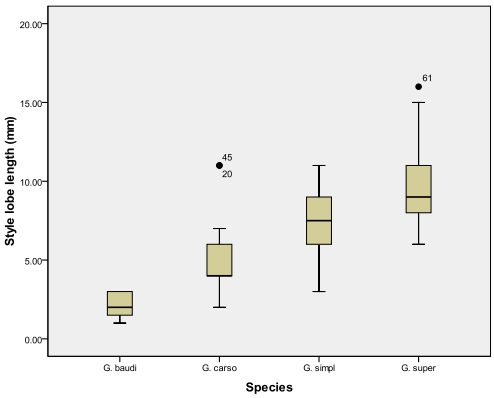
I


Style length (mm)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
39
31
36
G. baudi
G. carso
G. simpl
G. super
Species

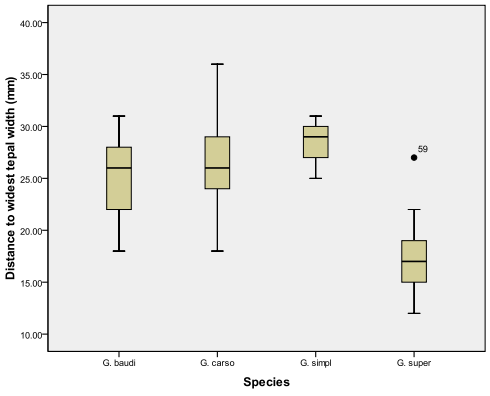
M


Tepal width (mm)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
4
12
G. baudi
G. carso
G. simpl
G. super
Species

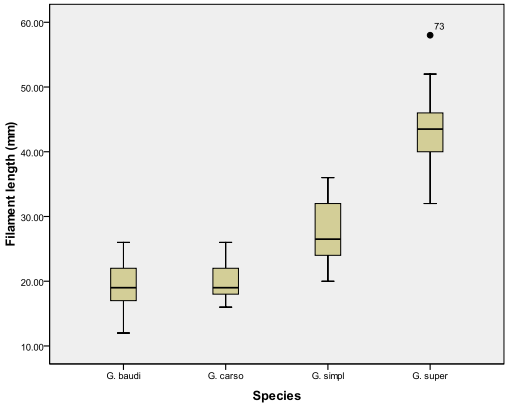
J


Style lobe length (mm)
20.00
15.00
10.00
5.00
0.00
61
45
20
G. baudi
G. carso
G. simpl
G. super
Species

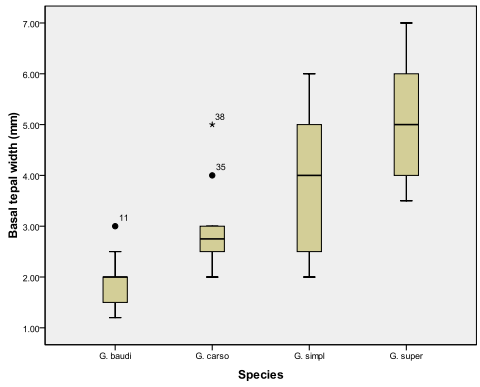
N


Distance to widest tepal width (mm)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
59
G. baudi
G. carso
G. simpl
G. super
Species

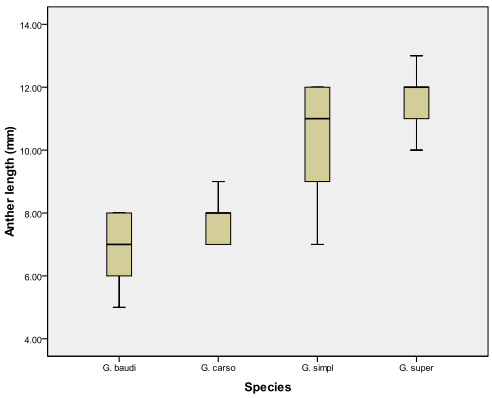
K


Filament length (mm)
60.00
50.00
40.00
30.00
20.00
10.00
73
G. baudi
G. carso
G. simpl
G. super
Species

O


Basal tepal width (mm)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
38
35
11
G. baudi
G. carso
G. simpl
G. super
Species

L


Anther length (mm)
14.00
12.00
10.00
8.00
6.00
4.00
G. baudi
G. carso
G. simpl
G. super
Species

P

The *G. baudii* (Terracc.) Chiov. Group A1

G. baudii was incorrectly placed in the genus *Littonia*. Baker (1898), considered it an imperfectly known species and hinted that it could be a *Gloriosa* species as the perianth segments were said to be reflexed. The formal combination was effected by Chiovenda in 1916. Later workers (e.g. Field 1972; Thulin 1995) hinted at the need to accord some taxonomic recognition of the dwarf plants of the arid regions of northern Kenya, Ethiopia and Somalia based mainly on their short, erect and non-climbing stature. In his treatment of Colchicaceae for the Flora of Ethiopia and Eritrea, Sebsebe Demissew (1997) recognised *G. baudii* as a distinct species. In the most recent taxonomic treatment of Colchicaceae for Flora of Tropical East Africa, Hoenselaar (2005) reduced *G. baudii* to a synonym of *G. superba* var. *graminifolia*. In this study, specimens of *G. baudii* form a distinct cluster within the *G. superba* complex which is also well supported by geographical distribution. Quantitative characters such as plant height, ratio of plant height to stem diameter, leaf width, distance from the base to widest leaf width, ratio of leaf length to width and anther width support the recognition of *G. baudii* as a distinct species. CA, PCA and univariate analysis agree with the recommendation to separate *G. baudii* from *G. superba* (after Sebsebe Demissew 1997).

The *G. carsonii* Baker Group A2

Baker (1898) considered *G. carsonii* as a distinct species; while Hepper (1968) and Hoenselaar (2005) treated it as a synonym of *G. simplex* and *G. superba* var. *superba* respectively. Baker (1898) recognised it as a short and erect form, characterised by oblong-lanceolate leaves, confined to Mozambique and Malawi. According to CA (Figure 4.1) and PCA (Figure 4.2), the *G. carsonii* Group A2 appears to be phenetically closer to the *G. baudii* Group A1 than to the Group B cluster (*G. simplex* and *G. superba*). These findings are consistent with morphological characters used by Baker (1898). Therefore, the morphometric distinctiveness of *G. carsonii* as demonstrated by CA and PCA in this study suggests that it should probably be treated as a separate species. We therefore, here propose its reinstatement at the specific level. But there is also need to revise the concept of *G. carsonii* on account of the type specimen and the distributional range of the species. It is erect and non-climbing; but taller than *G. baudii* and has a wider geographical range in tropical Africa. *G. carsonii* is not specific to one particular habitat, but has been recorded in miombo woodland, wooded grasslands, dry scrubby roadsides and open grasslands.

The *G. simplex* L. Group B1

Specimens of the *G. simplex* Group B1 do form a cluster distinct from specimens of *G. superba*. The qualitative character of the perianth segments supports the recognition of this cluster as a distinct taxonomic unit. Results of this study are consistent with morphological characters used by Baker (1897, 1898) to differentiate between *G. virescens* (= *G. simplex* L.) and *G. superba*. Baker (1897, 1898) described *G. virescens* (= *G. simplex* L.) as having wider, undulate to non-undulate perianth segments. This delimitation was adopted by several workers in east and west Africa (e.g. Andrews 1956; Berhaut 1967; Cufodontis 1971; Hepper 1968; Lund & Tallantire 1962; Van der Burg 2006; Verdcourt & Trump 1969). Although *G. simplex* L. has been considered a *nomen incertae sedis* by Field (1971, 1972), which led to the suggestion to abandon this widely used name. Here, we propose that the name, *G. simplex* L., should be reinstated.

The *G. superba* L. Group B2

This study has shown that the *G. superba* Group B2 is a well-defined cluster both in the CA and PCA. Baker (1898) described *G. superba* as a climbing perennial, characterised by crisped perianth segments occurring in South Africa, tropical Africa and Asia. Specimens with features matching the description of *G. superba* are widespread, recorded in South Africa, tropical Africa and Asia. Characters that can be considered diagnostic for *G. superba* are the narrow and crisped perianth segments. We hereby recommend the treatment of *G. superba* in a narrower sense, characterised by narrow, crisped to heavily crisped perianth segments.

Key to the species

1a. Stems long, usually higher than 100 cm; branched and climbing; stamens with long filaments, more than 2.2 cm long.....**2**

1b. Stems erect, short, less than 100 cm high, not branched; stamens with short filaments, less than 2.2. cm long.....**3**

2a. Perianth segments with much crisped margins, more or less the same width, less than 1.5 cm wide.....***G. superba***

2b. Perianth segments not crisped but with straight or slightly undulate margins, gradually narrowed at the base, broadening towards the middle and curving inwards in the upper half; usually more than 1.5 cm wide in the middle.....***G. simplex***

3a. Short stems, often less than 40 cm high; leaves crowded, leaf blade 0.2-1.5 cm wide, perianth segments fused for 4-5 mm at the base (Kenya, Ethiopia and Somalia)... .....***G. baudii***

3b. Stems often higher than 40 cm, lower leaves alternate, leaf blade more than 2 cm wide, perianth segments fused for less than 3 mm at the base.....***G. carsonii***

Chapter 5

Gloriosa and *Littonia* (Colchicaceae): delimitation and phylogenetic relationships based on *trn*L-*trn*F sequences

A. Maroyi, R.A. Wilschut, L.J.G. van der Maesen and L.W. Chatrou

Gloriosa superba **L., characterised by yellow, heavily crisped perianth segments, photograph taken by Prof. L.J.G. van der Maesen, outside Great Zimbabwe monuments, Great Zimbabwe, Masvingo, Zimbabwe**

Chapter 5: *Gloriosa* and *Littonia*: delimitation and phylogenetics

Abstract

Little information is available on the phylogenetic relationships within the genus *Gloriosa* L. *sensu lato*. Previous studies on phylogenetic relationships within family Colchicaceae based on three plastid regions (*atp*B-*rbc*L, *rps*16 and *trn*L-*trn*F) sequences demonstrated that *Gloriosa* was not monophyletic unless the closely related genus *Littonia* Hook. was included to render it monophyletic. In an attempt to test the monophyly of the expanded genus we utilised the chloroplast region *trn*L-*trn*F sequences, using *Baeometra uniflora, Hexacyrtis dickiana, Neodregea glassii, Onixotis punctata, Onixotis stricta, Ornithoglossum parviflorum*, *Ornithoglossum undulatum, Ornithoglossum viride, Ornithoglossum vulgare* and *Sandersonia aurantiaca* as an outgroup. We examined ca. 58% of all known species belonging to the expanded *Gloriosa* genus including *Gloriosa sessiliflora* Nordal & Bingham, a species considered to be intermediate between *Gloriosa* and *Littonia*. Results of maximum parsimony analysis revealed that *Gloriosa* is a well supported clade with the inclusion of *Littonia*. Therefore, these results support a much broader generic concept of the genus *Gloriosa* as suggested by Nordal & Bingham (1998) and Vinnersten & Reeves (2003), and implemented by Vinnersten & Manning (2007). The phylogenetic analysis resolves *Littonia modesta* Hook. as a sister to the main clade of *Littonia revoilii* Franch. nested within *Gloriosa sensu stricto* species. Within the main clade, *Littonia revoilii* and *Gloriosa baudii* (Terracc.) Chiov. form a well supported clade. Both species are near-endemics, occurring in east Africa with *L. revoilii* extending into south Yemen. The third clade comprises species of the *G. superba* L. complex and *G. sessiliflora* Nordal & Bingham. These three lineages are also strongly supported by ecological, geographical and morphological characters.

Introduction

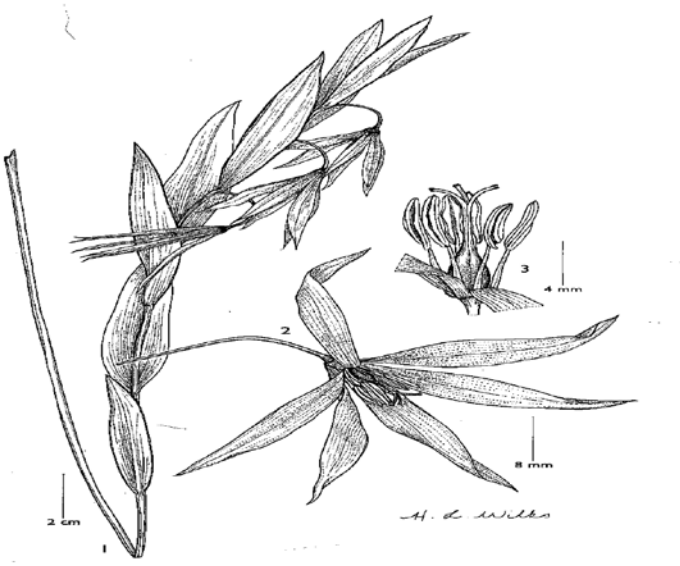
The family Colchicaceae includes about 250 species referred to 15 genera, and is distributed in temperate to arid habitats in Africa, Asia, America, Australia and Europe. A study of the re-circumscribed and expanded Colchicaceae family has demonstrated that the biosynthesis of colchicine evolved within the common ancestor to Colchicaceae, and that this alkaloid can be regarded as a synapomorphic character for the family (Vinnersten & Larsson 2010). As presently defined, Colchicaceae includes mainly perennial geophytes, herbs and vines, characterised by underground tuberous rootstock, creeping rhizome or corm (Nordenstam 1998). The family is monophyletic, although there is need for a revision of the infrafamilial

classification (Manning *et al.* 2007; Vinnersten & Manning 2007; Vinnersten & Reeves 2003). Recent work on family Colchicaceae has found strong molecular support for monophyly of genus *Gloriosa* L. including *Littonia* Hook. (Vinnersten & Reeves 2003). A molecular phylogenetic investigation using three non-coding sequences from cpDNA found a well-supported clade (100% jacknife support) in which *Littonia* species were nested within *Gloriosa* species (Vinnersten & Reeves 2003). Consequently, the genus *Gloriosa* has been expanded by including *Littonia* (Vinnersten & Manning 2007), rendering it monophyletic. Phylogenetic relationships of species within the expanded *Gloriosa* genus and their supposed allies are poorly known. These studies by Vinnersten & Reeves (2003) and Vinnersten & Manning (2007), have also brought into focus the need for further investigations to identify new synapomorphies that support the enlarged *Gloriosa* genus as supported by the molecular analyses and that can provide the basis for developing a formal generic classification.

Before, the genera *Gloriosa* and *Littonia* have been known to be very similar in vegetative and floral morphology (Baker 1879, 1897, 1898; Buxbaum 1937; Field 1972; Nordenstam 1998; Queva 1899). The pistils of *Gloriosa* and *Littonia* are generally tricarpellate and similar (Sterling 1975). The early workers' accurate observations and thorough diagnoses especially on floral characteristics for both genera, allowed these generic concepts to withstand the test of time. As originally described, the genus *Littonia* (Figure 5.1C) included species with straight, not bent style, and connivent, not reflexed tepals. However, these generic distinctions became questionable and ambiguous when Nordal & Bingham (1998) challenged the continued separation of the two genera in the description of *Gloriosa sessilifolia* Nordal & Bingham, a new species with intermediate characteristics between *Gloriosa* and *Littonia* (Nordal & Bingham 1998, Figure 5.1B).

Vegetative morphology is uniform in both genera, erect and climbing forms are common in both genera, although all species of *Littonia* are usually less than two metres high. Members of both genera are perennial, erect or climbing herbs characterised by tunicate corms (Dyer 1976; Nordenstam 1998; Sebsebe Demissew 1997; Thulin 1995). There is overlap in the distributions of the two genera (Figure 5.2); *Gloriosa* occurring in South Africa, tropical Africa, India and south-eastern Asia while *Littonia* occurs in South Africa, tropical Africa

A **B**



C

Figure 5.1. Morphological variation in *Gloriosa* and *Littonia*. A. *Gloriosa superba.* Flowering stem, immature fruit and underground corms (Bunyapraphastara & van Valkenburg 1999). **B**. *Gloriosa sessiliflora*. Flowering plant shoot (Nordal & Bingham 1998). **C**. *Littonia lindenii.* 1. Habit, 2. Flower, 3. Stamens and ovary (Hoenselaar 2005). All illustrations reproduced with permission of the publishers.

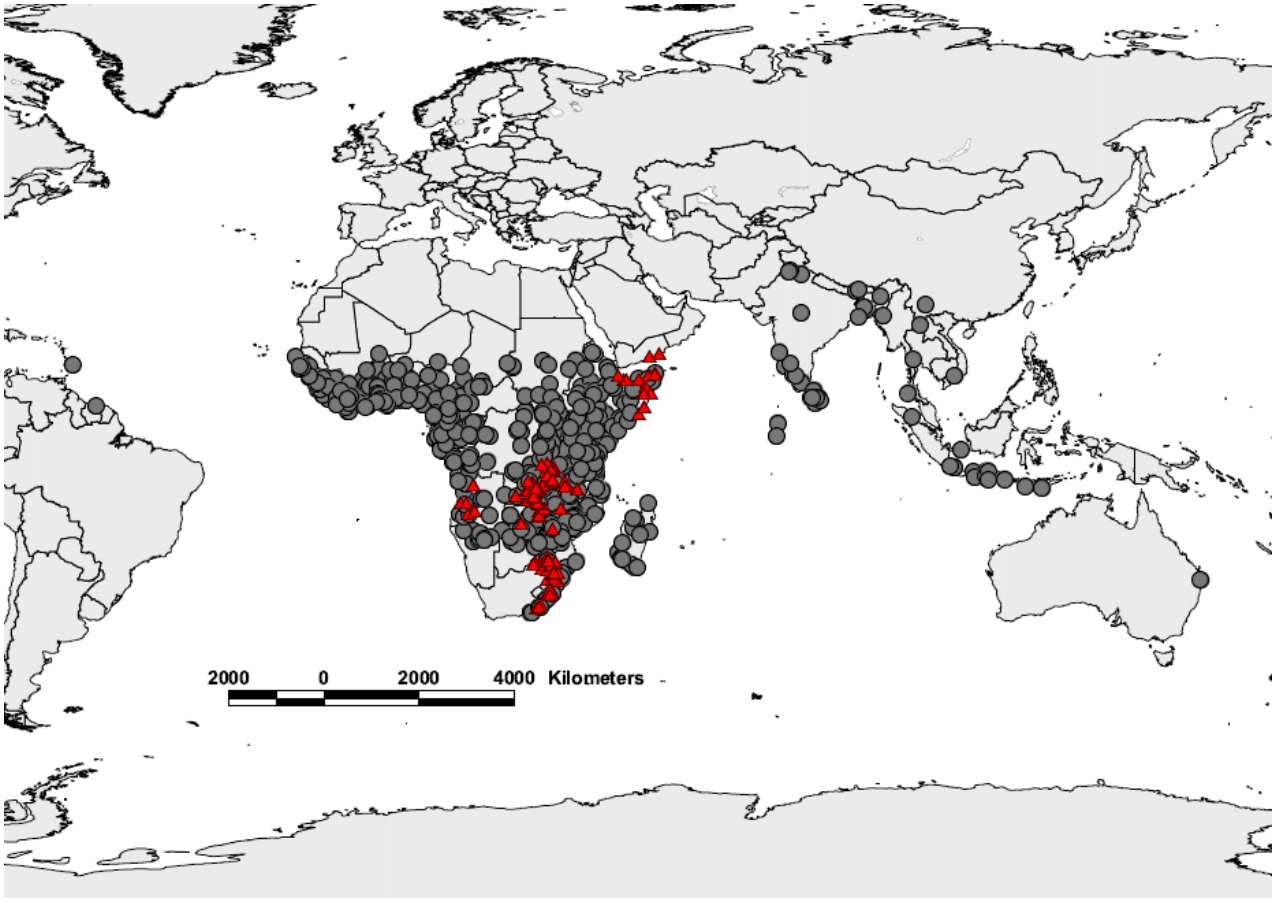


Figure 5.2. Distribution of *Gloriosa* and *Littonia* across their geographic ranges based on georeferenced herbarium specimens. ▲ *Littonia*; ● *Gloriosa*.

and south Yemen. Although the monophyly of *Gloriosa sensu lato* was demonstrated (Vinnersten & Manning 2007; Vinnersten & Reeves 2003), it was based on very limited sampling and does not provide a robust understanding of relationships within this clade. The generic delimitation was not properly and rigorously addressed in previous studies. Furthermore, the study did not include *G. sessilifolia*, a critical species which is morphologically intermediate between the two genera. In an attempt to address this deficiency, we have expanded the data set of Vinnersten & Reeves (2003) by augmenting the number of taxa within this clade and including *G. sessilifolia*. The current study also includes morphological characters in the discussion of the resultant groups based on *trn*L-*trn*F data set. Based on previous studies by Vinnersten & Manning (2007), the genus *Littonia* is not recognised anymore; but for argument's sake, *Littonia* species are maintained in this chapter. The aims of this study are to (i) further corroborate the monophyly of *Gloriosa* in light of

expanded species sampling, (ii) investigate their phylogenetic relationships within the expanded genus, and (iii) determine the circumscription of the genus or genera based on phylogeny and morphological characteristics. Key morphological characters were re-evaluated in the light of the molecular phylogeny.

Materials and Methods

DNA material, extraction, amplification and sequencing protocols

Names of all *Gloriosa* and *Littonia* species used in this study, along with their sources, voucher information, and corresponding DNA extraction numbers, are provided in Table 5.1. Leaf material for DNA extraction and sequencing was collected in the field or obtained from herbarium specimens (Table 5.1). *Littonia flavovirens* Dammer, *Littonia grandiflora* De Wild. & T.Durand, *Littonia lindenii* Baker, *Littonia littonioides* (Welw. ex Baker) Krause and *Littonia rigidifolia* Bredell were not included due to lack of material suitable for molecular work. Some of the nucleotide sequences were retrieved from GenBank and have been previously published by Vinnersten & Reeves (2003). *Baeometra uniflora, Hexacyrtis dickiana, Neodregea glassii, Onixotis punctata, Onixotis stricta, Ornithoglossum parviflorum*, *Ornithoglossum undulatum, Ornithoglossum viride, Ornithoglossum vulgare* and *Sandersonia aurantiaea* were selected as outgroup taxa based on the results from a broad molecular systematic studies of Vinnersten & Reeves (2003).

All samples were extracted using a modified cetyltrimethyl ammonium bromide protocol (CTAB) method of Doyle and Doyle (1987). The plastid *region trnL-trnF* was amplified and sequenced using the c, d, e, and f primers (Taberlet *et al*. 1991) as shown in Table 5.2. PCR reactions (25 µl) included 2.5 µl (10X Dream Taq polymerase buffer, including 3.5 µl of 20 mM $MgCl_2$, 1 µl of 10 mM/ml dNTPs, 10 mM/ul of 0.5 µl forward and reverse primers, 10 mg/ml of 1 µl BSA and 1 µl Fermentas Dream taq polymerase). PCR was performed on a PTC-200 Thermo Cycler (MJ-Research): 35 cycles; 30 sec.; 94°C, 1 min.; 55°C, 2 min.; 72°C, with an initial 4 min.; 94°C and final 7 min.; 72°C. Amplification products were cleaned up using the MinElute PCR purification kit (QIAGEN), following the manufacturers' protocols. Cycle sequencing reactions were performed with the use of the BigDye Terminator Cycle sequencing kit, following the manufacturers' protocols. The same primers were used as for the amplification. The products of the cycle sequencing reaction were processed in an ABI3100 capillary sequencer at the Greenomics sequencing facility. Assembly of the tracers

and sequence editing were done using CodonCode Aligner (v. 3.7.1.1., CodonCode Corp., Dedham, Massachusetts) for Mac OSX.

Table 5.1. Voucher specimens and GenBank accession for sequences

Taxon	Voucher/Reference	GenBank Accession number		
		***rps*16 intron**	***atp*B-*rbc*L spacer**	***trn*L-*trn*F**
Baeometra uniflora	Vinnersten & Reeves 2003	AJ551201	AJ554246	AJ560294
Gloriosa baudii	Vinnersten & Reeves 2003	AJ551215	AJ554259	AJ551359
G. carsonii	Sanane 1028 (Zambia)	New	-	-
G. sessiliflora	Bingham 12717 (Zambia)	New	-	-
G. simplex	Vinnersten & Reeves 2003	AJ551216	AJ554262	AJ551360
G. simplex	Vinnersten & Reeves 2003	AJ551219	AJ554263	-
G. superba	Vinnersten & Reeves 2003	AJ551218	AJ554261	AJ551362
G. superba	Vinnersten & Reeves 2003	AJ551217	AJ554260	AJ551361
Hexacyrtis dickiana	Vinnersten & Reeves 2003	AJ551220	AJ554264	AJ551363
Littonia modesta	Vinnersten & Reeves 2003	AJ551225	AJ554269	AJ551365
L. revoilii	Vinnersten & Reeves 2003	AJ551226	AJ554270	AJ551366
Neodregea glassii	Vinnersten & Reeves 2003	AJ551229	AJ554273	AJ551368
Onixotis punctata	Vinnersten & Reeves 2003	AJ551230	AJ554274	AJ551369
Onixotis stricta	Vinnersten & Reeves 2003	AJ551231	AJ554275	AJ560298
Ornithoglossum parviflorum	Vinnersten & Reeves 2003	AJ551232	AJ554276	AJ551370
Ornithoglossum undulatum	Vinnersten & Reeves 2003	AJ551233	AJ554277	AJ551371
Ornithoglossum viride	Vinnersten & Reeves 2003	AJ551234	AJ554278	AJ551372
Ornithoglossum vulgare	Vinnersten & Reeves 2003	AJ551235	AJ554279	AJ551373
Sandersonia aurantiaca	Vinnersten & Reeves 2003	AJ551236	AJ554280	AJ560299

Table 5.2. Primer sequences, annealing conditions and references of the DNA regions used in this study

Region	Primer name	Primer sequence(5'-3')	Annealing conditions	Reference
atpB-rbcL	*atp*B-F	GAAGTAGTAGGATTGATTCTC	20" at 62°C	Manen *et al.* 1994; Savolainen *et al*. 1994
atpB-rbcL	rbcL-R	TACAGTTGTCCATGTACCAG	20" at 62°C	Manen *et al.* 1994; Savolainen *et al*. 1994
rps16	rpsF	GTGGTAGAAAGCAACGTGCGACTT	20" at 60°C	Oxelman *et al.* 1997
rps16	rpsR2	TCGGGATCGAACATCAATTGCAAC	20" at 60°C	Oxelman *et al.* 1997
*trn*L-*trn*F	C	CGAAATCGGTAGACGCTACG	30" at 58°C	Taberlet *et al.* 1991
*trn*L-*trn*F	D	GGGGATAGAGGGACTTGAAC	30" at 58°C	Taberlet *et al.* 1991
*trn*L-*trn*F	E	GGTTCAAGTCCCTCTATCCC	20" at 64°C	Taberlet *et al.* 1991
*trn*L-*trn*F	F	ATTTGAACTGGTGACACGAG	20" at 64°C	Taberlet *et al.* 1991

Alignment of the three cpDNA data partitions was done by eye using Mesquite. Characters in parts of the sequences where alignment was ambiguous were excluded from the analyses. Microsatellites were excluded as well as variable regions within the species. Three gaps in the *rps*16 alignment, shared between two or more taxa, were binary coded as a single character for their presence or absence according to the simple indel coding method of Simmons & Ochoterena (2000). Individual markers were analysed under parsimony to test for incongruence (data not shown). Lack of 'hard incongruences' (conflicting nodes subject to BS > 70%; Hillis & Bull 1993) between individual gene trees was interpreted as congruence between the data partitions, which were then combined in further analyses. For the combined analyses a supermatrix approach was adopted, i.e., including all taxa, even where data was not available for particular markers, which were coded as missing.

Maximum parsimony analyses were performed using PAUP* version 4.10b (Swofford 2000) with the heuristic search option (TBR, ACCTRAN, MULPARS invoked). Character states were specified as unordered and equally weighted (Fitch parsimony; Fitch 1971). Alignment gaps were treated as described above. The search strategy consisted of 10,000 random addition sequence replicates, saving 100 trees per replicate. Clade support was assessed by non-parametric bootstrapping of the data, with 1000 bootstrap replicates, 50 addition sequence replicates per bootstrap replicate, saving 50 trees per replicate. The search options were identical as described above. When evaluating the results, we use the following descriptions of support by bootstrap values: 50-74% represents weak support, 75-84% moderate support, and 85-100% strong support.

Results

The maximum parsimony heuristic search produced 378 shortest trees with a tree length of 595 steps, with an overall consistency index (CI; Kluge & Farris 1969) of 0.914, and an overall retention index (RI; Farris 1989) of 0.877.

The maximum parsimony tree (Figure 5.3), shows that the ingroup species of *Gloriosa* including *Littonia* (after Vinnersten & Manning 2007; Vinnersten & Reeves 2003) is monophyletic. The monophyly of the ingroup was maximally supported (Figure 5.3). The southern African species, *Littonia modesta* is resolved as sister to a clade of *Littonia revoilii*

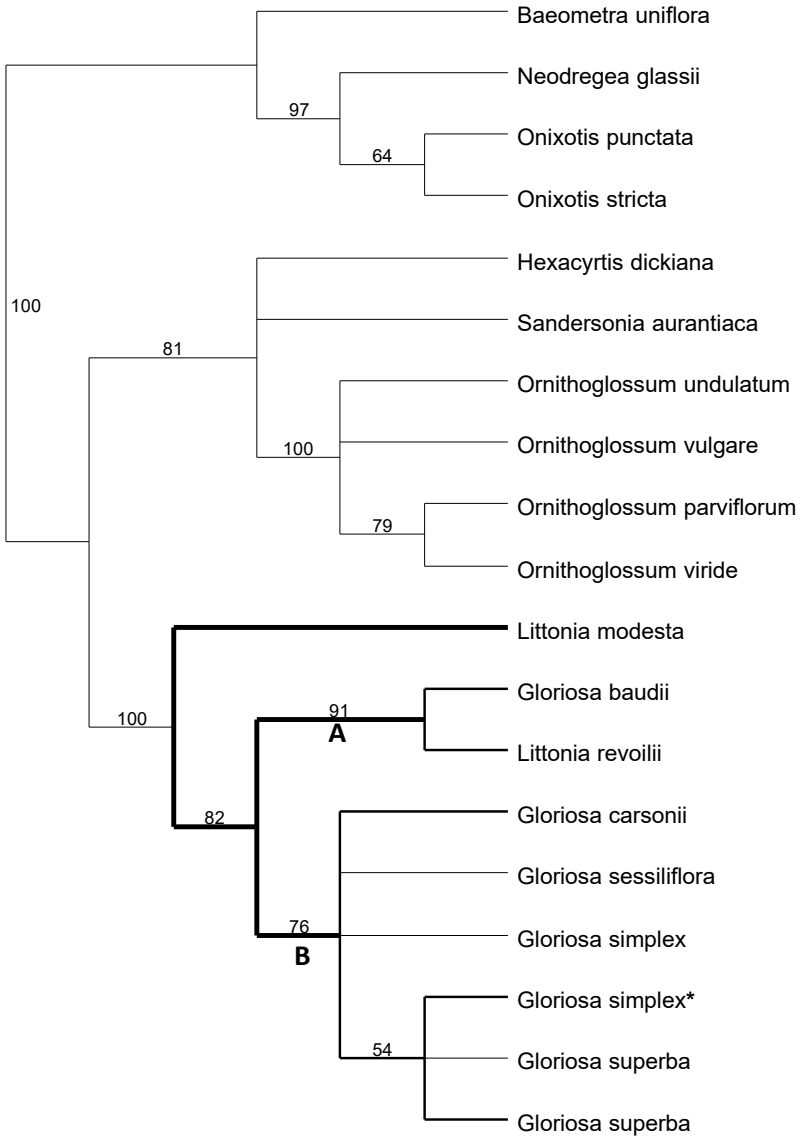


Figure 5.3. Maximum parsimony 50% majority rule consensus tree based on *trn*L-*trn*F dataset. Numbers above the branches indicate bootstrap percentages based on parsimony bootstrap analysis.

and all *Gloriosa* species, which is moderately supported (bootstrap support 82%). This clade is split into two subclades, hereafter called clade A and B. Clade A, comprising *Gloriosa baudii* and *Littonia revoilii*, is strongly supported with a bootstrap value of 91%. The two

near-endemic species are morphologically similar and occupy overlapping geographical habitats in Ethiopia and Somalia. However, clade B has a moderate bootstrap value of 76%, and is an unresolved clade of *Gloriosa* species. *G. carsonii, G. sessiliflora* and *Gloriosa virescens* was unresolved. *G. sessiliflora*, generally regarded as a distinct species is embedded in the *G. superba* complex. Two representatives of *G. superba* and *G. simplex* formed a weakly supported polytomous clade, with bootstrap support of 54% and the relationship within this clade was unresolved.

Discussion

The results of this study (Figure 5.3), confirmed the monophyly of the genus *Gloriosa* including *Littonia*. The results presented here support a re-circumscription of the genus *Gloriosa* in the broadest possible sense with the inclusion of *Littonia*, as was suggested by Nordal & Bingham (1998) and Vinnersten & Reeves (2003), and implemented by Vinnersten & Manning (2007). The monophyly of the genus *Gloriosa* gets additional support from morphological, biochemical and chromosomal characters. Both *Gloriosa* and *Littonia* are characterised by tuberous corms (Buxbaum 1937; Dyer 1976; Nordenstam 1998; Sebsebe Demissew 1997; Thulin 1995), their leaves frequently develop tendril-like, cirrhous tips (Dyer 1976; Nordenstam 1998; Queva 1899; Sebsebe Demissew 1997; Thulin 1995); and colchicine occurs in all (Hegnauer 1963; Raffauf 1970; Vinnersten & Larsson 2010; Wildman & Pursey 1968). Queva (1899) also noted that crystals of calcium oxalate were lacking in both *Gloriosa* and *Littonia*. The basic chromosome number is n = 11 for *G. simplex*, *G. superba* and *L. modesta* (Bell 1958; Cave 1962, 1963). Sampled taxa in this study represents 58% of all known species belonging to the expanded *Gloriosa* genus, and therefore, the obtained molecular phylogeny makes it possible to hypothesise the phylogenetic relationships within the group.

The present analysis revealed some morphologically, geographically and ecologically congruent clades (Figure 5.3). *Littonia modesta* is sister to the remaining species. *L. modesta* climbs by means of leaf tendrils and has campanulate flowers. Its stems and foliage are similar to those of *G. superba* and *G. simplex*; but the flowers are different, being simpler and bell-shaped. Vegetative and floral characteristics of *L modesta* makes it resemble a South African endemic, *L. rigidifolia*. *L. modesta* is distinguished from *L. rigidifolia* by being taller and having larger leaves; and *L. modesta* being more widespread than *L. rigidifolia*, confined

to the sandy areas of Waterberg, Transvaal region, South Africa. *L. modesta* is currently known from Mozambique, South Africa, Swaziland and Zimbabwe. *L. rigidifolia* would need to be sampled in further work to demonstrate whether or not morphological similarity is based on close phylogenetic relationship. *L. modesta* is the type species of the *Littonia* genus, described by Hooker (1853) differing from the genus *Gloriosa* particularly in its straight, not bent style and connivent, not reflexed tepals (Nordal & Bingham 1998). However, it is important to note that our sample does not include enough *Littonia* species to make concrete conclusions. As described in the methodology, we were unable to obtain DNA of these five *Littonia* species: *L. flavovirens*, *L. grandiflora*, *L. lindenii*, *L. littonioides* and *L. rigidifolia*. Expanding the sample to include some of these species confined to South Africa and south-central Africa would constitute a stronger test of the phylogenetic relationships within the *Littonia s.s.* species.

The second clade (B), comprises *Gloriosa baudii* and *Littonia revoilii*, and is a well supported, and geographically and morphologically coherent clade. *G. baudii* is a near-endemic taxon found in the arid regions of northern Kenya, Ethiopia and Somalia, common on sandy and stony ground. *L. revoilii* is also a near-endemic taxon, occurring in sandy and stony ground in Somalia and south Yemen. According to Sebsebe Demissew (1997) and Thulin (1995), *L. revoilii* also occurs in Djibouti and Ethiopia. Both, *G. baudii* and *L. revoilii* are erect, non-climbing and usually less than 40 cm tall. Their underground stem is covered by membraneous sheathing which is usually protracted into the lowermost leaf. The two species are also characterised by linear and narrow leaves, usually less than 1.5 cm wide.

Vegetatively, *G. baudii* and *L. revoilii* are very similar, they can only be distinguished using floral characters based on tepals and the style. According to Vinnersten & Manning (2007), the sister relationship between *G. baudii* and *L. revoilii* suggests that the erect tepals in *L. revoilii* are secondarily derived from the reflexed condition in *G. baudii*, and the slightly geniculate bend at the base of the style in this species may be a vestige of the sharp flexure that characterises *Gloriosa*. But this explanation does not adequately address the evolutionary relationships between *Gloriosa* and *Littonia* species considering the position of *L. modesta* which is characterised by erect tepals in the phylogenetic tree which resolves it as a sister to a clade of *L. revoilii*; and all other *Gloriosa* species (Figure 5.3). Occurrence of *L. revoilii* in east Africa and south Yemen has interesting biogeographical implications as it suggests a dispersal event northwards from east Africa. Given that east Africa appears as part of the

ancestral distribution of *L. revoilii* (Figure 5.3), the east Africa to south Yemen is the more likely route than the reverse route making the south Yemen node a possible result of a dispersal out of Africa.

Clade B is the least resolved (Figure 5.3), but revealed a moderately supported relationship between *G. sessiliflora* and other species of the *G. superba* complex. This result is consistent with an earlier observation made by Nordal & Bingham (1998) that *G. sessiliflora* is indistinguishable from the other forms within the *G. superba* complex in general habit. Although, *G. sessiliflora* has connivent tepals that are similar to those of *Littonia s.s.*, our phylogenetic tree suggests that it cannot be associated with this group. *G. sessiliflora* is clearly not phylogenetically distinct from the species that constitute the *G. superba* complex (Figure 5.3), and given the morphological diversity encompassed by *Gloriosa s.s.*, *G. sessiliflora* does not seem morphologically very distinct either. The only morphological character which separates *G. sessiliflora* from both *Gloriosa s.s.* and *Littonia s.s.*, is its sessile flowers.

Species differentiation in clade B is difficult and all the species in this clade apart from *G. sessiliflora* have been regarded as belonging to *G. superba* complex (Field 1971, 1972), a species characterised by a convoluted taxonomic history. Numerical methods utilising multivariate and univariate analyses (**Chapter 4**) recommended recognition of four distinct species in the *G. superba* complex: *G. baudii*, *G. carsonii*, *G. superba* and *G. simplex*. *G. superba* is the most widespread taxon, occurring in South Africa, tropical Africa and Asia. *G. virescens* and *G. carsonii* are confined to tropical Africa. *Gloriosa simplex** examined in the present study was taken from Vinnersten & Reeves (2003) and we did not examine the voucher specimen, and therefore we cannot conclude that it is different from *G. superba*.

In conclusion, the phylogenetic analysis of the expanded *Gloriosa* genus shows several interesting relationships among its species and we still need a full understanding of the group. Given unresolved relationships and low bootstrap support for the *Gloriosa s.s.* clade, we need to have additional sequences from both cpDNA and nuclear DNA. This will enable us to construct a robust and better resolved phylogeny for the *Gloriosa* genus. Such further analysis might also help in understanding the *G. superba s.s.*, a widely distributed species stretching from South Africa, tropical Africa, Asia to south-eastern Asia.

Chapter 6

Revision of Gloriosa L. (Colchicaceae)

A. Maroyi and L.J.G. van der Maesen

Gloriosa simplex **L., characterised by broad, not crisped perianth segments, photograph taken by Prof. L.J.G. van der Maesen, 4 km out of Zvishavane town, Zimbabwe**

Chapter 6: Revision of *Gloriosa* L. (Colchicaceae)

Abstract

In the present revision of genus *Gloriosa* L. (including *Littonia* Hook.), twelve species are recognised. An updated identification key, descriptions, notes on ecology, species distribution and conservation status are presented. Also included are illustrations and distribution maps of the species. All this information is important for identification purposes and future research that will be done on the species. *G. baudii*, *G. carsonii* and *G. simplex* synonymised under *G. superba* in recent treatments of the genus *Gloriosa* are here recognised as distinct species. The concept of *G. superba* is revised on account of its morphological variation throughout its distributional range; distinguished from related species by having perianth segments that are narrower, all six more or less the same width and the margins highly crisped. *G. superba* links South Africa and tropical Africa with tropical Asia and Indo-China. A new name *Gloriosa katangensis* Maroyi nom. nov. is suggested for *Gloriosa grandiflora* (De Wild. & T.Durand) J.C.Manning & Vinnersten from Democratic Republic of Congo (Kinshasa). The name *G. grandiflora* (De Wild. & T.Durand) J.C.Manning & Vinnersten which was published in Taxon **56** (2007: 178) is illegitimate since it was preoccupied (*Gloriosa grandiflora* (Hook.) O'Brien, 1904). *G. sessiliflora* previously recorded as an endemic from Bulozi floodplain, Western Zambia, has been shown to also occur in the Bié region in Angola.

Introduction

The core question at the start of this study was the specific delimitation of *Gloriosa* L. taxa, one of the most troublesome genera of family Colchicaceae. The major challenge in the taxonomy of the genus *Gloriosa* (Figure 6.1), has been the difficulty in finding good morphological characters to distinguish and fully circumscribe the species. More than 40 published *Gloriosa* species names are listed in the International Plant Index (IPNI 2011) worldwide (Table 6.1). Some new descriptions were made for species with names already in use. This is understandable for a genus characterised by great polymorphism (Wild 1965). This is also commom when a world monograph is lacking, species concepts vary considerably among regional floras. Accounts of this genus have only been published in national and regional floras (e.g. Andrews 1956; Baker 1897, 1898; Berhaut 1967; Blatter 1914; Cufodontis 1971; Dassanayake 2000; Gandhi 1976; Geerinck 2010; Hepper 1968; Hoenselaar 2005; Hooker 1894; Jessop 1979; Maroyi 2002; Polhill 1962; Sebsebe Demissew

1997; Thulin 1995; Trimen 1898; van der Burg 2006). Therefore, the present monograph represents the first comprehensive taxonomic revision of *Gloriosa* over its distributional range.

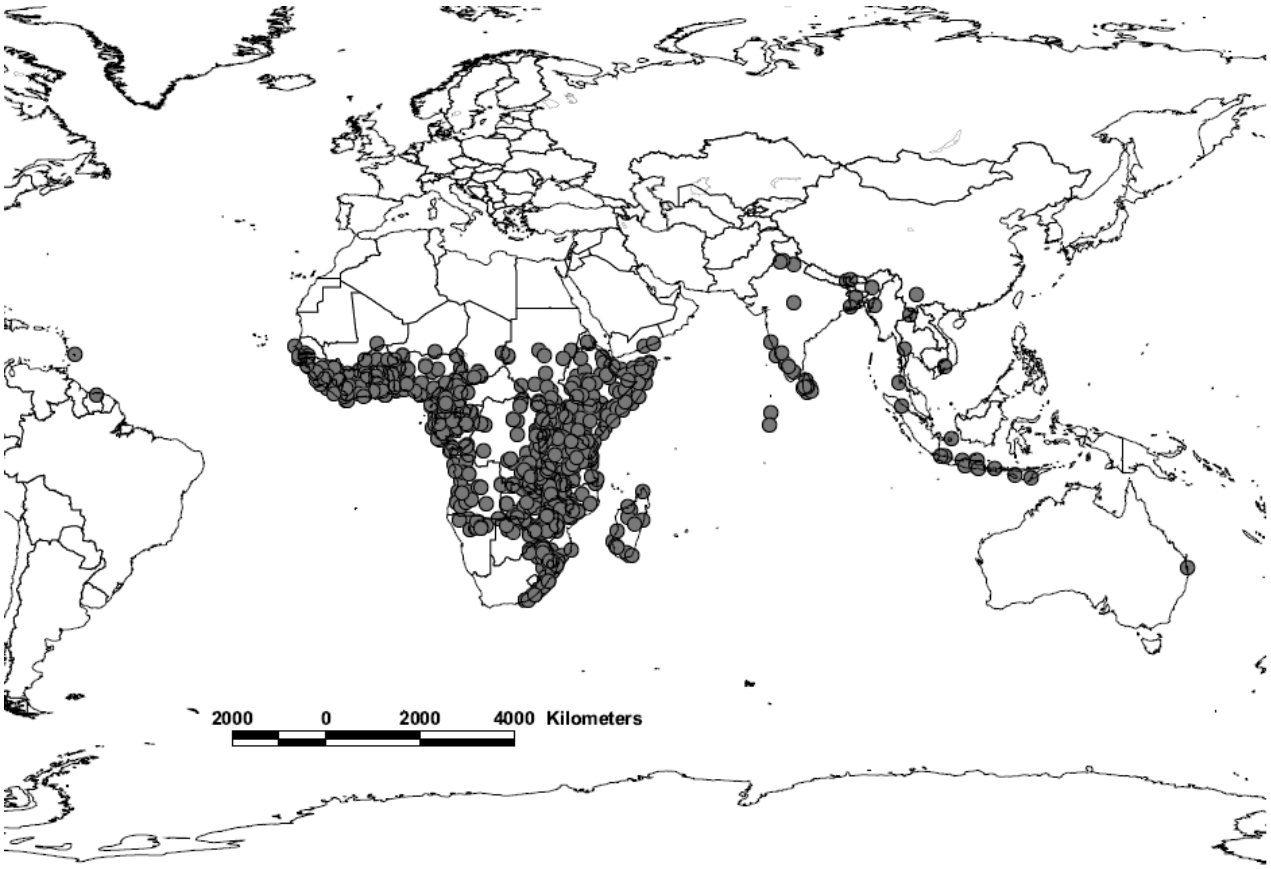


Figure 6.1. World distribution of the genus *Gloriosa* L., based on georeferenced herbarium specimens.

Gloriosa, including *Littonia* Hook. is a South African, tropical African, Arabian and Asian genus with twelve species. It consists of perennial herbs from 15 cm to about 6 m tall. A molecular phylogeny based on *trn*F-*trn*L plastid region (Figure 6.2) revealed that *Gloriosa* is a well supported clade with the inclusion of *Littonia*. These results support a much broader generic concept of the genus *Gloriosa* as suggested by Nordal & Bingham (1998) and Vinnersten & Reeves (2003), and implemented by Vinnersten & Manning (2007). The

phylogenetic analysis resolves *Littonia modesta* Hook. (now *G. modesta* J.C.Manning & Vinnersten) as a sister to the main clade (clade A and B) (Figure 6.2) of *Littonia revoilii* Franch. (now *G. revoilii* (Franch.) J.C.Manning & Vinnersten) nested within *Gloriosa s.s.* species. Within the main clade, *G. revoilii* and *Gloriosa baudii* (Terracc.) Chiov. form a well supported clade. The third clade (clade B) comprises species of the *G. superba* L. complex and *G. sessiliflora* Nordal & Bingham (Figure 6.2).

Circumscriptions and boundaries of some species within the genus *Gloriosa* have been questioned in the past. Therefore, the present study was aimed at assessing the species circumscriptions and species boundaries within the expanded *Gloriosa* genus. This study is based on morphological study of herbarium material as well as living plants. The work was carried out at the Herbarium Vadense (WAG), Wageningen University, the Netherlands. Observations and descriptions are based on herbarium material on loan to WAG from B, BM, BR, C, COI, F, K, L, P, S, U and UPS (abbreviations follow Holmgren *et al*. 1990). The typification and synonyms were checked and verified, distribution and phenological data were also added to the morphological descriptions of the species.

IUCN conservation status was carried out using herbarium specimen data. According to Rivers *et al*. (2011) and Willis *et al.* (2003), herbarium data can be used to determine IUCN categories of threat using criterion B (geographic range) and the number of locations as criterion D2 (small or restricted populations). According to Schatz (2000), herbarium specimens and their associated locality information must be accepted as sufficient for performing provisional IUCN conservation assessment on poorly known species. The categories defined by the IUCN Standards and Petitions Subcommittee (2010) are extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT), least concern (LC), data deficient (DD), and not evaluated (NE). To qualify as threatened, a species must be assessed as CR, EN or VU (Willis *et al.* 2003).

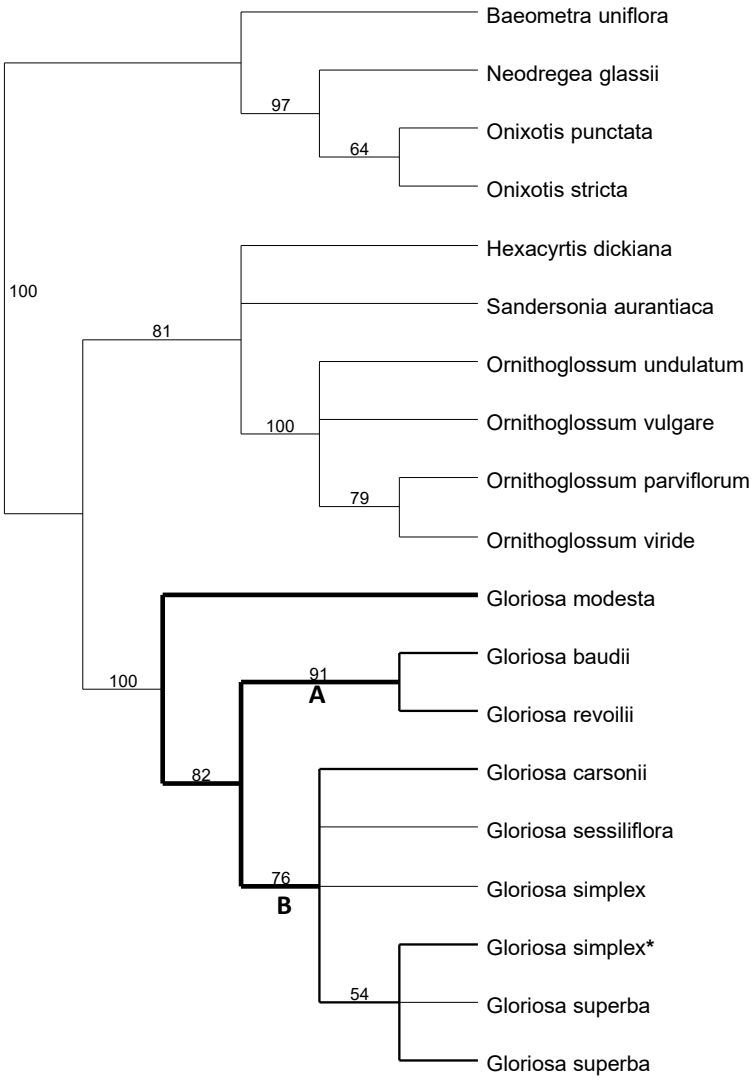


Figure 6.2. Maximum parsimony 50% majority rule consensus tree based on *trn*L-*trn*F dataset. Numbers above the branches indicate bootstrap percentages based on parsimony bootstrap analysis.

History of the genus *Gloriosa*

The nomenclature of genus *Gloriosa* L. generated a lot of interest during Linnaeus' time. The name *Gloriosa* was established by Linnaeus in 1737 and validated in 1753 (Linnaeus 1753). It was derived from the Latin word, 'gloriosus' which refers to the glorious appearance of the

flowers. The type species for the genus is *G. superba* L., a species described from a specimen collected in south west India (Malabar, present-day Kerala and part of Tamil Nadu). The Latin name *Gloriosa superba*, which translates as "gloriously superb", was described by Mathew (1995), as "probably the most tautological botanical name". Earlier botanists, e.g. Hooker (1853), regarded the name as very vulgar and he, together with others made several attempts to change the nomenclature of the genus *Gloriosa*. Hooker wrote this in 1853, "*Methonica* ought to be adopted, and not that *barbarissimum nomen*, *Gloriosa*, and the specific name ought to be *malabarorum*, not *superba*". Hooker's specific name *malabarorum*, refers to the locality Malabar where the type specimen of *Gloriosa* was collected from. Already, there were moves to adopt the name *Methonica* instead of *Gloriosa* (Table 6.1). Pierre-Joseph Redouté illustrated *G. superba* in his 8 volume Les Liliacées (1802-1816) as *Methonica superba* (Mathew 1995). *Methonica* is a name that was proposed by several botanists including Crantz (1766); Herman (1687); de Tournefourt (1707) (Table 6.1). Other alternative names that were proposed included: *Mendoni* (Adanson 1763), *Eugone* (Salisbury 1796) and *Clinostylis* (Hochstetter 1844) (Table 6.1). However, Wight (1853), concurred with Linnaeus nomenclature on the basis that some of the other names were not fully described and published. Therefore, moves by Adanson (1763), Crantz (1766), Herman (1687), Hochstetter (1844), Salisbury (1796) and de Tournefourt (1707) to adopt other names and not *Gloriosa* were against the present taxonomic practice of accepting the earliest valid name.

Table 6.1. Major events in the taxonomic history of *Gloriosa* and *Littonia*

Year	Described species and author	Previous taxonomic comments / references
1687	*Methonica malaborum* Herman	***ined.*** (Wight 1853).
1707	*Methonica* Tournef.	***ined.*** (Wight 1853).
1753	*G. superba* L.	Type species of *Gloriosa* L.
1763	*Mendoni superba* (L.) Adans.	Synonym of *G. superba* L. (IPNI 2011)
1766	*M. superba* (L.) Crantz	Synonym of *G. superba* L. (Baker 1879, 1897; Jessop 1979)
1767	*G. simplex* L.	No type specimen designated, *Nomen incerta sedis* (Field 1971)
1768	*G. caerulea* Mill.	Doubtful name, treated as a synonym of *G. virescens* Lindl. (Baker 1879, 1898)
1796	*Eugone superba* (L.) Salisb.	Synonym of *G. superba* L. (Cufodontis 1971)
1796	*Methonica superba* (L.) var. β Lam.	Synonym of *G. virescens* Lindl. (Baker 1897)
1812	*G. cirrhifolia* Stokes	Name inadequate, a synonym of *G. superba* L. (IPNI 2011)
1812	*Methonica gloriosa* Salisb.	Synonym of *G. superba* L. (IPNI 2011)
1825	*G. simplex* D. Don	Synonym of *G. superba* L. (IPNI 2011)
1825	*G. virescens* Lindl.	Synonym of *G. superba* L. var. *superba* (Hoenselaar 2005)
1827	*G. angulata* Schum. & Thonn.	Synonym of *G. superba* L. (Baker 1898)

1829	*G. doniana* Roem. & Schult.	Synonym of *G. superba* L. (Baker 1898)
1830	*G. nepalensis* G. Don	Synonym of *G. superba* L. (IPNI 2011)
1843	*M. doniana* (Roem. & Schult.) Kunth	Synonym of *G. superba* L. (Baker 1898)
1843	*M. virescens* (Lindl.) Kunth	Synonym of *G. virescens* Lindl. (Baker 1879)
1844	*Clinostylis speciosa* Hochst.	Synonym of *G. superba* L. (Sebsebe Demissew 1997)
1846	*M. leopoldii* van Houtte & Lem.	Synonym of *G. virescens* Lindl. var. *grandiflora* (Hook.) Baker (Baker 1898)
1851	*G. abyssinica* A. Rich.	Synonym of *G. superba* L. (Sebsebe Demissew 1997)
1852	*M. abyssinica* (A. Rich.) Walpers	Synonym of *G. superba* L. (Sebsebe Demissew 1997)
1853	*Littonia modesta* Hook.	Basionym of *G. modesta* (Hook.) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1853	*M. virescens* (Lindl.) var. *plantii* Planch.	Synonym of *G. virescens* Lindl. (Baker 1897, 1898)
1854	*Methonica plantii* Planch.	Synonym of *G. virescens* Lindl. (Baker 1879)
1855	*Gloriosa plantii* (Planch.) Loudon	Synonym of *G. superba* L. (IPNI 2011)
1860	*M. grandiflora* Hook.	Synonym of *G. virescens* Lindl. var. *grandiflora* (Hook.) Baker (Baker 1898)
1863	*M. petersiana* Klotzsch	Synonym of *G. virescens* Lindl. (Baker 1898)
1863	*M. platyphylla* Klotzsch	Synonym of *G. virescens* Lindl. (Baker 1898)
1868	*G. luxurians* Lour. ex Gomes	Synonym of *Hemerocallis fulva* (L.) L., Merrill in Trans. Am. Phil. Soc. n.s. xxiv.ii.16, 105 (1935).
1879	*G. superba* L. var *angustifolia* Baker	Synonym of *G. superba* L. var. *superba* (Hoenselaar 2005)
1879	*G. virescens* Lindl. var. *grandiflora* (Hook.) Baker	Synonym of *G. superba* L. var. *superba* (Hoenselaar 2005)
1882	*G. abyssinica* A.Rich. var. *graminifolia* Franch.	Synonym of *G. superba* L. var. *graminifolia* (Franch.) Hoenselaar (Hoenselaar 2005)
1882	*L. revoilii* Franch.	Basionym of *G. revoilii* (Franch.) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1883	*L. keiti* Leichtlin	Synonym of *G. modesta* (Hook.) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1883	*L. welwitschii* Benth. & Hook.f.	Synonym of *G. littonioides* (Welw. ex Baker) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1886	*L. minor* Deflers	Synonym of *G. revoilii* (Franch.) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1888	*L. hardeggeri* Beck	Synonym of *G. revoilii* (Franch.) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1892	*G. speciosa* Engler	Synonym of *G. superba* L. (Sebsebe Demissew 1997)
1892	*L. baudii* A.Terracc.	Synonym of *G. baudii* (Terracc.) Chiov. (Sebsebe Demissew 1997)
1894	*G. superba* L. forma *doniana* (Schult. & Schult.f.) T.Durand & Schinz	Synonym of *G. superba* L. (www.apps.kew.org)
1894	*G. superba* L. var. *leopoldii* (Van Houtte ex Lem.) T.Durand & Schinz	Synonym of *G. superba* L. (www.apps.kew.org)
1894	*G. superba* L. var. *petersiana* (Klotzsch ex Garcke) T.Durand & Schinz	Synonym of *G. superba* L. (www.apps.kew.org)
1894	*G. virescens* var. *plantii* (Planch.) T.Durand & Schinz	Synonym of *G. superba* L. (www.apps.kew.org)
1894	*G. superba* L. var. *platyphylla* (Klotzsch ex Garcke) T.Durand & Schinz	Synonym of *G. superba* L. (www.apps.kew.org)
1894	*L. obscura* Baker	Synonym of *G. revoilii* (Franch.) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1895	*G. carsonii* Baker	Synonym of *G. superba* L. var. *superba* (Hoenselaar 2005)
1895	*G. virescens* Lindl. forma *plantii* Sieb. & Voss	Synonym of *G. superba* L. (www.apps.kew.org)
1896	*G. minor* Rendle	Synonym of *G. superba* L. var. *graminifolia* (Franch.) Hoenselaar (Hoenselaar 2005)
1898	*L. lindenii Baker*	Basionym of *G. lindenii* (Baker) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)

1901	*L. grandiflora* De Wild. & T.Durand	Synonym of *G. katangensis* Maroyi nom. nov.
1912	*L. flavovirens* Dammer	Basionym of *G. flavovirens* (Dammer) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1913	*G. homblei* De Wild.	No recent study has been done on this taxon, type collected from Democratic Republic of Kongo (Kinshasa)
1916	*G. baudii* (Terracc.) Chiov.	Synonym of *G. superba* L. var. *graminifolia* (Franch.) Hoenselaar (Hoenselaar 2005)
1916	*G. graminifolia* (Franch.) Chiov.	Synonym of *G. superba* L. var. *graminifolia* (Franch.) Hoenselaar (Hoenselaar 2005)
1916	*G. graminifolia* (Franch.) Chiov. var. *heterophylla* Chiov.	Synonym of *G. superba* L. (Thulin 1995)
1916	*G. virescens* Lindl. var. *latifolia* Chiov.	Synonym of *G. simplex* L. (Cufodontis 1971)
1920	*G. sudanica* A.Chev.	Synonym of *G. simplex* L. (Hepper 1968)
1921	*G. sampiana* Pires de Lima	Synonym of *G. simplex* L. (Hepper 1968)
1921	*L. littonioides* Welw. ex K. Krause	Basionym of *G. littonioides* (Welw. ex K.Krause) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1928	*G. aurea* Chiov.	Synonym of *G. superba* L. (Thulin 1995)
1928	*G. richmondensis* Hort.	Horticultural cultivar of *G. superba*
1936	*L. rigidifolia* Bredell	Basionym of *G. rigidifolia* (Bredell) J.C.Manning & Vinnersten (Vinnersten & Manning 2007)
1998	*G. sessiliflora* Nordal & Bingham	Recognized as a distinct species (Nordal & Bingham 1998)
2005	*G. superba* L. var *graminifolia* (Franch.) Hoenselaar	Recognized as a distinct taxon (Hoenselaar 2005)

There has always been a close relationship between *Gloriosa* and *Littonia* found in South Africa, north to Somalia and south Yemen (Bell 1958; Cave 1962, 1963; Buxbaum 1937; Dahlgren *et al.* 1985; Field 1972; Hegnauer 1963; Nordenstam 1998; Nordal & Bingham 1998; Queva 1899; Raffauf 1970; Sterling 1975; Vinnersten & Manning 2007; Vinnersten & Reeves 2003; Wildman & Pursey 1968). The taxonomic history of both *Gloriosa* and *Littonia* are linked, mainly because of morphological affinities which led to some confusion on their distinction in the early stages of their history (Table 6.1). But the history of *Littonia* does not coincide with that of *Gloriosa* since they have been treated sepatately until their generic delimitation was questioned by Nordal & Bingham (1998). The revision of the genus *Gloriosa* is presented below.

GLORIOSA L. Sp. Pl. (1753)

Linnaeus in Gen. Pl. ed. 5: 144 (1754); Baker in J. Linn. Soc. Bot. **17**: 457-459 (1879), Fl. Cap. **6**: 525-527 (1897) & Fl. Trop. Afr. **7**: 563-567 (1898); Krause in E. & P. Nat. Pfl. Fam. ed 2 (15a): 227-386 (1930); Hutchinson in Fam. Fl. Pl. (1934, 1959); Field in Kew Bull. **25**: 243-244 (1971) & in The genus *Gloriosa*, Lilies and other Liliaceae 1973: 93-95 (1972);

Dyer in Genera of Southern African Flowering Plants **2** (1976); Nordenstam in Kubitzki, Fam. & Gen. Vasc. Pl. **3**: 183 (1998).

Mendoni Adans. in Fam. Pl. (Adanson) 2: 48, 576 (1763)

Methonica Tournef. ex Crantz in Inst. rei herb. 1: 474 (1766)

Clinostylis Hochst. in Flora 27: 26 (1844)

Littonia Hook. in Bot. Mag.: t. 4723 (1853)

TYPE SPECIES: *Gloriosa superba* L. TYPE: India, Malabaria, Hermann 3: 31, no. 122, designated by Wijnands, Bot. Commelins: 133 (1983). (BM, lectotype, not seen).

Perennial herbs with a tunicate underground corm with fibrous roots. Aerial stems annual, erect or climbing, leafy, glabrous to densely papillose-pubescent, simple or branching. Leaves cauline, sessile or shortly stalked and often sheathing, tubular cataphyll protracted or not protracted into a leaf blade. Leaves ± distichously arranged, alternate, opposite or subopposite to verticillate or clustered; blades dorsiventral, ovate, lanceolate to linear or subulate, parallel-veined with often distinct midrib, narrowing gradually to an apical coiled tendril, often lacking tendrils in erect plants. Pedicels absent or solitary, axillary in the axils of leaves. Flowers in leaf axils, pendulous, nodding or sometimes resupinate and brightly coloured, straight or recurved apically. Perianth segments equal, shortly connate, forming a small tube, otherwise free, nectariferous, obscurely saccate and pouch-shaped at the base often with white hairs. Perianth segments persistent but withering as the capsule enlarges. Stamens 6, free, inserted at the base of the perianth segments. Filaments filiform or sometimes flattened; anthers narrowly linear-oblong, dorsifixed, versatile, dehiscing latrorsely to extrorsely by longitudinal slits. Ovary ovoid to oblong, sessile, 3-celled; ovules many, superposed; style entire in the lower part, trifid towards the apex with 3 subulate forks obliquely stigmatose at the apex. Capsule ovoid to oblong, loculicidal, coriaceous; seeds globose, fleshy, red or orange.

Twelve species widespread in South Africa, tropical Africa, south Yemen and tropical Asia.

KEY TO THE SPECIES OF *GLORIOSA*

1a. Hanging and nodding flowers on long pedicels……...**2**

1b. Sessile flowers without distinct pedicel (Zambia and Angola)……**10. *G. sessiliflora***

2a. Tepals reflexed; style bent sharply outwards at base……...**3**

2b. Tepals not reflexed, but spreading; style straight ……**6**

3a. Stems long, usually higher than 100 cm; branched and climbing; stamens with long filaments, more than 2.2 cm long……**4**

3b. Stems erect, short, less than 100 cm high, not branched; stamens with short filaments, less than 2.2. cm long……...**5**

4a. Perianth segments not crisped but with straight or slightly undulate margins, gradually narrowed at the base, broadening towards the middle and curving inwards in the upper half; usually more than 1.5 cm wide in the middle……**11. *G. simplex***

4b. Perianth segment with much crisped margins, more or less the same width, less than 1.5 cm wide……...**12. *G. superba***

5a. Short stems, often less than 40 cm; leaves crowded, leaf blade 0.2-1.5 cm wide, perianth segments fused for 4-5 mm (Kenya, Ethiopia and Somalia)……...**1. *G. baudii***

5b. Stems often higher than 40 cm, lower leaves alternate, leaf blade more than 2 cm wide, perianth segments fused for less than 3 mm at the base……...**2. *G. carsonii***

6a. Sub-erect herbs, sometimes climbing, leaves attenuate into a well-developed terminal tendril……**7**

6b. Erect, non-climbing herbs, leaf apex acuminate……**8**

7a. Leaf blade more than 15 mm wide; perianth segments longer than 20 mm…**7. *G. modesta***

7b. Narrower and more rigid leaves, less than 10 mm wide; perianth segments shorter than 20 mm (South Africa)……**9. *G. rigidifolia***

8a. Perianth segments nectariferous, obscurely saccate and pouch-shaped at the base with long white hairs, about 2 mm in length (Angola)……**3. *G. flavovirens***

8b. Perianth segments nectariferous but mostly without white hairs, if hairs present, often less than 2 mm long……**9**

9a. Herb less than 35 cm high, narrow linear leaves, usually whorled below and alternate above, less than 5 mm wide (Somalia, Yemen)……**8. *G. revoilii***

9b. Herb higher than 40 cm, leaves narrowly elliptic-lanceolate, leaves usually alternate, wider than 5 mm……**10**

10a. Perianth segments longer than 25 mm……**11**

10b. Perianth segments between 15-20 mm long, 3-8 mm wide, yellowish green……**6. *G. littonioides***

11a. Perianth segments connate at base forming a tube, 3-8 mm long; green at the base, the segments outside orange, vermillion, light red to red outside, inside yellow to orange……**5. *G. lindenii***

11b. Perianth segments free, always white when dry, longer than 40 mm (Democratic Republic of Congo (Kinshasa)……...**4. *G. katangensis***

1. Gloriosa baudii (Terracc.) Chiov. in Res. Sci. Somalia Ital. **1**: 176 (1916). Cufodontis, Enum.: 1526 (1971); Sebsebe Demissew in Fl. Ethiopia & Eritrea **6**: 185 (1997). TYPE: Ethiopia, Harerge Region, Ogaden, Gerar-Amaden, Apr. 1891, *Baudi & Candeo* s.n. (FT, holotype, not seen). **Figure 6.3.**

Synonyms:

Gloriosa abyssinica A. Rich. var. *graminifolia* Franch. in Sert. Somal. 67 (1882). TYPE: Somalia, Karoma Peak in Medjourtine, *Révoil* s.n. (P!, holotype).

Littonia baudii A.Terracc. in Bull. Soc. Bot. Ital. 1892: 425 (1892). TYPE: Ethiopia, Harerge Region, Ogaden, Gerar-Amaden, Apr. 1891, *Baudi & Candeo* s.n. (FT, holotype, not seen).

Gloriosa minor Rendle in J. Bot. 34: 132 (1896); Baker in Fl. Trop. Afr. **7**: 564-565 (1898); Polhill in J. E. Afr. Nat. Hist. Soc. **24**: 19-20 (1962). TYPE: Somalia, West of Shebelle River, 6 Dec. 1894, *Donaldson Smith* s.n. (K!, holotype).

Gloriosa graminifolia (Franch.) Chiov. in Res. Sc. Miss. Stefan.-Paoli Somal. Ital. i: 176 (1916). TYPE: Somalia, Karoma Peak in Medjourtine, *Révoil* s.n. (P!, holotype).

Gloriosa graminifolia (Franch.) Chiov. var. *heterophylla* Chiov. in Res. Sc. Miss. Stefan.-Paoli Somal. Ital. i: 176 (1916). TYPE: S3, near "Chisimaio", *Paoli* 146 (FT, syntype, not seen) and near "Torda", *Paoli* 302 (FT, syntype, not seen).

Gloriosa aurea Chiov. in Pl. Nov. Aethiop. 8. (1928). TYPE: N3, "Nogal" Valley, *Puccioni & Stefanini* 855, 934 (FT, syntype, not seen).

Gloriosa superba L. var. *graminifolia* (Franch.) Hoenselaar in Fl. Trop. E. Afr. Colchicaceae: 6-7 (2005). TYPE: Somalia, Karoma Peak in Medjourtine, *Révoil* s.n. (P!, holotype).

Perennial herb, tuberous corm, obovate, fleshy, covered with brownish tunics, each 3-10 cm long, 0.5-1.5 cm in diameter, sometimes 20 cm below ground; roots fibrous. Underground stem usually covered by thinly membranous tunica, forming a tubular sheath, split above and loosely surrounding the stem, usually protracted into the lowermost leaf. Aerial stem annual,

erect, free-standing, glabrous to pubescent, not branched, less than 40 cm high. Leaves sessile, linear to elliptic, bearing many veins and a strong midrib, glabrous to pubescent, often recurved, subopposite, alternate, verticillate and clustered above the middle of the stem; 5-14 cm long, 0.2-1.2 cm wide, apex acute, sometimes ending in a tendril. Flowers axillary, 4-6 cm across, often green at the base, changing to red and yellow; pedicel in the axils of vegetative leaves, 3.5-9 cm long. Perianth segments oblanceolate, gradually narrowed at the base, reflexed, rarely spreading, with straight or only slightly crisped margins, 30-60 mm long, 4-10 mm wide; often shortly connate forming a small tube 4-5 mm long, perianth segments nectariferous. Filaments filiform, up to 10-20 mm long, anthers 3-7 mm long, 1 mm wide. Ovary 4-10 mm long, 1-6 mm wide. Pistil with style bent at right angle to the ovary, 14-25 mm long with 3-branched stigma, 1.5-5 mm long. Young capsule 25 mm long and 12 mm in diameter. Perianth segments persistent but withering as the capsule enlarges.

Distribution: This is a near-endemic taxon found in the arid regions of northern Kenya, Ethiopia and Somalia (**Map 6.1**). It is common on stony ground and open bush or sandy soil between 5-900 m altitude.

Phenology: Flowers collected all year round; while fruits were collected between October and January.

Uses: Said to be browsed by goats in Kenya.

IUCN conservation notes: *G. baudii* is well represented in herbaria in East Africa. Least Concern (LC) category is applied here because the habitat in which it occurs is fairly common in all the countries in which it occurs, although its distribution is limited. Furthermore, it has been collected frequently in recent years.

Notes: The sister group relationship between *G. baudii* and *G. revoilii* is well-supported (Figure 6.2). The two species in turn are sister to a clade of *G. sessiliflora* and *G. superba* complex species. *G. baudii* can be distinguished from *G. carsonii*, another short and erect species common in south east and east tropical Africa by its narrower, crowded leaves and a longer tepal tube averaging 4-5 mm in length. But its dwarf form, rarely exceeding 30 cm and geographical distribution are crucial in distinguishing *G. baudii* from all other *Gloriosa* species.

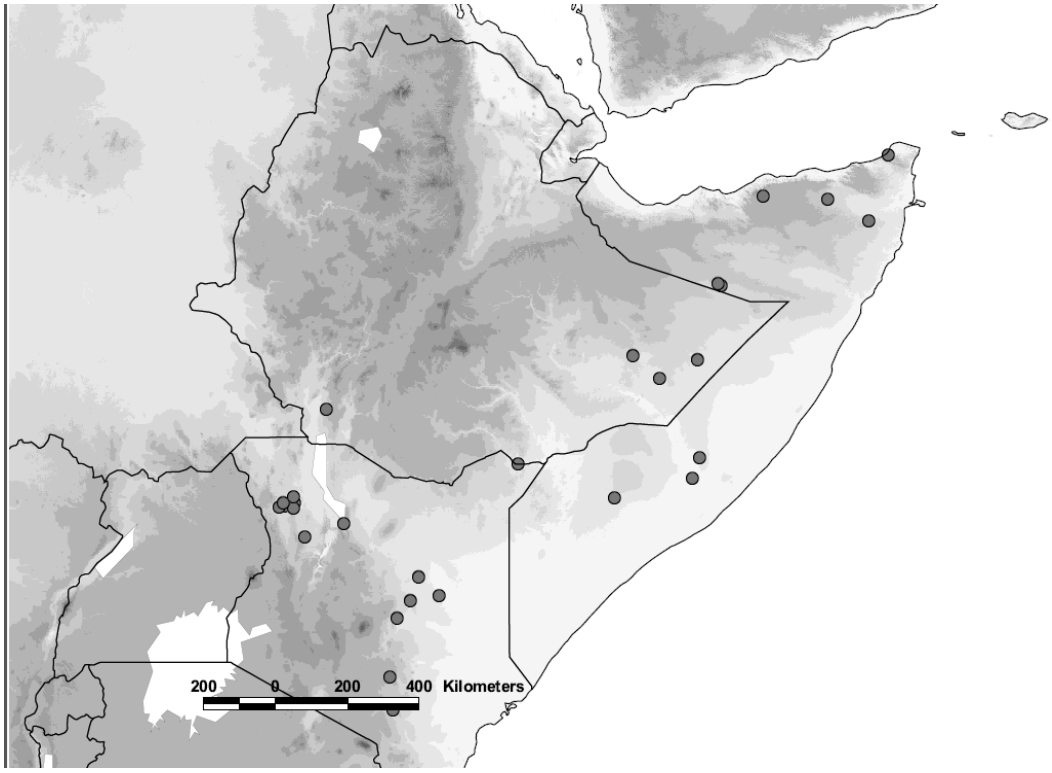
Extra references: Blundell (1987); Field (1972); Sebsebe Demmissew & Nordal (2010).

Figure 6.3. *G. baudii*. 1. flowering stem; 2. pair of leaf-bases; 3. young flower; 4. opened flower; 5. pair of leaves (from Sebsebe Demissew 1997, reproduced with permission).

Specimens examined

ETHIOPIA: Harari Region, east of Gorrahei, 6°39'N44°05'E, Alt. 700 m, 1 Nov. 1967 (fl.), *Bally* 12999 (K). Scillave, 6°05'N44°45'E, Alt. 390 m, 11 Apr. 1956 (fl.), *Simmons* S152 (EA, K). SW El Rago, 6°33'N45°43'E, Alt. 750 m, 31 Oct. 1953 (fl.), *Ellis* 174 (K). Kukub Banya, c. 8 km north of Kukub Banya, Alt. 390 m, 22 Apr. 1971 (fl.), *Brown* 59 (BR). **KENYA: Eastern Province, Kitui District,** Kibwezi-Kitui road, 11 km after the Athi road, 2°11'S38°5'E, Alt. 840 m, 19 May 1969 (fl.), *Napper & Jones* 1958 (K). **Meru District,** Meru National Park, Rojwero plains, 0°17'N38°18'E, Alt. 600 m, 25 May 1972 (fl.), *Ament & Magogo* 408 (BR, EA, FRO). **North Eastern Province, Garissa District**, Modo-Cash Garissa, 13 km S of Modo-Cash, 0°39'N39°14'E, Alt. 290 m, 11 Dec. 1977 (fl.), *Stannard & Gilbert* 950a (K). **Rift Valley Province**, **Turkana District,** 34 km from Lowdar on the road to Loiya, 3°00'N35°22'E, Alt. 580 m, 8 Nov. 1977 (fl.), *Carter & Stannard* 237 (C, K); 28 Mar. 1934 (fl.), *Martin* 96 (BR, K, S). **Lodwar**, 3°07'N35°35'E, Alt. 1400 m, Apr. 1932 (fl.), *Champion* T18 (K); 17 km S of Lowdar, Turkana desert, 3°07'N35°36'E, 29 July 1938 (fl.), *Pole Evans & Erens 1574* (BR, K, PRE, S); 37 km from Lokori on road to Lokichar, 2°23'N35°39'E, Alt. 900 m, 19

June 1970 (fl.), *Mathew* 6857 (K); 40 km SW of Lowdar, 3°07'N35°36'E, Alt. 540 m, 12 May 1953 (fl.), *Padwa* 150 (EA, K); 30 km S of Lowdar, 3°07'N35°35'E, Alt. 500 m, 1 May 1967 (fl.), *Strid* 3880A (S). Kapengoni, 65 km from Kitui on the way to Mutomo, 1°22'S38°00'E, 21 Nov. 1979 (fl.), *Gatheri, Mungai & Kibui* 79/95 (EA, K). Yabichu, near Ramu, 3°56'N41°12'E, Alt. 360 m, 23 May 1952 (fl.), *Gillett* 13297 (K). En route to Loruguru, 2°52'N35°14'E, *Fuchs* s.n. (K). Crossroads of the tracks towards Mt Kulal, Loyangalani and S Horr, 2°27'N36°51'E, Alt. 650 m, 22 Feb. 1979 (fl.), *Bamps* 6687 (BR, WAG). 10 km N of the Garba Tula turning to Merti, Alt. 520 m, 19 Dec. 1971 (fl.), *Bally & Smith* B14698 (K). Keebplain between Koia and Merti N.F.D, 1°12'N38°56'E, Alt. 600 m, *Wall* 20 (S). Balambala, Tanaland, 0°11'N39°07'E, 10 Jan. 1947 (fl./fr.), *Adamson* 354 (K). Dibabdebel, 13 Dec. 1982 (fl.), *Powys* 3 (EA, WAG). **SOMALIA**: **Baidoa,** near Baidoa, 3°06'N43°38'E, Alt. 436 m, 6 Apr. 1953 (fl.), *Popov* 1053 (K). **Bari,** Mts S of Bunder Murrayha Valley above Tayeega, 11°39'N50°29'E, Alt. 400 m, 15 Nov. 1986 (fl.), *Thulin & Warfa* 5819 (UPS). **Ballehyo Khairo**, Northern Region, 8°27'N46°14'E, Alt. 750 m, 18 Oct. 1961 (fl.), *Hemming* 2178 (EA, K). **Hiiraan**, 48 km on the Maas-Bulo Burti road, 4°06'N45°46'E, Alt. 300 m, 12 Dec. 1983 (fl.), *Thulin & Warfa* 4626 (K, UPS). **Hiiraan, Bulo-Burte,** 3°35'N45°35'E, Alt. 5 m, 4 June 1954 (fl.), *Hemming* 404 (K). **Sanaag, Erigavo,** 125 km E of Erigavo on Hubera road, 10°37'N47°21'E, 1 Oct. 1960 (fl.), *Hemming* 1990 (K). Hormo, 10°33'N48°59'E, Alt. 675 m, 17 Oct. 1929 (fl./fr.), *Collenette* 156 (K). Karoma Peak (Medjourtine), *Révoil* 136 (P). Settenter, Migiurtinia Lungo, Meragno-Durbo, 10°00'N50°00'E, 4 Dec. 1970 (fl.), *Bavazzano & Lavranos* s.n. (BR, K, UPS). N of Omr Aji at Balleh Murca Bugh, 8°24'N46°18'E, Alt. 720 m, 24 Oct. 1954 (fl.), *Bally* 10191 (K). **No locality,** 1 Sep. 1941 (fl.), *Peck* 396 (EA, K); *Appleton* s.n. (K).



Map 6.1. Distribution of *G. baudii.*

2. G. carsonii Baker in Bull. Misc. Inform. Kew 1895: 74 (1895). Baker in Fl. Trop. Afr. **7**: 565 (1898); Phiri in Checklist Zambian Vasc. Pl.: 107 (2005). TYPE: Zambia, Lake Tanganyika, Fwambo, 1894, *Carson* 53 (K!, holotype). **Figure 6.4.**

Synonyms:
Gloriosa homblei De Wild. in Fedde Repert Sp. Nov. **11**: 536 (1913). TYPE: Democratic Republic of Congo (Kinshasa), Upper-Katanga, Welgelegen, 1912, *Homblé* 590 (BR!, holotype).

Perennial herb, rootstock a 2-pronged, L or V-shaped tuberous corm with a growing point at each end, 3-8 cm long and 0.5-2 cm in diameter, covered with brownish tunics; roots fibrous. Underground stem sometimes covered by membranous sheathing or tubular cataphyll which is protracted into the lower most leaf, usually about 1-5 cm above ground. Aerial stems annual, erect, free-standing, glabrous, up to 90 cm high. Leaves sessile, lanceolate to ovate, broad below the middle, sheathing the stem, glabrous to pubescent, bearing many veins and a prominent midrib, lower leaves alternate, upper ones opposite to irregular, 8-15 cm long, 2-7.5 cm wide below the middle, apex acute, sometimes acuminate or having a short tendril at the apex. Flowers 1-4, axillary, 4-7 cm across, on long pedicels, cernuous at the apex, 4-9 cm long. Perianth segments strongly reflexed, lanceolate, rarely spreading, with straight or only slightly undulate margins, gradually narrowed at the base, broadening towards the middle, curving inwards in the upper half, acuminate, 4-5 cm long and 8-15 mm wide; red and yellow; fused for at most 3 mm at the base. Filaments 12-25 mm long; anthers linear, 3-7 mm long, 1 mm wide. Ovary 1 cm long; style 14-25 mm long with 3-branched stigma, 1.5-3 mm long. Young capsule 15 mm long. Seeds smooth, orange or red with a fleshy testa, up to 3 mm in diameter.

Distribution: *Gloriosa carsonii* is widespread in south central and east tropical Africa in forest edges, woodland, bushland, grassland and roadsides; 400-1950 m altitude.

Phenology: Flowers collected all year round; while fruits were collected between April and July.

IUCN conservation notes: *G. carsonii* is widespread in south-east and east tropical Africa. Least Concern (LC) category is recommended.

Notes: The molecular phylogeny links *G. carsonii* to *G. sessiliflora, G. simplex* and *G. superba* species (Figure 6.2), in a polytomous clade of moderate bootstrap value of 76%. *G. carsonii* is distinguished from *G. baudii* based on both morphology and ecology. Its floral features are similar to those of *G. simplex*. *G. carsonii* is an erect species with smaller perianth segments than those of *G. simplex*, and a slightly longer perianth tube which is ± 3 mm in length.

Extra reference: Field (1972); Phiri (2005).

Specimens examined

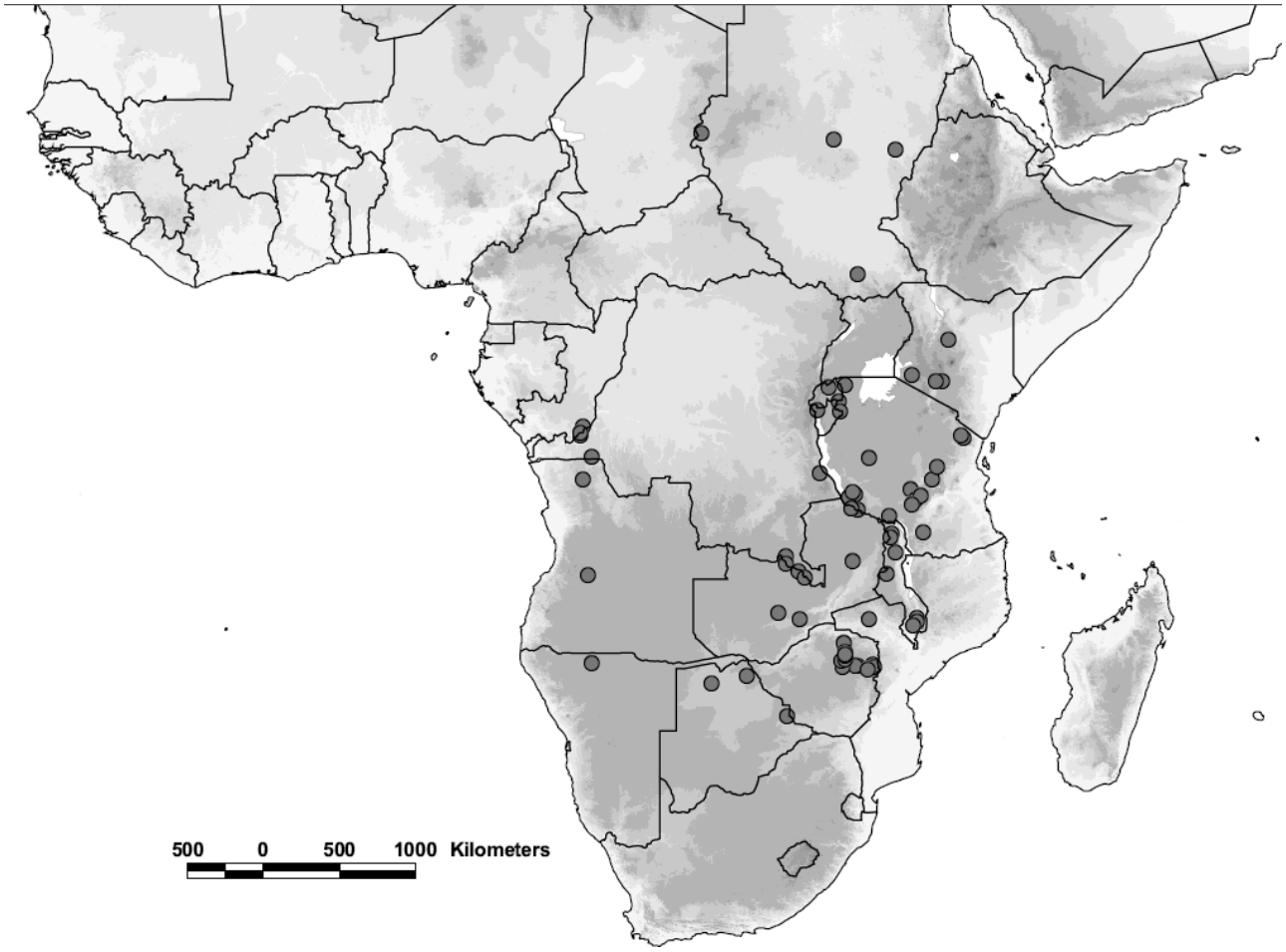
ANGOLA: Huambo District, Nova Lisboa, Chianga, 12°46'S15°44'E, Alt. 1750 m, 7 Dec. 1969 (fl.), *da Silva* 2691 (COI, K). Huila Province, Huila, 15°45'S14°05'E, 24 Aug. 1963 (fl.), *de Meneses* 682 (K). **Uige**, 2.5 km from Quimbel towards Camabatela, 7°07'S15°27'E, 1 Dec. 1970 (fl.), *de Sousa* 1421 (COI). **BOTSWANA: Ngamiland**, Botletle, 18°46'S25°09'E, Alt. 1027 m, Feb. 1897 (fl.), *Lugard* 213 (K); 19°14'S23°06'E, *Curson* 439 (B, UPS). Bokalaka area, NE Botswana, 5 km SE of Francistown-Matsiloge road, 21°09'S27°30'E, 19 Jan. 1967 (fl.), *McClintock* K75 (K). **BURUNDI: Bubanza Province,** Rusisi, between Mucherenge and Ruchivoka, 3°00'S29°20'E, 11 Dec. 1911 (fl.), *Fries* 1461 (UPS). **Bujumbura Province**, Mugere, 3°04'S30°40'E, Alt. 800 m, Nov. 1965 (fl.), *Lewalle* 24 (K). **CONGO (BRAZZAVILLE):** Plateau Batéké, by the Gatsou village, 3°57'S15°29'E, Alt. 720 m, 28 Nov. 1975 (fl.), *Markström* 77 (UPS). **DEMOCRATIC REPUBLIC OF CONGO (KINSHASA): Katanga (Shaba)**, Likasi, Lubumbashi-Likasi 70 km from Mangombo, 11°40'S27°28'E, 15 Feb. 1982 (fl.), *Malaisse & Robbrecht* 2135 (BR, K); Elisabethville (Lubumbashi), 15 Dec. 1959 (fl.), *Schwabe* s.n. (B); Upper-Katanga, Welgelegen, 1912 (fl.), 12°05'S27°31'E, *Homblé* 590 (BR). M'Pola, 21 Dec. 1946 (fl.), *van Meel* 308 (BR, WAG). **Katanga Province**, 4°19'S15°19'E, 23 July 1891 (fl.), *Dybowski* s.n. (P); Popokabaka, Kilenga, 5°45'S15°56'E, 25 Oct. 1958 (fl.), *Pauwels* 358 (BR, WAG); Kimuenza, 4°28'S15°17'E, 23 Nov. 1964 (fl.), *Pauwels* 4778 (BR. WAG). **KENYA: Nairobi Province, Nairobi District**, 5 km W of the town, Alt. 1700 m, 16 May 1949 (fl.), *Maas-Geesteranus* 4666 (L). **Nyanza Province**, Kisii Central District, near Ramasha, 0°53'S34°58'E, Alt. 1930 m, 15 Mar. 1978 (fl.), *Plaizier* 882 (WAG). **Rift Valley Province**, Kedong Valley, W of Kikuyu escarpment, 1°15'S36°25'E, Alt. 1800 m, 23 June 1966 (fl.), *Strid* 2506 (UPS); Lake Rudolf, 14 Sep. 1899 (fl.), *Wellby* s.n. (K). Samburu District, Ngeng, 1°12'N37°10'E, 10 Dec. 1958 (fl.), *Newbould* 3155 (K). **MALAWI: Northern Region**, Mzimba District, Mzuzu, Marymount, 11°28'S34°04'E, Alt. 1350 m, 25 Jan. 1974 (fl.), *Pawek* 7979 (MAL, MO, WAG). Rumphi District, Nyika Plateau, 23 km N of M1, 10°20'S33°47'E, Alt. 1700 m, 23 Dec. 1977 (fl.), *Pawek* 13325 (K, MAL, MO). Kapopo village, Chulu Native Authority, 15 Jan. 1959 (fl.), *Jackson* 2296 (K). **Southern Region**, Chiradzulu District, Magomero Turn off, 15°34'S35°16'E, 19 Jan. 1988 (fl.), *Salubeni & Balaka* 5122 (K). **Zomba Rural District**, near Mingoli Estate office, 15°24'S35°25'E, Alt. 730 m, 16 Jan. 1987 (fl.), *Nachamba &*

Usi 430 (K); Naisi, slopes of Zomba Mt., 15°22'S35°20'E, Alt. 1439 m, 30 Dec. 1959 (fl.), *Bloomfield* 10 (K). Blantyre District, lower slopes of Nduande near Coronation Dam, 15°47'S35°02'E, 15 Jan. 1970 (fl.), *Moriarty* 374 (K). **MOZAMBIQUE**: Shire Highlands, 15°30'S35°10'E, Alt. 915 m, 6 Apr. 1906 (fr.), *Adamson* 123 (K). No locality, *Tiesler* 40 (B). **NAMIBIA:** Amboland, Chimheke, 18°00'S16°00'E, 16 Jan. 1886 (fl.), *Schinz* 903 (COI, L). **RWANDA:** Byumba Province, Mutara, Shanga, 1°36'S30°03'E, Alt. 1400 m, 1 Dec. 1958 (fl.), *Troupin* 8898 (WAG). **SOUTH SUDAN,** Lado, Yei River, 5°07'N31°43'E, 23 Oct. 1919 (fl.), *Sillitoe* 396 (K). **SUDAN: Blue Nile Province**, Tozi, 10°50'N30°45'E, Alt. 450 m, 24 July 1953 (fl.), *Lea* 157 (K). **Kordofan Region**, Abu-Gerad, between Abudaraza and Derbeeu, Kordofan, 13°05'N30°21'E, Aug. 1875 (fl.), *Pfund* 139 (K). **West Darfur**, Geneina, 13°29'N22°28'E, 8 Aug. 1958 (fl.), *Rossetti* 8026 (P). **TANZANIA: Iringa Region, Iringa Rural District,** at Ifunda 34 km SW of Iringa along road to Mbeya, 8°02'S35°28'E, 28 Dec. 1971 (fl.), *Bjørnstad* 568 (K). Ruaha National Park near Mbage camp, 7°39'S34°55'E, Alt. 840 m, 10 Jan. 1966 (fl.), *Richards* 20935 (K). Mufindi District, Sao Hill, found on roadsides, 8°19'S35°12'E, Feb. 1959 (fl.), *Watermeyer* 235 (K). **Kagera Region**, Murgwanza District, Bugufi, 2°29'S30°38'E, Alt. 1650 m, 8 Dec. 1960 (fl.), *Tanner* 5461 (K, WAG). **Lake Province**, Karangwe District, near Lake Victoria, 1°00'S33°00'E, Alt. 900 m, Mar. 1862 (fl.), *Speke & Grant* 484 (K). **Mbeya Region, Rungwe District, Kyimbila**, 9°17'S33°39'E, Alt. 700 m, 18 Jan. 1906 (fl.), *Stolz* 137 (B, K, WAG). **Morogoro Region**, Kidatu, 7°07'S36°09'E, 3 Feb. 1971 (fl.), *Mhoro* 415 (K, UPS, WAG). **Ruvuma Region**, Mbinga District, Hehe, Nyololo, 10°56'S35°01'E, Alt. 1620 m, 16 Jan. 1968 (fl.), *Myembe* 223 (BR). Songea District, Gumbiro in abandoned cultivation, 10°35'S35°50'E, Alt. 900 m, 24 Jan. 1956 (fl.), *Milne-Redhead & Taylor* 8412 (B, BR, K). **Tabora Region**, Tabora Rural (Uyui) District, Kakoma, S of Tabora, 5°47'S32°26'E, Alt. 1140 m, 10 Jan. 1936 (fl.), *Lloyd* 73 (K). **Tanga Region, Lushoto District**, 8 km SE of Mkomazi, 4°39'S38°04'E, Alt. 460 m, 2 May 1953 (fl.), *Drummond & Hemsley* 2371 (K); West-Usambara Mts, Buiko, 178 km NW of Hedaru, 4°30'S37°54'E, Alt. 530 m, 11 June 1926 (fl.), *Peter* 41205 (B). **Western Province, Mpwapwa District**, Mpwapwa, 6°21'S36°29'E, Alt. 1820 m, 15 Feb. 1931 (fl.), *Hornby* 365 (K). 1950 (fl), *Bullock* 2226 (B, BR, K); Nkunde-Chapota, 7°51'S31°26'E, 1 Dec. 1949 (fl), *Bullock* 1968 (BR, K); Chapota, 8°09'S31°14'E, Alt. 1950 m, 4 Dec. 1949 (fl), *Bullock* 2035 (K). **ZAMBIA: Central Province**, Mumbwa District, 15°00'S27°04'E, July 1912 (fr.), *Macaulay-Gairdner* 28 (K). **Copperbelt Province,** Ndola District, 12°57'S28°37'E, 15 Jan. 1954 (fl.), *Fanshawe* 677 (BR). **Eastern Province**, Nyika Plateau, 48 km SE of Rest House, on Nchena-chena road, 10°34'S33°43'E, 10 Dec. 1958 (fl.), *Robson & Angus* 889 (BR). **Lusaka Province**, Lusaka Eastern Forest Reserve, 15°28'S28°25'E, Alt. 1279 m, 7 Jan. 1962 (fl.), *Lusaka National History Club* 89 (K). **Northern Province, Mbala (Abercorn) District**, Saisi Valley, roadside near Saisi River, 08°55'S31°45'E, Alt. 1500 m, 22 Jan. 1970 (fl.), *Sanane* 1028 (B); Abercorn, 08°50'S31°22'E, 15 Dec. 1949, *Bullock* 2106 (BR); road to Isanya, 08°50'S31°23'E, Alt. 1500 m, 26 Dec. 1951 (fl.), *Richards* 143 (BR). Mufulira, 12°33'S28°15'E, 14 Dec. 1947 (fl.), *Cruse* 112 (K). Mnika, airfield, 11°55'S31°25'E, 30 Dec. 1958 (fl.), *Stewart* 156 (K). **ZIMBABWE: Harare District,** 18 km from Harare along Harare-Bindura road, near the University of Zimbabwe farm, 17°49'S31°03'E, Alt. 1490 m, 13 Dec. 2006 (fl.), *Maroyi* 244a (SRGH, WAG); Lake Chivero (Mcllwaine), 17°53'S30°48'E, 17 Jan. 1965 (fl.), *Plowes* 2550 (K, SRGH); 60 km E of Harare on Rusape road opposite Mukuti Shop, area between raod and railway line, 18°08'S31°26'E, Alt. 1624 m, 29 Dec. 2010 (fl.), *van der Maesen & Maroyi* 8483 (SRGH, WAG); 94.5 km E from Harare on Rusape road, 18°10'S31°44'E, Alt. 1621 m, 29 Dec. 2010 (fl.), *van der Maesen & Maroyi* 8491 (SRGH, WAG). **Manicaland Province, Nyanga District**, Inyanga, 18°13'S32°44'E, Alt. 1700 m, 15 Dec. 1930

Figure 6.4. ***G. carsonii*** (Cruse 112).

(fl.), *Fries, Norlindh & Weimarck* 3726 (S); Ziwa Farm, 18°07'S32°38'E, 24 Jan. 1965 (fl.), *Chase 8250* (K, SRGH). Makoni District, c 10 km from Mutare (Umtali) towards Rusape, 18°21'S32°19'E, Alt. 1400 m, 29 Dec.

1930 (fl.), *Fries, Norlindh & Weimarck* 4007 (S). **Mashonaland Central Province,** Glendale, 65 km peg along Harare-Bindura road, 17°22'S31°05'E, 14 Dec. 2007 (fl.), *Maroyi* 246 (SRGH, WAG); Guruve District (Sipolilo), Nyamunyeche Estate, Gwenzi Dam, 16°47'S30°56'E, 19 Dec. 1978 (fl.), *Nyariri* 597 (COI, SRGH). **Mazowe District,** Mazowe Citrus, 44 km peg along Harare-Bindura road on the edge of Mazowe Citrus Plantation, 17°30'S30°59'E, 13 Dec. 2006 (fl.), *Maroyi* 243 (SRGH, WAG); Mazowe Veterinary Training College, 33 km peg along Harare-Bindura road, 17°30'S30°59'E, 5 Jan. 2008 (fl.), *Maroyi* 256 (SRGH, WAG). **Mashonaland East Province, Beatrice**, Kenombo, 18°13'S30°52'E, Alt. 1380 m, 28 Dec. 1966 (fl.), *Lady Drewe* 4 (K, SRGH). **Chegutu District**, edge of the road to Harare, N of Chegutu near the entrance of Bryden Country School, 18°07'S30°45'E, Alt. 1181 m, 6 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8633 (SRGH, WAG). **Chinhoyi District**, Chinhoyi (Sinoia), 17°21'S30°13'E, Alt. 1600 m, 5 Feb. 1967 (fl.), *Baretta* 7 (U).
CULTIVATED: Indonesia, Java, 22 May 1916 (fl.), *Brysman* 154 (K).



Map 6.2. Distribution of *G. carsonii.*

3. Gloriosa flavovirens (Dammer) J.C.Manning & Vinnersten in Taxon **56**: 178 (2007). TYPE: Angola, Malange, Malandsche, November 1879, *von Mechow* 371 (B?holotype, not seen). **Figure 6.5.**

Basionym:
Littonia flavovirens Dammer in Bot. Jahrb. Syst. **48**: 360 (1912). TYPE: Angola, Malange, Malandsche, November 1879, *von Mechow* 371 (B?holotype, not seen).

Perennial herb, rootstock a 2-pronged, L or V-shaped tuberous corm with a growing point at each end, 1.5 cm long, 0.8 cm in diameter, covered with brownish tunics; roots fibrous. Stem slender, erect, glabrous to papillose-pubescent, not branched, less than 40 cm high, sometimes a cataphyll present, up to 4 cm long. Leaves alternate, sessile, glabrous, entire, lanceolate, acuminate and recurved at the tip. Leaf base sheathing the stem, many veins with a prominent midrib, 8.5-12 cm long, 2.2-4 cm wide. The upper leaves end in a very short, ± 2 mm long tip, which is bent backwards. Flowers campanulate, concentrated in the upper half or third of the stem, pedicels glabrous, axillary, tip recurved, attached to the stem opposite to the leaves, 4-4.5 cm long. Perianth segments bearing many veins with a prominent midrib, connate at the base forming a tube ± 2-5 mm long, yellowish-green, elliptic, apex acuminate, 20-25 mm long, 5-8 mm wide. Perianth segments nectariferous and obscurely pouch-shaped at the base with white hairs about 2 mm long. Filaments 10 mm long, anthers oblong, 4-6 mm long and 1.5 mm wide; ovary obovate 4 mm long, style 15 mm long, tip trifid, style lobes 3 mm long. Fruits and seeds not seen.

Distribution: This is an endemic taxon only known from areas around Malange, Angola (**Map 6.3**), the type locality, about 1350 m altitude.

Phenology: Flowering in November.

IUCN conservation notes: *G. flavovirens* is represented by less than 5 accessions from Angola, mainly from unprotected areas. Therefore, the Vulnerable (VUD2) status is recommended. Major concerns include lack of recent collections and also all the previous collections were made near populated areas.

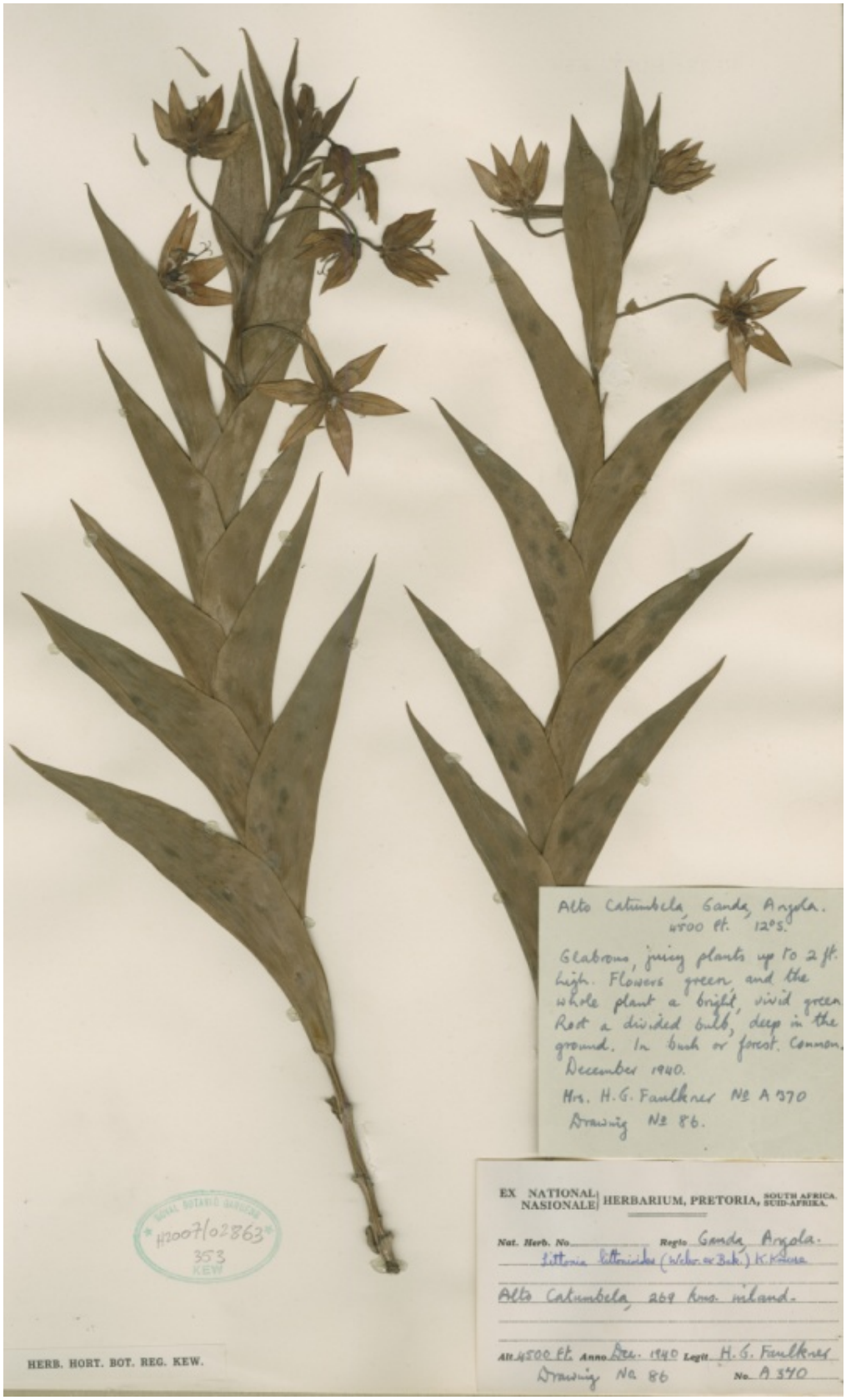
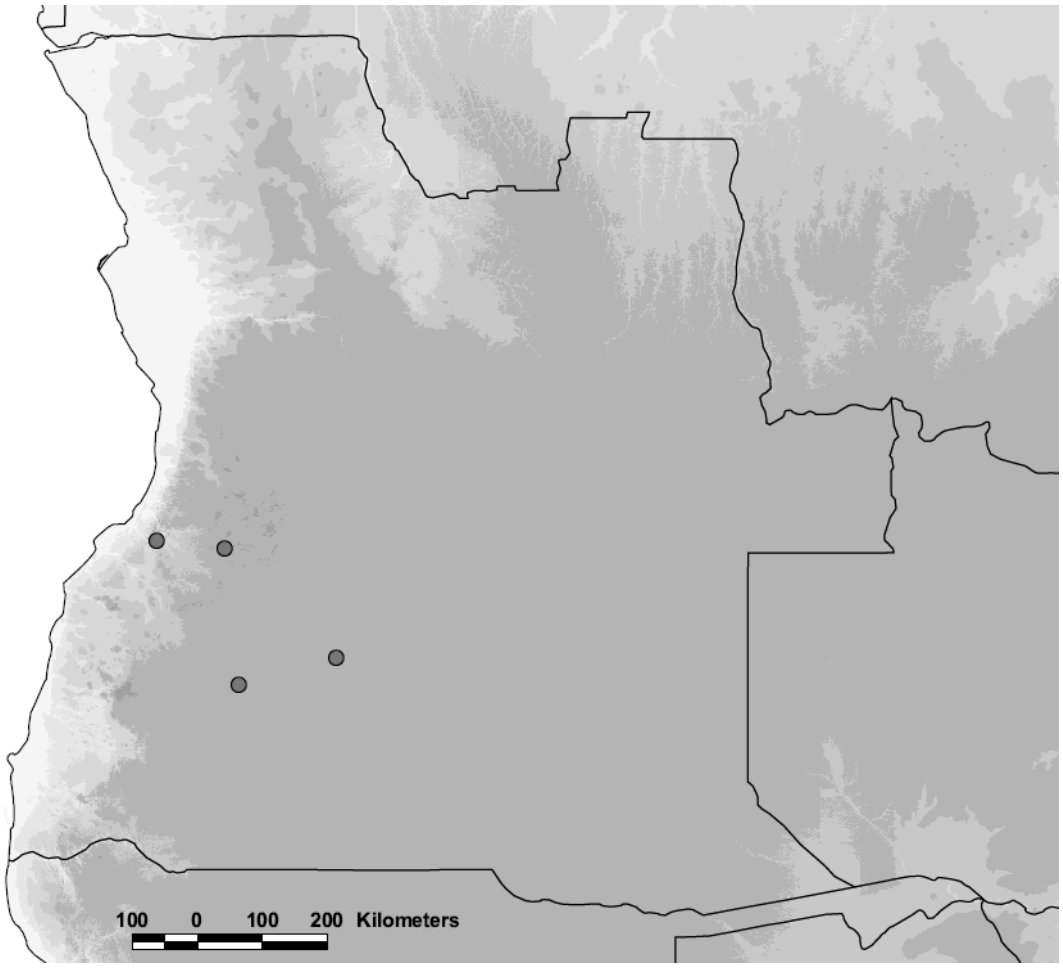


Figure 6.5. ***G. flavovirens*** (Faulkner A370).

Notes: *G. flavovirens* presents close affinities to *G. littonioides* in the majority of morphological and floral characters. The longer perianth segments, filament, style and presence of white hairs, about 2 mm long in the nectariferous groove at the base of perianth segments differentiates this species from *G. littonioides.*

Extra reference: Figueiredo & Smith (2008).



Map 6.3. Distribution of *G. flavovirens.*

Specimens examined

ANGOLA: Alto Calumbula. Ganda, 269 km inland, 12°57'S14º45'E, Alt. 1350 m, Dec. 1940 (fl.), *Faulkner* A370 (K). **Benguela**, 1910 (fl.), 12°51'S13º48'E, *Gossweiler* 2518 (BM). **Huila.** Sáda Bandeira, Caluquembe

near Fazenda Duma, 14°50'S14º56'E, 6 Jan. 1962 (fl.), *Santos* 802 (K). **Kubango.** Wolombo, 1905 (fl.), *Gossweiler* 2329 (BM).

4. Gloriosa katangensis Maroyi is suggested as a new name for *Gloriosa grandiflora* (De Wild. & T.Durand) J.C.Manning & Vinnersten from Democratic Republic of Congo (Kinshasa). The name *Gloriosa grandiflora* (De Wild. & T.Durand) J.C.Manning & Vinnersten, which was published in Taxon **56** (2007: 178), is illegitimate since it was preoccupied (*Gloriosa grandiflora* (Hook.) O'Brien, 1904). The necessary combination will be made in a forthcoming paper.

"Gloriosa katangensis Maroyi" **Figure 6.6.**

G. grandiflora (De Wild. & T.Durand) J.C.Manning & Vinnersten in Taxon **56**: 178 (2007) nom illegit., non O'Brien (1904).

Littonia grandiflora De Wild. & T.Durand in Bull. Soc. Bot. Belg. **40**: 34 (1901). TYPE: Democratic Republic of Congo (Kinshasa), Katanga, Region I, shores of the waters at Lukavu, November. 1899, *Verdick*, 288 (BR!, holotype).

Perennial herb, 40-55 cm high. Stem attached to a globose underground tuberous corm, about 1 cm in diameter, covered with brownish tunics; roots fibrous. Two cataphylls, 1 cm apart giving rise to the first two lowermost leaves. Aerial stem annual, slender, erect, glabrous to pubescent, not branched. Leaves sessile, entire, glabrous, alternate, sheathing stem, linear-lanceolate, bearing many parallel veins and a prominent midrib, apex acute, 11-17 cm long and 13-27 mm wide. Flowers campanulate, nodding on the upper part of the stem, pedicels long, axillary and appearing beside a leaf, up to 8 cm long, tip hooked. Perianth segments free, equal, erect, spreading, entire, glabrous, lanceolate, apex acuminate, white when dry, bearing many parallel veins and a prominent midrib, 4-5 cm long and 7-9 mm wide. Perianth segments nectariferous and obscurely pouch-shaped at the base with or without minute white hairs. Perianth segments persistent but withering as the capsule enlarges. Stamens 6, free, inserted at the base of the perianth segments. Filaments filiform, slender, 13 mm long, anthers narrowly linear-oblong, dorsifixed, versatile, 6 mm long and 1 mm wide; ovary oblong, 3-celled, glabrous, 7 mm long; style entire in the lower part, trifid towards the apex, 13 mm long, style lobes 5 mm long. Fruits and seeds not seen.

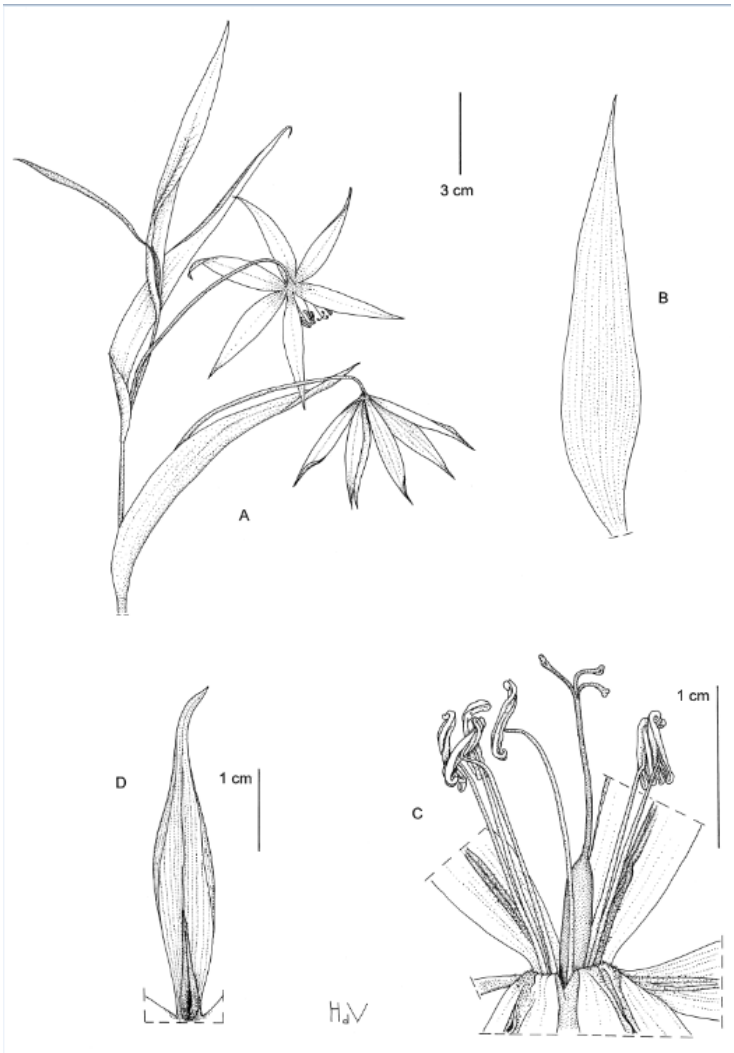


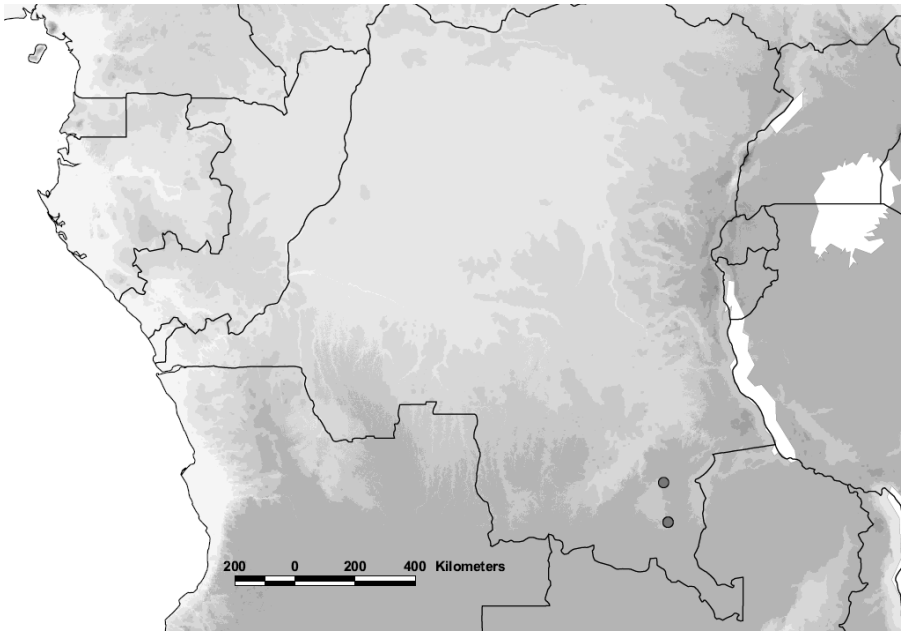
Figure 6.6. *G. katangensis*. A. habit; B. leaf; C. open flower; D. tepal. Drawn by Hans de Vries.

Distribution: This is an endemic taxon only known from areas around Lukavu area, Katanga Region, Democratic Republic of Congo (see **Map 6.4**), the type locality. It has been recorded along water shores; 500-1500 m altitude.

Phenology: Mature flowers collected in November and December.

IUCN conservation status: *G. katangensis* is only known from four accessions, all from the type locality in the Democratic Republic of Congo (Kinshasa). The last one was made in

1938. None of the collections are found in protected areas thus the Critically Endangered (CR B1abiii) category seems justified.



Map 6.4. Distribution of *G. katangensis.*

Notes: Morphologically, *G. katangensis* is similar to *G. lindenii* and can be differentiated based on its white and free perianth segments; unlike the green to red perianth segments of *G. lindenii* which are connate at the base forming a 3-8 mm long tube.

Specimens examined

DEMOCRATIC REPUBLIC OF CONGO: **Katanga (Shaba) Region, Kasenga District,** Region I, shores of the waters at Lukafu, 10°31'S27º33'E, Nov. 1899 (fl.), *Verdick* 288 (BR.); *Verdick*, 278 (BR). Lukafu, Dec. 1920 (fl.), *de Witte* 85 (BR). Lukafu, around Laumpure, 10°52'S27º55'E, 19 Dec. 1938 (fl.), *David* 92 (BR).

5. Gloriosa lindenii (Baker) J.C.Manning & Vinnersten in Taxon **56**: 178 (2007). TYPE: Tanzania, Kigoma District: Ujiji, *Linden* s.n. dd. 1884 (K, syntype, scan seen). **RD Congo,** Lake Mweru, *Descamps* s.n. (BR!, syntype). **Figure 6.7**

Basionym:

Littonia lindenii Baker in Fl. Trop. Afr. **7**: 566 (1898); Hoenselaar in Fl. Trop. E. Afr. Colchicaceae: 10-12 (2005).

Perennial herb between 40-70 cm high, stem slender, glabrous to pubescent; corm globose, about 1 cm in diameter, covered with brown tunics; with long roots fibrous up to 8 cm long; 2 cataphylls, 0.5-2 cm apart; lower cataphyll smaller than the upper one, up to 10 cm long. Leaves alternate, sessile, glabrous, bearing many veins and a strong midrib, sometimes sheathing the stem, narrowly elliptic-lanceolate to ovate, 5.5-16 cm long, 0.5-4.0 cm wide, apex acute, sometimes acuminate. Flowers campanulate, on long stalks in axils of upper leaves, facing downwards; pedicels up to 6 cm long. Perianth segments entire, glabrous, narrowly elliptic-lanceolate, tip short acuminate, bearing many veins and a strong midrib, 28-50 mm long, 3-7 mm wide; green at the base, upper part orange, vermillion, light red to red outside, yellow to orange inside. Perianth segments at the base connate into a short tube, 3-8 mm long. Perianth segments nectariferous and obscurely pouch-shaped at the base containing small white hairs. Stamens inserted at the base of the perianth tube. Filaments filiform, 4-8 mm long; anthers 4-6 mm long, 1 mm wide. Style erect, 4-12 mm long; stigma with 3 hooked branches each up to 3 mm long. Ovary 5-8 mm long, 2-2.5 mm wide. Capsule 13 mm long, 4 mm in diameter.

Distribution: Democratic Republic of Congo (Kinshasa), Malawi, Tanzania and Zambia (see **Map 6.5**), common in woodland or grassland. Altitude 665-1760 m.

Phenology: Mature flowers collected between October and January.

IUCN conservation notes: *G. lindenii* is well represented in herbaria in south central and east Africa. Least Concern (LC) category is applied here because the habitat in which it occurs is fairly common in countries of occurrence. Furthermore, it has been collected frequently in recent years.

Notes: *G. lindenii* is morphologically similar to *G. katangensis*, but can be separated from the latter by its compact, smaller and colourful perianth segments which are connate at the base forming a 3-8 mm long tube. In the Democratic Republic of Congo (Kinshasa), where the two species have been recorded, they occupy different habitats, with *G. lindenii* common in

woodland or grassland while *G. katangensis* has been recorded along water shores around Lukavu area, Katanga region.

Extra reference: Phiri (2005).

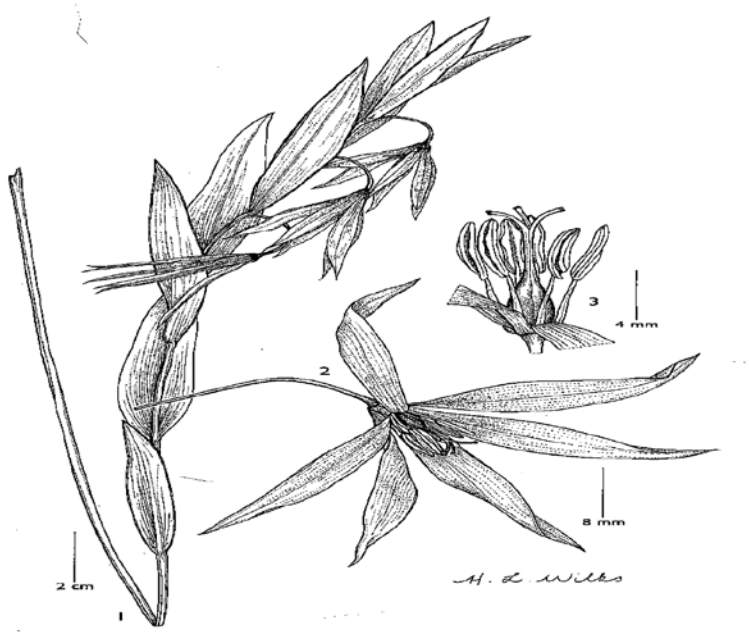
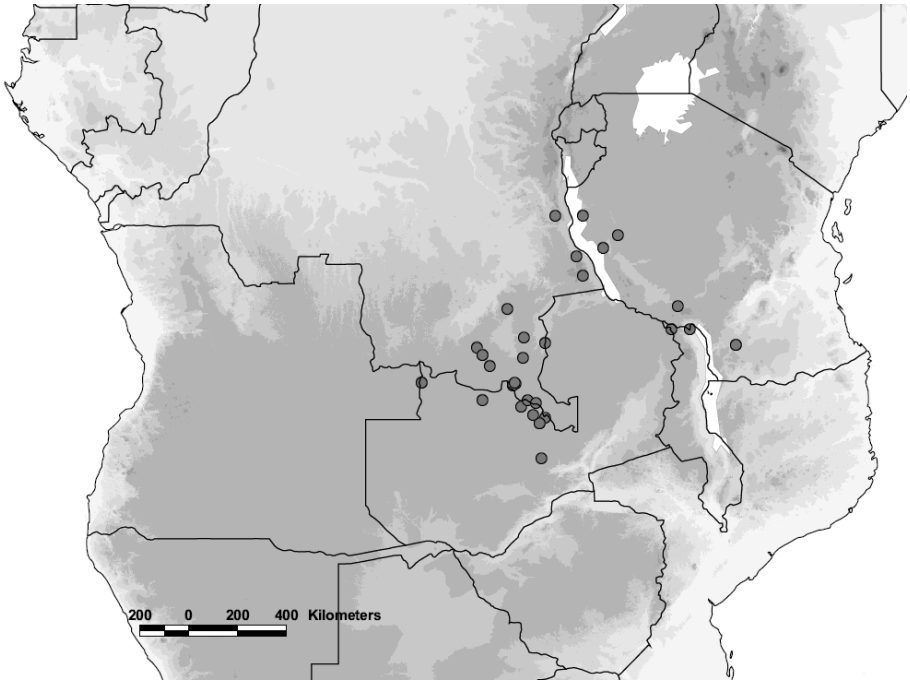


Figure 6.7. *G. lindenii*: 1. habit; 2. flower; 3. stamens and ovary (from Hoenselaar 2005, reproduced with permission).

Specimens examined

DEMOCRATIC REPUBLIC OF CONGO: **Katanga (Shaba)**, Mitwaba, Lusinga, right bank of the Lusinga River, 8°56'S27º12'E, Alt. 1760 m, Nov. 1947 (fl.), *de Witte* 3037 (K). Elizabethville, 1938 (fl.), *Salésiens* 533 (BR). Kalobe, Kunolelungu, 8°52'S24º59'E, 30 Nov. 1971 (fl.), *Thoen* T5053 (BR). Lake Mweru, *Descamps* s.n. (BR, syntype). Moba, Marungu, 7°42'S30º00'E, Alt. 1740 m, Nov. 1945 (fl.), *Quarré* 7415 (BR). 25 km NNE of Tshinsenda, 12°18'S27º58'E, Alt. 1180 m, 20 Nov. 1969 (fl.), *Symoens* 13308 (BR). Shimbolobu, 11°02'S26°35'E Dec. 1951 (fl.), *Hoffman* 972 (BR). 10°11'S28°36'E, Alt. 1680 m, 7 Nov. 1968 (fl.), *Malaisse* 5592 (BR, K). **Lubudi, Fungurume,** Zikule, 10°37'S26°18'E, Alt. 1475 m, 22 Nov. 2006 (fl.), *Kisimba & Saad* 1010 (BR); Shinkusu W, 10°37'S26°18'E, 13 Nov. 2006 (fl.), *Kisimba & Saad* 644 (BR). **Lubumbashi**, Keyberg, Kisanga Valley, 2°28'N26°35'E, Alt. 665 m, 22 Nov. 1956 (fl.), *Detilleux* 138 (BR, K); Sakania, 10 km from Lubumbashi along Mokambo-Lubumbashi road, 12°24'S28°17'E, 13 Nov. 1986 (fl.), *D'hose* 79 (BR). Makuen-Dembo, 27 Nov. 1956 (fl.), *Detilleux* 178 (BR). Kafubu, 17 Nov. 1927 (fl.), *Quarré* 810 (BR). Melleghem, Nov. 1928 (fl.), *Quarré* 1459 (BR); 2 km S of Lutshipuka, Alt. 1680 m, 7 Nov. 1968 (fl.). *Malaisse* 1968 (BR, K). **Nord-Kivu, Goma**, 10°21'S26°04'E, 17 Oct. 2006 (fl.), *Kisimba & Malaisse* 392 (BR). **Sud-**

Kivu, Shabunda, Ligulu River, 1946 (fl), 2°17'S26°32'E, *van Meel* 187 (BR). *Debeerst* 58 (fl.) (BR). **MALAWI**: **Northern Region, Chitipa district**, 65 km W of Karonga, Songa stream, 9°42'S33°55'E, Alt. 1100 m, 31 Dec. 1976 (fl.), *Pawek* 12145 (BR, MO, WAG); Songa stream, c. 15 km E of Crossroads, 9°42'S33°16'E, Alt. 1500 m, 5 Jan. 1974 (fl.), *Pawek* 7790 (K, MO, P). **TANZANIA**: You forgot Linden (dd. 1884) from Ujiji K, syntype), **Kigoma Region, Kigoma District**, Lunvugwise River, 5°30'S30°00'E, Alt. 900 m, 4 Nov. 1959 (fl.), *Richards* 11708 (K). **Mbeya Region**, **Mbeya District**, Mbosi circle, Boma Riva Estate, 8°50'S33°30'E, Alt. 1500 m, 15 Jan. 1961 (fl.), *Richards* 13934 (BR, K). **Rukwa Region, Mpanda District**, Katavi-Rukwa protected area, 6°41'S30°45'E, Alt. 1080 m, 1 Dec. 2002 (fl.), *Mwangulango* 1043 (BR, MO); Silkclub Highlands, 3°28'S18°44'E, Alt. 1500 m, 2 Dec. 1956 (fl.), *Richards* 7117 (K). **Ruvuma Region, Songea District**, about 12 km E of Songea by Nonganonga stream, 10°16'S35°39'E, Alt. 990 m, 21 Jan. 1956 (fl.), *Milne-Redhead & Taylor* 8294 (K); about 16 km S of Gumbiro, 10°15'S35°32'E, Alt. 899 m, 27 Jan. 1956 (fl.), *Milne-Redhead & Taylor* 8294a (K). **ZAMBIA**: **Central Province**, Kabwe District, Broken Hill, Forest Reserve, 14°27'S28°27'E, Nov. 1960 (fl.), *Morze* 301 (K). **Copperbelt Province,** Ndola District, Ndola, 12°50'S28°11'E, 24 Jan. 1956 (fl.), *Fanshawe* 2755 (K); W of Nkana, 27 Nov. 1947 (fl.), *Brenan* s.n. (K); Chingola - Solwezi road, 12°31'S27°51'E, Alt. 1366 m, 13 Nov. 1964 (fl.), *Rensburg* 2992 (K). **Luanshya Province**, Luanshya, 13°09'S28°24'E, 2 Dec. 1953 (fl.), *Fanshawe* 529 (BR, K); 13°09'S28°24'E, Alt. 1260 m, 15 Nov. 1951 (fl.), *Sinclair* 3 (BR, K). **North-Western Province, Mwinilunga District**, around Matonchi Farm, 11°39'S24º03'E, Alt. 1338 m, 3 Nov. 1938 (fl.), *Milne-Redhead* 3067 (BR, K); Matonchi Farm, 11°45'S24°26'E, Alt. 1338 m, 12 Nov. 1931 (fl.), *Paterson* s.n. (K). Solwezi District, 20 km along road to Mwinilunga, 12°11'S26°25'E, 20 Nov. 1972 (fl.), *Strid* 2511a (C, K). **Northern Province, Mbala District,** Abercorn, Kanda village, Ulungu, 27 Nov. 1948 (fl.), *Brédo* 6359 (BR**). No locality**, 1918 (fl.), *Autrique* 102 (BR).



Map 6.5. Distribution of *G. lindenii.*

6. Gloriosa littonioides (Welw. ex Baker) J.C.Manning & Vinnersten in Taxon **56**: 178 (2007). TYPE: Angola: Pungo Andongo, *Welwitsch* 1747 (K!, holotype). **Figure 6.8.**

Homotypic synonyms:
Sandersonia littonioides Welw. ex Baker in Trans. Linn. Soc., Ser. **2**: 262 (1878).
Littonia welwitschii Benth. & Hook.f. in Gen. Pl. **3**: 831 (1883), Baker in Fl. Trop. Afr. **7**: 566 (1898).
Littonia littonioides (Welw. ex Baker) K.Krause in Bot. Jahrb. Syst. **57**: 235 (1921); Hoenselaar in Fl. Trop. E. Afr. Colchicaceae: 12 (2005).

Perrenial herb, rootstock a tuberous corm, 2-pronged, L or V-shaped with a growing point at each end, 0.5-10 cm long, up to 1 cm in diameter covered with brown tunics; roots fibrous. Aerial stems annual, between 40-65 cm high, slender, glabrous to pubescent; cataphyll up to 19 cm long. Leaves alternate, sheathing around the stem, glabrous, entire, linear to lanceolate, bearing many veins and a strong midrib, apex sometimes acuminate, 6-14 cm long, 0.9-3.2 cm wide. Flowers campanulate, on long stalks in axils of upper leaves, facing downwards, pedicel up to 5 cm long. Perianth segments narrowly elliptic-lanceolate, apex sometimes acuminate, 15-20 mm long, 3-8 mm wide, yellowish green, main vein (central) prominent; perianth segments nectariferous and obscurely pouch-shaped at the base with or without white hairs, perianth tube 1-1.5 mm long. Stamens inserted at the base of the perianth tube. Filaments filiform, 5-8 mm long; anthers 3-4 mm long, 1 mm wide. Style up to 10 mm long including style lobes, style lobes not hooked, up to 2 mm long. Fruits and seeds not seen.

Distribution: Angola, RD Congo, Malawi, Tanzania and Zambia (see **Map 6.6**), common in woodland and grassland, 720-1650 m altitude.

Phenology: Mature flowers collected between October and January.

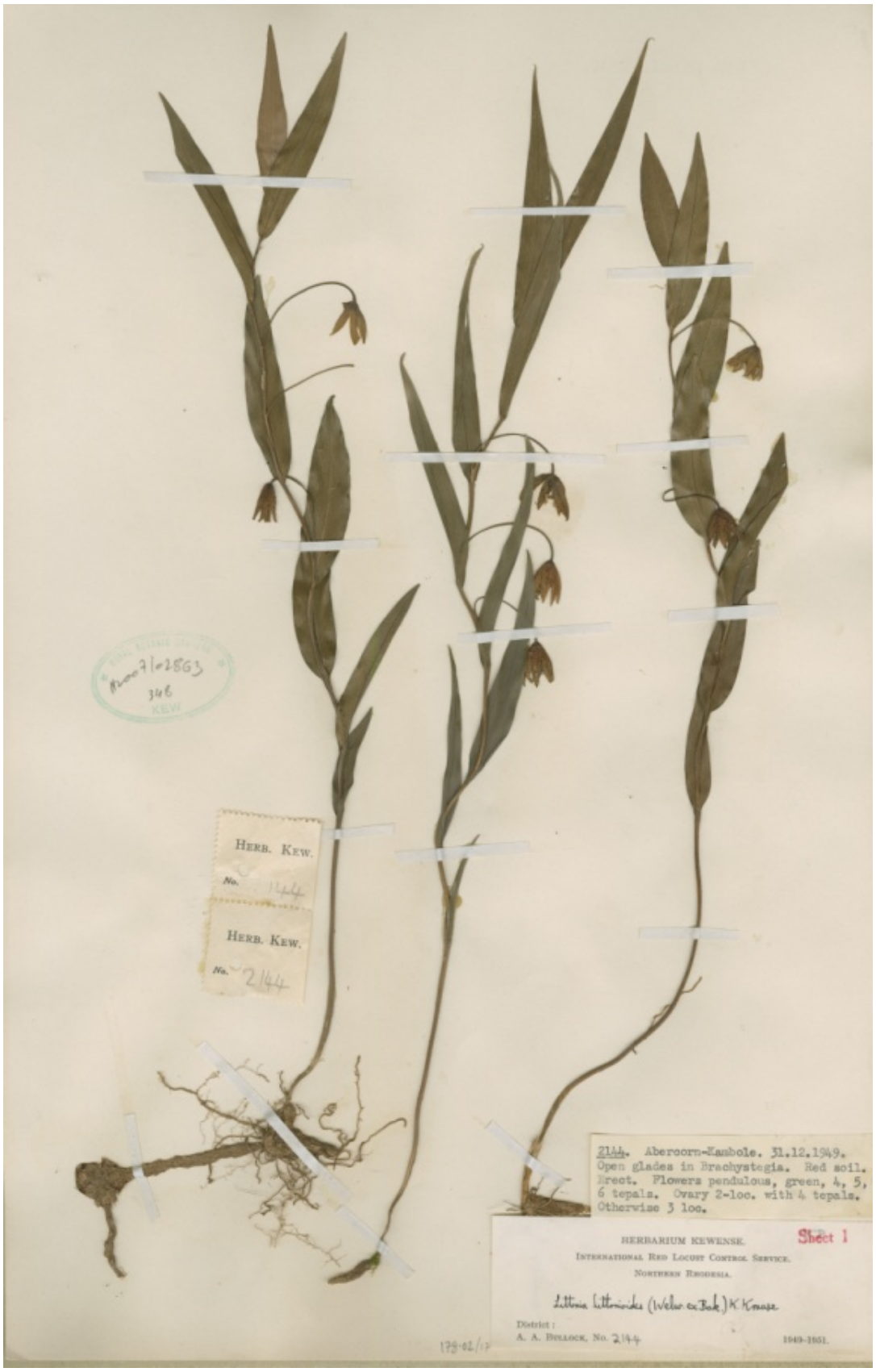
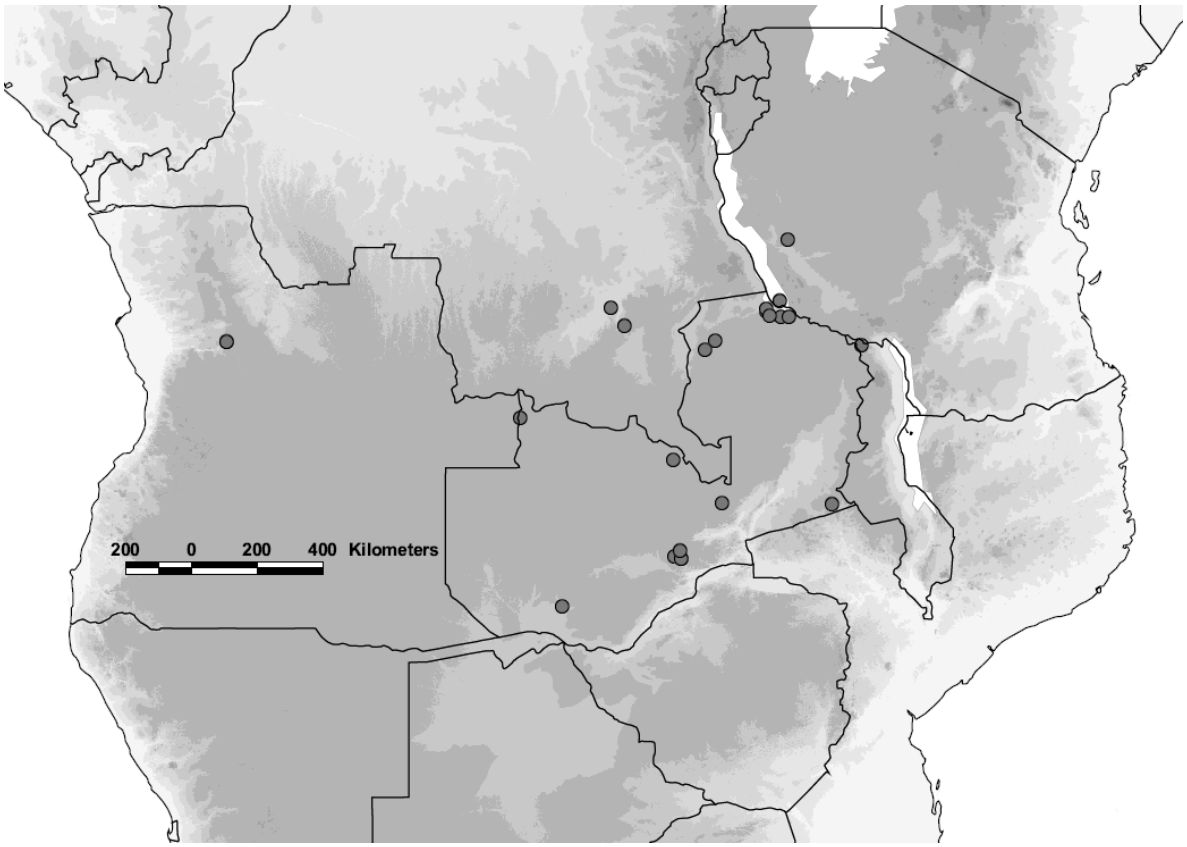


Figure 6.8. ***G. littonioides*** (Bullock 2144).



Map 6.6. Distribution of *G. littonioides.*

IUCN conservation notes: *G. littonioides* is well represented in herbaria in south Central and East Africa. Least Concern (LC) category is applied here because the habitat in which it occurs is fairly common and widely distribution in its countries of occurrence. Furthermore, it has been collected frequently in recent years.

Notes: *G. littonioides* can be easily distinguished from other *Gloriosa* species by having relatively small perianth segments which are less than 20 mm long.

Specimens examined

ANGOLA: **Pungo Andungo**, 9°57'S15º45'E, Alt. 720 m, Jan. 1857 (fl.), *Welwitsch* 1747 (BM, holotype); Jan. 1857 (fl.), *Welwitsch* 1748 (BM). **MALAWI**: **Northern Region**, Chitipa district, Kaseye mission, 16 km E of Chitipa, 9º40'S33°22'E, 26 Dec. 1977 (fl.), *Pawek* 13374 (BR, K, MAL, MO, SRGH, UC). **DEMOCRATIC**

REPUBLIC OF CONGO (KINSHASA): Upemba National Park, Vallée de Sense, 8°50'S26°44'E, Alt. 900 m, 19 Nov. 1959 (fl), *J.M.H.J.R. de Wilde* 90/770 (BR). **TANZANIA**: **Rukwa Region, Mpanda District**, Kapapa Camp, 4º40'S31°37'E, Alt. 1050 m, 28 Oct. 1959 (fl.), *Richards* 11612 (K). Sumbawanga Rural District, Kasanga county, Ngolotwe village, 8º27'S31°8'E, 11 Dec. 1948 (fl.), *Brédo* 6405 (BR). **ZAMBIA**: **Central Province**, **Mkushi District**, Fiwila, 13°58'S29º34'E, Alt. 1350 m, 4 Jan. 1958 (fl.), *Robinson* 2611 (K). **Copperbelt Province**, Kitwe District, 12º48'S28°14'E, 29 Nov. 1955 (fl.), *Fanshawe* 2634 (B, BR, K). **Eastern Province,** Chadiza District, Mwangazi Valley, 14°00'S32°34'E, Alt. 750 m, 26 Nov. 1958 (fl.), *Robson* 724 (K). **Luapula Province,** Kawambwa District, M'tunatusha River, 9º48'S29°05'E, Alt. 1290 m, 28 Nov. 1961 (fl.), *Richards* 15426 (K). **Lusaka Province, Lusaka District**, 8 km E of Lusaka, 15º26'S28°16'E, Alt. 1260 m, 10 Dec. 1955 (fl.), *King* 239 (K); between Kasisi and Constantia, 15º16'S28º25'E, Alt. 1130 m, 4 Jan. 1973 (fl.), *Kornas* 2937 (K); Jellis's farm (Lazy J Ranch), Lusaka SE 20 km, 15º29'S28°27'E, Alt. 1300 m, 7 Jan. 1995 (fl.), *Bingham* 10255 (K). **Mporokoso District**, Lumangwe Falls, 9º23'S29°22'E, Alt. 1290 m, 21 Dec. 1967 (fl.), *Simon & Williamson* 1482 (K). **Northern Province, Mbala District**, Chitimbwa road, 8º50'S30°52'E, Alt. 1650 m, 29 Dec. 1955 (fl.), *Nash* 239 (BM). Abercorn-Kambole, 8º45'S30°45'E, 31 Dec. 1949 (fl.), *Bullock* 2144 (K); Abercorn, Lufubu River, Iyendwe valley, path to Shulu Kwesa village, 8º40'S30°45'E, Alt. 780 m, 10 Dec. 1959 (fl.), *Richards* 11962 (K); Abercorn, Inono woodland and stream, 8º53'S31°23'E, Alt. 1050 m, 30 Nov. 1964 (fl.), *Richards* 19288 (K). **North-Western Province, Mwinilunga District**, slope E of Matonchi Farm, 11º39'S24°03'E, 11 Nov. 1937 (fl.), *Milne-Redhead* 3199 (BR, K); Luauzua Valley, Alt. 900 m, 11 Dec. 1954 (fl.), *Richards* 3611 (K). **Western Province,** Kalomo District, Machili, 16º48'S25º11'E, 14 Dec. 1960 (fl.), *Fanshawe* 5976 (BM, K).

7. Gloriosa modesta (Hook.) J.C.Manning & Vinnersten in Taxon **56**: 178 (2007). TYPE: South Africa, Port Natal, October 1883, *Sanderson* s.n. (K, holotype, not seen). **Figure 6.9.**

Homotypic synonym/basionym:
Littonia modesta Hook. in Bot. Mag.: t. 4723 (1853); Baker in Bot. J. Linn. Soc. **17**: 458-459 (1879); Baker in Fl. Cap. **6**: 527 (1897); Phillips in The Fl. Pl. SA 10, Plate 366 (1930).

Heterotypic synonyms:
Littonia keiti Leichtlin in The Garden **24**: 87 (1883). TYPE: South Africa, Nelson Kop, *Cooper* 880 (PRE!, holotype).
Littonia modesta Hook. var. β *keiti* Leichtlin in The Garden 28: 116 (1885); Baker in Fl. Cap. **6**: 527 (1897). TYPE: South Africa, Nelson Kop, *Cooper* 880 (PRE!, holotype).

Perennial herb, rootstock a 3-pronged tuberous corm with a growing point at each end, up to 8 cm long, 2 cm in diameter, covered with brown tunics; roots fibrous. Underground stem

sometimes covered by a membranous sheathing or tubular cataphyll, not protracted into a leaf blade. Aerial stem annual, glabrous, usually simple or sometimes moderately branched, erect or sarmentose, up to 180 cm tall. Leaves cauline, base rounded, opposite, upper ones usually in whorls of 3 to 6 or ocassionally alternate; simple, glabrous, sessile, entire, bearing many veins and a strong midrib, linear to lanceolate, apex tendril bearing, the basal leaf lacking tendril; 7-18 cm or more long, 1.5-4.5 cm wide. Flowers campanulate, on long stalks in axils of upper leaves, facing downwards, deep bright yellow to orange yellow. Perianth segments open outwards as the flower matures, attached on curved, terete, glabrous pedicels, 2.4-5 cm long. Perianth segments, lanceolate, acuminate, acute, entire, glabrous, bearing many veins with a strong midrib, marcescent, 20-45 mm long, 5-15 mm wide. Perianth segments at the base connate into a short tube, up to 7 mm long. Stamens inserted at the base of the perianth tube. Filaments filiform, flattened, linear, 8 mm long; anthers linear-oblong, 5 mm long, 1 mm wide, versatile, introrsely attached near the base, dehiscing extrorsely. Ovary sessile, oblong, deeply trisulcate, up to 6 cm long, 2 cm in diameter; ovules many, superposed; style 6 mm long, erect, cylindrical, with 3 falcate branches, about 3 mm long, Seed capsule subcoriaceous, persists long after the plant has shrivelled, oblong about 4 cm long, soft-skinned when fresh and becomes hard with age, deeply 3-lobed, septicidally valved; seeds glossy, round, red, numerous, glabrous, which cling to the undersurface for a long period without drying, about 5 mm in diameter.

Distribution: Mozambique, South Africa, Swaziland and Zimbabwe (see **Map 6.7**), in clumps in the undergrowth of forests at the coast or inland, on sandy areas or in scrub bush, 600-2000 m altitude.

Phenology: Mature flowers collected between October and February, while fruits were collected in January and December.

Uses: This species is poisonous to stock. Its poisonous properties are probably due to colchicine, the tropolon alkaloids regarded as the biological hallmark of family Colchicaceae. *G. modesta* is also widely cultivated as an ornamental plant, both in greenhouses, out-doors in tropical areas and as a cut flower.

IUCN conservation notes: *G. modesta* is known from few accessions in both Mozambique and Zimbabwe. The single accession from central Zimbabwe raises questions whether *G.*

modesta is indigenous or not, as it was collected from an old Cedrela plantation, which is probably an abandoned garden. But collections of *G. modesta* from South Africa are well represented in herbaria in southern Africa. Least Concern (LC) category is applied here because the habitat in which it occurs is fairly common and the species is also fairly common in both South Africa and Swaziland. Furthermore, it has been collected frequently in recent years. *G. modesta* is listed in South Africa as Least Concern (LC) (Raimondo *et al.* 2009), due to lack of major threats and its population numbers are relatively stable.

Figure 6.9. *G. modesta* shoots with flowers, buds and nearly mature pod (from Herklots 1976, reproduced with permission).

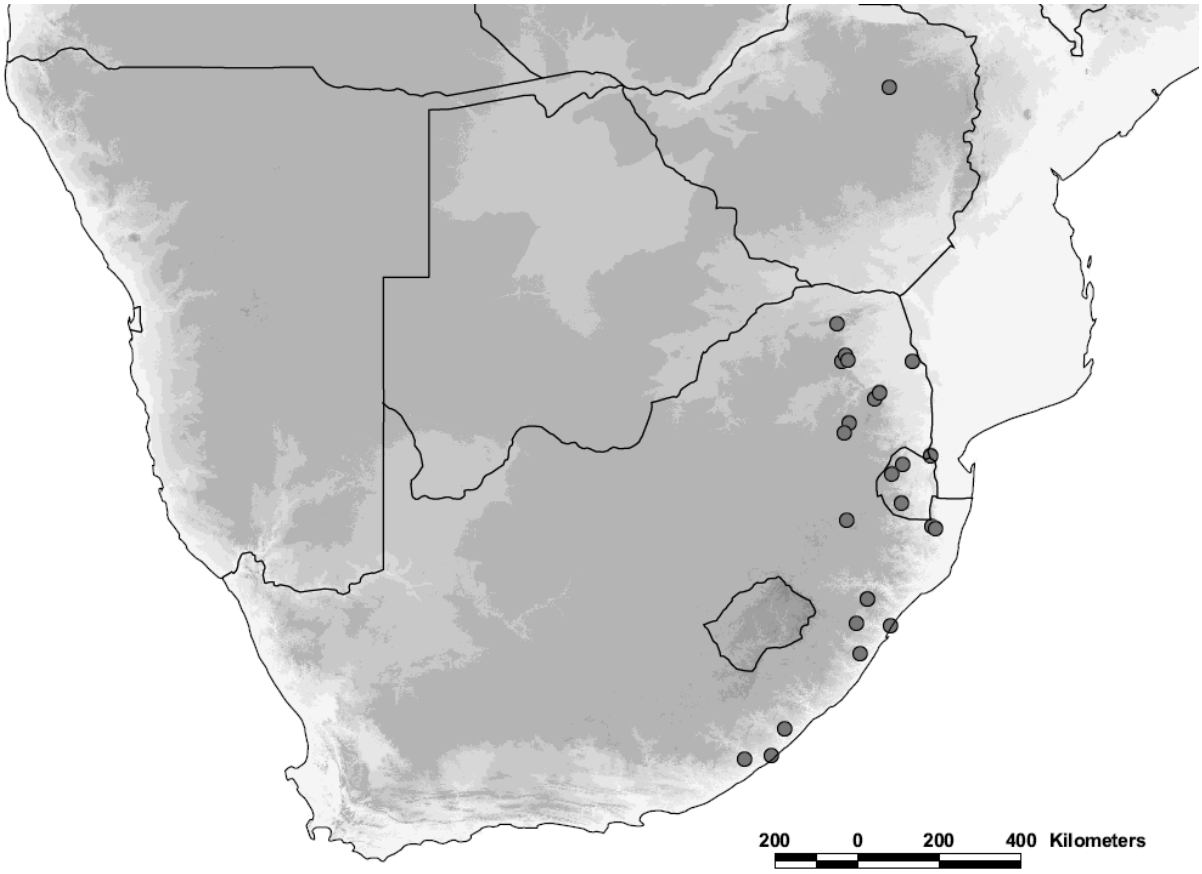
Notes: The molecular phylogeny results (Figure 6.2) showed *G. modesta* in an isolated position, not closely associated with other species. Such an isolated position of *G. modesta* makes it difficult to determine which species are its closest relatives. *G. modesta*, is often

found in the same localities as *Sandersonia aurantiaca* Hook., but distinguished by its climbing habit, and shape of its corolla. Its stems, foliage are similar to those of *G. superba* and *G. simplex*; it also climbs by means of thin tendrils which are produced at the tips of the leaves, but the flowers are very different, being simpler and bell-shaped. In cultivation it frequently produces abnormal flowers much larger than here described. *G. modesta* is distinguished from *G. rigidifolia* by being taller and having larger larger leaves; and *G. modesta* is more widespread than *G. rigidifolia* which is confined to the sandy areas of Waterberg, South Africa.

Extra references: Da Silva (2004); Eliovson (1973); Herklots (1976); Phillips (1930).

Specimens examined

MOZAMBIQUE: Maputo, Namaacha (Namahacha), Mt. Ponduine, 25º55'S32º00'E, 22 Feb. 1982 (fl.), *de Koning & Hiemstra* 9149 (SRGH). **SOUTH AFRICA: Eastern Cape Province**, Amatole District, Kentani, 32º30'S28º30'E, Alt. 1200 m, 1906 (fl.), *Pegler* 291 (BR); Umtata Waterfall, Tembuland, 21 Dec. 1911 (fl.), *Mason* s.n. (K). Komgha District, Komgha, 32º35'S27º54'E, Alt. 600 m, Dec. 1890 (fl.), *Flanagan* 370 (BR). Oshoek, 28 Jan. 1963 (fl.), *Vermeulen* s.n. (L). **Kwazulu-Natal Province**, Alexandra District, Dumisa Station, 30º16'S30º26'E, Alt. 750 m, 1 Dec. 1911 (fl.), *Rudatis* 1531 (S, WAG). Pietermaritzburg, Winterskloof, 29º36'S30º22'E, 31 Dec. 1945 (fl./fr.), *Smith* s.n. (K, PRE). Greytown District, 29º04'S30º35'E, 9 Dec. 1932 (fl.), *Wylie* s.n. (K, S). Zululand, Majozini District, 5 km S of Pongolo Poort, 27º29'S32º01'E, 10 Dec. 1961 (fl.), *Ward* 3898 (K, PRE). Around Durban, Oct. (fl.), *McKen* 534 (S). **Mpumalanga Province**, Ubombo, Josini Dam area, 27º29'S32º05'E, 13 Dec. 1973 (fl.), *Stirton* 500 (K, PRE); between Louw's Creek and Maid of the Mist Mts, 23º02'S29º55'E, 5 Jan. 1929 (fl.), *Hutchinson* 2416 (K). **Transvaal Region**, Woodbush drive, Magoeba's Kloof, 23º52'S29º59'E, Alt. 1398 m, 30 Jan. 1965 (fl.), *Taat* 382 (C, U, WAG). E of Griqualand, 20 Jan. 1939 (fr.), *Gerstner* 3168 (K); 25 km W of Tzaneen, 23º50'S30º10'E,17 Jan. 1952 (fl.), *Prosser* 1825 (K). Wakkerstroom, Alt. 1920 m, 28 Dec. 1960 (fl.), *Devenish* 389 (K, PRE). Letaba, New Agatha, eastern face of Piesang Kop, Oshoek, 23º51'S31º34'E, Alt. 1170 m, 25 Jan. 1960 (fl.), *Scheepers* 877 (K, PRE). Dullstroom, 30 Jan. 1959 (fl.), 25º25'S30º06'E, Alt. 2000 m, *Werdermann & Oberdieck* 2041 (B). Rietfontein-plantasie, 5 Jan. 1963 (fl.), *Sijde* 110 (L). Duiwelskloof, Westfalia Estate, 23º44'S30º07'E, 21 Jan. 1964 (fl./fr.), *Bos* 1149 (WAG). Lydenburg, Pilgrim's Rest, 24º40'S30º45'E, Nov. 1915 (fl.), s.n. 18628 (S); Mariepskop, Drakensberg, 24º32'S30º52'E, 15 Jan. 1959 (fl.), *Werdermann & Oberdieck* 1820 (B). **No locality**, *Drege* 4553 (S). **SWAZILAND: Hlalikulu**, 26º57'S31º21'E, Alt. 1034 m, Jan. 1911 (fl.), *Stewart* 40 (K). **Mbabane**, 26º19'S31º08'E, Alt. 1440 m, Jan. 1906 (fl.), *Bolus* 588 (BR). **ZIMBABWE: Harare**, Quorn Avenue, Mount Pleasant, 17º50'S31º05'E, Alt. 1500 m, Feb. 1956 (fl.), *Drummond* 5104 (K, S, SRGH).



Map 6.7. Distribution of *G. modesta.*

CULTIVATED: BELGIUM: Gent, Hortus (buiten), 25 Aug. 1949 (fr.), *Boom* 15934 (WAG). **KENYA**, Limoru, 14 Dec. 1930 (fl.), s.n. 596 (K). **NETHERLANDS**: Haarlem, warenhuis kwekerij van Tubergen, 24 June 1949 (fl.), *Boom* 14899 (L); Wageningen Botanic Garden, cultivated in glasshouse, 10 Aug. 1970 (fl.), *de Bruijn* 1999 (WAG); 2 July 1959 (fl.), *University of Delft* s.n. (L). **SWEDEN:** No locality (fr.), s.n. (S).

8. Gloriosa revoilii (Franch.) J.C.Manning & Vinnersten in Taxon **56**: 178 (2007). TYPE: Somalia, "Barroz" valley, *Revoil* s.n. (P!, holotype). **Figure 6.10.**

Basionym:

Littonia revoilii Franch. in Sert. Somal. 66 (1882); Baker in Fl. Trop. Afr. **7**: 567 (1898); Cufodontis in Enum. 1528 (1971); Thulin in Fl. Somalia **4**: 68 (1995); Sebsebe Demissew in Fl. Ethiopia & Eritrea **6**: 186 (1997).

Heterotypic synonyms:

Littonia minor Deflers in Bull. Soc. Bot. France **32**: 353 (1886); Blatter in Fl. Aden **7**: 343-344 (1914). TYPE: Yemen, Arabie-Territoire d'Aden, Gebel Hussan éboulis, *Deflers* s.n. (P!, holotype).

Littonia hardeggeri Beck in Paulitschk. Expedit. Harrar. 451, fig. 8-9 (1888). TYPE: Ethiopia, between Agarwejna (Aroueina) and Dadab, *Hardegger & Paulitschke* s.n. (W, holotype, not seen).

Littonia obscura Baker in Bull. Misc. Inform. Kew (1894): 342. TYPE: Kosseir in Hadramaut, *Lunt* 280 (P, holotype, not seen).

Perennial herb, 5-35 cm; globose corm or a 2-pronged, L or V-shaped tuber with growing point at each end, about 2.5 cm long and 1.5 cm in diameter, covered with brown tunics; fibrous roots. Underground stem usually covered by thinly membranous tunica, forming a tubular sheath, split above and loosely surrounding the stem, usually protracted into the lowermost leaf. Stem erect, simple, subterranean part slender, very long measuring up to 15 cm long. Aerial stem annual, glabrous to densely papillose-pubescent, erect and free-standing. Leaves linear, spreading, sessile, entire, glabrous to papillose-pubescent, usually in whorls, sometimes irregular, bearing many veins with a prominent midrib, 4.5-13 cm long and 4.5-6 mm wide, apex acute, sometimes acuminate. Flowers axillary; pedicel 20-50 mm long. Perianth segments separate, entire, elliptic, narrowing from the middle towards the base, bearing several veins, apex acuminate, reddish yellow, cream flushed with brown or yellow; each tepal 12-25(-40) mm long and 2-5 mm wide. Stamens 6, filaments 8-10(-20) mm long; anther 3-4(-8) mm long. Ovary oblong, glabrous with style 3-10(-30) mm long and 3-branched stigma lobes 0.5-1.5 mm long. Capsule 3-locular, 15-17 mm long, many seeded. Seeds globose and fleshy when fresh, angular when dry, obovate, 3 mm in diameter.

Distribution: Somalia and south Yemen (see **Map 6.8**), occurs in sandy or stony ground, 0-570 m altitude. *G. revoilii* also occurs in Djibouti and Ethiopia (Sebsebe Demissew 1997; Thulin 1995).

Phenology: Mature flowers collected from October to July.

Figure 6.10. *G. revoilii*. 1. lower part of the plant showing corm; 2. flowering stem; 3. flower; 4. capsule; 5. enlarged flower and 6. seeds (from Sebsebe Demissew 1997, reproduced with permission).

IUCN conservation notes: *G. revoilii* is well represented in herbaria in east Africa. Least Concern (LC) category is applied here because the habitat in which it occurs is fairly common in countries where it has been recorded. Furthermore, it has been collected frequently in recent years.

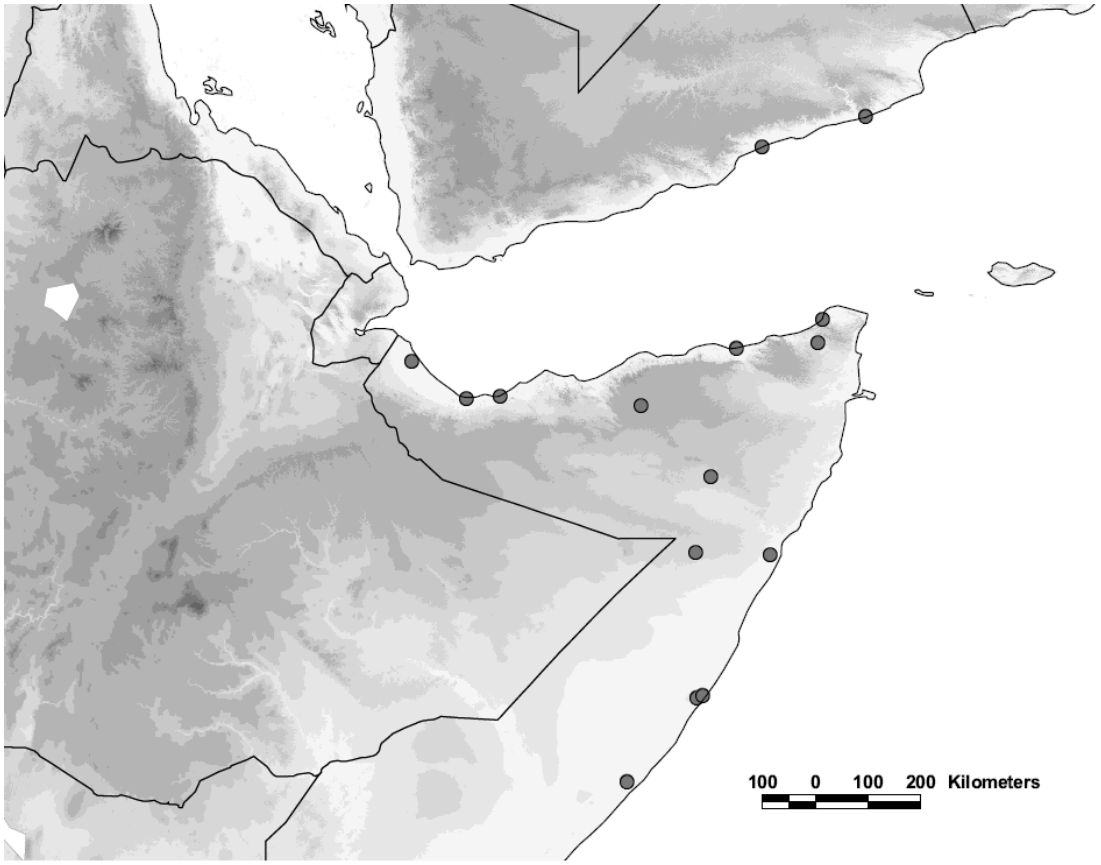
Notes: This species is highly variable, some specimens are glabrous and others papillose-pubescent. There is also variation in style-length, exceeding the stamens, but in some

specimens it is about half the length of stamens. The molecular phylogeny links *G. baudii* as sister to *G. revoilii* in a well-supported clade (Figure 6.2) that in turn is sister to a clade of *G. sessiliflora* and *G. superba* complex species. Both species have similar geographical, and ecological characteristics. *G. baudii* is a near-endemic taxon found in the arid regions of northern Kenya, Ethiopia and Somalia (**Map 6.1**), common on sandy and stony ground. *L. revoilii* is also a near-endemic taxon, occurring in sandy and stony ground in Somalia and south Yemen (**Map 6.8**).

Extra references: Sebsebe Demissew & Nordal (2010).

Specimens examined

SOMALIA: Bari, 2 km SW of Gheesaley, 11º44'N50º30'E, Alt. 10 m, 14 Nov. 1986 (fl.), *Thulin & Warfa* 5793 (UPS). **Berbera**, 10º25'N45ºE, Alt. 0 m, 1 Jan. 1933 (fl.), *Gillert* 4758 (K); *Drake-Brockman* 989 (K); *Drake-Brockman* 990 (K); *Drake-Brockman* 991 (K); *Drake-Brockman* 992 (K). **Galguduud**, Ceeldheer, E of town, 3º51'N47º10'E, Alt. 20 m, 7 May 1990 (fl.), *Thulin, Hedren & Dahir* 7294 (UPS). **Haudi**, 28 Mar. 1932 (fl.), *Godfrey-Faussett* 1 (K). **Hobyo**, 9.4 km SW of Hobyo NRA compound, 5 km from ocean, 4.5 km from nearest water, 5º19'N48º27'E, 18 May 1987 (fl.), *Wieland* 4241 (K). **Laskarei**, Alt. 0 m, 30 Nov. 1971 (fl.), *Lavranos* 9053 (K). **Medjourtines**, *Mission Revoil* s.n. (P). **Mijertein**, Daror depression, 24 km E of Carin-Ganda road, 11º2'N50º26'E, Alt. 450 m, 2 Oct. 1959 (fl.), *Hemming* 1621 (K); Vallei de Barror, 22 Jul. 1881 (fl.), *Revoil* 135 (P). **Mudugh**, 18 km SW of Obbia on road to Wisil, 5º17'N48º22'E, Alt. 50 m, 29 May 1979 (fl.), *Gillett, Hemming & Watson* 22226 (K). **Nugaal**, 8 km SW of Halin along road to Garoe, 9º03'N48º36'E, Alt. 570 m, 21 Nov. 1985 (fl.), *Thulin & Warfa* 5390 (UPS). 22 km along track from Gaalogod to Garadeen, 7º43'N49º36'E, Alt. 180 m, 9 May 2001 (fl.), *Thulin, Dahir, Khalid & Osman* 10513 (UPS). **Sanaag**, plains, 10º16'N47º24'E, 29 May 1949 (fl.), *Bally* 7237 (K). **Wela Arobis**, along the road on Geriad plain between Borausa Zeilah, 11º01'N43º29'E, 9 Jan. 1945 (fl.), *Glover & Gilliland* 670 (K). **Woqooyi Galbeed**, (Bullaxaar), 32 km S of Bulhar, 10º23'N44º25'E, Alt. 9 m, 12 Dec. 1956 (fl.), *Popov* 57/2 (EA, UPS). **Ziada**, near sea coast, 5 km E of Bauda, 11º15'N49º02'E, Alt. 0 m, Nov. 1929 (fl.), *Brown* 412 (K). **YEMEN**: **South Yemen**, 2 km before Qusayír on the way to Sayhut, 15º12'N51º14'E, Alt. 0 m, 11 Jan. 1985 (fl.), *Sanadiki* 19A (K). Hadramaut, 5 km E of Ar Riyan airport, coastal sandy plain, 14º41'N49º28'E, Alt. 2 m, 29 Nov. 1999 (fl.), *Hein, Hubaishan & Kilian* 6966 (C).



Map 6.8. Distribution of *G. revoilii.*

9. Gloriosa rigidifolia (Bredell) J.C.Manning & Vinnersten in Taxon **56**: 178 (2007). TYPE: South Africa, Waterberg District, Geelhoutkop, 5 Jan. 1936, *van der Merwe* s.n. (PRE!, holotype). **Figure 6.11.**

Basionym:
Littonia rigidifolia Bredell in Bull. Misc. Inform. Kew 1936: 495 (1936).

Perennial herb, with tuberous corm, small, fleshy, 1 cm in diameter covered with brownish tunics; roots fibrous. Underground stem covered by a membranous sheathing or tubular cataphyll, not protracted into a leaf blade. Aerial stem annual, erect, glabrous, simple, 60 cm high. Leaves sessile, glabrous, entire, first lower leaf single, second opposite and subsequent set of leaves in whorls of 3-4, linear, bearing many veins and a strong midrib, apex acute and with a tendril, margins inrolled and rim conspicuous below, 3-16 cm long, 0.2-0.8 cm wide. Flowers campanulate, facing downwards on glabrous, terete pedicels up to 3.5 cm long.

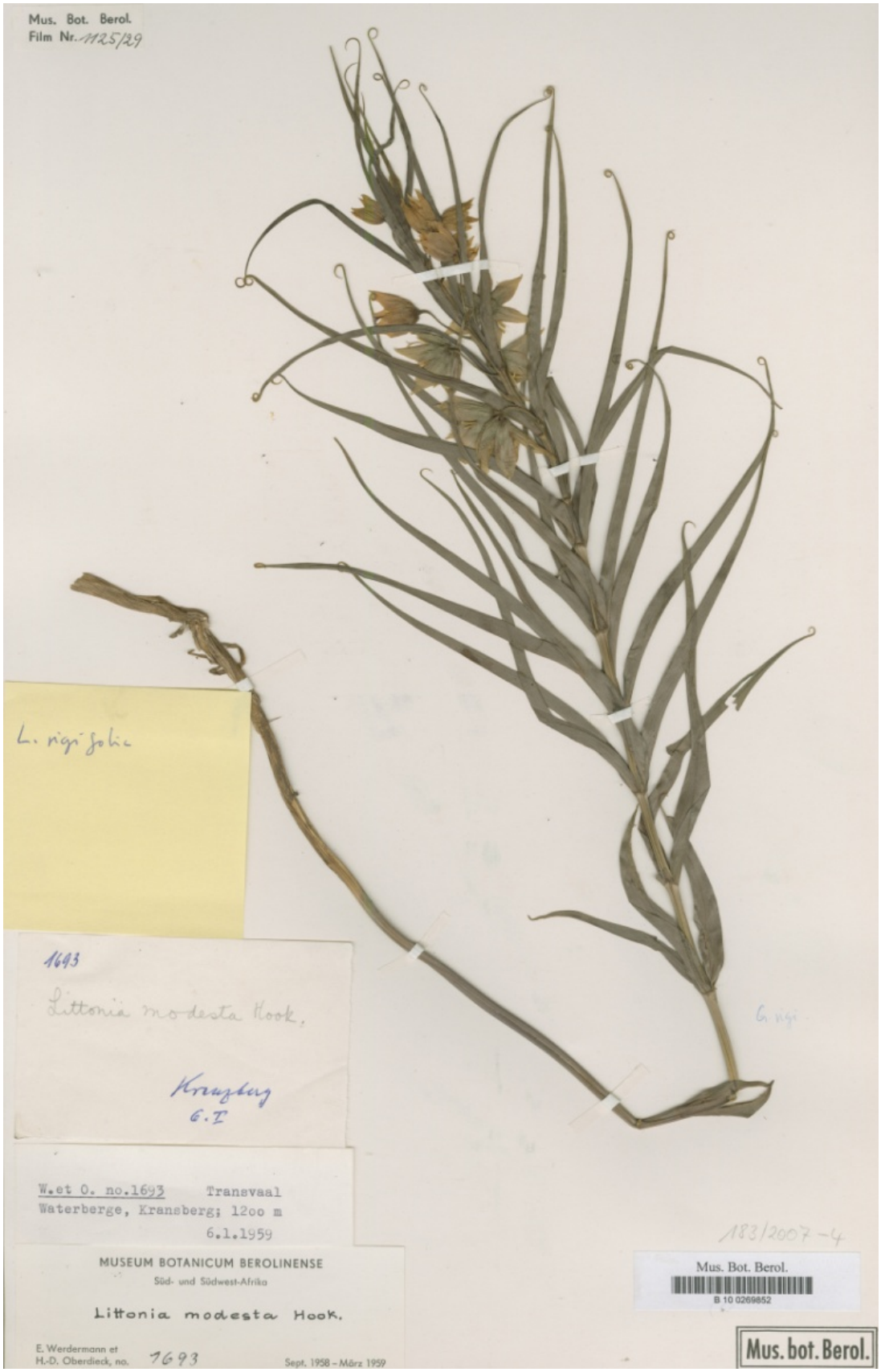


Figure 6.11. ***G. rigidifolia*** (Werdermann & Oberdieck 1693).

Perianth segments at the base connate into a short tube, up to 5 mm long, green or pale yellow, 15-20 mm long, 5-8 mm wide, lanceolate, tip a little acuminate. Perianth segments nectariferous and obscurely pouch-shaped characterised by fine hairs. Stamens inserted at the base of the perianth tube. Filaments 6 mm long; anthers linear-oblong, 6 mm long, 1 mm wide, filament attached near the middle. Ovary 3 mm long, with many ovules, style 12 mm long; style lobes 2 mm long, falcate. Fruits and seeds not seen.

Distribution: Known only from South Africa (see **Map 6.9**), occurring in sandy habitats in the Transvaal region, 1200-1350 m altitude.

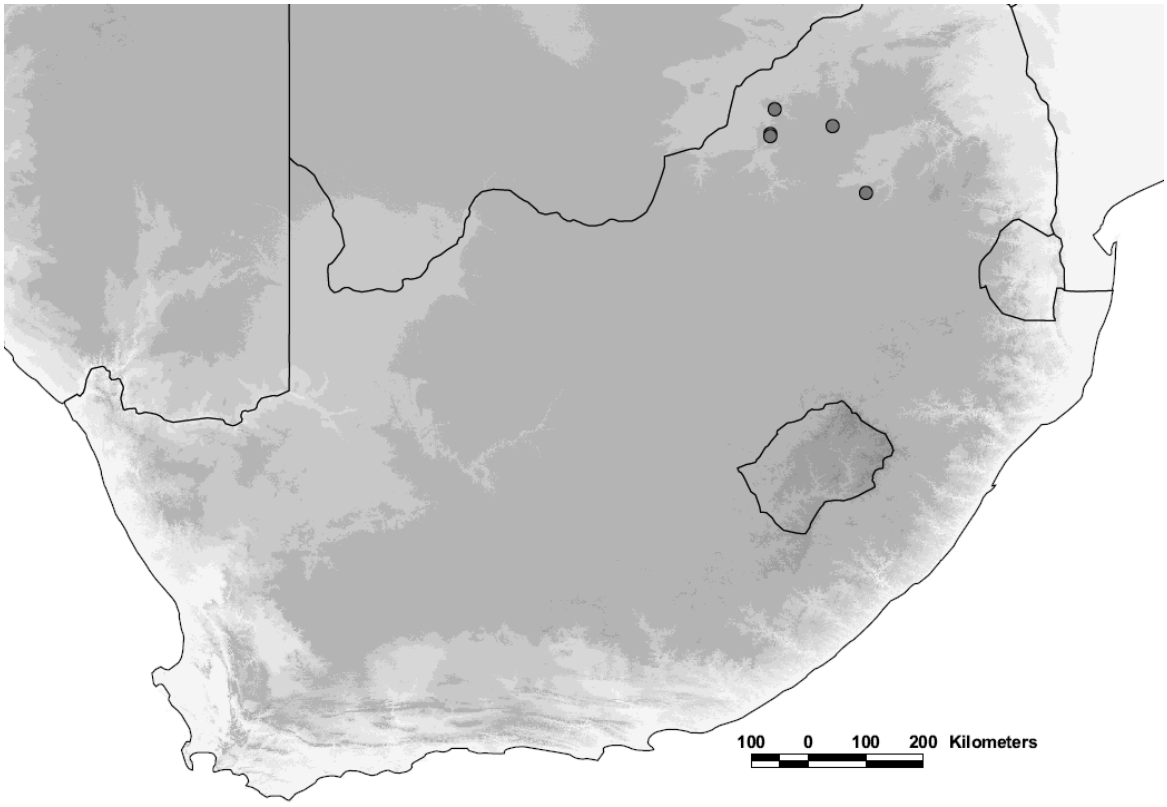
Phenology: Mature flowers collected from December to January.

IUCN conservation notes: *G. rigidifolia* is well represented in herbaria in South Africa. Least Concern (LC) category is applied here because the habitat in which it occurs is fairly common although has not been collected in recent years in South Africa. *G. rigidifolia* is considered of Least Concern (LC) in South Africa (Raimondo *et al.* 2009), due to lack of major threats and its population numbers are relatively stable.

Notes: *G. rigidifolia* differs from *G. modesta* in having much narrower and more rigid leaves, and is confined to the sandy areas of the Waterberg, while *G. modesta* is common in the northern and eastern regions but has also been found, though more rarely in the Rustenburg district near Warmbath in the Waterberg.

Specimens examined

SOUTH AFRICA: Transvaal, Limpopo, Waterberg District. P.P. Rust, Bokpoort, 6 km SE of P.O. Palala, 24º17'S28º30'E, Alt. 1350 m, 17 Dec. 1946 (fl.), *Codd* 2363 (K); foot and steep slopes of Krantzberg, SW slope, 24º24'S27º32'E, 12 Jan. 1942 (fl.), *Dyer & Verdoorn* 4225 (UPS); Warmbath, between Naboomspruit and Palala, 24º53'S28º17'E, 24 Jan. 1962 (fl.), *Schlieben* 9184 (K, PRE); Mt Elmerton to Olieboomspoort, 68 km from Vaalwater on road to Ellisras, 7 Jan. 1957 (fl.), *Meeuse & Strey* 10433 (K, PRE, S, UPS); Krantzberg, 24º26'S27º32'E, Alt. 1200 m, 6 Jan. 1959 (fl.), *Werdermann & Oberdieck* 1693 (B).



Map 6.9. Distribution of *G. rigidifolia.*

10. *Gloriosa sessiliflora* Nordal & Bingham in Kew Bull. **53**: 479-482 (1998). TYPE: Zambia, Bingham & Luwiika 10752 (K, holotype; MRSC, O, WAG!, isotypes). **Figure 6.12.**

Perennial herb, corm tuberous, 2-pronged, L or V-shaped, covered with brown tunics, 5 cm long, 1-2 cm in diameter; roots fibrous. Stem erect, up to 100 cm tall. Stems unbranched but with growth continued after flowering from lateral buds below the inflorescence, with numerous whorled leaves in the upper two-thirds. Leaves sessile, entire, base sheathing the stem with tubular cataphylls protracted or not protracted into a leaf blade; blades bearing many parallel veins with a prominent midrib, 7-13 cm long and 1.5-2.5 cm wide, lanceolate with cirrhose apex. Flowers sessile, 2-8 per stem, single or two together in the leaf axils near the stem apex, funnel-shaped. Perianth segments at the base connate into a short tube, up to 4 mm long. Perianth segments glabrous, entire, bearing many veins and a prominent midrib, 3.5-4 cm long and 1-1.5 cm long, narrowly ovate, slightly undulate, yellowish orange near the base, reddish distally, nectariferous, obscurely saccate and pouch-shaped at the base often

with white hairs. Filaments filiform, yellowish, 1.6-3.1 cm long; anthers orange, 6 mm long, versatile, with latrorse dehiscence. Style suberect, 2.3-2.6 cm long; stigma with 3 branches each 3 mm long. Fruits and seeds not seen.

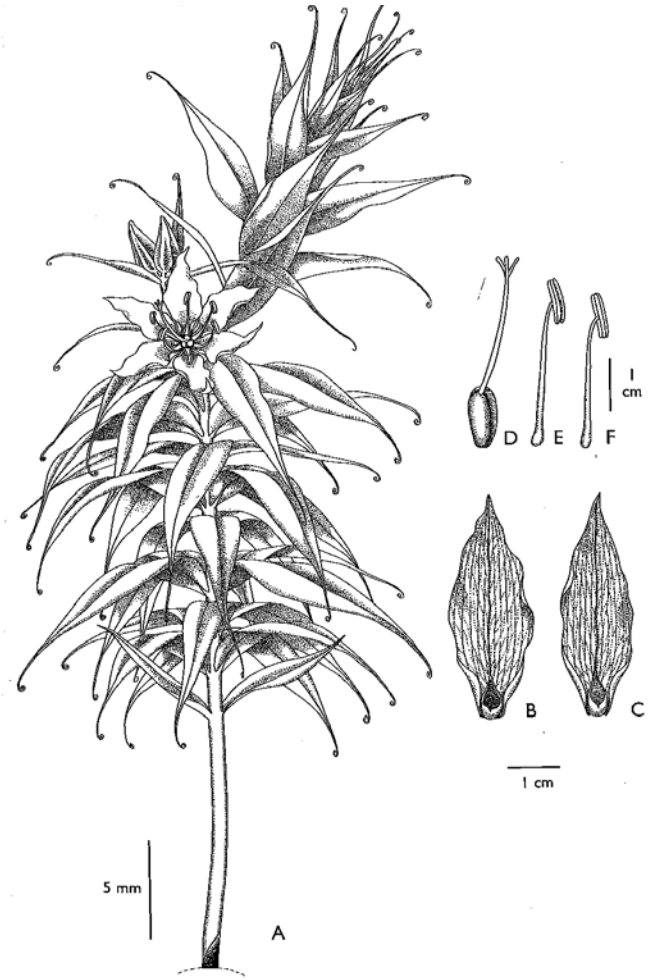
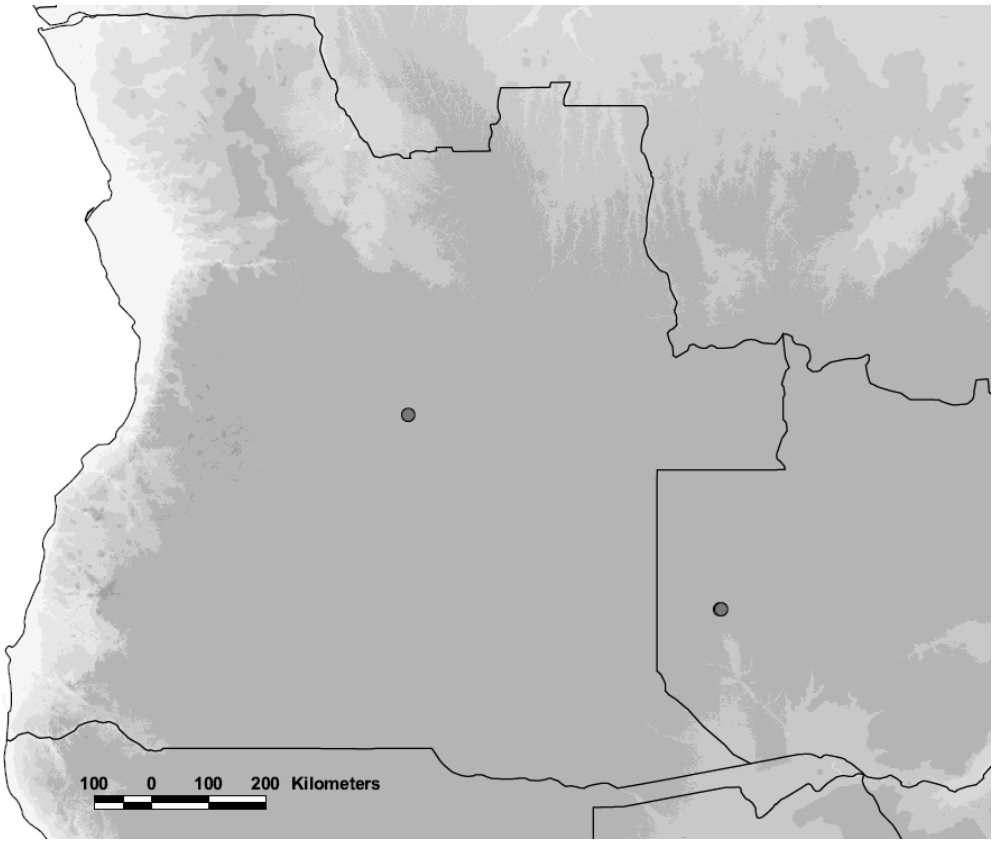


Figure 6.12. *G. sessiliflora*. Flowering plant shoot (from Nordal & Bingham 1998, reproduced with permission).

Distribution: Zambia and Angola (see **Map 6.10**), growing in open woodland, about 1000 m altitude in western Zambia. It has been recorded in *Syzygium* forest, flood plain termite mounds and sand banks with riverine forest in Zambia. In Angola, it has been recorded in sandy soils.

Phenology: Mature flowers collected between October and December.

IUCN conservation notes: *G. sessiliflora* is represented by less than 5 accessions from both Angola and Zambia, mainly from unprotected areas. Therefore, the vulnerable (VUD2) status is still recommended. Previously categorised as vulnerable, VUD2 (Bingham & Smith 2002), mainly because it was only known from the type locality, characterised by very small and restricted population. The taxon might be transferred to a lower category if more populations are found.



Map 6.10. Distribution of *G. sessiliflora.*

Notes: The molecular phylogeny links *G. sessiliflora* to *G. carsonii* and other species of the *G. superba* complex (Figure 6.2). *G. sessiliflora* is distinguished from all other *Gloriosa* species by lacking pedicels, unlike all other species which have hanging and nodding flowers on long pedicels.

Extra reference: Bingham & Smith (2002).

Specimens examined

ANGOLA: Bié Province, 12°35'S16°40'E, 6 Oct. 1965 (fl.), *Meudes dos Santos* 1968 (SRGH). **ZAMBIA**: **Western Province**. **Mongu District,** Bulozi floodplain, ca. 2 km W of Lealui, 15°13'S23°0'E, Alt. 1000 m, 9 Dec. 1995 (fl.), *Bingham & Luwiika* 10752 (K, MRSC, O, WAG); Lealui, 15°12'S23°00'E, 1022 m, 1 Dec. 2003 (fl.), *Bingham* 12717 (K).

11. *Gloriosa simplex* L. **Figure 6.13.**

In order to clarify the taxonomic status and to preserve the stability of the species, a neotype is designated for ***Gloriosa simplex*** L.

TYPE: to be selected (neotype, designated in future Taxon paper). No original specimens are known. The original description in Mant. Pl. Alt.: 62 (1767) is here considered original.

The designation of a neotype for *Gloriosa simplex* is necessary because the original description is ambiguous and there are no known original specimens. This is done to stabilise the use of the name *G. simplex*, which is probably one of the most well known and often cited species of the genus.

Synonyms:

Gloriosa caerulea Mill. in Gard. Dict. ed. 8. no. 2 (1768). *nom. illeg.*

Methonica superba (L.) var. β Lam. in Ency. 4: 133 (1796). TYPE: Mozambique, *Forbes* s.n. (K!, lectotype).

Gloriosa simplex D. Don in Prodr. Fl. Nepal: 51 (1825). TYPE: Nepal, *Wallich* s.n. (P, holotype, not seen).

Gloriosa virescens Lindl. in Bot. Mag. 52: t. 2539 (1825). TYPE: Mozambique, *Forbes* s.n. (K!, lectotype).

Methonica virescens (Lindl.) Kunth in Enum. Pl. 4: 277 (1843). TYPE: Mozambique, *Forbes* s.n. (K!, lectotype).

Clinostylis speciosa Hochst. in Flora 27: 26 (1844). TYPE: Ethiopia, TU, near Djeladjeranne, 31 July 1840, *Schimper* 1437 (BR!, isotype).

Methonica leopoldii van Houtte & Lem. in Fl. des Serres 2: t. 163-4 (1846). TYPE: Zanzibar, *van Houtte* s.n. (B, holotype, not seen).

Gloriosa abyssinica A.Rich. in Tent. Fl. Abyss. 2: 322 (1851). TYPE: Ethiopia, Shire Province, *Quartin & Petit* 48 (K!, P, syntype) & Tchélatchérané, *Schimper* s.n. (P!, syntype).

Methonica abyssinica (A.Rich.) Walpers in Ann. **3**: 630 (1852). TYPE: Ethiopia, Shire Province, *Quartin & Petit* 48 (K!, P, syntype) & Tchélatchérané, *Schimper* s.n. (P!, syntype).

Methonica virescens (Lindl.) Kunth var. *plantii* Planch. in Fl. des Serres 9: t. 865 (1853). TYPE: South Africa, Natal, *Drège* s.n. (PRE!, holotype).

Gloriosa plantii (Planch.) Loudon in Encycl. Pl., new ed.: 1544 (1855). TYPE: South Africa, Natal, *Drège* s.n. (PRE!, holotype).

Methonica grandiflora Hook. in Bot. Mag. 86: t. 5216 (1860). TYPE: Equatorial Guinea, Bioko Island (Fernando Po), *Mann* s.n. & *Mann* 72 (K!, holotype).

Methonica petersiana Klotzsch in Peters, Reise Moss. Bot. 519, t54. (1863). TYPE: Mozambique, *Forbes* s.n. (K!, lectotype).

Methonica platyphylla Klotzsch in Peters, Reise Moss. Bot. 520, t. 55 (1863). TYPE: Mozambique, *Forbes* s.n. (K!, lectotype).

Gloriosa virescens Lindl. var. *grandiflora* (Hook.) Baker in Bot. J. Linn. Soc. 17: 458 (1879). TYPE: Equatorial Guinea, Bioko Island (Fernando Póo), *Mann* s.n. & *Mann* 72 (K!, holotype).

Gloriosa speciosa (Hochst.) Engl. (1892). TYPE: TU, near Djeladjeranne, 31 July 1840, *Schimper* 1437 (BR!, isotype).

Gloriosa virescens Lindl. var. *leopoldii* (Van Houtte ex Lem.) T.Durand & Schinz in Consp. Fl. Afric. 5: 417 (1894). TYPE: Zanzibar, *van Houtte* s.n. (B, holotype, not seen).

Gloriosa virescens Lindl. var. *plantii* (Planch.) T.Durand & Schinz in Consp. Fl. Afric. 5: 417 (1894). TYPE: South Africa, Natal, *Drège* s.n. (PRE!, holotype).

Gloriosa virescens Lindl. var. *petersiana* (Klotzsch ex Garcke) T.Durand & Schinz in Consp. Fl. Afric. 5: 417 (1894). TYPE: Mozambique, *Forbes* s.n. (K!, lectotype).

Gloriosa virescens Lindl. var. *platyphylla* (Klotzsch ex Garcke) T.Durand & Schinz in Consp. Fl. Afric. 5: 417 (1894). TYPE: Mozambique, *Forbes* s.n. (K!, lectotype).

Gloriosa virescens Lindl. forma *plantii* Sieb. & Voss in Vilm., Blum. Ed 3,1: 1049 (1895). *nom. illeg.*

Gloriosa grandiflora (Hook.) O'Brien in Gard. Chron., Ser. Iii. Xxxvi. 186 (1904). TYPE: Equatorial Guinea, Bioko Island (Fernando Póo), *Mann* s.n. & *Mann* 72 (K!, holotype).

Gloriosa virescens Lindl. var. *latifolia* Chiov. in Res. Sc. Miss. Stefan.-Paoli Somal. Stal. 1: 176 (1916). *nom. illeg.*

Gloriosa sudanica A.Chev. in Expl. Bot. Afr. Gec. Franc. **1**: 658 (1920). TYPE: Benin, Dahomey, Djougou, *Chevalier* 23896 (P!, holotype).
Gloriosa sampaiana Pires de Lima in Brotéria, sér. Bot. **19**: 112 (1921). TYPE: Mozambique, *de Março* 173 (K!, holotype).
Gloriosa superba L. var. *planipetala* Engler in FWTA 2: 351 (1936). *nom. illeg.*

Perennial herb, tuberous rootstock subcylindrical, fleshy, bifurcately branched (or L or V-shaped), each 6-13 cm long, 1-3 cm in diameter; producing a new joint at the end of each arm each season, covered with brown tunics; roots fibrous. Stem erect, glabrous, usually branched and climbing up to 360 cm tall. The first leaf or two sheathing and scaly. Leaves entire, bearing many veins and a prominent midrib, sessile, alternate, sometimes opposite or verticillate and somewhat clustered, ranging from linear, elliptic-lanceolate to ovate, 6-25 cm long, (0.8-) 1.5-5 cm wide, rounded at the base, apex ending in a tendril; internodes longer with several flowers towards the top. Many flowers, 5-8 cm across, in axils of leaves, different shades of yellow, orange, red, crimson, purple mauve stripes or fading purple, often bicoloured. Pedicel erect, recurved apically, 6-18 cm long, nodding at the tip. Perianth segments persistent, sometimes connate at the base into a short tube, up to 2 mm long; oblanceolate to lanceolate, narrowing at the base, broadening towards the middle, curving inwards in the upper half, margins not crisped, 40-75 mm long, 17-25 mm wide, broadest above the middle, the apex pointed. Filaments filiform, sometimes flattened, 2-4 cm long, at first turned downwards, later spreading and turned up at ends. Anthers 7-15 mm long. Ovary 6-13 mm long, 3-5 mm wide; style 20-50 mm long including 3 stigma branches, 3-2 cm long. Capsule oblong, to 15 cm long and 3 cm wide, with three deep longitudinal grooves. Seeds smooth, vivid-red or orange-red up to 4 mm in diameter, with a fleshy testa.

Distribution: *G. simplex* is widespread in tropical and southern Africa (see **map 6.11**) in forest edges, woodland, bushland, grassland and roadsides; 30-2100 m altitude.

Phenology: Flowers collected all year round; while fruits were collected between July and September.

IUCN conservation notes: *G.simplex* is widespread in in tropical and southern Africa and is not under threat. Least concern (LC) category is recommended.

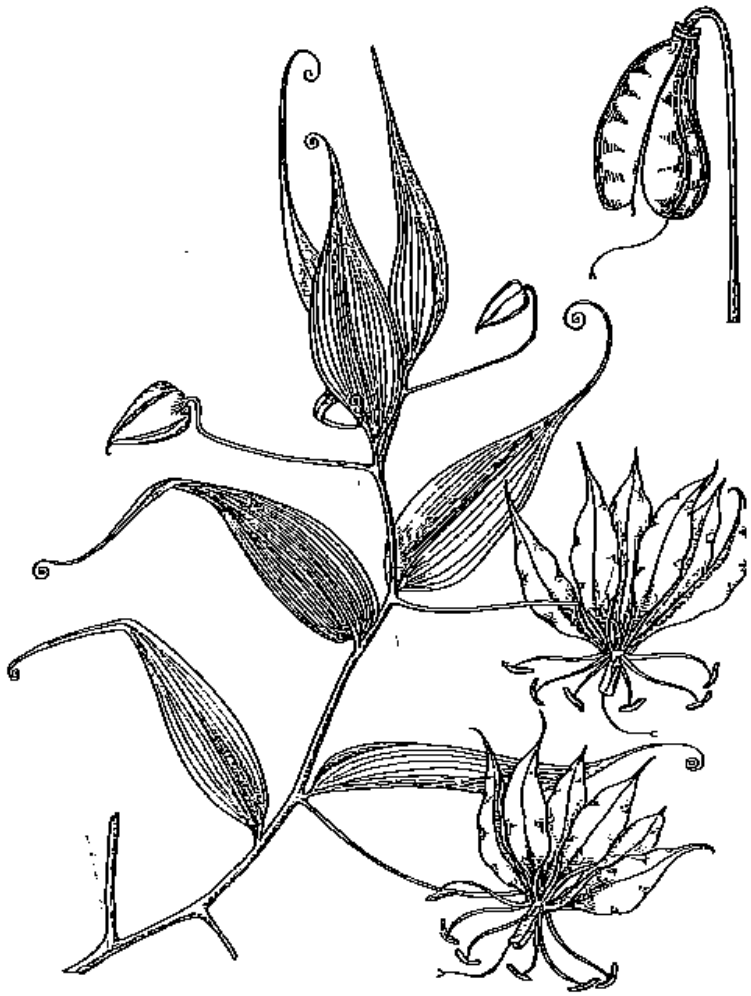
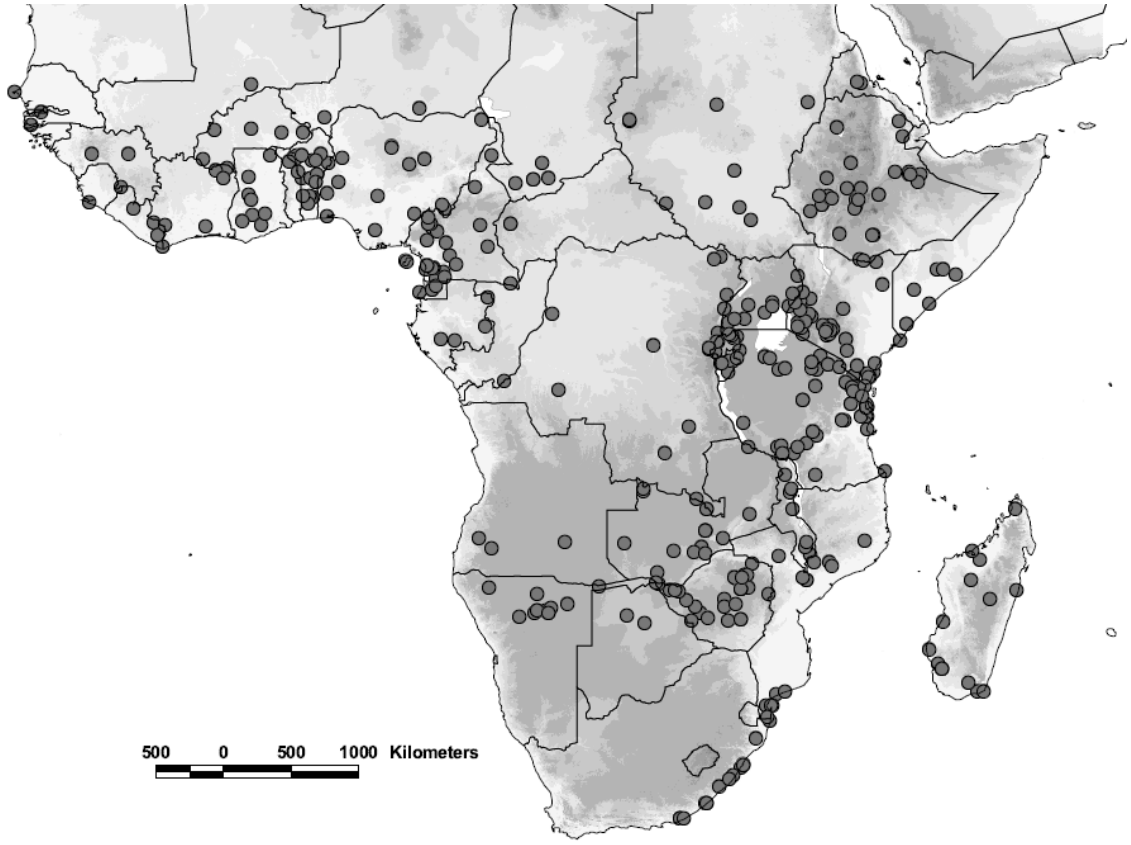


Figure 6.13. *G. simplex*. Flowering stem and immature fruit (from van der Burg 2006, reproduced with permission).



Map 6.11. Distribution of *G. simplex.*

Notes: The floral features of *G. simplex* are similar to those of *G. carsonii*. The latter species is erect with smaller perianth segments than those of *G. simplex*. *G. simplex* is distinguished from *G. superba* mainly by the perianth segments which are not crisped, but with straight margins, broadening towards the middle and curving inwards in the upper half. The molecular phylogeny links *G. simplex* with *G. superba* in a weakly supported polytomous clade with a bootstrap value of 56% (Figure 6.2).

Extra reference: Field (1972).

Specimens examined

ANGOLA: **Bié Province**, Cuilo-Cuanavale, 15°10'S19°10'E, 3 Feb. 1906 (fl.), *Gossweiler* 3570 (COI). Huila, Bandeira, 14°50'S14°56'E, 27 Dec. 1962 (fl.), *de Souza* 9 (K). **BENIN: Atakora,** Bassila, Gbaou (Alédjo), 9°27'N1°24'E, Alt. 460 m, 30 May 2001 (fl.), *Akoègninou* 4790 (BENIN, BRLU, WAG); Bassila, riv. Ngifela,

9°2'N1°39'E, 18 Sep. 1998 (fl.), *Pauwels* 7783 (BENIN, BRLU, WAG). **Borgou**, Djonyou, Alt. 450 m, June 1910 (fl.), *Chevalier* 23896 (P); Kanondé Mts., Alt. 400 m, 13 June 1910 (fl.), *Chevalier* 24012 (P); between Kouandé and Konkobiri, 10°34'N1°44'E, 28 June 1910 (fl.), *Chevalier* 24268 (P).Kalalé, Maréguita, 10°00'N3°27'E, 16 Aug. 1998 (fl.), *Sinsin, Agbani & Yédomonhan* 2062 (BENIN, BRLU, WAG); Parakou, Ferme Okpara, 9°15'N2°44'E, Alt. 350 m, 8 Aug. 2000 (fl.), *Essou* 2154 (BENIN, BRLU, WAG); Parakou, 4 km N of Parakou, 9°24'N2°37'E, 14 May 2000 (fl.), *van der Maesen, Akoègninou, Adomou & Agbani* 7330 (BENIN, BRLU, WAG). Tchaourou, Wari-Maro, 24 Aug. 1999 (fl.), *Sinsin, Agbani & Adokpo* 2903 (BENIN, BRLU, WAG); Tchaourou, 8°49'N2°36'E, Alt. 375 m, 7 Aug. 2001 (fl.), *Sokpon* 2157 (BENIN, BRLU, WAG). Outside Exp. field, Univ. of Parakou, Parakou, 9'20N2'37E, Alt. 360 m 3 Sept. 2011 (fr), *Quiroz* 833 (BENIN, WAG). **Dassa**, Bètècoucou, c 7°45'N2°27'E, 9 June 2000 (fl.), *Adjakidjè* 3569 (BENIN, BRLU, WAG); Dassa, 26 June 1999 (fl.), *Sokpon, Agbani & Yédomonhan* 655A (BENIN, BRLU, WAG); Dassa-Zoumé ferrugineux, 7°47'N2°10'E, 6 Aug. 1999 (fl.), *Adjakidjé & Agbani* 2944 (BENIN, BRLU, WAG); Tchakalakou (Toukountouna), Ouest de la route, 10°32'N1°19'E, 17 May 1999 (fl.), *van der Burg, Akoegninou, Essou & Agbani* 1497 (BENIN, BRLU, WAG). **Zou**, Djidja, Dan fdhsd dégradée, c 7°18'N2°04'E, Alt. 256 m, 16 June 2001 (fl.), *Adjakidjè* 4336 (BENIN, BRLU, WAG); Ouéssé, Toui-Vap, 8°44'N2°36'E, 14 July 2000 (fl.), *Sinsin* 3492 (BENIN, BRLU, WAG); Savalou, Tchetti, 7°51'N1°47'E, 23 June 2000 (fl.), *Sokpon* 1488 (BENIN, BRLU, WAG). **BOTSWANA:** Crocodile River, Oct. 1896, (veg.), *Klingberg* s.n. (S). Leshumo Valley (Lyshuma Valley), 17°50'S25°15'E, May 1876 (fl.), *Holub* s.n. (K). **Ngamiland**, Botletle, 20°30'S24°28'E, Alt. 1027 m, Dec. 1898 (fl.), *Lugard* 287 (K); c 10 km outside Maun along road to Toteng, 20°00'S23°25'E, 30 Jan. 1984 (fl.), *Blomberg* 443 (GAB, UPS); NW Ngamiland, 19°14'S23°06'E, *Curson* 717 (UPS). **BURKINA FASO:** Comoé, on the outskirts of Niangoloko, 10°17'N04°55'W, 7 Aug. 2005 (fl.), *van der Maesen, Nikiema & Bako* 8098 (CNSF, WAG). Diapaga, 12°04'N1°47'E, 9 July 1910 (fl.), *Chevalier* 24409 (P). Hte Volta, Fada N'gourma, 12°03'N00°21'E, 17 July 1975 (fl.), *Toutain* 1154 (P). Kadiogo, 16 km W of Ouagadougou, 12°27'N1°55'W, 10 Aug. 2005 (fl.), *van der Maesen, Nikiema & Bako* 8181 (CNSF, WAG). Solenzo, 12°11'N4°05'W, Alt. 320 m, July 1969 (fl.), *Boonounou* 184 (B, P). **BURUNDI: Karuzi Province,** Gitega Territory, Karuzi, confluent Karuzi Ruvuvu, 3°06'S30°09'E, Alt. 1450 m, 10 Feb. 1959 (fl.), *Van der Ben* 2465 (K). **Muramvya Province**, Bugarama Mission, 3°22'S29°52'E, 14 Feb. 1973 (fl.), *Baudet* 319 (BR, WAG); Kisoni Territory, Kisosi, 3°16'S29°37'E, 5 Mar. 1935 (fl.), *Lejeune* 195 (BR, WAG). **CAMEROON: Central Province**, **Bafia**, along Bafia-Ndikinimeki road, 4°45'N11°14'E, 10 Aug. 1969 (fl.), *Mpom* 379 (P); Yaoundé, Yaoundé station, 3°51'N11°31'E, Alt. 800 m, 1894 (fl.), *Zenker & Staudt* & 599 (K, S). **East Province,** Yoko Bétougou, Ngoum, 36 km N of Yoko, along Yoko-Tibati road, 2°01'N15°36'E, 9 May 1979 (fl.), *Biholong* 440 (P). **North Province**, Maroura, road to airport, 6 Aug. 1955 (fl.), *de Wit* 560 (WAG); Banyo, 20 km NNE of Banyo, 4°29'N14°01'E, 5 June 1967 (fl.), *Letouzey* 8497 (B, S). Garoura, 4 km S of Poli, 8°27'N13°15'E, Alt. 500 m, 29 May 1974 (fl.), *Geerling & Néné* 4922 (WAG). Mgaou, Mdéré, 3°18'N11°56'E, June 1939 (fl.), *Jacques-Félix* 3881 (K, P). Boumbui, *Botte* 318 (P). 2 km on the road from N´Koemvone to Akoakas (counted from the cross at N´Koemvone), 2°43'N11°17'E, 18 July 1975 (fl.), *de Wilde* 8365 (MO, WAG). **North-West Province, Bamenda Region**, Bipinde, 3°14'N10°02'E, July 1911 (fl.), *Zenker* s.n. (C, F); Bipinde, 3°14'N10°02'E, 1911 (fl.), *Zenker* 4079 (K, L, S). Metchen River, 27 Aug. 1952 (fl.), *Savory* UCI196 (K). Wum District, Nkom-Wum Forest Reserve, 6°14'N10°45'E, 14 July 1951 (fl.), *Ujor* FHI30464 (K). **South Province**, E of Kribi on S bank of Kienke R., 2°56'N9°55'E, 14 Oct. 1969 (fl.), *Bos* 5492 (P, WAG); Campo Ma´an area,

Ma´an ville behind Auberge, 2°22'N10°37'E, Alt. 530 m, 23 Aug. 2001 (fl./fr.), *van Andel & van der Hoeven* 4009 (KRI, SCA, WAG, YA). **West Province**, between Galim and Bagam. Alt. 1200 m, 8 May 1964 (fl.), *de Wilde & de Wilde-Duyfjes* 2509 (B, BR, K, MO, P, PRE, WAG, YA, Z). E side Mt. Nlonako base, between Enyunguéngué Ngalmoa and Quartier Ekanmberg, 10 km SE of Nkongsamba, 4°54'N9°59'E, Alt. 1050 m, 16 Sep. 1971 (fl.), *Leeuwenberg* 8389 (WAG). Surrounding of Mt. Mbapit NW of Foumbot, 5°32'N10°42'E, Alt. 1200 m, 24 Aug. 1972 (fl.), *Leeuwenberg* 10265 (WAG, YA). Ndop plain, savanna on pediment at Baba, 6°0'N10°15'E, *Brunt* 424 (K). **Dschang**, Ambam, near Ngom village, 16 km of Ambam on road Ebolowa-Ambam, 2°20´S of Ebolowa, 2°26'N11°11'E, Feb. 1979 (fl.), *Koufani* 198 (P). **CENTRAL AFRICAN REPUBLIC: Buar**, Alt. 1000 m, May 1914 (fl.), *Mildbraed* 9348 (B, K); Alt. 1000 m, May 1914 (fl.), *Mildbraed* 9366 (B, K). 5°33'N15°34'E, *Chevalier* 8658 (K). **CHAD:** Abou, Brousse, 12°14'N15°43'E, 31 July 1904 (fl.), *Newille* 78 (P). **Chari Central**, Chari, 8°57'N17°05'E, 12 July 1903 (fl.), *Chevalier* 8774 (P); Chari, 8°57'N17°05'E, 8 July 1903 (fl.), *Chevalier* 9248 (K). Déli, 8°42'N15°53'E, 15 Sep. 1966 (fl.), *Audry* A47 (P, TLM). **DEMOCRATIC REPUBLIC OF CONGO: Katanga (Shaba) Province**, Manono, Manono-Mitwaba road, 20 km, 7°28'S27°26'E, 16 Jan. 1960 (fl.), *Bamps* 796 (K). Bukama, Upemba, 9°12'S25°51'E, 14 Jan. 1929 (fl.), *Grant* 4095 (WAG). **Kivu Province**, Maniema, Kindu, Lomani, 2°03'S25°04'E, 17 Apr. 1959 (fl.), *Bamps* 515 (K). Montagnes Lake Kivu, Tshibinda, 2°19'S28°45'E, Alt. 600 m, 1929 (fl.), *Humbert* 7454 (K, P). Foothills of mounts W of Katana, Lake Kivu, Alt. 1650 m, 15 July 1959 (fl.), *Cambridge Congo Expedition* 505 (BM). **Sud-Kivu Province**, Kabare Territory, Katana, 2°14'S28°49'E, Alt. 1500 m, Dec. 1953 (fl.), *Christiaensen* 275 (K, UPS). 1°40'S29°59'E, Jan. 1938 (fl.), *Lebrun* 9403 (K). Kideke, Muchuchu, 1°32'S30°37'E, Alt. 1600 m, Jan. 1938 (fl.), *Lebrun* 9651 (K). Bandundu, Kikwit, 5°02'S18°48'E, 27 Aug. 1991 (fl.), *Masens* 1150 (BR, L, U, WAG). Canp, Gazamba, 4 May 1955 (fl.), *Micha* 143 (BR, WAG). Tshinsenda, Tshitadi, 12°18'S27°58'E, Nov. 1921 (fl.), *Achten* 620 (K). **No locality**, 1923 (fl.), *Overlaef* s.n. (F). **EQUATORIAL GUINEA:** Bata-Senye, Estrada km 17, 5 Feb. 1992 (fl.), *Carvalho* 5002 (WAG). Fernando Póo, 3°30'N8°42'E, 3 Sep. 1959 (fl.), *Wrigley & Melville* 450 (K). Region Continental, Maricage Jaudje, 1°27'N9°32'E, 29 July 1999 (fl.), *Eneme Efua* 461 (BATA, WAG). **Rio Muni, Centro Sur, Parque Nacional de Monte Alén**, Moka, 1°37'N10°19'E, 27 Aug. 1998 (fl.), *Pérez Viso* 297 (MA, WAG); Moka, 1°39'N10°19'E, 27 Oct. 2000 (fl.), *Pérez Viso* 4119 (MA, WAG). **ERITREA:** Amasen, Pianura Sabarguia, 15°25'N38°40'E, 2 Mar. 1902 (fl.), *Pappi* 3879 (S). Ma'akel, Asmara, Keren road, 30 km from Keren, 15°47'N38°27'E, 1 Sep. 1949 (fl.), *Townsend* PT10 (EA, K). **ETHIOPIA: Gamu-Gofa Province**, Alt. 1500 m, 30 Apr. 1959 (fl.), *Thesiger* 1962 (BM). **Gojam Province**, Gorge of the Blue Nile, 10°04'N38°11'E, Alt. 1600 m, 18 Sep. 1970 (fl.), *de Wilde* 7180 (LG, WAG). **Harar Province,** 5 km from Bati, near entrance of College of Agriculture, Alemaya on road to Kombolcha, 9°25'N42°05'E, 2 July 1974 (fl.), *Bos* 7990 (WAG); Campus area NE of Lake Alemaya, c 15 km NW of Harar, near Amaressa, 9°24'N41°10'E, Alt. 600 m, June 1963 (fl.), *Burger* s.n. (F); Feddis road, limestone hill, about 5 km from road to Harar, 9°16'N42°06'E, Alt. 1900 m, 25 June 1975 (fl.), *Jansen* 1713 (ACB, BM, BR, C, WAG); Fruit farm, Mrs Diggs, 3.5 km from road, Alemaya-Harar, side road from Hamaressa, Alt. 1980 m, 13 July (fl.), *Westphal & Westphal-Stevels* 585 (ACD, BR, MO, WAG); Jijiga, about 7 km past Harar, along the road to Jijiga, 9°14'N42°15'E, Alt. 1700 m, 6 June 1969 (fl.), *de Wilde* 5102 (WAG); near Harrar, 1908 (fl.), *Drake-Brockman* 59 (K). Jijiga, about 10 km S of Jijiga, 9°15'N42°49'E, Alt. 1750 m, 8 July 1976 (fl.), *Jansen* 6749 (WAG). limestone slopes W of Midaga, 8°48'N42°4'E, Alt. 1260 m, 9 May 1963 (fl.), *Burger* 2780 (F, K, WAG). **Kefa Province**, **Bonga**, forest behind the R.C. Mission, 7°16'N36°14'E, Alt.

1750 m, 21 July 1975 (fl.), *Jansen* 2185 (ACD, WAG); Goro Gomotou, Alt. 555 m, 19 Aug. 1904 (fl.), *Newille* 225 (P); surrounding R.C. Mission, 7°16'N36°14'E, Alt. 1800 m, 23 July 1975 (fl.), *Jansen* 2291 (WAG). **Jimma District**, about 58 km from Jimma-Bonga road, 7°25'N36°23'E, Alt. 1700 m, 31 Aug. 1974 (fl.), *Bos* 8510 (ACD, BR, ETH, WAG); about 7 km E of Jimma, along the road to Addis Ababa, 7°40'N36°53'E, 28 June 1969 (fl.), *de Wilde* 5213 (ACD, BR, MO, WAG); about 30 km NE of Jimma, 7°50'N36°40'E, Alt. 1900 m, 3 June 1965 (fl.), *de Wilde & de Wilde-Duyfjes* 6925 (WAG); about 10 km E of Jimma, Alt. 2000 m, 12 Aug. 1965 (fl.), *de Wilde & de Wilde-Duyfjes* 7614 (BR, ETH, K, MO, WAG). 4 km N of Jimma, May 1957 (fl.), *Jimma Agricultural Technical School* S29 (K); Jimma, Agaro road near Jimma, Kaffa, 7°55'N40°02'E, Alt. 2100 m, 26 July 1962 (fl.), *Mooney* 9144 (K, S). Debre Werk to Berber Uaha River, 6°50'N35°30'E, Alt. 1380 m, 21 Dec. 1964 (fl.), *Meyer* 9028 (WAG). Jijiga, 50 km W of Jijiga (Harrargie), along road to Harrar, near a wadi crossing, 9°11'N42°26'E, Alt. 1700 m, 11 July 1972 (fl.), *Seegeler* 2358 (ACD, BR, ETH, MO, WAG). **Shoa Province**, Debre Zeit (Debre Zeyit), hillside near Hara, 12°48'N41°24'E, Alt. 1800 m, Aug. 1971 (fl.), *Hovda* s.n. (UPS). Koka Dam, Lake westshore, 12°25'N37°19'E, Alt. 1700 m, 3 Oct. 1970 (fl.), *Ash* 575 (C, K, WAG). Lake Eleni, 8°22'N38°55'E, Alt. 1525 m, 7 Oct. 1962 (fl.), *Chojnacki & Mooney* 83 (WAG). S shore of lake Abiata, Arussi Rift Valley, 7°34'N38°34'E, Alt. 1345 m, 2 Aug. 1975 (fl.), *Ash* 3165 (UPS, WAG). **Sidamo Province**, **Sidamo**, W of Adola, 11°48'N41°42'E, 6 May 1962 (fl.), *Chojnacki & Mooney* 19 (K). 5 km N of Neghelle (from the gate) along the road to Kebre Mengist, Alt. 1300 m, 9 May 1982 (fl.), *Friis, Tadesse & Vollesen* 2629 (C, UPS). Awasa Junior Agricultural College Campus, behind the football field, 7°00'N38°30'E, 22 June 1979 (fl.), *Mesfin Tadesse* 535 (UPS). 9 km on the Negele-Filtu road, 5°13'N39°40'E, Alt. 1650 m, 9 May 1980 (fl.), *Thulin, Hunde & Tadesse* 3411 (UPS). **Shashamane**, about 10 km out of Shashamane, along the road to Awassa, in Sidal plantation, 7°09'N38°31'E, Alt. 1700 m, 25 July 1976 (fl.), *Jansen* 6633 (ACD, BR, C, ETH, MO, WAG); 141 km from Shashamane, road to Mojo, Alt. 1800 m, 9 Sep. 1967 (fl.), *Westphal & Westphal-Stevels* 1768 (ACD, BR, K, MO, WAG). 50 km S of Neghelli on Wachelli-Moyale road, Alt. 1600 m, 22 Apr. 1971 (fl.), *Ash* 822 (UPS). Dembea District, N of Lake Tana, Alt. 1860 m, 7 Sep. 1953 (fl.), *Ferguson* 27 (K). Flananan Mogarah, Bogon, Aug. 1881 (fl.), *Steudner* 446 (K). Lekemti, about 10 km E of Lekemti, 9°05'N36°33'E, Alt. 2000 m, 1 July 1965 (fl.), de *Wilde & de Wilde-Duyfjes* 7201 (B, BR, C, ETH, WAG). Tigray, Sana, near Djeladjeranne, 15°35'N44°24'E, 31 July 1840 (fl.) *Schimper* 1437 (BR, L, S). **No locality**, *Quartin, Dillon & Petit* s.n. (P); 21 Mar. 1921 (fl.), *Harrington* 6 (K); 1844 (fl.), 1853 (fl.), *Schimper* 346 (K, P). **GABON:** 19 km along the road from Mbigou to Mimongo, 1°47'S11°51'E, Alt. 680 m, 12 Feb. 1983 (fl.), *de Wilde, Arends, Louis, Bouman & Karper* 548 (BR, C, LBV, MO, P, WAG). Haut-Ogooué, 12 km on the road Alanga to Aboumi, 0°47'S13°51'E, Alt. 360 m, 1 Feb. 2008 (fl.), *Wieringa, Hoekstra, Niangadouma & Boussiengui* 6345 (LBV, WAG). H´Ngounié, St Martin, 1°48'S11°14'E, 22 July 1937 (fl.), *Walker* s.n. (P). Ogooué-Ivindo, 21 km on road Mékambo to Madjingo, NE of Zoula, 1°07'N14°05'E, Alt. 550 m, 27 Dec. 2000 (fl.), *Wieringa, Jongkind, Schoonhoven & Mbombet* 3624 (LBV, WAG). **GAMBIA:** Genieri, between Follofin and WC, 13°25'N15°37'E, 21 July 1949 (fl.), *Fox* 177 (K). **GHANA: Ashanti Region**, near Feyiase, Lake road, Ashanti, 6°36'N1°34'W, 5 Sep. 1978 (fl./fr.), *Enti* FE1803 (WAG). Bekwai, Ashanti, 6°11'N2°19'W, 14 May 1971 (fl.), *Obeng-Darko* 8027 (WAG). **Eastern Region**, Abetiti, 6°40'N0°45'W, 12 June 1908 (fl.), *Thompson* 88 (K). Bosomoa Forest Reserve 7°55'N1°49'W, Aug. 1937 (fl.), *s.n.* 4431 (K). Bosomoa Forest Reserve, 7°55'N1°49'W, June 1933 (fl.), *Vigne* 3059 (K). Coda, 5°55'N0°59'W, 8 Aug. 1963 (fl.), *Obeng-Darko* 5116 (WAG). Amantin, Nkoronza, 7°32'N1°14'W, 22 May 1932 (fl.), *Lamptey* 2420 (K). Conja District, Damango

Mts, 9°05'N1°49'W, Alt. 191 m, July 1948 (fl.), *Andoh* 5193 (B, K). No locality, 10 Oct. 1919 (fl.), *Saunders* s.n. (K). **GUINEA:** Bebai, Campo area, road to Anio, 22 Mar. 1910 (fl.), *Tessmann* 526 (K). **Dalaba Province**, **Fouta Djallon,** Telire, 11°35'N11°02'W, Alt. 1000 m, 5 Sep. 1990 (fl.), *Cordonnier* 463 (BR). **Kouroussa Province**, Kouroussa, 10°39'N9°53'W, Alt. 373 m, Aug. 1900 (fl.), *Pobéguin* 384 (K, P). **IVORY COAST: Bouna**, Ouangofétini, N side of Parc National de Bouna. Téhini c 40 km E of Ouangofétini, 22 Aug. 1963 (fl.), *de Wilde* 730 (WAG); Téhini, National Park, Téhini, 9°38'N3°39'W, 21 Aug. 1963 (fl.), *Oldeman* 290 (WAG); Varaleé, 18 Sep. 1967 (fl.), *Geerling & Bokdam* 944 (WAG). Guiglo, Guiglo-Taï road, 5°52'N7°27'W, Aug. 1942 (fl.), *Schnell* 1596 (P). N of Yakassé Mé, 5°49'N3°57'W, 4 Aug. 1970 (fl./fr.), *Leeuwenberg* 8091 (BR, K, MO, P, PRE, WAG). Tabou, Pata Idié, about 17 km W of Yaka, 1 km E of Pata Idie (Cavally), 4°28'N7°33'W, 30 Aug. 1975 (fl.), *van de Burg* 820 (WAG). Tiassalé, Ndouci, 6 km SSE of Ndouci, 5°48'N4°43'W, Alt. 50 m, 13 Aug. 1975 (fl.), *Beentje* 266 (WAG). **KENYA: Central Province**, Kiambu District, Chamia Valley near the Mid-Chania Water Project Camp, 0°45'S36°50'E, Alt. 1700 m, 4 June 1977 (fl.), *Gachathi* 208 (B); Machakos, Kibwesi, 1°31'S37°16'E, Alt. 1000 m, 2 Dec. 1905 (fl.), *Scheffler* 31 (K). **Coast Province, Kwale District,** Shimba Hills, 23 June 1970 (fl.), *Friis* 149 (C); Forest Reserve near Kwale, 4°13'S39°25'E, Alt. 390 m, 20 April 1968 (fl.), *Magogo & Glover* 917 (K); 16 km beyond Mariakani, 428 km on Nairobi to Mombasa road, 3°58'S39°20'E, 8 Dec. 1961 (fl.), *Polhill & Paulo* 762A (K). **Eastern Province**, Moyale District, by Moxale, 3°31'N39°03'E, Apr. 1931 (fl), *Brouwer* 40 (WAG). Isiolo District, Meru County, N of Mt Kenya, Lewa Downs farm, Isiolo, 0°20'N37°45'E, Alt. 1685 m, 9 Dec. 1979 (fl.), *Linsen & Giesen* 93 (B, WAG). **Lamu District,** N of Mombasa to Lamu and Witu, 2°16'S40°53'E, 1902 (fl.), *Whyte* s.n. (K); Kiunga Point, 89 km NE of Lamu, 1°45'S41°30'E, 24 July 1961 (fl.), *Gillespie* 39 (K). Malindi District, 32 km N of Malindi on the Garsen road, 4°06'S38°20'E, 15 Nov. 1961 (fl.), *Polhill & Paulo* 762 (K). c 8 km SE of Kaloleni, borders of Kaja natural forest along a road, 3°52'S39°42'E, 23 Nov. 1979 (fl.), *Reitsma* 272 (BR, MO, WAG). **Mombasa District,** Mombasa, 1°41'S37°55'E, Alt. 894 m, 1928 (fl.), *Humbert & Swingle* 4257 (P); Mombasa, vicinity of Changamwe on the Uganda railway, 23 km from Mombasa, 1°41'S37°54'E, Alt. 100 m, 21 Nov. 1909 (fl.), *Mearns* 2274 (C, F, UPS); S of Bridge over Tana on Thika-Sagana Road, 1°01'S37°03'E, Alt. 1140 m, 2 Dec. 1966 (fl.), *Agnew, Kiniaruh, Ngethe & Wyatt* 8845 (C, NAI). **Nairobi Province, Nairobi District**, between Nairobi and Thika, 1°03'S36°50'E, 17 Dec. 1921 (fl.), *Fries & Fries* 20 (UPS); Nairobi, Museum, near Snake Park, 1°18'S34°45'E, Alt. 1606 m, 4 May 1983 (fl.), *Rucina* 37 (K); Choromo Estate, 1°16'S36°47'E, 16 Dec. 1969 (fl.), *Kokwaro* s.n. (K). **North-Eastern Province**, Wajir District, 43 km on the E1 Wak road, 3°26'N39°52'E, Alt. 470 m, 29 Apr. 1978 (fl.), *Gilbert & Thulin* 1173 (UPS). **Nyanza Province, Kisii Central District,** near Ikoba, about 16 km SW of Kisii, 0°41'N34°46'E, Alt. 1650 m, 4 Nov. 1974 (fl.), *Vuyk & Breteler* 106 (WAG); 0°54'S34°58'E, Alt. 1600 m, July 1934 (fl.), *Napier* 6835 (K). Londiani District, Maura Mts, 0°10'S35°36'E, 28 Aug. 1957 (fl.), *Croockewit* 481 (WAG). North Kavirondo, Kakamega, forest near Kakamega saw-mill, 0°15'N34°52'E, Alt. 1600 m, 23 July 1966 (fl.), *Strid* 2873A (S). The site of KSTC, Ngong road near Dagoretti corner, 1°18'S36°46'E, Alt. 1700 m, 19 May 1966 (fl.), *Strid* 2576 (S). **Rift Valley Province, Lake Naivasha District,** Naivasha, 0°46'S36°21'E, Alt. 1860 m, 24 Feb. 1964 (fl.), *Polhill* 58 (K); Naivasha, Nairobi-Naivasha road, 0°53'S36°31'E, 30 Apr. 1978 (fl.), *Luck* KE26 (B). **Trans-Nzoia District**, eastern slope above Japata estate, 1°13'N34°46'E, Alt. 2100 m, 30 May 1948 (fl.), *Hedberg* 1062 (UPS); Elgon Mount, 0°45'S34°30'E, Alt. 1700 m, May 1920 (fl.), *Lindblom* 20 (S). Turkana District, Kacheliba Escarpment, 1°19'N35°00'E, Alt. 1800 m, May 1932 (fl.), *Napier* 2001 (K). Turkana District, West Suk, Kachalaba,

2°19'N35°03'E, Alt. 1500 m, 1932 (fl.), *Champion* T63 (K). **Masai**, Ledong Valley, 1°10'S36°30'E, May 1931 (fl), *Brouwer* 102 (WAG); Kajiado, Ngong Hills, near Ngong, 1°25'N36°38'E, Jan. 1966 (fl.), *Nilsson* 4157 (UPS). W slope of Rift Valley, Kikuyu Escarpment, near the main road, 0°55'S36°40'E, Alt. 2050 m, 21 May 1966 (fl.), *Strid* 2583 (UPS); Trans-Nzoia District, Kitale Club, Elgon, caves of Elgon Kitale, 0°53'N34°50'E, Aug. 1942 (fl.), *Tweedie* 78 (EA, K). Kericho District, about 13 km E of Lumbura, 0°30'N35°10'E, Alt. 558 m, 27 July 1938 (fl.), *Pole Evan & Erens* 1466 (B). **Western Province,** Mt Elgon District, about 23 km W of Endebess near the foot of Mt Elgon along the Kibyoyon River, 4 May 1970 (fl.), *Cheseny* 9 (EA, K). Northern Kenya, Dandu, 3°26'N39°54'E, Alt. 750 m, 1 May 1952 (fl.), *Gillett* 12994 (B). No locality, May 1944 (fl.), *Leakey* B3164 (K). **LIBERIA:** Bong, Gbarnga District, 7°00'N9°29'W, Alt. 256 m, 16 July 1952 (fl.), *Blickenstaff* 62 (COI, MO). Chien, 8 km E of Tapita, along the road to Chien, 6°29'N8°47'W, 15 July 1968 (fl.), *Jansen* 805 (BR, MO, P, WAG). Grand Cape Mountain, Bendu village, 6°46'N11°13'W, 26 Sep. 1968 (fl.), *Jansen* 978 (BR, K, MO, WAG). Grand Gedeh, Tchien, 6°4'N8°8'W, 22 July 1969 (fl.), *Blyden* 913 (WAG). Zorzor, Loffa county, road to Voinjama, 28 July 1966 (fl.), *Bos* 2191 (BR, K, LIB, P, WAG). No locality, 1968 (fl.), *Blyden* 36 (WAG). **MADAGASCAR: Toliara (Tulear) Province**, Amborombe, 24°30'S46°00'E, 6 Feb. 1931 (fl.), *Decary* 8539 (S). **Antananarivo Province**, Antananarivo, Parc de Tsimbazaza, 18°55'S47°31'E, 8 Feb. 1984 (fl.), *Dorr* 2747 (K, MO, WAG). Antsiranana (Diego Suarez), Ankarana, Andranobakoho, 23°05'S47°39'E, Alt. 30 m, 24 Jan. 1960 (fl.), *Humbert* 32447 (G, K, MO, P, S, WAG). **Central Madagascar**, Centre, 17°39'S46°14'E, Dec. 1885 (fl.), *Baron* 4547 (K). **Mahajanga (Majunga),** Mahajanga, Ankarafantsika, on trails around Ampijoroa Forest Station, c 4 km W of Andranofasika and c 120 km E of Mahajanga, 16°19'S46°49'E, Alt. 150 m, 6 Feb. 2000 (fl.), *Nilsson, Kårehed, Vinnersten & Randriamboavonty* D108 (UPS); Majunga, 15°43'S46°19'E, 15 Aug. 1921 (fl.), *Afzelius* s.n. (K, S, UPS). **Toliara (Tulear) Province**, Andranovory, 15 km SW of Andranovory on route Nationale 7, 23°11'S44°03'E, Alt. 400 m, 15 Jan. 1989 (fl.), *Phillipson & Rabesihanaka* 3186 (K, MO); along route 10, 16 km W of Manambaro, 25°02'S46°48'E, Alt. 110 m, 21 Feb. 1975 (fl.), *Croat* 31961 (MO, WAG). Fort-Dauphin, Route Tiambe-Ambovombe, 25°02'S47°00'E, 27 Jan. 1990 (fl.), *Dumetz* 1254 (K, MO, WAG). Manasoa Tanosy, 23°33'S44°18'E, 13 Jan. 1913 (fl.), *Afzelius* s.n. (K, S, UPS). Morondava, Kirindi Forest, Southern part, 20°4'S44°36'E, Alt. 73 m, 20 Jan. 2007 (fl.), *De Block, Dessein, Groeninckx & Rakotonasolo* 2198 (BR, MO, P, TAN, WAG). N of Toliara, in Forêt de Mikea, 23-35 road-km W of Vorehe, 22°15'S43°25'E, Alt. 50 m, *McPherson, Razafimandimbison, Olson & Alongi* 17430 (K, MO, WAG). Toliara, Sud de Madagascar, Fivondronana de Fort-Dauphin, Réserve Naturelle Intégrale d'Andohahela, 24°49'S46°32'E, Alt. 30 m, 17 Mar. 1994 (fl.), *Randriambololona et al*. 85 (WAG). No locality (fl.), *Decary* 9652 (K). **MALAWI: Central Region,** Nchisi, Kota-Kota, 12°56'S34°18'E, Alt. 1440 m, 20 Feb. 1944 (fl.), *Benson* 562 (K). **Northern Region,** Nkata District, Nkata Bay, 11°36'S34°16'E, Alt. 570, 20 Feb. 1961 (fl.), *Richards* 14427 (K). Northern Province, Nkhata Bay District, Chinteche, 11°49'S34°10'E, Alt. 450 m, 30 Dec. 1978 (fl.), *Phillips* 4510 (WAG). **Nyika Plateau**, 10°40'S33°50'E, 5 Mar. 1903 (fl.), *McCloune* 76 (K); 15 Feb. 1976 (fl.), *Phillips* 1211 (K, MO, WAG). Shire Highlands, 15°30'S35°10'E, Dec. 1894 (fl.), *Scott Elliot* 8626 (K). **Southern Region**, Zomba District, Plains of Zomba, 15°23'S35°19'E, Alt. 750 m, July 1896 (fl.), *Whyte* s.n. (K, P). **Southern Region**, Machinga District, Namanja Railways Station, 15°10'S35°18'E, 19 Jan. 1985 (fl.), *Balaka & Nachamba* 886 (K). Mulanje District, Nambazo Village, NE of Mulanje, 15°55'S35°41'E, 2 Feb. 1984 (fl.), *Tawakali & Patel* 145 (C, K, MAL). **MALI:** Goro, Gomotou, 12°37´N9°01´W, 7 July 1905 (fl.), *Newille* 225 (P). Pitondu, Guari-Toudu, Hombori, 15°16'N1°40'W, 18 Oct.

1958 (fl.), *Jaeger* 5461 (P). **MOZAMBIQUE: Gaza Province**, Bilene District, Bilene, 4.25 km from Bilene towards Macia, 24°43'S33°13'E, 15 May 1983 (fl.), *da Silva, Jansen & Manhiça* 144 (WAG). **Maputo, Inhaca Island**, Marracuene, 4 km from the centre, 25°58'S32°35'E, 16 Dec. 1964 (fl.), *Marques & Balsinhas* 149 (WAG); 37 km E of Loureno, 26°00'S32°55'E, Alt. 30 m, 15 Dec. 1956 (fl.), *Mogg* 26776 (K). **Maputo,** 26°00'S32°55'E, 9 July 1975 (fl.), *Moura* 201 (COI, WAG); Maputo**,** 26°00'S32°55'E, 5 July 1975 (fl.), *Moura* 501 (COI); Maputo, 26°00'S32°55'E, Alt. 61 m, 13 Dec. 1980 (fl.), *Nuvunga* 408 (K, WAG); Polona Beach about 13 km from Loureno, 25°58'S32°35'E, 1927 (fl.), *van Nouhuys* 8824 (K, PRE); Hlembye, 14 June 1984 (fl), *Zunguze & Singa* 740 (WAG); Maputo**,** 26°00'S32°55'E, Alt. 50 m, 12 Dec. 1984 (fl.), *Groenendijk & Dunge* 1540 (WAG). **Zambézia Province, Milange**, serra do Chiperone, 16°30'S35°44'E, Alt. 500 m, 8 Feb. 1972 (fl.), *Correira & Marques* 2555 (WAG); on Mocuba to Milange road, 18 km from Mocuba, 16°50'S36°59'E, 20 May 1949 (fl.), *Barbosa & Carvalho* 2745 (K); Sambesi-Mittellauf, Boruma (Boroma), 16°03'S33°26'E, 1891 (fl.), *Menyhart* s.n. (UPS). Chai-Chai, 25°04'S33°48'E, July 1949 (fl), *Boegman* 9215 (B). Opposite Senna (Sena Hill), 17°30'S35°03'E, July 1859 (fl.), *Kirk* s.n. (K). Quelimane, Namagoa Estate, 16°26'S36°45'E, Alt. 60 m, 1944 (fl.), *Faulkner* 361 (K). Shamwarra Hill, mouth of Shire River, 17°42'S35°19'E, July 1859 (fl.), *Kirk* 915 (K). Nampula, 15°02'S39°07'E, Alt. 300 m, 26 Mar. 1983 (fl.), *Nuvunga* 1282 (WAG). **NAMIBIA: Khomas Region**, Windhoek Rural District, Rietfontein, 21°55'S20°54'E, Alt. 1191 m, Jan. 1956 (fl.), *Klatt* 654 (B).). **Kunene Region**, Outjo District, about 60 km W of Outjo, on farm Abyssinia near number 53, 20°06'S16°09'E, 22 Feb. 1963 (fl.), *Kers* 961 (S). Okavango, Okavango Native Territory, Shitangadimba Camp at Andara Mission Station, 18°04'S21°27'E, 13 Jan. 1956 (fl.), *de Winter* 4239 (K, PRE). **Otjozondjupa, Grootfontein District**, on Tsuakwe Grootfontein road, 19°14'S19°20'E, 17 Jan. 1971 (fl.), *Giess & van der Watt* 11158 (S). Amalienhof, 25°01'S16°45'E, Feb. 1958, *Klatt* 1470 (WAG); Besirk, farm Ondera, 25°01'S16°45'E, 13 Dec. 1952 (fl.), *Walter* 507 (B); Besirk, farm Berg Ankas, 25°58'S17°01'E, 26 Dec. 1952 (fl.), *Walter* 693 (B); Otjozondjupa, 15 Mar. 1960 (fl.), *Seydel* 2151 (B, BR, C, WAG). Kreyfontein, 24°18'S19°28'E, 24 Jan. 1925 (fl.), *Dinter* 5452 (B); Ovamboland, Ohopoho, 43 km E of Ohopoho, 18°04'S13°51'E, 7 Apr. 1973 (fl.), *Giess & van der Walt* 12634 (K, WAG). **Ohangwena Region,** Zwischemn Otjiwarongo und Otavi, 18°05'S13°05'E, Alt. 1400 m, 1 Mar. 1959 (fl.), *Werdermann & Oberdieck* 2371 (B), Kreyfontein, 24°18'S19°28'E, 26 Jan. 1925 (fl.), *Dinter* 5474 (B). **NIGER:** Girmon et Guidinouni, 13°42'N9°30'E, 6 Sep. 1966 (fl.), *Fabrèques* 2070 (P). Dosso, Koni et Dorro, Argile, Loiterite, 13°03'N3°12'E, 24 Aug. 1967 (fl.), *Fabrèques* 2478 (P). Toukormaun dunes, 14°31'N3°18'E, Sep. 1961 (fl.), *Koechlin* 6456 (P). **NIGERIA: Adamawa State**, Mambila Plateau, 7°00'N11°10'E, Alt. 1650 m, 2 July 1958 (fl.), *Chapman* 38 (K). **Cross Rivers State**, Obudu District, Utugwang, 6°40'N9°10'E, 10 July 1978 (fl.), *Oriwaodo* 40 (WAG). **Kaduna State, Zaria Province**, S of Samaru, 11°15'N4°16'E, 6 Nov. 1970 (fl.), *Blum* 2478 (F); Nabordo, 10°13'N9°24'E, Alt. 690 m, 20 May 1921 (fl.), *Lely* 211 (K). **Kwara State**, Ilorin Province, Shagunu, 16 km N of Bussa, 80 km S of Yelwa, 10°20'N4°25'E, 29 July 1965 (fl.), *Cook* 452 (K). **Lagos State**, Lagos, 6°27'N3°23'E, Jan. 1896 (fl.), *Millen* 7 (K). **North East State**, Sardauna Province, Mambilla Plateau, 7°16'N11°02'E, 31 July 1973 (fl.), *Chapman* 31 (K). **Plateau State**, Jos District, Naraguta Forest Reserve, 9°56'N8°52'E, Alt. 1200 m, 27 July 1962 (fl.), *Lawlor & Hall* FHI46534 (K). **Oyo State**, 7 km W of Igbeti, northern Oyo state, 8°45'N4°08'E, 21 May 1977 (fl.), *Pilz* 2066 (B). Isheyin District, Oke-Iho, Rest-House hill,8°02'N3°21'E, 11 July 1952 (fl.), *Savory* UC1262 (K); Old Oyo Forest Reserve, Ago-IIorin, 8°55'N4°00'E, 20 July 1971 (fl.), *Geerling* 3568 (WAG); Bauchi Plateaux, 10°19'N9°5'E, Alt. 626 m, May 1928 (fl.), *Lely*

P268 (K). North-East State, Nambilla Plateau, 1 June 1972 (fl.), *Chapman* 28 (WAG). **Northern** Nigeria, around Zungeru and Lokoja, 7°48'N6°44'E, 29 July 1907 (fl.), *Lugard* s.n. (K); within 80 km of Maifoni, Bornu, 12°30'N13°00'E, *Parsons* s.n. (K). Nupe, 7°56'N7°26'E, 1857 (fl.), *Barter* 1517 (K, U). **RWANDA: Byumba Province**, Mimuli, Mutare, 1°26'S30°16'E, Alt. 1400 m, 6 Nov. 1957 (fl.), *Troupin* 5185 (C, P). Kibungo Province, Mutara, colline Shonga, 2°11'S30°33'E, Alt. 1400 m, 5 Dec. 1958 (fl.), *Troupin* 8904 (BR, K, WAG). **Kibungo Province**, Rusumo, Bulera, 2°23'S30°47'E, Alt. 1900 m, 17 Feb. 1972 (fl.), *Auquier* 2590 (BR). **Kibuye Province, Gisenyi-Kibuye**, 39 km from Kayove, Préfect, Gisenyi, 1°52'S29°22'E, Alt. 2150 m, 6 Feb. 1972 (fl.), *Bamps* 3105 (BR); Kibuye-Gisenyi route, 1°48'S29°18'E, 22 Feb. 1974 (fl.), *Nuyt* 223 (WAG). **Ruanda Province**, Cyangugu, Uwinka, on Bukavu-Astrida road, 2°29'S29°12'E, 2 Mar. 1959 (fl.), *Troupin* 9796 (WAG). 20 km N of Gabiro, Rukaraka, 2°25'S29°20'E, 6 Feb. 1972 (fl.), Alt. 1500 m, *Germain* 1464 (BR, WAG). **SENEGAL: Basse-Casamance Region**, Djibelor, 12°33'N16°20'W, 31 Aug. 1979 (fl.), V*andenBerghen* 3600 (BR). **Dakar District**, Dakar, 14°44'N17°26'W, July 1905 (fl.), *Moussa* 25250 (P). **SIERRA LEONE:** Maburu, 8°25'N10°19'E, 17 Aug. 1914 (fl.), *Thomas* 1657 (K). Tasso, 8°35'N13°06'E, 4 Jan. 1916 (fl.), *Poole* 385 (K). **No locality**, *Afzelius* s.n. (UPS); 1891 (fl.), *Scott Elliot* 3838 (K). **SOMALIA:** Bay Region, between Baydhabo (Baidoa) and Buur Hakaba (Bur Akaba), 3°06'N43°38'E, 18 June 1987 (fl.), *Alstrup & Michelsen* 156 (C). Brava District, Lower Shabeelle, c. 12 km S Qunyo Barrow, Cara Cadde, Dünengebiet, 0°40'N43°24'E, 1 Aug. 1988 (fl.), *Kilian & Lobin* 2100 (B, K). **Lower Juba (Jubbada Hoose)**, Kismaiyo towards Yamani through Bulahayi, 0°39'S41°47'E, 22 June 1978 (fl.), *Kazmi, Elmi & Rodol* 642 (B, MO, WAG); Kismaiyo towards Yamani through Bulahayi village, 0°39'S41°57'E, 22 June 1978 (fl.), *Kazmi, Elmi & Rodol* 643 (MO, WAG). Saakow District, Saakow, 1°38'S42°27'E, 30 Sep. 1987 (fr.), *Synnott* 1954 (K). South Somalia, Bur Heybe, 3°00'S44°19'E, Alt. 230 m, Apr. 1985 (fl.), *O'Brien* 1985 (K). **SOUTH AFRICA: Cape Province, Bathurst District,** coastal sand areas, 33°30'S26°50'E, Jan. 1956 (fl.), *Sidey* 2500 (F, S); Jan. 1960 (fl.), *Sidey* 3416 (F, S); Jan. 1966 (fl.), *Sidey* 4084 (F, S); Fish River mouth, 31°55'S25°25'E, Dec. 1961 (fl.), *Sidey* 3634 (F); Omsamculo, 32°06'S26°27'E, 21 Feb. 1832 (fl.), *Drège* 4515 (K, P); Port Elizabeth, Northend Park, Jan. 1904 (fl.), *Potts* 156 (L); Transkei District, Mazeppa Bay, along seashore, 32°27'S28°39'E, Dec. 1911 (fl.), *Worsdell* s.n. (K). **Eastern Cape**, Amatole District, Kentani District, 32°30'S28°30'E, 29 Mar. 1909 (fl.), *Pegler* 300 (K); Humansdorp, St Francis Bay, Garden of Basil Place, 34°9'S24°50'E, 29 Aug. 2002 (fl.), *Brand, Logie, Logie, du Toit & Bosch* 496 (WAG). **Kwazulu Natal Province**, Alexandra, Dumisa Station, 29°50'S31°00'E, 22 Dec. 1911 (fl.), *Rudatis* 1561 (S, WAG); Brighton Beach, 29°56'S31°01'E, 23 Jan. 1930 (fl.), *Nielsen* 1429 (C); Hlabisa District, Alt. 53 m, 7 Feb. 1957 (fl.), *Ward* 3041 (K); Prope Port Natal, 29°14'S30°07'E, 1851 (fl.), *Plant* 19 (P, S); Syakysten, near Durban, 28°56'S30°49'E, Jan. 1927 (fl.), *Lansen* 10 (C). Kaikamma, British Kaffraria 1887 (CBS), Mar. 1868 (fl.), *Hutton* s.n. (K). Pondoland, 31°20'S29°30'E, 1887 (fl.), *Bachmann* 214 (K). South African Gold fields, 31 May 1871 (fl.), *Baines* 1870 (K). Tongoland, near Maputa and Big Kosi Lake, 26°59'S32°45'E, 26 May 1948 (fl.), *Rodin* 4654 (F, S). **SOUTH SUDAN:** Djin, Seriba, Ghatta, 19 June 1869 (fl.), *Schweinfurth* s.n. (S). **SUDAN:** Bahr el Jebel, Abu Kika, 13°25'N33°09'E, Alt. 459 m, 10 July 1862 (fl.), *Pethirick* s.n. (K). Bor, Bahr el Gebel, 6°12'N31°33'E, 6 July 1929 (fl.), *Simpson* 7244 (K). **Jebel Marra**, 13°25'N33°09'E, Alt. 990 m, 25 July 1964 (fl.), *Wickens* 2003 (K); Jebel Marra, 12°55'N23°29'E, Alt. 1020 m, 1 Aug. 1964 (fl.), *Wickens* 2052 (K). **Jonglei Province**, c. 20 km N of Bor, Alt. 415 m, 1981 (fl.), *Fison & Lock* 82/30 (K). **Kordofan**, Om Lubie, West Kordofan, 13°35'N24°32'E, 20 Aug. 1875 (fl.), *Pfund* 865 (K). No locality, 9 Oct. 1932 (fl.), *Smith* 15 (K). **TANZANIA: Arusha Region**, Arusha

District, Arusha, roadside 7 km, 3°22'S36°41'E, Alt. 1350 m, 16 Mar. 1955 (fl.), *Huxley* 180 (B).; Meru, Seoski, 3°22'S36°41'E, Alt. 1350 m, 22 Jan. 1914 (fl.), *Peter* 1789 (B); Arusha, 3°22'S36°41'E, 10 Feb. 1932 (fl.), *Saint Clair Thompson* 411 (K, S). Monduli District, Ketumbane Mt, Ketumbeine Forest Reserve, 2°45'S36°13'E, Alt 1800 m, 10 Jan. 1936 (fl.), *Greenway* 4300 (K). Mbulu District, Endabash Plain, 1 km from the turn off, 3°35'S35°37'E, 2 June 1965 (fl.), *Greenway & Kanuri* 11814 (K); Tarangire T.T., 3°41'S35°57'E, 20 Feb. 1961 (fl.), *Mwinyjuma Game Scout* 622 (K). Kiteto (Ngorongoro) District, Ngorongoro Crater, 3°15'S35°31'E, 12 Feb. 1965 (fl.), *Hultén* s.n. (S). **Dar es Salaam Region**, Kinondoni District, Bush near University College, 6°49'S39°16'E, June 1967 (fl.), *Jeaasund* s.n. (C). Dares Salaam District, Dares Salaam, 6°48'S39°15'E, May 1952 (fl.), *Revell* 152 (K). **Dodoma Region**, Kondoa District, Great North road, Kolo, 24 km N of Kondoa, 4°44'S35°50'E, Alt. 1530 m, 12 Jan. 1962 (fl.), *Polhill & Paulo* 1151 (K, P). **Iringa Region**, Iringa Rural District, Njombe, 17 km W of Makambako on Mbeya road, 8°50'S34°40'E, Alt. 1440 m, 6 Feb. 1989 (fl.), *Gereau, Lovett, Kyalawa & Mbwambo* 3069 (F); Iringa Rural District, Mufundi area, Mufundi artificial dam, 8°35'S35°15'E, Alt. 1850 m, 16 Mar. 1985 (fl.), *Hedrén, Kibuwa & Pettersson* 106 (EA, K, NHT, UPS). **Kagera Region**, Ngara District, Bushubi, Muganza, 2°56'S30°40'E, Alt. 1350 m, 1 Dec. 1959 (fl.), *Tanner* 4564 (BR). **Kilimanjaro Region**, Kilimanjaro Mts, Kake, 6°50'S15°50'E, 1911 (fl.), *Lindblom*20 (S). **Mbeya Region**, Mbeya Rural District, Mshewe villae, Iduga area, 8°50'S33°20'E, Alt. 1250 m, 8 Feb. 1990 (fl.), *Lovett, Sidwell & Kayombo* 4129 (C); Chunya Escarpment, 8°45'S33°35'E, 20 Jan. 1957 (fl.), *Richards* 7942 (K); Rungwe District, Kyimbila, 9°17'S33°39'E, Alt. 1400 m, 10 Feb. 1912 (fl.), *Stolz* 1120 (S). **Morogoro Region,** Ulanga District, Bunduki, 7°02'S37°38'E, 26 Dec. 1938 (fl.), *Vaughan* 2614 (K). Morogoro Rural District, Matombo, 7°03'S37°46'E, May 1955 (fl.), *Anatoli* 15 (EA, K); Ulanga District, Ulanga, 1964 (fl.), *Haerdi* 571 (WAG). **Mwanza Region**, **Mwanza District**, 2°50'S32°30'E, Alt. 1140, 10 Apr. 1952 (fl.), *Tanner* 620 (B); Mbarika Parish, Bukumbi, Mbarika Chiefdom, 2°55'S32°51'E, Alt. 1140 m, 11 Apr. 1953 (fl.), *Tanner* 1364 (BR); Mwanza, 2°50'S32°30'E, 25 Oct. 1932 (fl.), *Geilinger* 3242 (K). **Shinyanga Region, Shinyanga District,** 3°40'S33°26'E, Nov. 1938 (fl.), *Koritschoner* 1935 (K). Kahama District, Uduhe, on road to Sekenke beyond Mango, 3°35'S33°50'E, Alt. 1080 m, 24 Jan. 1936 (fl.), *Burtt* 5531 (K). **Pwani Region**, Kibaha District, 6°46'S38°55'E, Apr. 1970 (fl.), *Flock* 386 (S). **Rukwa Region**, Mpanda District, Kisi-Katisunga, 7°12'S31°02'E, Alt. 1350 m, 18 Jan. 1950 (fl.), *Bullock* 2275 (K). **Tanga Region, Lushoto District, West-Usambara Mts**, Ndelemai Forest Reserve, 5°05'S38°39'E, Alt. 1600 m, 5 Mar. 1984 (fl.), *Borhidi, Hedrén, Mziray & Pocs* 84623 (UPS); Valley NE above Mazinde village, 4°48'S38°13'E, Alt. 600 m, 11 Mar. 1984 (fl.), *Borhidi, Sebsebe Demissew, Hedrén, Iversen, Mziray & Pocs* 84759 (UPS); Lushoto-Mombo road, 6 km SE of Lushoto, 4°40'S38°10'E, Alt. 1250 m, 10 June 1953 (fl.), *Drummond & Hemsley* 2879 (B, K, S); Muheza District, Kilulu Hill, 4 km from the coast, 4°46'S39°07'E, 25 May 1992 (fl.), *Frontier-Tanzania Coastal Forest Research Programme* 2740 (K); Usambara Mts, 4°45'S38°30'E, Feb. 1883 (fl.), *Holst* 2154 (K); Haudei in Pori bei Jengeni, Alt. 300 m, 28 July 1915 (fl.), *Peter* 12471 (B); East Usambaras, Amani, c 5°05'S38°40'E, Alt. 400 m, 6 Aug. 1974 (fl.), *Baagøe, Danielsen & Vollesen* 268 (C, DSM, EA, WAG); West Usambara Mts, 4°45'S38°30'E, Feb. 1983 (fl.), *Holst* 2154 (K); West Usambara Mts, 4°45'S38°30'E, Alt. 250 m, 30 May 1917 (fl.), *Peter* 20350 (B); Saranda, 5°43'S34°58'E, Alt. 1095 m, 23 Dec. 1925 (fl.), Peter 33455 (B); E of Saranda to Makutupora, 560.5 km, 5°42'S34°58'E, Alt. 1095 m, 27 Dec. 1925 (fl.), *Peter* 33681 (B); Urundi, N of Nisikassi, 8°39'S34°18'E, Alt. 1900 m, 4 Mar. 1926 (fl.), *Peter* 38225 (B); West-Usambara Mts, 131 km W of Mombo, 4°53'S38°17'E, Alt. 440 m, 1 Feb. 1926 (fl.), *Peter* 40724 (B). **Zanzibar**, Mjini, Kizimbani,

6°05'S39°16'E, Alt. 90 m, 20 May 1959 (fl.), *Faulkner* 2260 (B, S); Pemba, 6°01'S39°09'E, 12 Sep. 1910 (fl.), *Morland* s.n. (K); Zanzibar, 1881 (fl.), *Saileus* 239 (P); Zanzibar, 6°10'S39°20'E, 1927 (fl.), *Toms* 72 (K); Mangafwani road, 6°00'S39°11'E, 10 Apr. 1950 (fl.), *Williams* 10 (K). Dabaja, 5 Feb. 1932 (fl.), *Lynes* 6 (K). Kysengere, Basement Complex, 9°17'S34°26'E, Alt. 2100 m, 17 Jan. 1968 (fl.), *Prins-Lambert* 328 (WAG). Seronera plains, 11 Jan. 1968 (fl.), *van Heerdt* 1344 (U). **TOGO:** Kéran Hunting Reserve, 10 km SW of Naboulgou, 10°09'N0°53'E, 30 July 1979 (fl.), *Scholz, Koumassi, Kuhn & Peuker* 248 (B). **UGANDA: Busoga Province,** Busana, Begerere, 0°46'N32°59'E, Alt. 1200 m, Apr. 1932 (fl.), *Eggeling* 419 (K). **Central Province**, Entebbe, Kitubulu near Entebbe, 0°05'N32°28'E, Alt. 1170 m, June 1934 (fl.), *Chandler* 1161 (K); Mengo District, Buikwe, Mabira forest, 0°30'N32°57'E, Alt. 1200 m, 18 Nov. 1938 (fl.), *Loveridge* 82 (B). **Eastern Province**, Elgon Mt, Sipi, 1°20'N34°22'E, Alt. 1950 m, Sep. 1934 (fl.), *Synge* S1045 (BM); Peru Teso, 0°43'N34°21'E, Alt. 1080 m, May 1932 (fl.), *Chandler* 550 (K). **Northern Region**, Murchison Falls, Banyoro side, 2°17'N31°41'E, 24 Sep. 1961 (fl.), *Rose* 10126 (K). **Southern Province, Buganda**, Kabula County, Masaka District, 1 km S of Kaliro, 0°54'N33°10'E, Alt. 1350 m, 26 Oct. 1969 (fl.), *Lye & Rwaburindore* 4667 (UPS); Mubende, near Mubenda, 0°35'N31°23'E, Alt. 1200 m, 6 Feb. 1931 (fl.), *Lugard* s.n. (K); Kabale, Kuchwekano farm, Kyzi, 1°15'N29°59'E, Alt. 2040 m, Jan. 1950 (fl.), *Purseglove* P3231 (K); Buhweju County, Ankole, W Ankole District, Kamukaaki, 0°22'N30°28'E, Alt. 1550 m, 24 Sep. 1982 (fl.), *Rwaburindore* 999 (WAG). **Western Province**, Kabarole, Mt Ruwenzori, Bugongo ridge, 2°38'N30°21'E, 28 Feb. 1925 (fl.), *Heller* (F); Mitoma, Igara, Ankole, 0°37'S30°03'E, Oct. 1938 (fl.), *Purseglove* P435 (K). Kenamoja, Maroto Lodoketemit, 2°32'N34°39'E, Alt. 1290 m, 12 July 1958 (fl.), *Kerfoot* 337 (K). Orochor Hill, Butela, 10 km N of Bosia, Samia-Bugure to Mtuli District, 0°33'N34°07'E, Alt. 1200 m, 4 May 1951 (fl.), *Wood* 188 (K). No locality, 8 May 1880 (fl.), *Wilson* 108 (K). **ZAMBIA: Copperbelt Province, Ndola District**, Ndola Trial plots, 12°57'S28°37'E, 7 Dec. 1951 (fl.), *Lees* 79/51 (K); route Ndola-Lubure, Mundubi, 12°57'S28°38'E, Alt. 1140 m, 27 Jan. 1963 (fl.), *Symoens* 10022 (K). **Central Province**, **Broken Hill Forest Reserve,** 14°27'S28°27'E, Nov. 1960 (fl.), *Morze* 302 (K); Jan. 1960 (fl.), *Morze* 303 (K); *Morze* 304 (K); *Morze* 303x304 (K). **Lusaka Province, Lusaka District**, Luano Valley, Shikabeta, 14°54'S29°42'E, Alt. 560 m, 25 Jan. 2004 (fl.), *Bingham* 12733 (K); Lusaka, 11 km E of Lusaka, 15°26'S28°16'E, Alt. 1260 m, 9 Feb. 1958 (fl.), *King* 421 (K). **Northern Province**, Mbala District, Abercorn, 8°50'S31°23'E, Alt. 1620 m, 4 Jan. 1952 (fl.), *Richards* 234 (K). Mfuwe District, Luangwa Valley, 13°16'S31°30'E, Alt. 600 m, 30 Dec. 1968 (fl.), *Astle* 5398 (K). **North-Western Province, Mwinilunga District**, Mwinilunga, 11°38'S24°25'E, Alt. 1350 m, Nov. (fl.) *Marks* 32 (K); 52 km from Mwinilunga along road to Solwesi, 12°11'S26°25'E, 20 Nov. 1972 (fl.), *Strid* 2507 (C). **Western Province**, Mongu District, Mongu, 15°16'S23°08'E, 22 Dec. 1965 (fl.), *Robinson* 6743 (B, K). **Southern Province**, Bombwe, 15°45'S26°27'E, 1932 (fl.), *Martin* 478/32 (K). Lanwala, *Gordon Read* 7 (K). Mazabuka District, 15°50'S27°47'E, Alt. 1070 m, 1931 (fl.), *Martin* 145/31 (K). **ZIMBABWE: Beatrice**, Kenombo, 18°15'S30°55'E, Alt. 1380 m, 4 Jan. 1967 (fl.), *Lady Drewe* 5 (K, SRGH); 46 km along Harare-Masvingo road, 18°18'S30°51'E, 1 Jan. 2008 (fl.), *Maroyi* 254 (SRGH, WAG); 46 km along Harare-Masvingo road, 18°17'S30°45'E, 1 Jan. 2008 (fl.), *Maroyi* 254a (SRGH, WAG). **Harare District**, Harare to Kariba, 29 km out of Harare, between road and railway line, 17°40'S30°45'E, Alt. 1450 m, 8 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8634 (SRGH, WAG). **Manicaland Province**, Nyanga District, Honde Valley, 18°35'S32°42'E, *Chase* 1353 (COI). **Mashonaland Central**, Darwin District, Kandeya Native Reserve, S slopes of Mavuradona Mt, 16°26'S31°30'E, 17 Jan. 1960 (fl.), *Phipps* 2284 (K, SRGH). Harare to Kariba, 81 km out of Harare. Great Dyke

to Banket, 17°27'S30°30'E, Alt. 1284 m, 8 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8643 (SRGH, WAG). Harare to Kariba, 84 km out of Harare. Great Dyke to Banket, 17°26'S30°28'E, Alt. 1235 m, 8 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8648 (SRGH, WAG). Bindura to Harare main road, 22 km from Bindura, W side of the road, 17°20'S31°08'E, Alt. 1138 m, 9 Jan. 2011, *van der Maesen & Maroyi* 8666 (SRGH, WAG). Bindura to Harare main road, 21 km from Bindura, E side of the road, 17°20'S31°08'E, Alt. 1121 m, 9 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8667 (SRGH, WAG). Bindura District, Bindura, opposite Cottco Depot, near cemetry, 17°20'S31°21'E, 13 Dec. 2006 (fl.), *Maroyi* 240 (SRGH, WAG). **Mazowe District**, Mazowe Citrus, 49 km peg along Harare-Bindura road, 17°32'S30°51'E, 13 Dec. 2006 (fl.), *Maroyi* 241 (SRGH, WAG). **Masvingo District**, 6 km peg along Masvingo-Beitbridge road, 20°16'S30°45'E, 1 Jan. 2008 (fl.), *Maroyi* 247 (SRGH, WAG); Great Zimbabwe, 17 km peg along Masvingo-Great Zimabwe road, 20°18'S30°53'E, 1 Jan. 2008 (fl.), *Maroyi* 249 (SRGH, WAG); **Matebeleland North Province**, Bulawayo District, near Bulawayo, 20°10'S28°42'E, 23 Jan. 1929 (fl.), *Grant* 4535 (WAG); Bulawayo to Victoria Falls, 51 km out of Bulawayo, 19°49'S28°14'E, Alt. 1234 m, 3 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8590 (SRGH, WAG). Bulawayo to Victoria Falls, 123 km out of Bulawayo, 19°24'S27°49'E, Alt. 1069 m, 3 Jan. 2011 (fl), *van der Maesen & Maroyi* 8602 (SRGH, WAG). Bulawayo to Victoria Falls, 197 km out of Bulawayo, 18°58'S27°18'E, Alt. 1037 m, 3 Jan. 2011 (fl), *van der Maesen & Maroyi* 8603 (SRGH, WAG). Bulawayo to Victoria Falls, 303 km out NW of Bulawayo, 18°24'S26°48'E, Alt. 845 m, 4 Jan. 2011 (fl), *van der Maesen & Maroyi* 8605 (SRGH, WAG). Bulawayo to Victoria Falls, 371 km out W of Bulawayo, 106 km from junction to Hwange National Park, 18°18'S26°12'E, Alt. 902 m, 4 Jan. 2011 (fl), *van der Maesen & Maroyi* 8610 (SRGH, WAG).; Bulalima-Mangwe District, Plumtree Intensive Conservation Area (ICA), Dombodema Mission, 20°29'S27°48'E, Alt. 1348 m, 7 Jan. 1972 (fl.), *Norrgrann* s.n. (S); **Hwange (Wankie) District, Hwange**, 18°22'S26°30'E, 20 Dec. 1934 (fl.), *Eyles* 8289 (K, SRGH); Matetsi Safari area headquarters, 18°16'S25°56'E, Alt. 1005 m, 19 Dec. 1979 (fl.), *Gonde* 264 (COI, SRGH); Hwange District, along the road, 40 km from Victoria Falls to Kazungula, 17°55'S25°27'E, Alt. 1052 m, 4 Jan. 2011 (fl), *van der Maesen & Maroyi* 8613 (SRGH, WAG). **Midlands Province**, Gweru District, 18 km NE of Gweru to Harare, 19°18'S29°47'E, Alt. 1403 m, 6 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8625 (SRGH, WAG); Athlope, 18°57'S29°46'E, Alt. 1183 m, 2 Jan. 1963 (fl.), *Loveridge* 517 (K, SRGH). Kwekwe District, road Kwekwe to Gokwe, 3.5 km from the main road, 18°57'S29°46'E, Alt. 1183 m, 6 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8628 (SRGH, WAG). Zvishavane District, Masvingo to Bulawayo, 100 km from Masvingo, 4 km out of Zvishavane (Asbestos mines), 20°21'S30°01'E, Alt. 961 m, 2 Jan. 2011, *van der Maesen & Maroyi* 8580 (SRGH, WAG). **Mvuma District**, 14 km out of Mvuma town towards Harare, along Harare-Masvingo road, 18°21'S30°47'E, 1 Jan. 2008 (fl.), *Maroyi* 255 (SRGH, WAG).

CULTIVATED: AUSTRALIA: Queenland, Amity Point, North Stradbroke Island, 40 km SO Brisbane, Sand dunes near the beach, 19 Feb. 1983 (fl.), *Saltzman* s.n. (UPS). **DENMARK:** Copenhagen, Botanic Garden of Copenhagen, 28 June 1967 (fl.), s.n. 1099B2 (C). **FRANCE:** W. Marais, grown from plants collected in Ethiopia, *Ash* s.n. (K). **NETHERLANDS: Wageningen**, Landbouwhogeschool, originally from South Africa, Herb. Lugd. *Batav*. s.n. (L); Wageningen University glasshouse, grown from plants collected in Addis Ababa, Ethiopia, 8 July 1965 (fl.), *Bos* 1690 (WAG). **SIERRA LEONE:** Freetown, garden origin, 18 Aug. 1958 (fl.), *Melville & Hooker* 241 (K). **UNITED KINGDOM:** Cultivated in Royal Botanic Gardens, Kew, 19 June 1924 (fl.) (K); cultivated possibly in Royal Botanic Gardens, Kew, Aug. 1907 (fl.), *Pits* s.n. (K). **UNITED STATES OF AMERICA: Adelante**, the Garden of Anson and Anita Blake, Berkeley, California. Grown from plants

collected from tropical Africa, 2 Sep. 1945 (fl.), *Bracelin* 2241 (F, L); Adelante, the Garden of Anson and Anita Blake, Berkeley, California. Grown from plants collected from tropical Africa, 19 July 1942 (fl.), *Bracelin* 1490 (F); **Florida**, 20 May 1956 (fl.), *My Home Seminole Co.* 23145 (B, F, S, WAG); 15 May 1958 (fl.), *My Home Seminole Co. 23145* (C); California Botanical Garden, Berkeley. Grown from plants collected from Africa, 27 May 1963 (fl.), *Hutchinson* s.n. (F); Originally from East Central Africa, *Old Sea Captains* s.n. (B). **ZAMBIA:** Kafue, grown from seed no. 350 collected by *H.L. Shantz*, 7 Dec. 1919 (K).

12. *G. superba* L. Sp. Pl. **2**: 437 (1753). Wight in Ic. 6. T. 2047 (1853); Baker in J. Linn. Soc. Bot. **17**: 457-458 (1879), Hooker in Fl. Br. India **6**: 358 (1894); Fl. Cap. **6**: 526 (1897) & Fl. Trop. Afr. **7**: 563-564 (1898); Hook. f. in Trimen, Handb. Fl. Ceylon **4**: 294 (1898); Ridl. in Fl. Mal. Pen. **4**: 338 (1924); Gamble in Fl. Madras 1519: 1061 (1928); de Silva in Cey. J. Sci. Sect. A. **12**: 155 (1945); Hepper in Fl. W. Trop. Afr. ed. **2**: 351 (1968); Cufodontis, Enum.: 1527 (1971); Field in Kew Bull. **25**: 243-244 (1971); Gandhi in Fl. Hassan Distr. Karnataka India (1976); Jessop in Fl. Malaysia **9**: 193-195 (1979); Thulin in Fl. Somalia **4**: 67-68 (1995); Sebsebe Demissew in Fl. Ethiopia & Eritrea **6**: 184-185 (1997); Dassanayake in Fl. Ceylon **14**: 113 (2000); Maroyi in Kirkia **18**: 3 (2002). Hoenselaar in Fl. Trop. E. Afr. Colchicaceae: 4 (2005). Van der Burg in Fl. Analytique Bénin: 68-69 (2006). Geerinck in Flore du Gabon **41**: 23-26 (2010). TYPE: India, Malabaria, Hermann 3: 31, no. 122, designated by Wijnands, Bot. Commelins: 133 (1983). (BM, lectotype, not seen). **Figure 14.**

Homotypic synonyms:
Mendoni superba (L.) Adans. in Fam. 2: 48, 576 (1763).
Gloriosa superba Mill. in Gard. Dict. ed. 5 (1768).
Methonica superba (L.) Crantz in Inst. Rei Herb. 1: 474 (1766).
Eugone superba (L.) Salisb. in Prodr.: 238 (1796).
Methonica gloriosa Salisb. in Trans. Hort. Soc. London **1**: 331 (1812).
Methonica superba (L.) Kunth in Enum. Pl. **4**: 276 (1843).

Heterotypic synonyms:
Methonica malaborum Herman in Hort. Academ Lugd. Batav. 688, t.689 (1687). *nom. illeg.*
Gloriosa cirrhifolia Stokes in Bot. Mat. Med. ii: 237 (1812). *nom. illeg.*
Gloriosa angulata Schum. & Thonn. in Beskr. Guin. Pl. 171 (1827). TYPE: Guinea, *Thonning* s.n. (C!, holotype).

Gloriosa doniana Roem. & Schult. in Syst. Veg. **7**: 366 (1829). TYPE: Nepal, Zeylona, *Wallich* 4 (L!, holotype).
Methonica doniana (Roem. & Schult.) Kunth in Enum. Pl. **4**: 277 (1843). TYPE: Nepal, Zeylona, *Wallich* 4 (L!, holotype).
Gloriosa superba L. var. *angustifolia* Baker in J. Linn. Soc. Bot. **17**: 458 (1879) & Fl.Trop. Afr. 7: 563 (1898). TYPE: Mozambique, Lower Rovuma River, 28 miles from the coast, *Meller* s.n. (K!, holotype).

Perennial herb, tuberous rootstock of arched, solid, fleshy-white cylindrical corms, with two arms pointed at each end, bifurcately branched (L or V-shaped), each 10-30 cm long, 1-3 cm in diameter; producing a new joint at the end of each arm each season, covered with brown tunics; roots fibrous. Aerial stems annual, erect, glabrous, simple or branched, usually climbing up to 6 m high. The first leaf or two sheathing and scaly. Leaves sessile, bearing many veins and a prominent midrib, alternate, sometimes opposite or verticillate and somewhat clustered, ranging from linear, elliptic-lanceolate, elliptic to ovate, 6-25 cm long (including the tendril), (0.8-) 1.5-5 cm wide, apex almost always ending in a tendril (usually less than 2 cm long). Many flowers, 5-12 cm across, in axils of leaves, different shades of either yellow, orange, red, crimson, or bicoloured. Pedicel erect, recurved apically, 6-18 cm long, nodding at the tip. Perianth segments persistent, sometimes connate at the base into a short tube, up to 2 mm long, nectariferous with white hairs; linear to narrowly elliptic-lanceolate, strongly crisped margins, 49-85 mm long, 5-15 mm wide; prominently keeled beneath and ridged at base above, at first reflexed, later horizontal. Filaments filiform, sometimes flattened, 4-6 cm long, at first turned downwards, later spreading and turned up at ends. Anthers 7-15 mm long. Ovary 6-13 mm long, 3-5 mm wide; style 20-50 mm long including 3 stigma branches, 3-2 cm long. Capsule oblong, to 15 cm long and 3 cm wide, with three deep longitudinal grooves. Seeds smooth, vivid-red or orange-red up to 4 mm in diameter, with a fleshy testa.

Distribution: South Africa, tropical Africa, tropical Asia and Indo-China (see **Map 6.12**). It occurs in forest edges, thickets, woodland, bushland, grassland, semi-desert plains, roadsides, often in sandy or rocky places, waste ground, cultivated land; 0-2400 m altitude. Widely planted and naturalised in many tropical areas.

Phenology: Flowers and fruits collected all year round.

Uses: All parts of the plant, especially the corm are poisonous and widely used to induce abortion, as a murder poison and to commit suicide in some communities. However, *G. superba* is widely used medicinally in several countries; covering many important pathologies. Its poisonous properties are due to colchicine (see Chapters 2 and 3). *G. superba* is now naturalised in Fiji, Réunion-Mascarene Archipelago, Moreton Island, Lord Howe Island, French Polynesia Society Islands, Karibati Line Islands and Solomon Islands. Furthermore, *G. superba* is also cultivated throughout the world in several botanical and private gardens as an ornamental plant. A number of cultivars are used as greenhouse ornamentals in the USA and Europe.

IUCN conservation notes: *G. superba* is well represented in major herbaria worldwide, although threatened in India and Bangladesh because of over-collection from the wild, Least Concern (LC) category is recommended. *G. superba* is listed in South Africa as Least Concern (LC) (Raimondo *et al.* 2009), due to lack of major threats and its stable population sizes.

Notes: *G. superba* has perianth segments that are narrower than those of *G. simplex*. The perianth segments of *G. superba* have highly crisped margins, unlike those of *G. simplex* which are not crisped but have straight or slightly undulate margins. The molecular phylogeny links *G. superba* with *G. simplex*, in a weakly supported polytomous clade (Figure 6.2).

Extra references: Conran (1987); Grove *et al.* (2005); Hancork & Henderson (1988); Le Cussan (2006); Orchard (1994); Sebsebe Demissew & Nordal (2010); Tassin *et al.* (2007); Welsh (1998); Wester (1985); Wright *et al.* (2005).

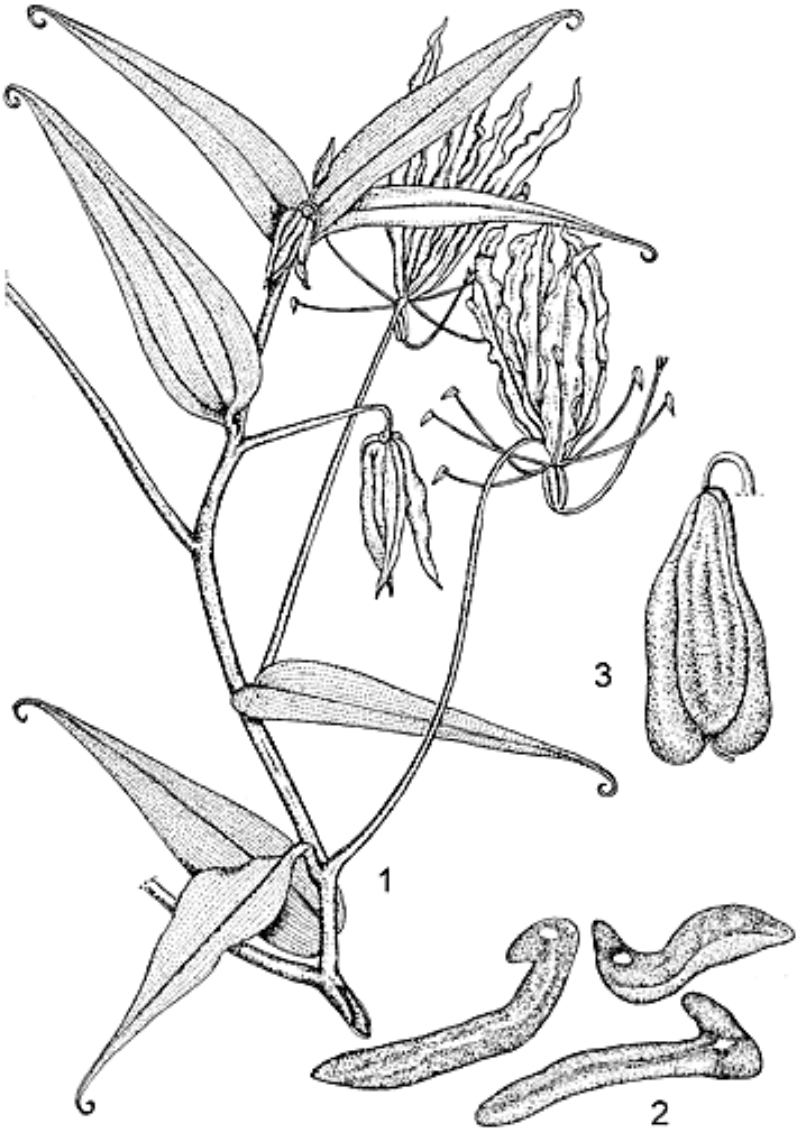


Figure 6.14. *G. superba*. Flowering stem, immature fruit and underground tubers (from Bunyapraphastara & van Valkenburg 1999, reproduced with permission).

Specimens examined

ANGOLA: Bié, Machado District, 1 km from Matchalo Chindumba, 13°20'S23°35'E, Alt. 1100 m, 19 Oct. 1965 (fl.), *Teixeira* 9049 (COI). **Cabinda**, Hombe, Belire, 4°38'SN12°45'E, 1 Feb. 1919 (fl.), *Gossweiler* 7777 (COI; K); Maladi, 24 km from Ambriz road to Beube, 7°44'S13°07'E, Mar. 1873 (fl.), *Monteiro* s.n. (K); near Cataboanga-Situlo, 18 June 1960 (fl.), *Murta* & *Monteiro* 278 (COI). **Cazengo**, 1°27'S22°10'E, 24 Feb. 1910 (fl.), *Gossweiler* 4621 (COI); Laurisila, 11°27'S22°10'E, 10 May 1910 (fl./fr.), *Gossweiler* 4561 (COI); Laurisitra da Entoqūs, Cazengo, 11°27'S22°10'E, Jan. 1912 (fl.), *Gossweiler* 5238 (COI). **Cuanza Norte District**, 8°38'S14°48'E, 26 Nov. 1962 (fl.), *Cardoso* 4 (COI); 10°51'S14°22'E, 29 Jan. 1970 (fl.), *da Silva* 2765

(COI); Sâlazar Estudes, 12°00'S'17°4'E, Alt. 1283 m, 7 Feb. 1964 (fl.), *Silva* 671 (COI). Ganda, Alt. 1260 m, 29 Nov. 1937 (fl.), *Pittard* 64 (BM). **Huambo District,** Huambo**,** 14°49'S15°21'E, *Castro* 16 (COI). Lobito, 9°16'S21°13'E, 11 Jan. 1916 (fl.), *Gossweiler* 6130 (COI). Luanda District, Luanda, 8°49'S13°14'E, Mar. 1904 (fl.), *Gossweiler* 1612 (COI). **No locality**, *Puincé* s.n. (P). **BARBADOS:** Hopewell, St Thomas, 13°06'N59°33'W, Alt. 89 m, 20 Sep. 1904 (fl.), *s.n* (F). **BENIN: Atakora**, Bassila, 9°2'N1°39'E, 19 Sept. 1998 (fl.), *Pauwels* 7835 (WAG). **Atlantique**, Niaouli 6°44'N2°07'E, 23 Aug. 1999 (fl.), *Essou, Agbani & Yédomonhan* 1658 (BENIN, BRLU, WAG). Ouidah, 6°20'N2°05'E, 6 Sep. 1998 (fl.), *Essou & Adomou* 981 (BENIN, BRLU, WAG). **Collines,** Dassa-Zoumé, Mt. Grote, 7'47'N2'12'E, 7 July 2011 (fl), *Quiroz* 580 (BENIN, WAG). **Ouémé**, Adélé, 1km N Dikpélélou, Alt. 740 m, 24 Oct. 1982 (fl./fr.), *Pasch* 7673 (WAG); Adja-Ouéré, Toffo, 4 km W of Pobè, road to Adja-Ouéré, 6°59'N2°38'E, 24 Nov. 1998 (fl.), *van der Maesen, Akoègninou, Essou & Agbani* 6607 (BENIN, BRLU, WAG). 2 km N Dikpélélou, 8°13'N0°37'E, Alt. 740 m, 24 Oct. 1982 (fl./fr.), *Schäfer* 7673 (B). Kétou, Ewè forest (Adakplamè), 7°28'N2°35'E, 3 Nov. 2000 (fl.), *Essou* 2577 (BENIN, BRLU, WAG). Pobè, Toffo Itchèdè, 6°59'N2°37'E, 31 Oct. 2000 (fl.), *Essou* 2482 (BENIN, BRLU, WAG); Petit, 2 Oct. 1999 (fl.), *Lisowski* D90 (WAG). Porto-Novo, Tchaka-Vedo, 6°27'N2°41'E, Alt. 23 m, 6 Aug. 2001 (fl.), *Adjakidjè* 4582 (BENIN, BRLU, WAG). **Zou**, Covè, Houin 7°13'N2°19'E, Adjakidjè & Agbani 2974 (BENIN, BRLU, WAG); 7°37'N2°12'E, Alt. 277 m, 20 June 2001 (fl./fr.), *Adjakidjè* 4435 (BENIN, BRLU, WAG). Djidja, Agouna, 6 km Agouna, 7°35'N1°41'E, 20 Oct. 2001 (fl.), *Essou* 3091 (BENIN, BRLU, WAG). **BURMA (MYANMAR):** Upper Burma, Chin Hills, 22°30'N93°30'E, July 1892 (fl.), *Huk* s.n. (U). **BURUNDI: Muramvya Province**, 3°29'S29°36'E, Alt. 800 m, 22 Oct. 1976 (fl.), *Reekmans* 5463 (WAG). **CAMEROON: Central Province, N'kolbisson**, 3°51'N11°28'E, Alt. 1000 m, 23 May 1970 (fl.), *Bos* 6882 (BR, MO, P, WAG, YA); 8 km W of Yaoundé, Alt. 650 m, 24 May 1964 (fl./fr.), *de Wilde & de Wilde-Duyfjes* 2617 (WAG); 2 km N of N'kolbisson, 7 km W of Yaoundé, 3°53'N11°27'E, Alt. 900 m, 29 May 1965 (fl.), *Leeuwenberg* 5733 (BR, P, WAG); Fébé Mt., near Yaoundé, Alt. 850 m, 5 Nov. 1964 (fr.), *de Wilde & de Wilde-Duyfjes* 3785 (WAG). **Bafia**, Serere, 35 km NNE of Bafia, 4°59'N11°23'E, 8 Sep. 1966 (fl.), *Letouzey* 7796 (K, P). Mbalmayo, 12 km SSW of Mbalmayo, 3°31'N11°30'E, 16 June 1972 (fl.), *Letouzey* M284 (P). Etoug, near top of hill "Akondoi" NW of Handicapped Center, Etoug Ebe, 3°51'N11°28'E, 3 June 1987 (fl.), *Manning* 1911 (WAG). **East Province,** Lomié, 3 km N of Lomié, Alt. 590 m, 9 Sep. 1965 (fl.), *Leeuwenberg* 6586 (BR, K, P, WAG, YA). 2 km SW of Yanda I (between Bertoua and Diang), 19 June 1978 (fl.), *van den Burg* 63 (WAG). **Littoral Province**, Edea, Poama, 3°51'N10°31'E, Alt. 450 m, 10 Aug. 1969 (fl.), *Meurillon* 1705 (P). **North Province**, Banyo, 2 km W of Banyo, 6°46'N11°48'E, Alt. 1100 m, 3 July 1972 (fl.), *Leeuwenberg* 10105 (BR, MO, P, PRE, UPS, WAG, YA). Lac Tison, 8 km S of N'gaoundéré, 7°17'N13°34'E, Alt. 1200 m, 10 Aug. 1981 (fl.), *van der Zon* 1167 (WAG). **South Province,** Edéa-Kribi, 2 km E of 58 km of Edéa-Kribi, Alt. 100 m, 11 Aug. 1965 (fl.), *Leeuwenberg* 6309 (WAG). Bipinde, 1896 (fl.), *Zenker* 1005 (P, S). **South-West Province**, 10 km between Ikata & Munyenge, NE of Muyuka, at foot of Cameroon Mt., 4°22'N9°21'E, Alt. 200 m, 26 Aug. 1983 (fl.), *Letouzey* 1984 (BR, MO). Munyenge, between Ikata and Munyenge, NE of Muyuka at foot of Cameroon Mt, 4°22'N9°21'E, Alt. 200 m, 26 Aug. 1983 (fl.), *Thomas* 2537 (B, BR, WAG). Victoria, 3 km S of Victoria, near Bimbia, 3°57'N9°14'E, Alt. 50 m, 12 Oct. 1965 (fl.), *Leeuwenberg* 6946 (WAG). **West Province, Dschang**, 5°27'N10°04'E, Alt. 1300 m, 9 June 1970 (fl), *Meurillon* 1876 (BM, WAG); Djuttitsa, 5°35'N10°05'E, Alt. 1500 m, 14 July 1955 (fl.), *Saxer* 188 (K, WAG). d'Ayon Region, 17 Dec. 1957 (fl.), *de Wit* 7972 (WAG). Basfond Asok, vers Benbis, 5°19'N12°14'E, Alt. 600 m, 1 Apr.

1986 (fl.), *van der Zon* 3172 (WAG). Mbussa, 6°N14°20'E, Alt. 800 m, Apr. 1914 (fl.), *Mildbraed* 9119 (B, K). **CENTRAL AFRICAN REPUBLIC:** Sangha Economique, Dzanga-Sangha Reserve, 2°21'N16°09'E, Alt. 350 m. 3 Aug. 1988 (fl.), *Harris & Fay* 895 (K, MO). **CHINA:** Yunnan Province, 25°35'N102°19'E, Alt. 1200 m, Aug. 1982 (fl.), *Xiulan & Xingwu* s.n. (F). **CONGO (BRAZZAVILLE): Cuvette Region,** Dimonika, on Makaba-Kakamoeka road, 4°14'S12°25'E, 11 Mar. 1980 (fl.), *Cusset* 1050 (B, P). **Makoua District**, 20 km S of Makoua on Makoua-Owando road, 0°08'S15°42'E, 20 July 1985 (fl.), *Cusset* 1507 (P); between Makoua and Etoumbi, 0°00'S15°20'E, 20 July 1985 (fl.), *Assi* 16997 (P). **DEMOCRATIC REPUBLIC OF CONGO (KINSHASA): Equateur Province**, Ingende Territory, Flandria, 0°20'S19°06'E, 20 Sep. 1944 (fl.), *Hulstaert* 1372 (BR, WAG). **Mbandaka**, Eala, 0°03'N18°19'E, 1936 (fl.), *Leemans* 249 (B, K); Mbandaka, Eala, 0°03'N18°19'E, 1936 (fl./fr.), *Leemans* 325 (BM, K). **Katanga (Shaba) Province**, Kiala, 31 Jan. 1960 (fl.), *Thiebaud* 851 (BR, WAG); Lubumbashi, 1937 (fl.), *Salésiens* 608 (WAG). **Kivu Province**, Luana Region, Kabanbaure Territory, Alt. 800 m, 10 Oct. 1953 (fl.), *Christiaensen* 143 (BR, WAG). Lubonja, Fizi Territory, on Fizi-Albertville road, 4°18'S28°56'E, Alt. 1100 m, 20 Oct. 1954 (fl.), *Christiaensen* 689 (BR, K, UPS, WAG). **Léopoldville Province**, Bandundu, Popokabaka Territory, between Kimvidi and Kinkosi, 5°38'S15°40'E, 9 Mar. 1939 (fl.), *Pauwels* 2084 (WAG). **Masisi Territory**, 20 Aug. 1957 (fl.), *Gutzwiller* 1522 (BR, WAG); Luhanga, Bukombo, Alt. 1300 m, 7 Mar. 1958 (fl.), *Gutzwiller* 3514 (BR, WAG); Bukombo, Alt. 1350 m, 24 Oct. 1958 (fl.), *Leonard* 1365 (BR, WAG). **Orientale Province**, **Uele,** 17 km from Baglele, along Baglele-Dunegu road, 4°21'S29°17'E, Alt. 800 m, 19 Apr. 1950 (fl.), *Noirfalise* 233 (K). P.N. Garamba, 36 km to Nakobo, 4°00'S29°23'E, Alt. 700 m, 7 July 1952 (fl.), *Troupin* 1416 (K). Upemba National Park, 8°50'S26°44'E, Alt. 1400 m, 7 Dec. 1948 (fl.), *de Witte* 4753 (BR, WAG). Rio Kankunda Region, Upemba National Park, 8°50'S26°44'E, Alt. 1400 m, 26 Nov. 1947 (fl.), *de Witte* 3105 (BR, COI, WAG). **Yangambi Region**, Isangi, Yalibwa, 0°56'N24°30'E, Alt. 470 m. 19 July 1937 (fl.), *Louis* 5608 (B). Isangi, Yanonga, 0°46'N24°28'E, 1 Aug. 1976 (fl.), *Bolangi Bo'yango* 49 (P). Bos, Omjemy, Manlegville, 2 Oct. 1957 (fl.), *Croockewit* 717 (WAG). Kabula, 19 Sep. 1931 (fl.), *Luxen* 85 (BR, WAG). Kiala, Feb. 1958 (fl.), *Thiebaud* 718 (BR, WAG). Linpungu Territory, Mwene District, 29 Oct. 1957 (fl.), *Liben* 3898 (WAG). Makunga, 4°59'S28°50'E, 21 Nov. 1874 (fl.), *Soyaux* 170 (K). Sabuka, 6 Apr. 1967 (fl.), *Pauwels* 4991 (BR, WAG). On Walbuzge to Tsinboko road, 22 Nov. 1956 (fl.), *Risopoulos* 549 (BR, WAG). **EAST TIMOR:** Qatunaba, near Dili, 8°33'S125°35'E, Alt. 300 m, 2 Feb. 1883 (fl.), *Forbes* 3435 (L). **EQUATORIAL GUINEA: Bioko (Fernando Póo)**, Malabo-Luba, patio Agrifer km 36, 3°27'N8°33'E, 22 July 1986 (fl.), *Carvalho* 2061 (B, BM, BR, F, S, UPS, WAG); 27 km from Mallo, 3°38'N8°38'E, 8 July 1989 (fl.), *Carvalho* 4011 (BR); Puerto Viejo, 3°46'N8°47'E, 2 Aug. 1990 (fl.), *Carvalho* 4441 (BR, WAG); Puerto de Musola 3°42'N8°48'E, Alt. 750 m, 29 June 1986 (fl.), *Carvalho, Casas, Requeiro & Telleria* 10085 (BR, WAG); Malabo, Basilé, Alt. 240 m, 1 July 1986 (fl.), *Carvalho, Casas, Requeiro & Telleria* 10110 (B, BR; F, WAG). **GABON: Estuaire Province**, Libreville, about 14 km along the road Libreville to Cape Estérias, 26 Nov. 1983 (fl.), *de Wilde, Arends, Louis, Bouman & Karper* 798 (WAG). Cap Estérias, 16 Jan. 1986 (fl.), *Louis & Gassita* 1993 (WAG). Pointe Ekwata, 0°20'N9°21'E, Alt. 5m, 4 Jan. 2000 (fl.), *Simons & Westerduijn* 570 (LBV, WAG). **Ogooué-Maritime, Gamba**, 400 m from well GA-26, roadside, 2°43'S10°12'E, Alt. 10 m, 1 Dec. 1995 (fl.), *Bergen & van den Houten* 128 (WAG); Colas, 15 km from Gamba airport along road to Mayonami, just behind beach/coast, 2°53'S10°08'E, 12 Aug. 1976 (fl.), *de Wilde & de Wilde-Bakhuizen* 11249 (WAG); W of the Shell terminal, along the road to the beach, 2°47'S10°00'E, Alt. 5 m, 4 Jan. 1998 (fl.), *van Proosdij* 17 (WAG). Rabi-Kounga, in forest 1°55'S9°55'E,

1 Nov. 1991 (fl.), *Breteler & Jongkind* 10271 (WAG). Port Gentil (Paysannat), 0°43'S8°47'E, 23 Dec. 1967 (fl.), *van Raalte* 2 (WAG). Kanzo, 0°09'N10°08'E, Jan. 1977 (fl.), *Thiebaut* s.n. (P). Near Ivinga, near beach, 2°51'S10°07'E, 31 Dec. 1990 (fl.), *van Nek* 521 (WAG). **Nyanga**, Doudou Mountains, Village Mbougou, 2°59'S10°23'E, Alt. 15 m, 26 Nov. 2003 (fl.), *Niangadouma, van Valkenburg, Jongkind & Mabicka* 319 (BR, LBV, MO, P, WAG). Moukalaba Doudou, National Park, S of Nyanga River, 3°00'S10°23'E, Alt. 12 m, *van Valkenburg, Ngok Banak, Issembé & Nzabi* 2836 (WAG). **GHANA: Greater Accra Region**, Accra, 5°33'N0°13'W, *Dalziel* 163 (C, K). Sansam, 5°32'N0°12'W, Alt. 25 m, July 1976 (fl.), *Ryding* 32 (K). Akim Swedra C.P., 5°54'N1°01'E, 24 Aug. 1925 (fl./fr.), *Flowes* 964 (K). **Ashanti Region**, Ayigya-Kumasi, Kumasi, 6°16'N0°34'W, 19 Nov. 1978 (fl.), *Enti & Cudjoe* FE1933 (WAG). **Volta Region**, Amezofe, V.R., 3 Jan. 1974 (fl.), *Veldkamp* 6119 (L). Tantra Hill, 20 July 1983 (fl.), *Enti* FE2186 (B). Vane, Togo, 6°49'N0°25'E, 15 Nov. 1953 (fl.), *Morton* A163 (K). Roadside in Volta River Forest Reserve, 6°11'N0°01'E, Nov. 1951 (fl.), *Morton* 6050 (K). **GUINEA: Conakry**, 9°32'N13°4'W, 12 Oct. 1891 (fl.), *Maclaud* 92 (P). Golea near Conakry, 9°32'N13°4'W, 17 July 1955 (fl.), *Wit* 55 (WAG). Mamou, Kouria, 9°46'N13°21'W, 1905 (fl.), *Chevalier* 15059 (K). Tristao Island, 10°49'N14°54'W, 1895 (fl.), *Paroisse* 34 (P). **GUINEA-BISSAU:** Canenque, 11°15'N15°01'W, Alt. 20 m, 11 Nov. 1995 (fl.), *Malaise & Claes* 14869 (BR). Cubisseque, Paiunco, 11°37'N15°28'W, 5 Oct. 1945 (fl.), *Espirito Santo* 2193 (WAG). **INDIA: Andamans**, Little Andaman**,** Hut Bay, Alt. 0 m, 21 Aug. 1967 (fl.), *Bhargava* 4160 (L). Hut Bay, Alt. 0 m, 21 Aug. 1976 (fl.), *Bhargava* 4167 (L). **Assam State**, Assam Valley, 26°00'N93°00'E, *Jenkins* s.n. (B). Cachar, Gunjong, Alt. 750 m, 7 June 1951 (fl.), *Koelz* 28187 (L). Kainlup District, Sauyashipara on way to Ukiam beyond Patgou, about 8 km, 20 June 1964 (fl.), *Rao* 39004 (L)., **Bihar State**, Chota Nagpur, 22°13'N88°54'E, Alt. 239 m (fl.), 1881 (fl.), *Gamble* 10187 (K). Muhammadganj, 2 Sept. 1947 (fl.), *Koelz* 18753 (L). **Goa, S**aligao, 15°33'N73°47'E, 1 Oct. 2008 (fl.), *Fadela Fuchs* s.n. (WAG). **Jharkhand:** Surguja district, Ramanujganj, 7 Oct. 1947 (fl.), *Koelz* 19226 (L). **Karnataka (Mysore) State**, S India, Bandipur State Forest, Alt. 1100 m, 2 Aug. 1960 (fl.), *Thorne, Rao & Razi* 27858 (L). Mangalore, 12°52'N74°5'E, Alt. 34 m, *Hohenacker* 217 (K, S, U).. **Madhya Pradesh**, Chawni Bhopal, 23°00'N78°00'E, 21 Aug. 1958 (fl.), *Puri* 42142 (B). Goa, Oct. 2008 (fl.), *Fuchs* s.s. (WAG). **Punjab**, Alt. 1500 m, 1884 (fl.), *Drummond* 1958 (K). Thinjhari jungle, 31°00'N76°00'E, 1 Sep. 1887 (fl.), *Drummond* 26536 (K). **Tamil Nadu**, Carnatic, Thiuoga, Maisor (Mysore), South India, 13°55'N75°34'E, Alt. 600 m, Oct. 1908 (fl.), *Meebold* 10169 (S). Coimbatore District, northern slope of Kuudimalai, 11°00'N76°58'E, Alt. 820 m, 16 Nov. 1956 (fl.), *Subramanyam* 1319 (B). **Uttarakhand**, Dehra Dun, 30°25'N77°56'E, Alt. 660 m, 10 Aug. 1928 (fl.), *Singh* 384 (F, S). **Uttar Pradesh,** Allahabad, Sirathu, 15 Sep. 1978 (fl.), *Bumisra* 740 (L). **West Bengal**, Kolkata (Calcutta), 24°00'N90°00'E, 1836 (fl.), *Helfer* s.n. (B, UPS). **INDONESIA:** Borneo, Kalimantan Timur, Manggar, 2°53'S108°16'E, *Boschproefstation* 4926 (WAG). **Lesser Sunda Islands (Nusa Tenggara), Bali**, Kuta, *Ramsahai* s.n. (WAG). Kuta, Alt. 50 m, 24 Jan. 1976 (fl./fr.), *Prawiroatmodjo* 35 (L) Bali, Batoer, 0°08'S100°38'E, 12 Feb. 1928 (fl.), *van der Meer* 63 (WAG).**Sumba**, Ibaamanoe nr Waingapoe, 9°39'S120°16'E, 27 Mar. 1935 (fl.), *Iboet* 115 (B, U). , **Lombok**, Mangkung-Pancoran, W Praya, Alt. 350 m, 23 Jan. 1976 (fl./fr.), *Prawiroatmodjo* 22 (L). Kuta, Alt. 50 m, 24 Jan. 1976 (fl./fr.), **East Java, Jawa Timur**, Puger, 8°23'S113°27'E, 31 Mar. 1929 (fl.), *Booberg* s.n. (S, UPS). Besuki, Puger, 27 Feb. 1940 (fl.), *Buwalda* 7156 (K, L). Lawang, c. Baong, 7°50'S112°41'E, 17 Jan. 1932 (fl.), *Groenhart* 215 (U). Bogor, 1950 (fl.), *Flermens* 50 (WAG). **West Java, Jawa Barat**, Weltevreden**,** Batavia T. Priole, 6°10'S106°52'E, Alt. 0 m, 11 Nov. 1917 (fl.), *Bakhuizen* 2033 (L). Madura, Lapoeloen, 1915 (fl.), *Backer* 19499 (U). Puger, Besuki, 8 Mar.

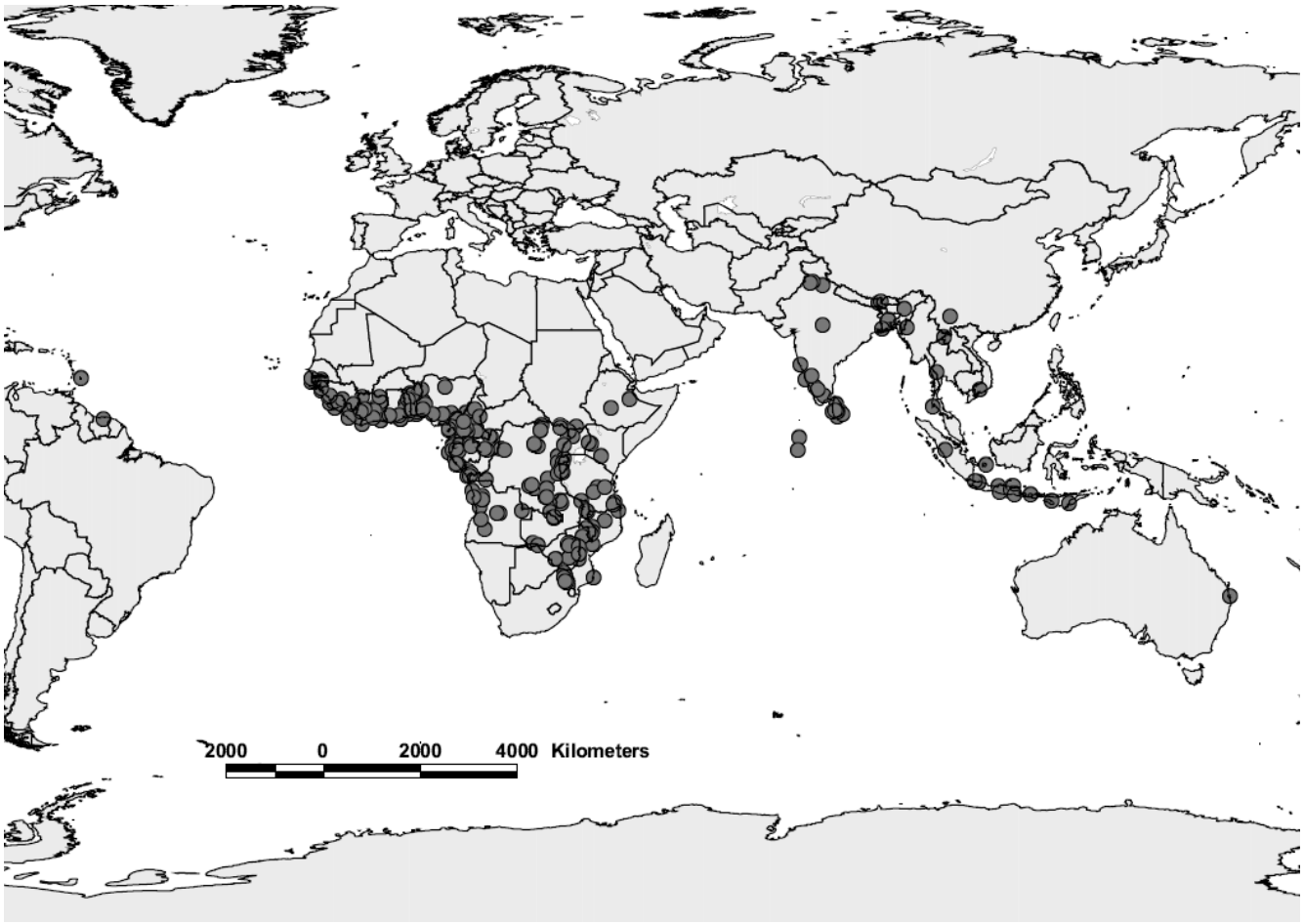
1898 (fl.), *Koorders* 29967 (L). Tanjung Priok, 6°06'S106°53'E, 3 Apr. 1906 (fl.), *Pulle* s.n. (U). Weltevreden, 1 Nov. 1925 (fl.), *van der Brink* Jr 3586 (U). **Central Java, Jawa Tengah**, Semarang, 6°57'S110°25'E, Nov. 1932 (fl.), *Kooper* s.n. (U). Yogyakarta, near Imogiri, about 20 km S of Yogyakarta, 7°54'S110°50'E, Alt. 200 m, 6 Feb. 1984 (fl.), *Leeuwenberg & van der Meer* 13002 (L, WAG). **IVORY COAST:** Bondoukou, N of Bondoukou, 7°05'N5°03'W, 14 July 1967 (fl.), *Geerling* 250 (BR, WAG). **Bouaflé**, Marahoué National Park, 7°07'N5°56'W, 19 May 1999 (fl.), *Jongkind & Diomaudé* 4625 (WAG); 30 km on road Bouaké to Yamoussoukro, 7°26'N5°05'W, 3 Aug. 1979 (fl./fr.), *de Kruif* 281 (WAG). Bouna, North side of Parc National de Bouna, Téhini, c. 40 km E of Ouangofétini, 9°34'N4°03'W, Alt. 313 m, 24 Aug. 1963 (fl.), de *Wilde* 757 (WAG). Divo, surroundings, 28 June 1958 (fl./fr.), *Gruys* 65 (WAG). Gansé, 8°38'N3°55'W, 10 Aug. 1967 (fl.), *Geerling & Bokdam* 663 (WAG). **Guiglo**, about 14 km. SWS of Toulepleu, 3.5 km SW of Klobli, 9 Sep. 1975 (fl./fr.), *van der Burg* 984 (WAG). Near Bingerville, 18 Aug. 1956 (fl.), *de Wilde* 234 (WAG). Issia, Bassin du Sassandra, 6°29'N6°35'W, Alt. 220 m, 6 May 1962, *Leeuwenberg* 4135 (WAG). Tabou, Sassandra, from Tabou 15 km to Bereby, along the road, 12 Oct. 1973 (fl.), *de Koning* 2386 (WAG). Tiassalé, N'douci, 10 km N of N'douci, 5°52'N4°46'W, 4 Dec. 1963 (fr.), *Oldeman* 716 (BR, WAG). Vavoua, Haut Sassandra N, 7°18'N7°01'W, 25 Nov. 1993 (fl.), *Gautier, Kouamé & Téré* LG2276 (BR). **KENYA: Nyanza Province**, Kisii Central District, near Nyamatutu, 0°37'S34°40'E, Alt. 1510 m, 15 Feb. 1978 (fl.), *Plaizier* 493 (WAG). **Rift Valley Province,** Marakwet District, Marakwet, 0°56'N35°30'E, 1958 (fl.), *Lindsay* 144 (K). **Trans-Nzoia District,** about 20 miles N of Kitale, 1°01'N35°12'E, 27 July 1938 (fl.), *Pole Evan & Erens* 1500 (B). **Western Province, Mt Elgon District**, Mt Elgon, 1°08'N34°33'E, Alt. 1950 m, Oct. 1930 (fl.), *Lugard* 63 (K). **LAOS:** Mong Hsing, Haut Lad, 20°47'N100°20'E, Alt. 600 m, 2 June 1929 (fl.), *Ward* 8930 (F). **LIBERIA: Bong County**, Dobli Island, 6°37'N9°12'E, 21 July 1952 (fl.), *Traub* 348 (COI, MO). Suakoko, 5 km NE Suakoko, Gbarnga, 6°59'N9°35'W, 9 Aug. 1950 (fl.), *Okeke* 4 (BR, K, MO). Grand Bassa, Fish Town, 5°12'N7°52'E, 28 Dec. 1897 (fl.), *Dinklage* 1833 (B). **Nimba County**, Ganta, 5°38'N9°48'W, Alt. 22 m, 31 July 1952 (fl.), *Daniel* 413 (COI, MO). **No locality**, *Harley* 1229 (WAG). **MADAGASCAR:** Mandrare, 18°22'S49°16'E, Alt. 400 m, Dec. 1933 (fl.), *Humbert* 13028 (B). **MALAWI: Southern Region,** Blantyre District, Mpingwe Hill, Limbe, 15°48'S35°03'E, Feb. 1970 (fl.), *Moriarty* 448 (K). **Northern Region,** Mzimba District, Mzuzu, 3.5 km E of Mzuzu, 11°27'S34°01'E, Alt. 1290 m, 10 Dec. 1977 (fl.), *Phillips* 3142 (WAG). Nkhata Bay district, 11°37'S34°18'E, 15 May 1973 (fl.), *Pawek* 6536 (CAM, K, MO, U, WAG). Zomba District, Zomba Plateau road, 15°19'S35°18'E, 5 Apr. 1984 (fl.), *Banda & Salubeni* 2141 (C, K, MAL). **MALAYSIA:** Borneo, Kinabatangan District, Sabah, Kampung Sukau, 5°15'N117°00'E, 14 Nov. 1983 (fl.), *Braim* 60049 (L). Johore, Mersing, 1.5 km S, Mersing to Jemerluang, 2°26'N103°50'E, 17 July 1968 (fl.), *Teo* 141 (K, L). **MALDIVES:** Fua Mulaku Islands, near Gem Miskit road, 0°17'N73°26'E, 31 May 1977 (fl.), *Munch-Petersen* 80 (C). Isdhoo, Laam Atoll, 2°07'N73°34'E, 8 July 1991 (fl.), *Schmelzer* 84 (WAG). **MOZAMBIQUE:** Inhambane, 20 km E of Inhambane, 23°51'S35°29'E, Mar. 1936 (fl.), *Gomes e Sousa* 1712 (K). Inyamatshira Mt. Range, 19°00'S32°41'E, 29 Jan. 1950 (fl.), *Chase* 1952 (COI). Mocimboa, c 15 km on Mocimboa-Mueda road, 11°23'S40°14'E, 7 Mar. 1983 (fl.), *Jansen* 8156 (WAG). Montepuez, 13°09'S39°00'E, 3 Jan. 1973 (fl.), *Mafumo* 39 (WAG). Niassa, Marrupa, c 15 km on road to Nungo, slope of Mt Kuwanku, 13°20'S37°41'E, Alt. 850 m, 22 Feb. 1982 (fl.), *Jansen & Boane* 8043 (WAG). **Tete Province**, N of Serra Dómuá, 16°10'S33°35'E, 20 Feb. 1980 (fl.), *Macuácua & Mateus* 1093 (WAG). Lower Valley of River Shire, 16°34'S35°08'E, May 1861 (fl.), *Meller* s.n. (F). **NEPAL**: Zeylona, *Wallich* 4 (L). **NIGERIA: Adamawa State**, Adamawa beside the road

between Beli and Serti, 11°27'N7°51'E, 17 July 1973 (fl.), *Chapman* 11 (K). **Cross River State**, Calabar District, Uwet, Buden Dunlop Estate, 5°16'N8°13'E, 3 August 1959 (fl.), *Binuyo* FHI41427 (WAG). **Enugu State, Enugu District**, Miliken Hill, Enugu-Onitsha road, 6°40'N9°10'E, 17 July 1972 (fl.), *Enwiogbon* s.n. (FHI, WAG); Ngwo Forest Reserve, by the side of Ngwo stream, 6°26'N7°29'E, Alt. 217 m, 9 July 1973 (fl.), *Emwiogbon* s.n. (FHI, WAG). **Oyo State, Ibadan District,** 7 km W of the Polytechnic, Ibadan, 7°23'N3°53'E, 22 Oct. 1977 (fl.), *Pliz* 2174 (B; F); Gambari Forest Reserve, about 32 km SE of Ibadan, 8°16'N4°20'E, 10 Jan. 1966 (fl.), *van Eijnatten* 1040 (WAG); Gambari, about 32 km SE of Ibadan, 25 May 1966 (fl.), *van Eijnatten* 1561 (WAG); Ibadan, S of University of Ibadan, 16 Aug. 1968 (fl.), *van Meer* 866 (WAG). **Southern Nigeria**, Ikpoba River, 6°21'N5°39'E, 16 Sep. 1908 (fl.), *Farquhar* 197 (K); Southern Nigeria, 1912 (fl.), *Thomas* 1705 (K); Southern Nigeria, 1912 (fl.), *Thomas* 1782 (K). **PAPUA NEW GUINEA: Lombok,** Kuta, Alt. 50 m, 24 Jan. 1976 (fl./fr.), *Prawiroatmodjo* 35 (BO, L). **RWANDA: Butare Province**, Rubona, Ndusu, Ruhengeri, 2°29'S29°46'E, Alt. 1700 m, 16 Feb. 1960 (fl.), *Michel* 6388 (BR, WAG). **Kigali Province,** Tarabana Territory, 1°47'S30°05'E, Alt. 1800 m, Nov. 1932 (fl.), *Becquet* 294 (BR, WAG). **SENEGAL: Casamance**, Cap skiring Boukot Ouslof, 12°25'N16°45'W, Alt. 6 m, 15 Aug. 1977 (fl.), *VandenBerghen* 2127 (BR). Oibéné, 13°05'N16°22'W, Alt. 6 m, 23 Aug. 1993 (fl.), *VandenBerghen* 9801 (BR). Tobor, 12°39'N16°16'W, Alt. 6 m, 25 Sep. 1981 (fl.), *VandenBerghen* 4730 (BR). Delta National, Park, Saloum, at highroad Kaolack to Gambia, 16°33'W13°38'W, Alt. 0 m, 14 Oct. 1990 (fl.), *Lawesson & Goudiaby* 7584 (WAG). Saré Keita, 12°50'N14°55'W, 22 Sep. 1967 (fl.), *Baudet* 3725 (P). **SIERRA LEONE: Northern Province**, Loma Mountains, path from camp 1 to camp 2, 9°10'N11°07'W, 15 June 1966 (fl.), *Morton* SL3560 (FHI, GC, IFAN, K, SL, WAG). **Southern Province,** Bonthe District, Momaligi, 7°36'N12°21'W, 11 Sep. 1965 (fl.), *Morton & Jarr* SL2194 (FHI, IFAN, JKM, SL, WAG). **SOUTH AFRICA: Cape Province**, Mazeppa Bay, along seashore, close to high wave mark, 32°28'S28°39'E, 15 Mar. 1952 (fl.), *Theron* 1231 (K, PRE). **Mpumalanga Province,** 16 km E of Mariepskop Forestry quarters, on road to Klaserie, 24°45'S30°34'E, 15 Jan. 1972 (fl.), *Vorster & Coetzer* 2074 (PRE, UPS). **Transvaal Region**, Sekukuniland, Driekop farm, base of Lulu mountains, 24°35'S30°10'E, Alt. 1020 m, 4 Jan. 1939 (fl.), *Barnard & Mogg* 667 (PRE, WAG). Zoutpanesberg Mountains, about 8 km above Louis Trichardt, 23°03'S29°54'E, 6 Mar. 1948 (fl.), *Rodin* 3977 (F). Duiwelskloof, 23°42'S30°08'E, 19 Jan. 1959 (fl.), *Werdermann & Oberdieck* 1925 (B). **SRI LANKA: Central Province**, Ella, 6°52'N81°03'E, Alt. 969 m, 8 Dec. 2010 (fl.), *Schutte* 2 (WAG). Under Nuwara Eliya, 6°58'N80°45'E, Alt. 1200 m, 14 Dec. 1980 (fl.), *Schwabe* s.n. (B). **Eastern Province**, Trincomalee District, ca. 10 km NW of Kathiraveli, along the Trincomalee road, Alt. 5 m, 4 Dec. 1974 (fl.), *Davidse & Sumithraarachchi* 9050 (L). **North Central Province**, Anuradhapura District, Anuradhapura, along road A9 at 100 km, 8°21'N80°25'E, 6 Jan. 1971 (fl.), *Koyama & Koyama* 13907 (C). **Southern Province**, Dickwella, village gardens, 5°57'N80°41'E, Alt. 3 m, Oct. 2009 (fl.), *Schutte & de Vries* 1 (WAG). Southern and Uva Provinces, Ruhuna-Yala National Park, 6°25'N81°30'E, 25 Dec. 1975 (fl.), *Schwabe* s.n. (B). **Uva Province**, Monaragala, W of Wellawaya on highroad A4, Montane Forest, 6°57'N81°14'E, 19 Feb. 1978 (fl.), *Lundqvist* 11396 (UPS). **Western Province**, the road S of Colombo, 6°55'N79°51'E, 21 Dec. 1968 (fl.), *Hoff* s.n. (C). Benlola, Mellem Buski pan strauda, 7°03'N80°08'E, 1 Jan. 1976 (fl.), *Larsen* s.n. (C). **SUDAN: Kordofan**, Mazrub, 19 Aug. 1962 (fl.), *Wickens* 198 (K). Sugura, Gidarif District (Block 16), 5 Aug. 1951 (fl.), *Beskir* 8 (K). Yei District, Experimental plots on Loka-Bibi road, 26 May 1954 (fl.), 7°2'N25°53'E, Alt. 680 m, *Jackson* 3195 (K). Mt Imatong and surroundings: Acholi, W of junction to Palataka, near Magwe, 4°7'N32°17'E, 4 June 1984 (fl.), *Lund* 837 (C). **SURINAME:**

Zanderij, Forest of Zanderij, 5°27'N55°12'W, 3 July 1916 (fl.), *Samuels* 516 (F). Paramaribo, *Ramsahai 1* (WAG). **TANZANIA: Iringa Region, Iringa District,** N of dam site, 8°00'S35°35'E, 26 Mar. 1971 (fl.), *Mhoro* 865 (UPS). **Lindi Region**, Lindi Urban District, 40 km W Lindi, 9°59'S39°24'E, Alt. 250 m, 14 Jan. 1935 (fl.), *Schlieben* 5872 (B). **Morogoro Region**, Kidatu District, Kidatu, 7°07'S36°09'E, 23 Mar. 1971 (fl.), *Mhoro* 800 (UPS). Uluguru, 7°10'S37°40'E, Alt. 900 m, 19 Jan. 1933 (fl.), *Schlieben* 3272 (B). Rovuna Bay, Mar. 1861 (fl.), *Kirk* s.n. (K). **THAILAND: Malay Peninsular, Phuket Province**, Karon Bay, 7°51'N98°17'E, Alt. 27 m, July 1981 (fl.), *Ryding* 436 (UPS). **Southeastern Province**, Chon Buri, Toong Brong, Sattahib, 12°40'N100°54'E, 31 July 1971 (fl.), *Maxwell* 71468 (L). **Southwestern Province**, Kanchanaburi District, Salag Prah, Wildlife Sanctuary Sadong, 14°9'N99°12'E, Alt. 100 m, 29 Nov. 1971 (fl.), *van Beusekom, Phengkhlai, Geesink & Wongwan* 4038 (L). Prachuap Khiri Khan, Sam Roi Yot, 12°16'N99°52'E, 10 Nov. 1964 (fl.), *Sangkhachand & Smitinand* 1059 (L). **TOGO:** Adéle, 2 km N of Dikpélélou, 8°13'N0°37'E, Alt. 740 km, 24 Oct. 1982 (fl.), *Schäfer* 7673 (B, WAG). Lome, 7°06'N1°36'E, Alt. 49 m, 1900 (fl.), *Warnecke* 175 (P). Palimé, 6°54'N0°38'E, 14 Sep. 1974 (fl.), *Mathey & Scholz* 44 (B). **Plateaux Region**, 9°15'N1°12'E, 21 Sep. 1976 (fl.), *Ern, Hein & Pircher* 790 (B). W of Badon, 7°35'N0°35'E, 25 Oct. 1977 (fl.), *Leuenberger, Scholz, Scholz & Schwarz* 2194 (B). Tsévié-Gapé, Davie, 5 km S of Tsevié, 6°23'N1°12'E, Alt. 90 m, 1 Aug. 1965 (fl.), *Davidson* 15 (K). **UGANDA: West Nile Province,** on the Terego road to the south of Mt. Eti (Mt. Wati), 3°13'N31°02'E, Alt. 1110 m, 26 July 1953 (fl.), *Chancellor* 54 (S). **Western Region**, Bwamba county, 8 km N of Bandibagyo, 0°43'N30°04'E, Alt. 780 m, 18 Sep. 1952 (fl.), *Ross* 1141 (BM). **VIETNAM: Southern Region,** Cochinchina, 11°00'N107°00.'E, July 1866 (fl.), *Pierre* s.n. (B). **ZAMBIA: Copperbelt Province**, Kitwe District, 12°48'S28°14'E, 6 Feb. 1956 (fl.), *Fanshawe* 2770 (B). Mufulira District, Mufulira N.R., 3 Jan. 1948 (fl.), *Cruse* 141 (K). **Luapula Province**, Kawambwa District, Mukabi PFA, 10°11'S29°40'E, 8 Feb. 1962 (fl.), *Lawton* 831 (K). **Northern Province**, Mporokoso District, Lumangwe Falls, Kalungwishi River, 9°33'S29°22'E, Alt. 900 m, 9 Jan. 1960 (fl.), *Richards* 12307 (K). **ZIMBABWE: Harare District,** 18 km from Harare, along Harare-Bindura road, near University of Zimbabwe farm, 17°49'S31°03'E, Alt. 1490 m, 13 Dec. 2006 (fl.), *Maroyi* 244 (SRGH, WAG); Waterfalls, corner Masotsha Ndhlovu and Beatrice road (Masvingo road), 17°49'S31°03'E, Alt. 1490 m, 20 Dec. 2006 (fl.), *Maroyi* 245 (SRGH, WAG); Hatfield, 17°52'S31°05'E, Jan. 1960 (fl.), *Whellan* 1629 (K, SRGH). **Manicaland Province**, **Mutare District**, Engwa, 19°24'S32°46'E, Alt. 1600 m, 1 Feb. 1955 (fl.), *Exell, Mendonça & Wild* 23 (BM, SRGH); in forest on Vumba Mts, 19°05'S32°47'E, Alt. 1350 m, 1 Jan. 1966 (fl.), *Plowes* 2748 (K, SRGH); Burma Valley in Bvumba area SE of Mutare, 30 km from Mutare, 3 km from junction from the main road, 19°07'S32°46'E, Alt. 1600 m, 31 Dec. 2010 (fl.), *van der Maesen & Maroyi* 8551 (SRGH, WAG); S of Mutare, 44 km from junction to Chipinge, 20°05'S32°38'E, Alt. 948 m, 1 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8574 (SRGH, WAG); Cashel Valley, 19°31'S32°45'E, 4 Feb. 1967 (fl.), *Lady Drewe* 7 (K, SRGH). **Nyanga District**, c 3km out of Nyanga, 18°16'S32°41'E, Alt. 1750 m, 13 Jan. 1931 (fl.), *Norlindh & Weimarck* 4262 (BM, SRGH); 44 km E of Rusape on Nyanga road, 18°24'S32°27'E, Alt. 1790 m, 29 Dec. 2010 (fl.), *van der Maesen & Maroyi* 8505 (SRGH, WAG). **Chipinga District**, Chirinda Forest outskirts, 20°26'S32°42'E, Alt. 1140 m, Dec. 1908 (fl.), *Swynnerton* 6507 (BM, K); S of Mutare, 42 km from junction to Chipinge, along fence near telephone line, 20°05'S32°37'E, Alt. 898 m, 1 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8575 (SRGH, WAG). **Mashonaland Central Province,** Mazowe District, 48 km peg towards Bindura along Harare-Bindura road, 17°30'S30°58'E, Alt. 1290 m, 13 Dec. 2006 (fl.), *Maroyi* 242 (SRGH, WAG). Harare to Kariba, 54 km out of Harare, 17°40'S30°45'E, Alt. 1477 m, 8 Jan. 2011 (fl.), *van der*

Maesen & Maroyi 8635 (SRGH, WAG). **Masvingo (Victoria) District, Masvingo**, Great Zimbabwe, outside the Great Zimbabwe Hotel fence, 20°16'S30°55'E, Alt. 1110 m, 1 Jan. 2008 (fl.), *Maroyi* 248 (SRGH, WAG); near Great Zimbabwe, just outside the gates en route to the ruins, 20°16'S30°55'E, Alt. 1135 m, 2 Jan. 2011 (fl.), *van der Maesen & Maroyi* 8576 (SRGH, WAG). **Matebeleland South Province, Matobo District**, Matopo Hills, 20°27'S28°30'E, Alt. 1500 m, July 1904 (fl.), *Eyles* 32 (BM); Grassland farm, Besna Kobila, 20°26'S28°44'E, Alt. 1440 m, Dec. 1954 (fl.), *Miller* 2596 (K, SRGH). **Matebeleland north Province**, Hwange District, along the road, 200 m Kazungula border post, 17°49'S25°16'E, Alt. 937 m, 4 Jan. 2011 (fl), *van der Maesen & Maroyi* 8614 (SRGH, WAG). **No locality**, 5 Feb. 1967 (fl.), *Lady Drewe* 8 (K, SRGH).

CULTIVATED: BRAZIL: Brasilia, Jan. 1889 (fl.), *Hampe* s.n. (F). **CAMEROON:** Victoria Botanic Garden, Sep. 1904 (fl.), *Winkler* 381 (K). **COSTA RICA:** San Jose, 25 Sep. 1933 (fl.), *Calvo* 551 (F). **GERMANY:** Beyond the Rhine River, National History Society for Rhineland and Westfalia, plant obtained in 1936, Botanical Garden of Bonn, 1831, Herb. L.C. *Treviranus* s.n. (B). **INDONESIA:** Bogor, Java, Buitenzorg, 12 Feb. 1950 (fl.), *Jesma* 98 (WAG). **IVORY COAST:** Bouaké, 8 Nov. 1977 (fl.), *Bouharmont* 10887 (BR). Abidjan, near Adiopodoumé, 6 Apr. 1959 (fl.), *Leeuwenberg* 3164 (WAG). **MALAYSIA:** Campus, University of Malaya, 18 Mar. 1972 (fl.), *Ismail & Sauji* C-8 (L); Malaysia, Sena, Van Niel 3596 (L); Malaysia, Kuala Lumpur, Selangor, Botanic Garden, University of Malaya, 4 February 1971 (fl.), Alt. 126 m, Stone 9627 (L). **MOZAMBIQUE:** Manica, grown on coast belt, 1921 (fl.), *Honey* 641 (K). **NETHERLANDS:** Wageningen University glasshouse, grown from seeds collected in Ivory Coast, 1 May 1969, *de Bruijn* 1879 (WAG); grown in L.J.G. van der Maesen's home in Bennekom, grown from a tuber bought in Sep. 2009 from Amsterdam flower market, origin purportedly from Kenya. 30 Dec. 2009, *van der Maesen* 8451 (WAG); 25 Feb. 1949 (fl.), *Ruisch* s.n. (WAG); Wageningen University Botanic Gardens, greenhouse conservatory, 25 July 1978 (fl.), *van Setten* 194 (WAG). **SABAH (EAST MALAYSIA)**, North Bornea, Elopura F.D. Sandakan, Alt. 30 m, 6 Oct. 1948 (fl.), *Keith* A1539 (L). **SINGAPORE**, Singapore Botanic Gardens, 19 Oct. 1967 (fl.), *Chew Wee-lek* 1449 (L). **SOUTH AFRICA**, Pretoria, Fountains Nursery, 13 Mar. 1936 (fl.), *Replon* 507 (K, PRE). **UNITED KINGDOM:** cultivated in Temperate glasshouse, Royal Botanic Gardens, Kew, 11 Dec. 1922 (fl.) (K); cultivated probably in Royal Botanic Gardens, Kew, from seeds said to have been received from Pearce Seed Co., E.N. 399-61 (fl.), July 1962 (K); cultivated in Royal Botanic Gardens, Kew, *Johnson* s.n. (fl.), 25 Aug. 1930 (F); cultivated probably in Royal Botanic Gardens, Kew, from plant material collected in Pemba, Zanzibar, 12 Sep. 1910 (fl.), *Morland* A190 (K). **UNITED STATES OF AMERICA**, Florida, The Sanders Garden, 13 Jan. 1971 (fl.), *Brumbach* 7401 (C, S, UPS); Florida, cultivated at Jacksonville, 1938 (fl.), *Florists Publ. Co*. (F). **WEST INDIES**, 1963 (fl.), *Buxton* 64149 (K).



Map 6.12. Distribution of *G. superba*

Chapter 7

The genus *Gloriosa* L. (Colchicaceae): valid species names.

A. Maroyi and L.J.G. van der Maesen

Gloriosa simplex **L., characterised by broad, not crisped perianth segments, photograph taken by Prof. L.J.G. van der Maesen, 197 km out of Bulawayo towards Victoria Falls, Zimbabwe**

Chapter 7: *Gloriosa* L.: valid species names

Abstract

A list of valid species names of the genus *Gloriosa* L. is presented, together with their synonyms. This is an attempt to provide basic information on all names that have been used and published in the course of the taxonomic history of *Gloriosa*. Distribution of taxa is indicated by the country in which they occur. For each accepted name, the author, reference to the original publication and details of type species are given.

Introduction

This chapter catalogues all the 78 known species names of *Gloriosa* L. These names have appeared in literature since the starting point of binomial nomenclature in Linnaeus' Species Plantarum (1753). According to the most recent taxonomic study of the genus (Maroyi & van der Maesen 2012, **chapter 6**), only twelve species are recognised. Therefore, the numerous names that appear in the genus *Gloriosa* and the continued use of such and doubtful names creates intractable problems and considerable taxonomic confusion. *Gloriosa* is a variable genus that continue to elude taxonomists in delineating a natural classification system. Nevertheless, new approaches in plant systematics have clarified many unresolved circumscriptions. For example, the study on phylogenetic relationships within the genus *Gloriosa* based on the *trn*L-*trn*F plastid region (**Chapter 5**) has demonstrated that *Gloriosa* is monophyletic with the inclusion of the closely related *Littonia* Hook. genus. These findings support a much broader generic concept suggested by Nordal & Bingham (1998) and Vinnersten & Reeves (2003) and implemented by Vinnersten & Manning (2007). The synthesis of traditional taxonomic works on the genus *Gloriosa* that rely heavily on morphological characters (e.g. Andrews 1956; Baker 1879, 1897, 1898; Berhaut 1967; Dassanayake 2000; Dyer *et al.* 1962; Dyer 1976; Field 1971, 1972; Gandhi 1976; Geerinck 2010; Hepper 1968; Hoenselaar 2005; Hooker 1894; Jessop 1983; Maroyi 2002; Nordal & Bingham 1998; Polhill 1962; Sebsebe Demissew 1997; Thulin 1995; Van der Burg 2006; Wild 1965) or nucleotide sequences (e.g. **Chapter 5**; Vinnersten & Reeves 2003; Vinnersten & Manning 2007) have greatly improved the understanding of this group of plants.

Following the establishment of *Gloriosa*, more than forty species have been described (IPNI 2011). The majority of new descriptions were made for species with names already in use. This has increased confusion in the nomenclature of the genus. It is understandable for a

genus characterised by great polymorphism. The majority of species descriptions in *Gloriosa* were based on a single morphological character. Having examined some of the type material and early literature, a number of discrepancies have been noticed. For example, there are names on specimens not validly published nor accompanied by any description, e.g. *Gloriosa banguirmiensis* (Chevalier 8774), *G. aethiopica* (Welwitsch 1746), *G. micrantha* (Peter 33681) and *G. sanguinea* (Welwitsch 1745). In some cases, species names have been published without a description (*nomina nuda*), examples include *G. superba* L. var. *planipetala* Engl. and *G. superba* L. var. *platypetala* Engl. *G. superba* L. var. *planipetala* Engl. (Zenker 1005) is printed as a name only in FWTA.

Elements of the list

Table 7.1 is a list of accepted species in *Gloriosa*. Abbreviations for authorities follow the standards used in Brummitt & Powell (1992). The reference to the original description of a species is given in abbreviated format stating the author, page number and year of publication. To make the list more useful, type locations have been included.

Table 7.1. List of species accepted in *Gloriosa* in the recent taxonomic revision (Maroyi & van der Maesen 2012, **Chapter 6**).

Species name	Original publication	Type	Distribution[1]
G. baudii (Terracc.) Chiov.	Chiov. in: Res. Sc. Miss. Stefan.-Paoli Somal. Ital. i: 176 (1916).	Ethiopia, Harerge Region, Ogaden, Gerar-Amaden, Apr. 1891, *Baudi & Candeo* s.n. (FT, holotype).	Et, K, So
G. carsonii Baker	Baker in Kew Bull. 1895: 74 (1895).	Zambia, Lake Tanganyika, Fwambo, 1894, *Carson* 53 (K, holotype).	A, Bo, Bur, Co, DRC, K, Maw, Mo, N, R, SS, Sud, T, Za, Zi
G. flavovirens (Dammer) J.C.Manning & Vinnersten	J.C.Manning & Vinnersten in Taxon **56**: 178 (2007).	Angola, Malange, Malandsche, November 1879, *Mechow* 371 (B?, holotype).	A
G. lindenii (Baker) J.C.Manning & Vinnersten	J.C.Manning & Vinnersten in Taxon **56**: 178 (2007).	Tanzania, Kigoma District: Ujiji, *Linden* s.n. (K, syntype). RD Congo, Lake Mweru, *Descamps* s.n. (BR!, syntype).	DRC, Maw, T, Za
G. littonioides (Welw. ex Baker) J.C.Manning & Vinnersten	J.C.Manning & Vinnersten in Taxon **56**: 178 (2007).	Angola: Pungo Andongo, *Welwitsch* 1747 (K, holotype).	A, Maw, T, Za
G. katangensis Maroyi nom. nov.	New combination to be published in a forthcoming paper	Democratic Republic of Congo (Kinshasa), Katanga, Region I, shores of the waters at Lukavu, November. 1899, *Verdick*, 288 (BR, holotype).	DRC

G. modesta (Hook.) J.C.Manning & Vinnersten	J.C.Manning & Vinnersten in Taxon **56**: 178 (2007).	South Africa, Port Natal, October 1883, *Sanderson* s.n. (K, holotype).	Mo, SA, Sw, Zi
G. revoilii (Franch.) J.C.Manning & Vinnersten	J.C.Manning & Vinnersten in Taxon **56**: 178 (2007).	Somalia, "Barroz" valley, *Revoil* s.n. (P, holotype).	So, Y
G. rigidifolia (Bredell) J.C.Manning & Vinnersten	J.C.Manning & Vinnersten in Taxon **56**: 178 (2007).	South Africa, Waterberg District, Geelhoutkop, 5 Jan. 1936, *van der Merwe* s.n. (PRE, holotype).	SA
G. sessiliflora Nordal & Bingham	Nordal & Bingham in Kew Bull. **53**: 479-480 (1998).	Zambia, Bingham & Luwiika 10752 (K, holotype; MRSC, O, WAG, isotype).	A, Za
G. simplex L.	L in Mant. Pl. Alt.: 62 (1767).	Neotype to be designated in the fortcoming Taxon paper.	A, Be, Bo, BF, Bur, Cam, CAF, Ch, DRC, EQ, Er, Et, G, Ga, Gh, Gu, Iv, K, Li, M, Mali, Maw, Mo, N, Ni, Nig, R, Se, SA, SL, So, SS, Su, T, To, U, Za, Zi
G. superba L.	L in Sp. Pl. **2**: 437 (1753).	India, Malabaria, Hermann 3: 31, no. 122, designated by Wijnands, Bot. Commelins: 133 (1983). (BM, lectotype).	A, B, Be, Bu, Bur, C, Cam, CAF, Co, DRC, Ea, EQ, G, Gh, Gu, GB, I, In, Iv, K, L, Li, M, Ma, Mal, Maw, Mo, Ne, Ni, P, R, Se, SA, SL, Sr, Su, Sur, T, Th, To, U, V, Za, Zi

[1]Distribution of taxa are indicated by the countries in which they occur and the countries are abbreviated here alphabetically in the list as follows: A = Angola; B = Barbados; Be = Benin; BF = Burkina Faso; Bu = Burma; Bur = Burundi; Bo = Botswana; C = China; Ca = Cameroon; CAF = Central African Republic; Ch = Chad; Co = Congo (Brazzaville); DRC = Democratic Republic of Congo; Ea = East Timor; EQ = Equatorial Guinea; Er = Eritrea; Et = Ethiopia; G = Gabon; Ga = Gambia; Gh = Ghana; Gu = Guinea; GB = Guinea Bissau; I = India; In = Indonesia; Iv = Ivory Coast; K = Kenya; L = Laos; Li = Liberia; M = Madagascar; Ma = Maldives; Maw = Malawi; Mal = Malaysia; Mali = Mali; Mo = Mozambique; N = Namibia; Ne = Nepal; Ni = Nigeria; Nig = Nigeria; P = Papua New Guinea; R = Rwanda; Se = Senegal; SL = Sierra Leone; So = Somalia; SA = South Africa; SS = South Sudan; Sr = Sri Lanka; Su = Sudan; Sur = Suriman; Swa = Swaziland; T = Tanzania; Th = Thailand; To = Togo; U = Uganda; V = Vietnam; Za = Zambia; Zi = Zimbabwe and Y = Yemen.

Table 7.2. Synonyms in the genus *Gloriosa* and reference to species combinations

Taxon	Accepted or suggested name	Reference(s)
Clinostylis speciosa Hochst. (1844)	***G. simplex*** L.	Maroyi & van der Maesen 2012.
Eugone superba (L.) Salisb. (1796)	***G. superba*** L.	Hooker 1894; Cufodontis 1971
Gloriosa abyssinica A.Rich. (1851)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. abyssinica A.Rich. var. *graminifolia* Franch. (1882)	***G. baudii*** (Terracc.) Chiov.	Sebsebe Demissew 1997
G. angulata Schum. & Thonn. (1827)	***G. superba*** L.	Baker 1879, 1898
G. aurea Chiov. (1928)	***G. baudii*** (Terracc.) Chiov.	Maroyi & van der Maesen 2012
G. caerulea Mill. (1768)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. cirrhifolia Stokes (1812)	***G. superba*** L.	Maroyi & van der Maesen 2012
G. doniana Roem. & Schult. (1829)	***G. superba*** L.	Baker 1879, 1898
G. graminifolia (Franch.) Chiov. (1882)	***G. baudii*** (Terracc.) Chiov.	Maroyi & van der Maesen 2012
G. graminifolia (Franch.) Chiov. var. *heterophylla* Chiov. (1916)	***G. baudii*** (Terracc.) Chiov.	Maroyi & van der Maesen 2012

G. grandiflora (Hook.) O'Brien (1904)	***G. simplex*** L. L.	Maroyi & van der Maesen 2012
G. homblei De Wild (1913)	***G. carsonii*** Baker	Maroyi & van der Maesen 2012
G. lutea auct. (1901)	Horticultural cultivar of ***G. superba*** L.	
G. lutea Hort. (1901)	Horticultural cultivar of ***G. superba*** L.	
G. luxurians Lour. ex Gomes (1868)	***Hemerocallis fulva*** (L.) L.	Merrill in Trans. Am. Phil. Soc. n.s. xxiv.ii.16, 105(1935)
G. minor Rendle (1896)	***G. baudii*** (Terracc.) Chiov.	Sebsebe Demissew 1997
G. nepalensis G. Don (1830)	Horticultural cultivar of ***G. superba*** L.	
G. plantii (Planch.) Loudon (1855)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. richmondensis Hort. (1928)	Horticultural cultivar of ***G. superba*** L.	
G. rockefelleriana Stehlé & M. Stehlé (1965)	Horticultural cultivar of ***G. superba*** L.	
G. rotschildiana citrina Hort. (1905)	Horticultural cultivar of ***G. superba*** L.	
G. rothschildiana O'Brien (1903)	Horticultural cultivar of ***G. superba*** L.	
G. rotschildiana var. *citrina* O'Brien (1903)	Horticultural cultivar of ***G. superba*** L.	
G. sampaiana Pires de Lima (1921)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. simplex D. Don (1825)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. simplex L. (1767)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. speciosa (Hochst.) Engl. (1892)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. sudanica A.Chev. (1920)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. superba L. var. *angustifolia* Baker (1879)	***G. superba*** L.	Maroyi & van der Maesen 2012
G. superba L. var. *graminifolia* (Franch.) Hoenselaar (2005)	***G. baudii*** (Terracc.) Chiov.	Maroyi & van der Maesen 2012
G. superba L. var. *planipetala* Engler (1936)	***G. superba*** L.	Maroyi & van der Maesen 202012
G. superba Mill. (1768)	***G. superba*** L.	Maroyi & van der Maesen 2012
G. virescens Lindl. forma *plantii* Sieb. & Voss (1895)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. virescens Lindl. var. *grandiflora* (Hook.) Baker (1879)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. virescens Lindl. var. *latifolia* Chiov. (1916)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. virescens Lindl. var. *leopoldii* (Van Houtte ex Lem.) T.Durand & Schinz (1894)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. virescens Lindl. var. *petersiana* (Klotzsch ex Garcke) T.Durand & Schinz (1894)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. virescens Lindl. var. *plantii* (Planch.) T.Durand & Schinz (1894)	***G. simplex*** L.	Maroyi & van der Maesen 2012
G. virescens Lindl. var. *platyphylla* (Klotzsch ex Garcke) T.Durand &	***G. simplex*** L.	Maroyi & van der Maesen 2012

Schinz (1894)		
G. verschuurii Hoog (1950)	Horticultural cultivar of ***G. superba*** L.	
Littonia baudii A.Terrac. (1892)	***G. baudii*** (Terracc.) Chiov.	Cufodontis 1971; Sebsebe Demissew 1997
L. flavovirens Dammer (1912)	***G. flavovirens*** (Dammer) J.C.Manning & Vinnersten	Vinnersten & Manning 2007
L. grandiflora De Wild. & T.Durand	***G. katangensis***Maroyi nom. nov	
L. hardeggeri Beck (1888)	***G. revoilii*** (Franch.) J.C.Manning & Vinnersten	Maroyi & van der Maesen 2012
L. lindenii Baker (1898)	***G. lindenii*** (Baker) J.C.Manning & Vinnersten	Vinnersten & Manning 2007
L. littonioides (Welw. ex Baker) K.Krause (1921)	***G. littonioides*** (Welw. ex Baker) J.C.Manning & Vinnersten	Vinnersten & Manning 2007
L. keiti Leichtlin (1883)	***G. revoilii*** (Franch.) J.C.Manning & Vinnersten	Maroyi & van der Maesen 2012
L. minor Deflers (1886)	***G. revoilii*** (Franch.) J.C.Manning & Vinnersten	Maroyi & van der Maesen 2012
L. modesta Hook. (1853)	***G. modesta*** (Hook.) J.C.Manning & Vinnersten	Vinnersten & Manning 2007
L. modesta Hook. var. β *keiti* Leichtlin (1885)	***G. modesta*** (Hook.) J.C.Manning & Vinnersten	Maroyi & van der Maesen 2012
L. obscura Baker (1894)	***G. revoilii*** (Franch.) J.C.Manning & Vinnersten	Maroyi & van der Maesen 2012
L. revoilii Franch. (1882)	***G. revoilii*** (Franch.) J.C.Manning & Vinnersten	Vinnersten & Manning 2007
L. rigidifolia Bredell (1936)	***G. rigidifolia*** (Bredell) J.C.Manning & Vinnersten	Vinnersten & Manning 2007
L. welwitschii Benth. & Hook.f. (1883)	***G. littonioides*** (Welw. ex Baker) J.C.Manning & Vinnersten	Maroyi & van der Maesen 2012
Mendoni superba (L.) Adans. (1763)	***G. superba*** L.	Maroyi & van der Maesen 2012
Methonica abyssinica (A. Rich.) Walpers (1852)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. doniana (Schult. & Schult.f.) Kunth (1843)	***G. superba*** L.	Baker 1879, 1898
M. gloriosa Salisb. (1812)	***G. superba*** L.	Maroyi & van der Maesen 2012
M. grandiflora Hook. (1860)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. leopoldii van Houtte ex Lem. (1846)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. malaborum Herman (1687)	***G. superba*** L.	Maroyi & van der Maesen 2012
M. petersiana Klotzsch ex Garcke (1863)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. plantii Planch. (1854)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. platyphylla Klotzsch ex Garcke (1863)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. superba (L.) Crantz (1766)	***G. superba*** L.	Baker 1898; Jessop 1983
M. superba (L.) var. β Lam. (1796)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. superba (L.) Kunth (1843)	***G. superba*** L.	Baker 1879
M. virescens (Lindl.) Kunth (1843)	***G. simplex*** L.	Maroyi & van der Maesen 2012
M. virescens (Lindl.) Kunth var.	***G. simplex*** L.	Maroyi & van der Maesen

plantii Planch. (1855)		2012
Sandersonia littonioides Welw. ex Baker (1878)	***G. littonioides*** (Welw. ex Baker) J.C.Manning & Vinnersten	Maroyi & van der Maesen 2012

Chapter 8

General discussion

Gloriosa simplex **L., characterised by broad, not crisped perianth segments, photograph taken by Prof. L.J.G. van der Maesen, 197 km out of Bulawayo towards Victoria Falls, Zimbabwe**

Introduction

The present study on the ethnobotany, phylogeny and taxonomy of the genus *Gloriosa* L. has made significant and much needed contribution to the better understanding of this popular genus. The genus *Gloriosa* comprises the following twelve species:

1. *G. baudii* (Terracc.) Chiov.
2. *G. carsonii* Baker
3. *G. flavovirens* (Dammer) J.C.Manning & Vinnersten
4. *G. lindenii* (Baker) J.C.Manning & Vinnersten
5. *G. littonioides* (Welw. ex Baker) J.C.Manning & Vinnersten
6. "*G. katangensis* Maroyi nom. nov."
7. *G. modesta* (Hook.) J.C.Manning & Vinnersten
8. *G. revoilii* (Franch.) J.C.Manning & Vinnersten
9. *G. rigidifolia* (Bredell) J.C.Manning & Vinnersten
10. *G. sessiliflora* Nordal & Bingham
11. *G. simplex* L.
12. *G. superba* L.

Gloriosa species are perennial herbs, with the majority of species (83%) occurring in South Africa and tropical Africa; and only two species (17%) recorded outside this distributional range. These two species are *G. superba* and *G. revoilii*. *G. superba* has also been recorded in tropical Asia and Indo-China. *G. revoilii* has also been recorded in south Yemen. Six species of the genus (50%) are endemic or near endemic. *G. rigidifolia* is an endemic species, confined to Waterberg, Transvaal region of South Africa. *G. flavovirens* is an endemic species, confined to the Malange region of Angola. "*G. katangensis"* is also another endemic species confined to the Lukavu region, Katanga, Democratic Republic of Congo. *G. revoilii* is a near-endemic, occurring in Djibouti, Ethiopia, Somalia and south Yemen. *G. baudii* is another near-endemic confined to the arid regions of Ethiopia, Kenya and Somalia. *G. sessiliflora* is also a near-endemic, originally described from Zambia, but is here recorded for the first time in the Bié region of Angola. All other species are fairly widespread in tropical Africa and South Africa, with a major concentration of the species in south-central Africa. The findings of this research are discussed below in terms of their economic, ethnobotanical, phylogenetic and taxonomic value.

Economic and ethnobotanical importance of *Gloriosa*

The genus *Gloriosa* is economically important with some of its members used as horticultural plants and as traditional medicine. The early botanical exploration of the tropics resulted in a number of *Gloriosa* species being taken into cultivation in Europe and America. Examples of such species that are important on the horticultural market and as ornamental plants are *G. carsonii, G. modesta, G. simplex* and *G. superba*. *G. superba* is cultivated throughout the world in several botanical and private gardens as an ornamental plant. It has escaped from cultivation and is now an environmental weed in a number of countries, among them are Australia (Conran 1987, Le Cussan 2006), Fiji (Wright *et al.* 2005), Réunion-Mascarene Archipelago (Tassin *et al.* 2007), Lord Howe Island (Orchard 1994), French Polynesia Society Islands (Welsh 1998), Karibati Line Islands (Wester 1985) and Solomon Islands (Hancork & Henderson 1988).

The study of ethnobotanical uses of *G. superba* throughout its distributional range was crucial and resulted in the documentation of how the species is utilised by different people of different cultural backgrounds. Many similarities in its use in different countries were noted. Major uses of *G. superba* in South Africa, tropical Africa and Asia included its use as an abortifacient, head lice killer, remedy for female sterility, snake bite antidote, murder poison, suicidal agent and culpable homicide (**Chapters 2 & 3**). Such similarities were also noted in vernacular names of the species. The Manding-Bambara people of Senegal call the species *donon tulu*, the Tumbuka cluster of Zambia / Malawi call it *nyaka-jongwe*, the Ndebele people of South Africa call it *amagugulume*, and the Ndebele and Shona people of Zimbabwe call it *amakukhulume* and *kajongwe* respectively. All these names are describing the resemblance of the flower structure and its colouration of red or purple and yellow to a cock's head. Such shared cultural heritage could be attributed to exchange of ethnobotanical information between different communities. For example, when *G. superba* was introduced in Australia, its common name was also passed on to the local community. Its English common name in Australia is Rhodesian Flame Lily, the name describing its native country of origin, Rhodesia, now Zimbabwe.

The pharmacological studies conducted on *G. superba* indicate the immense potential of this species in the treatment of inflammatory, parasitic and bacterial ailments. Different pharmacological studies in a number of experiments have convincingly demonstrated the ability of *G. superba* to exhibit a wide range of pharmacological activities lending support to

the rationale behind several of its traditional ethnobotanical uses as detailed in **Chapters 2 & 3**. Traditional healers seem to be aware of its toxicity as the amounts they prescribe are such that toxic effects are minimised. On the basis of current information and evidence, *G. superba* extracts are characterised by instances of toxicity and therefore, the species should be used under supervision of a physician.

Species delimation in *G. superba* complex

Despite being such a common horticultural and ethnobotanically important plant species, species delimitation in *G. superba* complex remained problematic for a long time. Morphometric investigation using multivariate and univariate analyses were used in this study in an attempt to evaluate species delimitations in the *G. superba* complex. A morphological study using herbarium specimens, covering the entire geographical range of the species has revealed the existence of four phenetic species in the group. Recognition of these species is based on habit, inflorescence characters and distribution patterns. It is proposed that four species should be recognised in the *G. superba* complex: *G. baudii* (Terracc.) Chiov., *G. carsonii* Baker, *G. simplex* L. and *G. superba* L. *G. superba* is the most widespread taxon, occurring in subtropical-tropical Africa and Asia. *G. simplex*, *G. carsonii* and *G. baudii* are confined to the African continent; with *G. baudii* having the most restricted range, confined to the arid regions of northern Kenya, Ethiopia and Somalia. The concept of *G. superba* is revised on account of its morphological variation in South Africa, tropical Africa and Asia; distinguished from related species by having perianth segments that are narrower, all six more or less the same width and the margins highly crisped. *G. superba* links South Africa, tropical Africa with tropical Asia and Indo-China. This study has defined the species limits for the taxa, and a diagnostic key has been provided to separate the species.

Phylogeny and taxonomy of the genus *Gloriosa*

The species relationships within *Gloriosa* were considered uncertain, therefore, a phylogenetic analysis using chloroplast DNA data was considered necessary to properly understand the genus. The *trn*L-*trn*F region was amplified and the results compared with distribution, ecological and morphological characters. The phylogenetic results confirm the monophyly of the genus *Gloriosa* including the genus *Littonia* as it is currently known according to Vinnersten & Manning (2007). The maximum parsimony tree strongly supports

the recognition of three lineages with 100% bootstrap support. The phylogenetic analysis resolves *G. modesta* (= *Littonia modesta* Hook.) as a sister to the main clade of *G. revoilii* (= *Littonia revoilii* Franch.) nested within *Gloriosa s.s.* species. Within the main clade, *G. revoilii* and *G. baudii* (Terracc.) Chiov. formed a well supported clade. The two species are near-endemics, occurring in east Africa with *G. revoilii* extending into south Yemen. The sister relationship of *G. baudii* and *G. revoilii* gets additional support from morphological characteristics as the two species are very similar, and can only be distinguished using floral characters based on tepals and the style. The third clade comprises species of the *G. superba* L. complex and *G. sessiliflora*, a species said to be intermediate between the genera *Gloriosa* and *Littonia*. This unexpected result showing close affinity between *G. sessiliflora* and *G. superba* complex species gets support from morphological characters. According to Nordal & Bingham (1998), *G. sessiliflora* is indistinguishable from the other forms within the *G. superba* complex in general habit.

The enlarged *Gloriosa* genus is distributed in South Africa, tropical Africa and Asia. It is characterised by tunicate underground corms with fibrous roots, parallel-veined leaves, often with a distinct midrib. An apical, coiled tendril is usually present, with erect plants lacking tendrils. Leaves are cauline, sessile or shortly petiolate and often sheathing, tubular cataphyll protracted or not protracted into a leaf blade. Pedicels are usually axillary or completely absent. Flowers are pendulous, nodding or sometimes resupinate and brightly coloured, straight or recurved apically. Perianth segments shortly connate, forming a small tube, otherwise free, nectariferous and obscurely pouch-shaped at the base sometimes with white hairs. The seeds are globose, fleshy, red or orange in colour.

Concluding remarks

Before this study, the major concern about the genus *Gloriosa* was that its taxonomy and phylogeny was poorly understood. The long list of synonyms and the confusing taxonomic history of the genus, illustrate the apparent taxonomic complexity of the genus. The current study has information on ethnobotanical uses, phylogeny, species delimitations and boundaries; and morphological characters that can be used in the construction of diagnostic keys. Considerable progress has been made in the past in reconstructing evolutionary relationships between taxa in the Colchicaceae family, and the present study is a contribution towards this goal. The phylogenetic analysis of approximately 58% of the species of *Gloriosa*

led to a well supported topology of the genus. According to the phylogenetic tree presented in this thesis, the genus *Gloriosa* as currently defined is monophyletic.

The taxonomic history of *Gloriosa*, its ethnobotany, economic and horticultural value are closely linked. And recently, conservation concerns for *G. superba* have been raised in Bangladesh, India and Zimbabwe. *G. superba* is emerging as a commercial source of colchicine, horticultural plant, as both out door plant and cut-flower. There is evidence that *G. superba* might be useful in the treatment of several human ailments. Considering the amount of ethnobotanical information documented in this thesis, there is no doubt that *G. superba* has not been fully exploited as a source of useful products. This species and its allied taxa deserves more recognition and research from an economic, phylogenetic and taxonomic standpoint.

Suggestions and recommendations for future research:

- As in any study, there were some taxa which were consistently difficult to amplify and sequence. Of particular interest in future phylogenetic studies would be the inclusion of *G. flavovirens, G. lindenii, G. littonioides, G. katangensis* and *G. rigidifolia*, which were difficult to amplify due to use of old herbarium material.

- The sequencing of additional chloroplast regions to *trn*L-*trn*F, which was used in this study and also used in the phylogenetic study of the family Colchicaceae by Vennersten & Reeves (2003) would contribute to a more robust dataset. Likewise, the use of nuclear DNA dataset is also likely to further clarify phylogenetic relationships in the genus. With well resolved basal relationships between clades, questions about *Gloriosa*'s biogeography can be answered. For example, where and when did *Gloriosa* originate, and what factors have contributed to its widespread distribution? Has vicariance or dispersal played a more prominent role in creating this intercontinental distribution?

- Ethnobotanical, horticultural and economic importance of *Gloriosa* species such as *G. modesta* and *G. superba* needs to be quantified.

References

Adanson, M. 1763. *Familles de plantes,* vol. 2. Vincent, Paris.

Ade, R. & Rai, M.K. 2010. Review: colchicine, current advances and future prospects. *Nus. Biosci.* **2**: 90-96.

Ade, R. & Rai, M.K. 2009. Review: current advances in *Gloriosa superba* L. *Biodivers*. **10**: 210-214.

Agunawella, R.M. & Fernando, H.A. 1971. Acute ascending polyneuropathy and dermatitis following poisoning by tubers of Gloriosa superba. *Ceylon Med. J*. **16**: 233-235.

Aleem, H.M. 1992. Gloriosa superba poisoning. *J. Assoc. Physicians India* **40**: 541-542.

Ambasta, S.P. 1986. *The useful plants of India*. National Institute of Science Communication, Council of Scientific and Industrial Research, New Delhi.

Andrews, F.W. 1956. *The flowering plants of the Sudan*. Vol. iii: Compositae-Gramineae. T. Buncle & Co., Arbroath.

A.P.G. [= Angiosperm Phylogeny Group] III. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Bot. J. Linn. Soc.* **161**: 105-121.

Backlund, A. & Bremer, K. 1998. To be or not to be: principles of classification and monotypic plant families. *Taxon* **47**: 391-400.

Bagavan, A., Kamaraj, C., Elango, G., Abduz Zahir, A. & Abdul Rahuman, A. 2009. Adulticidal and larvicidal efficacy of some medicinal plant extracts against tick, fluke and mosquitoes. *Vet. Parasitol*. **166**: 286-292.

Baker, J.G. 1879. A synopsis of Colchicaceae and the aberrant tribes of Liliaceae. *Bot. J. Linn. Soc.* **17**: 405-510.

Baker, J.G. 1897. Liliaceae. Pp. 253-567 in: Thiselton Dyer, W.T. (ed.), *Flora Capensis 6.* Lovell Reeve & Co. Ltd., London.

Baker, J.G. 1898. Liliaceae. Pp. 385-568 in: Thiselton Dyer, W.T. (ed.), *Flora of Tropical Africa 7.* Lovell Reeves & Co. Ltd., London.

Barrett, S.C.H. 1992. Gender variation and the evolution of dioecy in *Wurmbea dioica* (Liliaceae). *J. Evol. Biol*. **5**: 423-444.

Bell, C.R. 1958. *Index to plant chromosome numbers for 1956*. University of North Carolina Press, Chapel Hill, N.C.

Berhaut, J. 1967. Gloriosa. P. 257 in: Berhaut, J. (ed.), *Flore du Sénégal*. ed. 2. Clairafrique, Dakar.

References

Bhargava, N. 1983. Ethnobotanical studies of the tribes of Andaman and Nicobar Islands, India. I. Onge. *Econ. Bot*. **37**: 110-119.

Bingham, M.G. & Smith, P.P. 2002. Zambia: red data list. Pp. 135-156 in: Golding, J.S. (ed), *Southern African plant red data list*. Southern African Botanical Diversity Network Report No. 14. SABONET, Pretoria.

Birky, C.W. Jr. 1995. Uniparental inheritance of mitochondrial and chloroplast genes: mechanisms and evolution. *Proc. Natl. Acad. Sci. USA* **92**: 11331-11338.

Blatter, E. 1914. Littonia Hook. Pp. 343-344 in: Blatter, E. (ed.), *Flora of Aden*. Superintendent Government Printing, Calcutta.

Blundell, M. 1987. *Collins guide to the wild flowers of East Africa*. Collins, London

Bose, T.K., Yadav, L.P., Pal, P., Parthasarathy, V.A. & Das, P. 2003. *Commercial flowers*. Naya Udyog, Kolkata.

Botha, C.J. & Penrith, M.L. 2008. Poisonous plants of veterinary and human importance in southern Africa. *J. Ethnopharmacol*. **119**: 549-558.

Brummitt, R.K. & Powell, C.E. 1992. *Authors of plant names*. Royal Botanic Gardens, Kew.

Brunell, M.S. & Whitkus, R. 1999. Assessment of morphological variation in *Eriastrum densifolium* (Polemoniaceae): implications for subspecies delimitation and conservation. *Syst. Bot.* **23**: 351-368.

Bruneton, J. 1999. *Toxic plants dangerous to humans and animals*. Intercept, Hampshire.

Bryant, A.T. 1966. *Zulu medicine and medicine-men*. C. Struk Press, Cape Town.

Bunce, M., Szulkin, M., Lerner, H.R.L., Barnes, I. & Shapiro, B. 2005. Ancient DNA provides new insights into the evolutionary history of New Zealand's extinct giant eagle. *PloS Biol.* **3**: 44-46

Bunyapraphatsara, N. & van Valkenburg, J.L.C.H. 1999. *Gloriosa superba* L. Pp. 289-292 in: de Padua, L.S., Bunyapraphatsara, N. & Lemmens, R.H.M.J. (eds.), *Plant resources of South-East Asia: medicinal and poisonous plants 12*. Backhuys Publishers, Leiden.

Burge, G.K., Morgan, E.R., Eason, J.R., Clark, G.E., Catley, J.L. & Seelye, J.F. 2008. *Sandersonia aurantiaca*: domestication of a new ornamental crop. *Scient. Hort*. **118**: 87-99.

Burkill, H.M. 1995. *The useful plants of West Tropical Africa 3.* Families J-L. Royal Botanic Gardens, Kew.

Buxbaum, F. 1937. Die Entwicklungslinien der Lilioideae. ii. Die Wurmbaeoideae. *Bot. Arch.* **38**: 305-398.

References

Buxbaum, F. 1936. Die Entwicklungslinien der Lilioideae. i. Die Wurmbaeoideae. *Bot. Arch.* **38**: 213-293.

Buxbaum, F. 1925. Vergleichende anatomie der Melanthoideae. *Feddes Repert., Beiheft* **29**: 1-80.

Case, A.L., Graham, S.W., Macfarlane, T.D. & Barrett, S.C.H. 2008. A phylogenetic study of evolutionary transitions in sexual systems in Australasian *Wurmbea* (Colchicaceae). *Int. J. Plant Sci.* **169**: 141-156.

Caujapé-Castells, J., Jansen, R.K., Membrives, N., Pedrola-Monfort, J., Montserrat, J.M. & Ardanuy, A. 2008. Historical biogeography of *Androcymbium* Willd. (Colchicaceae) in Africa: evidence from cpDNA RFLPs. *Bot. J. Linn. Soc.* **136**: 379-392.

Caujapé-Castells, J., Jansen, R.K., Pedrola-Monfort, J. & Membrives, N. 1999. Chloroplast DNA restriction site phylogeny of the genus *Androcymbium* (Colchicaceae). *Syst. Bot.* **24:** 581-597.

Cave, M.S. 1962. *Index to plant chromosome numbers for 1961*. Chapel Hill, N. C., University of North Carolina Press.

Cave, M.S. 1963. *Index to plant chromosome numbers for 1962*. Chapel Hill N. C., University of North Carolina Press.

Cerquaglia, C., Diaco, M., Nucera, G., La Regina, M., Montalto, M. & Manna, R. 2005. Pharmacological and clinical basis of treatment of Familial Mediterranean Fever (FMF) with colchicine or analogues: an update. *Curr. Drug Targets Inflamm. Allergy* **4**: 117-124.

Chambers, R. 1992. *Rural appraisal: rapid, relaxed and participatory*. Discussion paper 311. Institute of Development Studies, University of Sussex, Sussex.

Chase, M.W. *et al*. 1993. Phylogenetics of seed plants: an analysis of nucleotide sequences from the plastid gene *rbc*L. *Ann. Missouri Bot. Gard.* **80**: 528-580.

Chase, M.W., Duvall, M.R., Hills, H.G., Conran, J.G., Cox, A.V., Eguiarte, L.E., Hartwell, J., Fay, M.F., Caddick, L.R., Cameron, K.M. & Hoot, S. 1995. Molecular phylogenetics of Lilianae. Pp. 109-137 in: Rudall, P.J., Cribb, P.J., Cutler, D.F. & Humphries, C.J. (eds.), *Monocotyledons: systematics and evolution*. Royal Botanic Gardens, Kew.

Chopda, M.Z. & Mahajan, R.T. 2009. Wound healing plants of Jalgaon District of Maharashtra State, India. *Ethnobot. Leaflets* **13**: 1-32.

Chopra, R.N., Nayar, S.L. & Chopra, I.C. 1956. *Glossary of Indian medicinal plants*. Council of Scientific and Industrial Research, New Dehli.

References

Clewer, H.W.B., Green, S.J. & Tutin, F. 1915. The constituents of Gloriosa superba. *J. Chem. Soc.* **107**: 835-846.

Cohen, L. & Manion, L. 1989. *Research methods in education*. Routledge, London & New York.

Conran, J.G. 1987. Gloriosa. in: George, A.S. (ed.), *Flora of Australia 45*. Hydatellaceae to Liliaceae. Australian Government Publishing Service, Canberra.

Conran, J.G. 1985. Family distributions in the Liliiflorae and their biogeographical implications. *J. Biogeogr*. **22**: 1023-1034.

Cracraft, J. 1983. Species concepts and speciation analysis. *Curr. Ornith*. **1**: 159-187.

Crantz, H.J.N. 1766. *Institutiones rei herbariae*. Luxemburg, Viennae.

Cron, G.V., Balkwill, K. & Knox, E.B. 2007. A multivariate analysis of variation in *Cineraria lobata* L'Hér. and *C. ngwenyensis* Cron. *S. Afr. J. Bot.* **73**: 530-545.

Cufodontis, G. 1971. Enumeratio plantarum Aethiopiae spermatophyta. *Bull. Jard. Bot. Nat. Belg.* **41**: 1525-1528.

Dahlgren, R.M.T. 1975. A system of classification of the angiosperms to be used to demonstrate the distribution of characters. *Bot. Notiser* **128**: 119-147.

Dahlgren, R.M.T. 1980. A revised system of classification of the angiosperms. *Bot. J. Linn. Soc.* **80**: 91-124.

Dahlgren, R.M.T., Clifford, H.T. & Yeo, P.F. 1985. *The families of the monocotyledons: structure, evolution and taxonomy*. Springer Verlag, Berlin.

Dalziel, J.M. 1955. Useful plants of West Tropical Africa. Appendix in: Hutchinson, J. & Dalziel, J.M. (eds.), *Flora of West Tropical Africa*. Crown Agents for Overseas Governments and Administrations, London.

Dasheiff, R.M. & Ramirez, L.F. 1985. The effects of colchicine in mammalian brain from rodents to rhesus monkeys. *Brain Res.* **357**: 47-67.

Da Silva, M.C., Izidine, S. & Amude, A.B. 2004. A preliminary checklist of the vascular plants of Mozambique. Southern African Botanical Diversity Network Report No. 30. SABONET, Pretoria.

Dassanayake, M.D. 2000. Colchicaceae. Pp. 112-115 in: Dassanayake, M.D. & Clayton, W.D. (eds.), *A revised handbook to the Flora of Ceylon XIV*. A.A. Balkema / Rotterdam / Brookfield.

Davis, P.H. & Heywood, V.H. 1967. *Principles of angiosperm taxonomy*. Oliver & Boyd, Edinburgh & London.

de Candolle, A.P. 1805. Colchicaceae. Pp. 192-193 in: M.M. Lamarck & A.P. de Candolle (eds.), *Flore française 3.* Stoupe, Paris.

Del Hoyo, A., García-Marín, J.L. & Pedrola-Montfort, J. 2009. Temporal and spatial diversification of the African genus *Androcymbium* (Colchicaceae). *Mol. Phylog. Evol*. **53**: 848-861.

Del Hoyo, A. & Pedrola-Montfort, J. 2008. Phylogenetic of *Androcymbium* (Colchicaceae) based on morphology and DNA sequences. *Plant Syst. Evol.* **273**: 151-167.

Del Hoyo, A. & Pedrola-Monfort, J. 2006. Missing links between disjunct populations of *Androcymbium* (Colchicaceae) in Africa using chloroplast DNA noncoding sequences. Pp. 604-616 in: Columbus, J.T., Friar, E.A. Porter, J.M., Prince, L.M. & Simpson, M.G. (eds.), *Monocots: comparative biology and evolution 1*. Rancho Santa Ana Botanic Garden, Claremont, California.

De Queiroz, K. & Donoghue, M.J. 1988. Phylogenetic systematics and the species problem. *Cladistics* **4**: 317-338.

Deroles, S.C., Seelye, J.F., Javellana, J. & Mullan, A.C. 2010. In vitro propagation of *Sandersonia aurantiaca* Hook. using thidiazuron. *Plant Cell Tiss. Organ. Cult*. **102**: 115-119.

de Tournefourt, J.P. 1707. Acta gallica: 86, t. 7, f. 5

Donoghue, M.J. 1985. A critique of the biological species concept and recommendations for a phylogenetic alternative. *The Bryologist* **88**: 172-181.

Doreen, W.F. 1997. *Sandersonia aurantiaca*: a new crop with economic potential. *Acta Hort.* **430**: 727-730.

Dounias, E. 2006. *Gloriosa superba* L. In: Schmelzer, G.H. & Gurib-Fakim, A. (eds.). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands. http://database.prota.org/search.htm. [accessed 30 Apr. 2011].

Downing, T.L., Duretto, M.F. & Ladiges, P.Y. 2004. Morphological analysis of the *Grevillea ilicifolia* complex (Proteaceae) and recognition of taxa. *Aust. Syst. Bot.* **17**: 327-341.

Doyle, J.J. & Doyle, J.L. 1987. A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochem. Bull*. **19**: 11-15.

Dunuwille, R., Balasubramanian, K. & Bibile, S.W. 1968. Toxic principles of Gloriosa superba. *Ceylon J. Med. Sci*. **17**: 1-6.

Dyer, R.A. 1976. *The genera of Southern African flowering plants 2: gymnosperms and monocotyledons.* Department of Agricultural Technical Services, Pretoria.

References

Dyer, R.A., Verdoorn, I.C. & Codd, L.E. 1962. Pp. 17-20 in: Letty, C. (ed.), *Wild Flowers of Transvaal*. Division of Botany, Department of Agriculture, Pretoria.

Eddleston, M. 2000. Patterns and problems of deliberate self-poisoning in the developing world. *Q. J. Med.* **93**: 715-731.

Ehrhart, C. 2005. The Chilean *Calceolaria integrifolia* s.l. species complex (Scrophulariaceae). *Syst. Bot.* **30**: 383-411.

Eliovson, S. 1973. *South African wild flowers for the garden*. Macmillan, Johannesburg.

FAO 1989. *The community tool box: Ideas, methods and tools for participatory analysis, monitoring and analysis in community forestry*. Community Forestry Note 2. Rome, FAO.

Farooqi, A.A. & Sreeramu, B.S. 2001. *Cultivation of medicinal and aromatic crops*. Universities Press (India), Private Limited, Bangalore.

Farris, J.S. 1989. The retention index and homoplasy excess. *Syst. Zool.* **38**: 406-407.

Fernando, C. 2001. Poisoning due to *Abrus precatorius* (jequirity bean). *Anaesth*. **56**: 1178-1180.

Fernando, R. & Fernando, D. 1990. Poisoning with plants and mushrooms in Sri Lanka: a retrospective hospital based study. *Vet. Hum. Toxicol*. **32**: 579-581.

Field, A. 2009. *Discovering statistics using SPSS.* Sage Publication Ltd, London.

Field, D.V. 1971. The identity of *Gloriosa simplex* L. (Liliaceae). *Kew Bull.* **25**: 243-245.

Field, D.V. 1972. The genus *Gloriosa*, Lilies and Other Liliaceae 1973: 93-95.

Figueiredo, E. & Smith, G.F. 2008. *Plants of Angola*. Strelitzia 22. South African National Biodiversity Institute, Pretoria.

Finnie, J.F. & Van Staden, J. 1996. *Sandersonia aurantiaca* Hook. (Christmas bells): micropropagation and in vitro production of Colchicine. Pp. 355-369 in: Bajaj, Y.P.S. (ed.), *Biotechnology in agriculture and forestry:medicinal and aromatic plants IX.* Springer Verlag, Berlin.

Finnie, J.F. & Van Staden, J. 1994. *Gloriosa superba* L. (Flame Lily): micropropagation and *in vitro* production of colchicine. Pp. 147-166 in: Bajaj, Y.P.S. (ed.), *Biotechnology in agriculture and forestry: medicinal and aromatic plants X.* Springer Verlag, Berlin.

Finnie, J.F. & Van Staden, J. 1991. Isolation of colchicine from *Sandersonia aurantica* and *Gloriosa superba*: variation in the alkaloid level of plants grown in vivo. *J. Pl. Phys.* **138**: 691-695.

Fitch, W.M. 1971. Toward defining the course of evolution: minimum change for a specified tree topology. *Syst. Zool.* **20**: 406-416.

References

Fowler, D.G. 2007. *Zambian plants: their vernacular names and uses.* Royal Botanic Gardens, Kew.

Gandhi, K.N. 1976. *Gloriosa* Linnaeus. Pp. 797 in: Saldanha, C. J. & Nicolson, D. H. (eds.). *Flora of Hassan District, Karnataka, India*. Amerind Publishing Co., Pvt. Ltd., New Delhi.

Ganesan, S., Pandi, N.R. & Banumathy, N. 2007. Ethnomedicinal survey of Alagarkoil hills (reserved forest), Tamil Nadu, India. *Elect. J. Indian Med*. **1**: 1-19.

Geerinck, D.J.L. 2010. Colchicaceae. Pp. 23-26 in Sosef, M.S.M., Florence, J., Banak, L.N. & Bourobou, H.P.B. (eds.). *Flore du Gabon 41*. Margraf Publishers, Weikersheim.

Geetha, S., Poornima, S. & Vaseegari, J. 2007. Studies on the ethnobotany of Irulars of Anaikatty hills, Coimbatore District. *Coll. Sci. India* **1**: 1-20.

Gelfand, M., Drummond, R.B., Mavi, S. & Ndemera, B. 1985. *The traditional medical practitioner in Zimbabwe: his principles of practice and pharmacopoeia*. Mambo Press, Gweru.

Ghani, A. 1998. *Medicinal plants of Bangladesh: chemical constituents and uses*. Asiatic Society of Bangladesh, Dhaka.

Gilmore, M.R. 1932. Importance of ethnobotanical investigation. *Am. Anthr.* **34**: 320-327.

Goldblatt, P. 1978. An analysis of the flora of Southern Africa: its characteristics, relationships, and origins. *Ann. Missouri Bot. Gard*. **65**: 369-436.

Grant, V. 1957. The plant species in theory and practice. Pp. 39-80 in: Mayr, E. (ed.), *The species problem*. A.A.A.S., Washington D.C.

Groves, R.H., Boden, R. & Lonsdale, W.M. 2005. *Jumping the garden fence: invasive garden plants in Australia and their environmental and agricultural impacts.* CSIRO report prepared for WWF-Australia. WWF-Australia, Sidney.

Haerdi, F. 1964. Die eingeborenen-Heilpflanzen des Ukanga-Distriktes Tanganjikas (Ostafrica). *Acta Trop. (Suppl.)* **8**: 1-278.

Hancock, I.R. & Henderson, C.P. 1988. *Flora of the Solomon Islands*. Research bulletin No. 7. Ministry of Agriculture and Lands, Honiara.

Harborne, J.B., Baxter, H. & Moss, G.P. 1997. *Dictionary of plant toxins*. John Wiley & Sons, Chichester.

Hartung, E.F. 1954. History of the use of colchicine and related medicaments in gout. *Ann. Rheum. Dis.* **13**: 190-199.

Hassan, S.A.K.M. & Roy, S.K. 2005. Micropropagation of *Gloriosa superba* L. through high frequency shoot proliferation. *Plant Tis. Cult*. **15**: 67-74.

References

Hegnauer, R. 1963. *Chemotaxonomie der pflanzen. ii. Monocotyledons.* Macmillan, London.

Hemaiswarya, S., Raja, R., Anbazhagan, C. & Thiagarajan, V. 2009. Antimicrobial and mutagenic properties of the root tubers of Gloriosa superba Linn. (Kalihari). *Pak. J. Bot.* **41**: 293-299.

Hepper, F.N. 1968. Gloriosa Linn. Pp. 351 in: Hepper, F.N. (ed.), *Flora of West Tropical Africa 3*. ed 2. Crown Agents for Overseas Government and Administration, London.

Herklots, G. 1976. *Flowering tropical climbers*. Dawson Science History Publications, Folkestone, Kent.

Herman, P. 1687. Horti academici lugduno-batavi catalogus 688, t. 689. Cornelius Boutesteyn, Leiden.

Hill, C.R. & P.R. Crane. 1982. Evolutionary cladistics and the origin of angiosperms. Pp. 269-362 in: Joysey, K.A. & Friday, A.E. (eds.), *Problems of phylogenetic reconstruction*. Academic Press, London.

Hillis, D.M. & Bull, J.J. 1993**.** An empirical test of bootstrapping as a method for assessing confidence in phylogenetic analysis. *Syst. Biol.* **42**: 182-192.

Hillebrand, W. 1888. *Flora of the Hawaiian Islands: a description of their phanerogams and vascular cryptogams*. Williams & Norgate, London.

Hochstetter, C.F.F. 1844*. Nova genera plantarum Africaetum Australistrum tropicae borealis (Flora 26).* Esslingen, Regensburg.

Hoenselaar, K. 2005. Colchicaceae. Pp. 1-20 in: Beentje, H.J. & Ghazanfar, S.A. (eds.), *Flora of Tropical East Africa*. Royal Botanic Gardens, Kew.

Holmgren, P.K., Holmgren, N.H. & Barnett, L.C. 1990. Index Herbariorum, part I: the herbaria of the world. *Regnum Vegetabile* **120**: 1-693.

Hoog, T. 1950. A new Gloriosa (G. verschurii). *J. Royal Hort. Soc*. **75**: 22-23.

Hooker, J.D. 1853. Littonia modesta. *Bot. Mag*. **79**: Table 4723.

Hooker, J.D. 1894. Gloriosa Linn. Pp. 358 in: Hooker, J.D. (ed.), *Flora of British India VI.* L. Reeve & Co. Ltd., NR. Ashford, Kent

Huber, H. 1969. Die sSmenmerkermale und Verwandtschaftsverhaltnisse der Liliiflorae. *Mitt. Bot. Staatssamml. München* **8**: 219-538.

Hull, D.L. 1976. Are species really individuals? *Syst. Zool.* **25**: 174-191.

Humphries, C.J. & Parenti, L. 1999. *Cladistic biogeography*. Oxford University Press, Oxford.

Hutchinson, J. 1934. *The families of flowering plants 2.* Macmillan, London.

Hutchinson, J. 1959. *The families of flowering plants 2.* 2nd ed. Macmillan, London.

IPNI (International Plant Name Index). 2011. http://www.ipni.org [accessed 21 April 2011].

IUCN Standards and Petitions Subcommittee. 2010. Guidelines for using the IUCN red list categories and criteria version 8.1. http://www.iucnredlist.org. [accessed 1 Oct. 2011].

Iwu, M.M. 1993. *Handbook of African medicinal plants*. CRC Press, Boca Raton, Florida.

Jagtap, S.D., Deokule, S.S. & Bhosle, S.V. 2006. Some unique ethnomedicinal uses of plants used by the Korku tribe of Amravati District of Maharashtra, India. *J. Ethnopharmacol.* **107**: 463-469.

Jain, A., Katewa, S.S., Chaudhary, B.L. & Praveen, G. 2004. Folk herbal medicines used in birth control and sexual diseases by tribals of southern Rajasthan, India. *J. Ethnopharmacol.* **90**: 171-177.

Jana, S. & Shekhawat, G.S. 2011. Critical review on medicinally potent plant species: Gloriosa superba. *Fitoter.* **82**: 293-301.

Jessop, J.S. 1983. Gloriosa. Pp. 193-195 in: van Steenis, C.G.G.J. (ed.), *Flora Malesiana 9.* Martinus Nijhoff / Dr W. Junk Publishers, The Hague, Boston & London.

Jha, S., Bandyopadhyay, M., Chaudhuri, K.N., Ghosh, S. & Ghosh B. 2005. Biotechnological approaches for the production of forskolin, withanolides, colchicines and tylophorine. *Pl. Genet. Res.* **3**: 101-115.

John, J.C., Fernandes, J., Nandgude, T., Niphade, S.R., Savla, A. & Deshmukh, P.T. 2009. Analgesic and anti-inflammatory activities of the hydroalcoholic extract from Gloriosa superba Linn. *Int. J. Green Pharm.* **3**: 215-219.

Jokat, W., Boebel, T., König, M. & Meyer, U. 2003. Timing and geometry of early Gondwana breakup. *J. Geophys. Res.* **108**: 2428.

Joshi, C.S., Priya, E.S. & Mathela, C.S. 2010. Isolation and anti-inflammatory activity of colchicinoids from Gloriosa superba seeds. *Pharmaceut. Biol*. **48**: 206-209.

Joshi, P. 1993. Tribal remedies against snake bites and scorpion stings in Rajasthan. *Glimpses Pl. Res*. **10**: 23-25.

Kahraman, A. & Celep, F. 2010. Anatomical properties of *Colchicum kurdicum* (Bornm.) Stef. (Colchicaceae). *Aust. J. Crop Sci*. **4**: 369-371.

Kala, C.P., Farooquee, N. & Dhar, U. 2004. Prioritization of medicinal plants on the basis of available knowledge, existing practices and use value status in Uttaranchal, India. *Biodivers. Conserv*. **13**: 453-469.

Kapadia, V.H., Dev, S., Rao, R.S. & Ansari, M.Y. 1972. New sources of colchicine in *Iphigenia*. *Phytochemistry* **11**: 1193-1194.

Katewa, S.S., Chaudhary, B.L. & Jain, A. 2004. Folk herbal medicines from tribal area of Rajasthan, India. *J. Ethnopharmacol*. **92**: 41-46.

Kee, N.L.A., Mnonopi, N., Davids, H., Naudé, R.J. & Frost, C.L. 2008. Antithrombotic / anticoagulant and anticancer activities of selected medicinal plants from South Africa. *Afr. J. Biotech*. **7**: 217-223.

Khan, H., Khan, M.A. & Hussan, I. 2007. Enzyme inhibition activities of the extracts from rhizomes of Gloriosa superba Linn (Colchicaceae). *J. Enzyme Inhib. Med. Chem*. **6**: 722-725.

Khan, H., Khan, M.A., Mahmood, T. & Choudhary, M.I. 2008. Antimicrobial activities of Gloriosa superba Linn. (Colchicaceae) extracts. *J. Enzyme Inhib. Med. Chem*. **23**: 855-859.

Kluge, A.G. & Farris, J.S. 1969. Quantitative phyletics and the evolution of anurans. *Syst. Zool.* **18**: 1-32.

Kozak, D. 2002. Effect of medium components on in vitro tuberization of Gloriosa rothschildiana O'Brien. *Acta Hort*. **624**: 515-520.

Krause, J. 1986. Production of Gloriosa tubers from seeds. *Acta Hort.* **177**: 353-360.

Krause, K. 1930. Liliaceae. Pp. 227-386 in: Engler, A. & Prantl, K. (ed.), *Die natürlichen Pflanzenfamilien*. Engelmann, Leipzig.

Lamarck, J.B.P.A.M. 1796. *Encyclopédie méthodique botanique*. Panckoucke, Paris.

Lambert, J., Srivastava, J. & Vietmeyer, N. 1997. Medicinal plants: rescuing a global heritage. World Bank Technical Paper 355. World Bank, Washington, D.C.

Lather, A., Gupta, V., Garg, S., Singh, A. & Sachdeva, K. 2011. Pharmacological potential of the plants used in treatment of piles: a review. *J. Nat. Conscientia* **2**: 255-265.

Le Cussan, J. 2006. Eradication of invasive alien plants on Lord Howe Island, NSW using three *Asparagus* species (*Asparagus asparagoides* (L.) Druce, *A. plumosus* Baker and *A. aethiopicus* L.) as a case study. *Pl. Protect. Quart*. **21**: 117-121.

Linnaeus, C. 1737. *Genera plantarum*. Salvii, Stockholm.

Linnaeus, C. 1753. *Species plantarum*. Holmiae, Stockholm.

Lowrie, J. 1903. The gardeners' chronicle: 364.

Luckow, M. 1995. Species concepts: assumptions, methods, and applications. *Syst. Bot.* **20**: 589-605.

Lund, E.M. & Tallantire, A.C. 1962. *Some common flowering plants of Uganda*. Oxford University Press, Oxford.

Malpani, A.A., Aswar, U.M., Kushwaha, S.K., Zambare, G.N. & Bodhankar, S.L. 2011. Effect of the aqueous extract of Gloriosa superba Linn. (Langli) roots on reproductive system and cardiovascular parameters in female rats. *Trop. J. Pharm. Res*. **10**: 169-176.

Manandhar, N.P. 2002. *Plants and people of Nepal*. Timber Press, Portland.

Manen, J.-F., Natali, A. & Ehrendorfer, F. 1994. Phylogeny of *Rubiaceae-Rubieae* inferred from the sequence of a cpDNA intergene region. *Pl. Syst. Evol.* **190**: 195-211.

Manning, J., Forest, F. & Vinnersten, A. 2007. The Genus *Colchicum* L. redefined to include *Androcymbium* Willd. based on molecular evidence. *Taxon* **56**: 872-882.

Maradjo, M. 1977. *Flora Indonesia*. Karya Nusantara, Jakarta.

Maroyi, A. 2002. Colchicaceae in Zimbabwe. *Kirkia* **18**: 1-10.

Matos, J.A. 1995. *Pinus hartwegii* and *P. rudis*: a critical assessment. *Syst. Bot*. **20**: 6-21.

Matthew, B. 1995. Sinister glory. *Kew Summer 1995*: 36-39.

Maurya, R., Srivastava, S., Kulshreshta, D. & Gupta, C. 2004. Traditional remedies for fertility regulation. *Curr. Med. Chem*. **11**: 1431-1450.

Mavi, S. 1996. Medicinal plants and their uses in Zimbabwe. Pp. 67-73 in: Norman, H., Snyman, I. & Cohen, M. (eds.), *Indigenous knowledge and its uses in Southern Africa*. HSRC, Pretoria.

Maxwell, M.J., Muthu, P. & Pritty, P.E. 2002. Accidental colchicine overdose: a case report and literature review. *Emerg. Med. J*. **19**: 265-267.

McGaw, L.J. & Eloff, J.N. 2008. Ethnoveterinary use of southern African plants and scientific evaluation of their medicinal properties. *J. Ethnopharmacol*. **119**: 559-574.

McLoughlin, S. 2001. The breakup history of Gondwana and its impact on pre-Cenozoic floristic provincialism. *Aust. J. Bot.* **49**: 271-300.

Miles, M.B. & Huberman, A.M. 1994. *Qualitative data analysis: an expanded source book*. Sage, London.

Miller, P. 1768. *Gardener's dictionary*. 8th ed. P. Miller, London.

Mishler, B.D. & Donoghue, M.J. 1982. Species concepts: a case for pluralism. *Syst. Zool*. **31**: 491-503.

Modi, N.S. 1988. *Modi's textbook of medicinal jurisprudence and toxicology*. Tripathi Pvt (Ltd), Bombay.

Mors, W., Célia do Nascimento, M., Ruppelt, P.B. & Alvares, P.N. 2000. Plant natural products active against snake bite: the molecular approach. *Phytochem.* **55**: 627-642.

Mukhopadhyay, M.J., Mukhopadhyay, S. & Sen, S. 2002. *In vitro* propagation of *Iphigenia indica*, an alternative source of colchicines. *Plant Cell Tiss Org.* **69**: 101-104.

Nadkarni, A.K. 2002. *Indian materia medica*. Popular Prakashan limited, Mumbai.

Neuwinger, H.D. 1996. *African ethnobotany: Poisons and drugs, chemistry, pharmacology, toxicology.* Chapman & Hall, London [translated by the author and Aileen Porter].

Nidiry, E.S.J., Khan, R.M. & Reddy, P.P. 1993. *In vitro* nematicidal activity of *Gloriosa superba* seed extract against *Meloidogyne incognita*. *Nematol. Medit.* **21**: 127-128.

Nixon, K. & Wheeler, Q. 1990. An amplification of the phylogenetic species concept. *Cladistics* **6**: 211-223.

Nordal, I. & Bingham, M.G. 1998. Description of a new species, *Gloriosa sessiliflora* (*Colchicaceae*), with notes on the relationship between *Gloriosa* and *Littonia*. *Kew Bull*. **53**: 479-482.

Nordenstam, B. 1998. Colchicaceae. Pp. 175-185 in: Kubitzki, K. (ed.), *The families and genera of vascular plants 3.* Springer-Verlag, Berlin.

Nordenstam, B. 1986. The genus *Wurmbea* (Colchicaceae) in the Cape region. *Opera Bot.* **87**: 1-41.

Nordenstam, B. 1982. A monograph of the genus *Ornithoglossum* (Liliaceae). *Opera Bot.* **64**: 1-51.

Nordenstam, B. 1978. The genus *Wurmbea* in Africa except the Cape region. *Notes Roy. Bot. Gard. Edinb.* **36**: 211-233.

O'Brien, J. 1903. Gardeners' chronicle. Ser.3.33: 322-324.

O'Brien, J. 1904. Gardeners' chronicle. Ser.3.36: 127-128.

Orchard, A.E. 1994. *Flora of Australia: Oceanic Islands 49*. Australian Government Publishing Service, Canberra.

Otieno, D.F., Balkwill, K. & Paton, A.J. 2006. A multivariate analysis of morphological variation in the *Hemizygia bracteosa* complex (Lamiaceae, Ocimeae). *Pl. Syst. Evol*. **261**: 19-38.

Oxelman, B., Lidén, M. & Berglund, D. 1997. Chloroplast rps16 intron phylogeny of the tribe Sileneae (Caryophyllaceae). *Pl. Syst. Evol*. **206**: 393-410.

Pawar, B.M., Wavhal, V.P., Pawar, N.D., Agarwal, M.R., Shinde, P.B. & Kamble, H.V. 2010. Anthelmintic activity of Gloriosa superba Linn. *Int. J. Pharm. Tech. Res*. **2**: 1483-1487.

Persson, K. 2007. Nomenclatural synopsis of the genus Colchicum (Colchicaceae), with some new species and combinations. *Bot. Jahrb. Syst*. **127**: 165-242.

Phillips, E.T. 1930. Littonia modesta. Plate 366 in: Pole Evans, B. (ed.), *The flowering plants of South Africa 10*. L. Reeve & Co., Ltd., NR. Ashford, Kent.

Phiri, P.S.M. 2005. *A checklist of Zambian vascular plants*. Southern African Botanical Diversity Network Report No. 32. SABONET, Pretoria.

Pinheiro, F. & De Barros, F. 2009. Morphometric analysis of the *Brasiliorchis picta* complex (Orchidaceae). *Revista Brasil. Bot*. **32**: 11-21.

Polhill, R.M. 1962. Common perennial lilies of Kenya with ephemeral flowering shoots. *J. E. Afr. Nat. Hist. Soc.* **24**: 19-20.

Prakash, J.W., Anpin Raja, R.D., Anderson, N.A., Williams, C., Regini, G.S. & Bensar, K. 2008. Ethnomedicinal plants used by Kani tribes of Agasthiyarmalai biosphere reserve Southern western Ghats, India. *J. Trad. Knowl*. **7**: 410-413.

Prayoonrat, P. 2005. Biodiversity of medicinal weeds in Chonburi region, Thailand. *Acta Hort*. **675**: 23-29.

Queva, C. 1899. Contributions à l'anatomie des monocotylédonées. 1. Les Uvulariées tubereuses. *Trav. Mem. Univ. Lille* 7(22).

Quisumbing, E. 1978. *Medicinal plants of the Philippines*. Katha Publishing Inc., Quezon City.

Raffauf, R.F. 1970. *A handbook of alkaloids and alkaloid-containing plants*. Wiley Interscience, New York.

Rahmatullah, M., Noman, A., Hossan, M.S., Harun-Or-Rashid, M., Rahman, T., Chowdhury, M.H. & Jahan, R. 2009. A survey of medicinal plants in two areas of Dinajpur district, Bangladesh including plants which can be used as functional foods. *Am-Euras. J. Sustain. Agric.* **3**: 862-876.

Raimondo, D., von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. & Manyama, P.A. 2009. *Red List of South African Plants*. Strelitzia 25, South African National Biodiversity Institute, Pretoria.

Raina, R. & Gupta, L.M. 1999. Increasing seed yield in Glory Lily (Gloriosa superba): experimental approach. *Acta Hort.* **502**: 175-179.

Reynolds, A.F. & Oakley, J.C. 1984. The colchicine experimental epileptic focus: an intracellular study. *Brain Res.* **322**: 326-328.

Rigante, D., La Torraca, I., Avallone, L., Pugliese, A.L., Gaspari, S. & Stabile, A. 2006. The pharmacologic basis of treatment with colchicine in children with familial Mediterranean fever. *Eur. Rev. Med. Pharmacol. Sci.* **10**: 173-178.

Rivers, M.C., Taylor, L., Brummitt, N.A, Meagher,. T.R., Roberts, D.L. & Lughadha, E.N. 2011. How many herbarium specimens are needed to detect threatened species?. Biol. Conserv. doi:10.1016/j.biocon.2011.07.014.

Roberts, M. 1990. Indigenous healing plants. Southern Book Publishers, Halfway House.

Rohlf, F.J. 2002. NTSYS-pc. *Numerical taxonomy and multivariate analysis system*. V. 2.11a. Exeter Software, New York.

Rudall, P.J, Furness, C.A., Chase, M.W. & Fay, M.F. 1997. Microsporogenesis and pollen sulcus type in Asparagales (Lilianae). *Can. J. Bot.* **75**: 408-430.

Sahu, S.C., Dhal, N.K. & Mohanty, R.C. 2010. Potential medicinal plants used by the tribal of Deogarh District, Orissa, India. *Ethno Med.* **4**: 53-61.

Salisbury, R.A. 1796. *Prodromus stirpium in horto ad Chapel Allerton vigentium*, London.

Samarajeewa, P.K., Dassanayake, M.D. & Jayaawardena, S.D.G. 1993. Clonal propagation of Gloriosa superba L. *Indian J. Exp. Biol*. **31**: 719-720.

Samy, R.P., Thwin, M.M., Gopalakrishnakone, P. & Ignacimuthu, S. 2008. Ethnobotanical survey of folk plants for the treatment of snakebites in Nouthern part of Tamilnadu, India. *J. Ethnopharmacol*. **115**: 302-312.

Sandhya, B., Thomas, S., Isabel, W. & Shenbagarathai, R. 2006. Ethnomedicinal plants used by the Valaiyan community of Piranmalai Hills (reserved forest), Tamilnadu, India: a pilot study. *Afr. J. Trad. CAM.* **3**: 101-114.

Saralamp, P., Chuakul, W., Temsiririrkkul, R. & Clayton, T. 1996. *Medicinal plants in Thailand*. Siambooks and Publications Ltd, Bangkok.

Saravanapavananthan, T. 1985. Plant poisoning in Sri Lanka. *Jaffna Med. J.* **20**: 17-22.

Satri, B.N. 1956. *Wealth of India 4 (F-G)*. Council of Scientific and Industrial Research, New Delhi.

Savolainen, V., Manen, J.F., Douzery, E & Spichiger, R. 1994. Molecular phylogeny of families related to Celastrales based on rbcL 5' flanking sequences. *Molec. Phylog. Evol*. **3**: 27-37.

Schatz, G.E. 2000. Endemism in the Malagasy tree flora. Pp. 1-11 in: Lourenco, R., Goodman, S.M. (eds.), *Diversity and endemism in Madagascar*. Mémoires de la Societé de Biogéographie. Paris.

Schulze, W. 1975. Beiträge zur Taxonomie der Liliifloren. ii. Colchicaceae. *Wiss. Zeitschr. Friedrich Schiller-Univ. Jena Math. Nat. R*. **24**: 417-428.

Sebsebe Demissew. 1997. Colchicaceae. Pp. 184-189 in: Edwards, S., Sebsebe Demissew & Hedberg, I. (eds.), *Flora of Ethiopia and Eritrea*. Vol 6. Addis Ababa and Uppsala.

Sebsebe Demissew & Nordal, I. 2010. *Aloes and lilies of Ethiopia and Eritrea*. Shama Books, Addis Ababa.

Sechi, G., De Riu, P., Mameli, O., Deiana, G.A., Cocco, G.A. & Rosati, G. 2003. Focal and secondarily generalized convulsive status epilepticus induced by thiocolchicoside in the rat. *Seizure* **12**: 508-515.

Shaw, J., Lickey, E., Beck, J.T., Farmer, S.B., Liu, W., Miller, J., Siripun, K.C., Winder, C.T., Schilling, E.E. & Small, R.L. 2005. The tortoise and the hare II: relative utility of 21 noncoding chloroplast DNA sequences for phylogenetic analysis. *Amer. J. Bot.* **92**: 142-166.

Shaw, J., Lickey, E.B., Schilling, E.E., & Small, R.L. 2007. Comparison of whole chloroplast genome sequences to choose noncoding regions for phylogenetic studies in angiosperms: the tortoise and the hare III. *Amer. J. Bot.* **94**: 275-288.

Siddique, N.A., Bari, M.A., Naderuzzaman, A.T.M., Khatun, N., Rahman, M.H., Sultana, R.S., Matin, M.N., Shahnewaz, S. & Rahman, M.M. 2004. Collection of indigenous knowledge and identification of endangered medicinal plants by questionnaire survey in Barind Tract of Bangladesh. *J. Biol. Sci*. **4**: 72-80.

Simmons, M.P. & Ochotorena, H. 2000**.** Gaps as characters in sequence-based phylogenetic analysis. *Syst. Biol.* **49:** 369-381.

Singh, V.K. 1993. Selected Indian Folk medicinal claims and their relevance in primary health care programme. *Glimpses Pl. Res.* **10**: 147-152.

Singh, V.K., Argal, A., Aeri, V., Jain, G. & Kannojia, P. 2007. Anti-inflammatory activity of Gloriosa superba Linn. *The Pharmacist* **2**: 19-20.

Sivakumar, G. & Krishnamurthy, K.V. 2002. Gloriosa superba L.: a useful medicinal plant. Pp. 465-481 in: Singh, V.K., Govil, J.N., Hashmi, S. & Singh, G. (eds.), *Recent progress in medicinal plants: ethnomedicine and pharmacognosy II.* Sci-Tech Publishing LLC, Houston.

Sneath, P.H.A. & Sokal, R.R. 1973. *Numerical taxonomy*. W. H. Freeman and Company, San Francisco.

Soltis, D.E. & Soltis, P.S. 1998. Choosing an approach and an appropriate gene for phylogenetic analysis. Pp. 1-42 in: Soltis, D.E, Soltis, P.S. & Doyle, J (eds.), *Molecular systematics of plants II: DNA sequencing*. Kluwer Academic Publishers, Boston.

Snow, N. 1997. Application of the phylogenetic species concept: a botanical monographic perspective. *Austrobaileya* **5**: 1-8.

Sterling, C. 1975. Comparative morphology of the carpel in the Liliaceae: Glorioseae. *Bot. J. Linn. Soc.* **70**: 341-349.

Stuessy, T.F. 1990. *Plant taxonomy*. Columbia University Press, New York.

Suri, O.P., Gupta, B.D. & Suri, K.A. 2001. A new glycoside, 3-Odemethylcolchicine-3-O-alpha-d-glucopyranoside from Gloriosa seeds. *Nat. Prod. Lett*. **15**: 217-219.

Swofford D.L. 2000. PAUP*. Phylogenetic Analysis Using Parsimony (* and other methods), version 4.0b10. Sinauer Associates, Sunderland, Massachusetts.

Taberlet, P., Gielly, L., Pautou, G. & Bouvet, J. 1991. Universal primers for amplification of three non-coding regions of chloroplast DNA. *Pl. Molec. Biol*. **17**: 1105-1109.

Tassin, J., Triolo, J. & Lavergne, C. 2007. Ornamental plant invasions in mountain forests of Réunion (Mascarene Archipelago): a status review and management directions. *Afr .J. Ecol*. **45**: 444-447.

Thulin, M. 1995. Colchicaceae. Pp. 67-69 in: Thulin, M. (ed.). *Flora of Somalia 4*. Royal Botanic Gardens, Kew.

Tiwari, D.K. & Yadav, A. 2003. Ethnobotanical investigation of some medicinal plants availed by Gond tribe of Naoradehi Wild Life Sanctuary, Madhya Pradesh. *Anthropol.* **5**: 201-202.

Trimen, H. 1898. *A handbook to the flora of Ceylon*. Part iv: Euphorbiaceae-Naiadeae. Dulau & Co., London.

Tyteca, D. & Dufrene, M. 1994. Biostastical studies of Western European allogamous populations of the Epipactis helleborine (L.) Crantz species group (Orchidaceae). *Syst. Bot*. **19**: 424-442.

Van der Burg, W.J. 2006. Pp 68-69 in: Akoègninou, A., Van der Burg, W.J. & van der Maesen, L.J.G. (eds.), *Flore Analytique du Bénin*. Backhuys Publishers, Leiden.

Van Duong, N. 1993. *Medicinal plants of Vietnam, Cambodia and Laos*. Mekong Printing, California.

Van Steenis-Kruseman, M.J. 1953. *Select Indonesian medicinal plants*. Flora Malesiana Foundation, Kebun Raya.

Van Wyk, B.-E., Van Heerden, F. & Van Oudtshoorn, B. 2002. *Poisonous plants of South Africa*. Briza Publications, Pretoria.

Verdcourt, B. & Trump, E.C. 1969. *Common poisonous plants of East Africa*. Collins, London.

Vinnersten A. & Larsson, S. 2010. Colchicine is still a chemical marker for the expanded Colchicaceae. *Biochem. Syst. Ecol*. **38**: 1193-1198.

Vinnersten, A. & Manning, J. 2007. A new classification of Colchicaceae. *Taxon* **56**: 171-178.

Vinnersten, A. & Reeves, G. 2003. Phylogenetic relationships within Colchicaceae. *Amer. J. Bot.* **90**: 1455-1462.

Vinnersten, A. & Bremer, K. 2001. Age and biogeography of major clades in Liliales. *Amer. J. Bot.* **88**: 1695-1703.

Watt, G. 1972. Gloriosa Linn. Pp. 435-437 in: Watt, G. (ed.), *A dictionary of economic products of India 3*. Shahdara, Delhi. Reprint of the 1889-1893 ed.

Watt, J.M. & Breyer-Brandwijk, M.G. 1962. *The medicinal and poisonous plants of southern and eastern Africa: Uses, chemical composition, pharmacological effects and toxicology in man and animals*. E. Livingstone, Edinburgh.

Welsh, S.L. 1998. *Flora Societensis: a summary revision of the flowering plants of the Society Islands*. E.P.S. Inc., Orem, Utah.

Wester, L. 1985. Checklist of the vascular plants of the northern Line Islands. *Atoll Res. Bull.* **287**: 1-38.

Wild, H. 1965. Suggestions for the application of experimental taxonomic techniques to species indigenous to Rhodesia and neighbouring territories in Africa. *Ann. Missouri. Bot. Gard.* **52**: 476-484.

Wild, H., Biegel, H.M. & Mavi, S. 1972. *A Rhodesian dictionary of African and English plant names*. Government Printer, Salisbury.

Wildman, W.C. & Pursey, B.A. 1968. Colchicine and related compounds. Pp. 407-457 in: Manske, R.H.F. (ed.), *The alkaloids, chemistry and physiology 11*. Academic Press, London.

Willis, F., Moat, J. & Paton, A. 2003. Defining a role for herbarium data in Red List assessments: a case study of *Plectranthus* from eastern and southern tropical Africa. *Biodivers. Conserv.* **12**: 1537-1552.

Wight, R. 1853. *Flora of India*. Vol. 6: 23-25.

Wilkin, P. 1999. A morphometric study of *Dioscorea quartiniana* A. Rich. (Dioscoreaceae). *Kew Bull.* **54**: 1-18.

Williams, R.O. 1949. *The useful and ornamental plants in Zanzibar and Pemba.* Zanzibar Protectorate.

Wisniewski, H. & Terry, R.D. 1967. Experimental colchicine encephalopathy. *Lab. Invest.* **17**: 577-587.

Wright, J.G., Pelasio, M. & McKenzie, E.H.C. 2005. *Weeds and pathogenic fungi and viruses in Tokelau.* SPC Land Resources Division, Suva.

Yamanda, T. 1999. A report on the ethnobotany of the Nyindu in the eastern part of the former Zaire. *Afr. Stud. Monogr*. **20**: 1-72.

Yineger, H. & Yewhalaw, D. 2007. Traditional medicinal plant knowledge and use by local healer in Sekoru District, Jimma Zone, southern Ethiopia. *J. Ethnobiol. Ethnomed*. **3**:24.

Zahir, A.A., Rahuman, A.A., Kamaraj, C., Bagavan, A., Elango, G., Sangaran, A. & Kumar, B.S. 2009. Laboratory determination of efficacy of indigenous plant extracts for parasites control. *Parasit. Res*. **105**: 453-461.

Appendix 1: Specimens of *G. superba* complex used in phenetic study, identifying codes, collector and locality.

Code	Species	Collector	Locality
B01	*G. baudii*	Bally & Smith B14698	Kenya, Garba Tula
B02	*G. baudii*	Bamps 6687	Kenya, Turkana Province, mount Kulal
B03	*G. baudii*	Brown 59	Ethiopia, Banya
B04	*G. baudii*	Carter & Stannard 237	Kenya, Turkana Province, Lowdar
B05	*G. baudii*	Ellis 174	Ethiopia, Gorrahei
B06	*G. baudii*	Gillett 13297	Kenya, Yabichu, near Ramu
B07	*G. baudii*	Gatheri, Mungai & Kibui 79/95	Kenya, Kitui District
B08	*G. baudii*	Hemming 404	Somalia, Bulo Burti
B09	*G. baudii*	Hemming 1990	Somalia, Erigavo
B10	*G. baudii*	Martin 96	Kenya, Turkana Province
B11	*G. baudii*	Mathew 6857	Kenya, Turkana Province
B12	*G. baudii*	Pole Evans & Erens 1574	Kenya, Lowdar, Turkana desert
B13	*G. baudii*	Powdre 150	Kenya, Turkana Province, Lowdar
B14	*G. baudii*	Popov 1053	Somalia, near Baidoa
B15	*G. baudii*	Powys G.3	Kenya, Dibabdebel
B16	*G. baudii*	Strid 3880A	Kenya, Turkana Province, Lowdar
B17	*G. baudii*	Wall 20	Kenya, Melka-Koia
V01	*G. carsonii*	Souza, de 1421	Uige, Angola
V02	*G. carsonii*	Bloomfield 10	Malawi, Zomba Mt.
V03	*G. carsonii*	Malaisse & Robbrecht 2135	Katanga, Shaba, DRC
V04	*G. carsonii*	Bullock 1968	Tanzania
V05	*G. carsonii*	Bullock 2226	Tanzania, Sumbawanga
V06	*G. carsonii*	Cruse 112	Zambia, Mufulira
V07	*G. carsonii*	Fries 1461	Burundi, Rusizi River
V08	*G. carsonii*	Fries, Norlindh & Weimarck 4007	Zimbabwe, Manicaland
V09	*G. carsonii*	McClintock 75	Botswana
V10	*G. carsonii*	Jackson 2296	Malawi
V11	*G. carsonii*	Lewalle 24	Burundi, Bujumbura
V12	*G. carsonii*	Lea 157	Blue Nile, Sudan
V13	*G. carsonii*	Lusaka National History Club 89	Zambia, Lusaka province, Lusaka
V14	*G. carsonii*	Maroyi 243	Zimbabwe
V15	*G. carsonii*	Maroyi 246	Zimbabwe
V16	*G. carsonii*	Milne-Redhead & Taylor 8412	Tanzania, Ruvuma, Songea District
V17	*G. carsonii*	Myembe 223	Tanzania, Iringa
V18	*G. carsonii*	Pawek 7979	Malawi, Northern Province, Mzuzu
V19	*G. carsonii*	Richards 20935	Tanzania, Iringa, Ruaha National Park
V20	*G. carsonii*	Robson & Angus 889	Zambia
V21	*G. carsonii*	Maas-Geesteranus 5448	Kenya, Nairobi
V22	*G. carsonii*	Salubeni & Balaka 5122	Malawi
V23	*G. carsonii*	Sanane 1028	Zambia, Northern Province, Mbala
V24	*G. carsonii*	Silva 2691	Angola, Huambo
V25	*G. carsonii*	Stolz 137	Tanzania, Mbeya
V26	*G. carsonii*	Strid 2506	Kenya, Nairobi
V27	*G. carsonii*	Tanner 5461	Tanzania, West Lake, Ngara, Bukiriro
V28	*G. carsonii*	Bjornstad 568	Iringa, Tanzania
V29	*G. carsonii*	Watermeyer 235	Tanzania, Sao Hill
V30	*G. carsonii*	Kokwaro s.n.	Kenya, Nairobi
V31	*G. simplex*	Ash 575	Ethiopia, Shoa
V32	*G. simplex*	de Wilde & de Wilde-Duyfjes 7201	Ethiopia, Lekemti
V33	*G. simplex*	Drummond & Hemsley 2879	Tanzania, Usambara Mountains
V34	*G. simplex*	King 421	Zambia, Central, Lusaka
V35	*G. simplex*	van der Maesen, Nikiema & Bako 8181	Burkina Faso, Kadiogo
V36	*G. simplex*	Polhill & Paulo 1151	Tanzania, Kondoa District

V37	*G. simplex*	Purseglove 3231	Uganda, Southern, Kabale, Kachwekano
V38	*G. simplex*	Tawakali & Patel 145	Malawi, Mulanje
V39	*G. simplex*	Westphal & Westphal-Stevels 585	Ethiopia, Harerge
V40	*G. simplex*	Westphal & Westphal-Stevels 1768	Ethiopia, Harerge
U01	*G. superba*	VandenBerghen 2127	Senegal, Casamance
U02	*G. superba*	Cruse 141	Zambia, Mufulira
U03	*G. superba*	de Wilde 757	Ivory Coast, Bouna, Ouangofetini
U04	*G. superba*	de Wilde & Wilde-Duyfjes 2617	Cameroon, Central Province, Nkolbison
U05	*G. superba*	Fanshawe 2770	Zambia, Kitwe
U06	*G. superba*	Gruys 65	Ivory Coast
U07	*G. superba*	Koelz 18753	India, Bihar
U08	*G. superba*	Koelz 19226	India, Surguja State
U09	*G. superba*	Leeuwenberg & van der Meer 13002	Indonesia, Java
U10	*G. superba*	Louis & Gassita 1993	Gabon, Estuaire
U11	*G. superba*	Maroyi 248	Zimbabwe, Masvingo
U12	*G. superba*	Mhoro 865	Tanzania, Iringa
U13	*G. superba*	van Proosdij 17	Gabon, Ogooué-Maritime, Gamba
U14	*G. superba*	Reekmans 5463	Burundi, Bururi
U15	*G. superba*	Simons & Westerduijn 570	Gabon, Estuaire
U16	*G. superba*	Silva 671	Angola, Cuanza Norte
U17	*G. superba*	Veldkamp 6119	Ghana, Amezofe
U18	*G. superba*	Ward 8930	Laos
U19	*G. superba*	van der Zon 3172	Cameroon
U20	*G. superba*	Bos 6882	Cameroon, Central Province
U21	*G. superba*	Leeuwenberg 4135	Ivory Coast
U22	*G. superba*	Leeuwenberg 5733	Cameroon, Central Province, Nkolbison

Summary

This thesis focuses on the ethnobotany, phylogeny and taxonomy of the genus *Gloriosa* L. over its distributional range. Some *Gloriosa* species are known to have economic and commercial value, but the genus is also well known for its complex alpha taxonomy. An appropriate taxonomy for this group is of great importance because it includes widely used species as traditional medicine, horticultural plants and sources of industrial and pharmaceutical chemical colchicine. The seeds and tubers of *G. superba* are valued as a commercial source of colchicine. The genus *Gloriosa* has considerable horticultural appeal because of the conspicuous inflorescence of its members and the ease with which taxa are propagated, introduced into new areas and hybridise in cultivation. *G. carsonii, G. modesta, G. simplex* and *G. superba* have been taken into cultivation as ornamental plants in several countries, including native countries of these species.

The first part of the thesis deals with ethnobotanical studies on *G. superba*. These studies documented how people throughout the distributional range of *G. superba* utilise it. Over 45 ethnobotanical applications in 31 subtropical, tropical African and Asian countries were documented, the majority (93%) of which described medicinal uses. One major question that emerged from this analysis is whether *G. superba* is a remedy or a poison. (**Chapter 2**). This question was somehow addressed by analysing the pharmacological properties of the species. *G. superba* was found to have immense potential as a chemotherapeutic agent to prevent or inhibit the growth of tumours or cancers. **Chapter 3** focused on vernacular names, folkloristic and economic uses of *G. superba* over its distributional range. In total 279 vernacular names in 38 countries are documented for *G. superba*. This long list of names indicates that local people in countries where *G. superba* occurs, have an active interest in the species.

G. superba represents a species complex showing a mosaic of morphological characters (**Chapter 4**). It also occurs in a wide range of ecological habitats in subtropical and tropical Africa and Asia. The morphological variation in *G. superba* was found to be complicated and therefore, multivariate and univariate analyses were used to re-evaluate variation and species delimitation in the *G. superba* complex. It is proposed that four species should be recognised in the *G. superba* L. complex: *G. baudii* (Terracc.) Chiov., *G. carsonii* Baker, *G. simplex* L. and *G. superba* L. *G. superba* is the most widespread taxon, occurring in South Africa, tropical Africa and tropical Asia. *G. simplex*, *G. carsonii* and *G. baudii* are confined to the

African continent; with *G. baudii* having the most restricted range, the arid regions of northern Kenya, Ethiopia and Somalia.

The final part of the thesis (**Chapters 5, 6 & 7**) describe how phylogenetic studies have changed the taxonomy of the genus *Gloriosa*. The many taxonomical changes introduced in this investigation are a result of molecular phylogenetic analysis which recommended sinking of the genus *Littonia* Hook. into *Gloriosa*. The expanded genus also meant the need for a wider generic circumscription, and a detailed account of species relationships. This section is concluded by providing a monograph of the genus. Twelve species are recognised for the genus *Gloriosa*: *G. baudii* (Terracc.) Chiov.; *G. carsonii* Baker; *G. flavovirens* (Dammer) J.C.Manning & Vinnersten; "*G. katangensis* Maroyi nom. nov."; *G. lindenii* (Baker) J.C.Manning & Vinnersten; *G. littonioides* (Welw. ex Baker) J.C.Manning & Vinnersten; *G. modesta* (Hook.) J.C.Manning & Vinnersten; *G. revoilii* (Franch.) J.C.Manning & Vinnersten; *G. rigidifolia* (Bredell) J.C.Manning & Vinnersten; *G. sessiliflora* Nordal & Bingham; *G. simplex* L. and *G. superba* L. It is intended that this revisionary account of the genus *Gloriosa* will enable users to identify different taxa based on morphological relationships. A key to the twelve recognised species is presented, as well as descriptions and distribution maps for each species.

Samenvatting

Dit proefschrift behandelt de etnobotanie, fylogenie en taxonomie van het genus *Gloriosa* L. van het gebied waar het voorkomt. Sommige *Gloriosa* soorten zijn bekend om hun economische en commerciële waarde, maar het genus is ook bekend om zijn complexe alfa-taxonomie. Een passende taxonomie voor de groep is van groot belang omdat het veelvuldig gebruikte soorten omvat die traditionele medicijnen leveren, tuinbouwkundig belangrijke planten, en bronnen van de industriële en farmaceutische stof colchicine. De zaden en knollen van *Gloriosa superba* zijn waardevol als commerciële bron van colchicine. Het genus is tuinbouwkundig zeer aantrekkelijk vanwege de opvallende bloeiwijze van zijn leden en het gemak waarmee taxa kunnen worden vermeerderd, geïntroduceerd in nieuwe gebieden, en kruisen gedurende de teelt. *Gloriosa carsonii, G. modesta, G. simplex en G. superba* zijn in cultuur als sierplanten in diverse landen, waaronder de oorsprongslanden van deze soorten.

Het eerste deel van het proefschrift behandelt etnobotanische studies van *Gloriosa superba.* Deze onderzoeken legden vast hoe mensen over het gehele gebied van voorkomen de soort in gebruik hebben. Meer dan 45 etnobotanische toepassingen in 31 subtropische en tropische Afrikaanse en Aziatische landen werden gedocumenteerd, de meeste daarvan (93%) betreffen medisch gebruik. Een belangrijke vraag die opkwam in deze analyse is of *G. superba* een geneesmiddel is of een gif (Hoofdstuk 2). Deze vraag werd in zekere zin beantwoord door de farmacologische eigenschappen van de soort te analyseren. *G.superba* blijkt een groot potentieel te hebben als chemotherapeuticum om de groei van tumoren of kankergezwellen te voorkomen of te remmen. Hoofdstuk 3 levert de volksnamen, folkloristische en economische gebruiken van *G. superba* overal waar deze soort gevonden wordt. In totaal zijn 279 volksnamen in 38 landen gedocumenteerd voor *G. superba.* Deze lange lijst van volksnamen geeft aan dat de inwoners van landen waar *G. superba* gevonden wordt, actief geïnteresseerd zijn in deze soort.

Gloriosa superba vertegenwoordigt een soortscomplex dat een mozaïek aan morfologische kenmerken laat zien (Hoofdstuk 4). Deze soort komt bovendien voor in een brede reeks van ecologische groeiplaatsen in subtropisch en tropisch Afrika en Azië. De morfologische variatie in *G. superba* bleek gecompliceerd te zijn en daarom weren multivariate en univariate analyses gebruikt om de variatie en het soortsonderscheid in het *G. superba* te re-evalueren. Wij stellen voor dat er vier soorten worden erkend in het *G. superba* L. complex: *G. baudii* (Terracc.) Chiov., *G. carsonii* Baker, *G. simplex* L. en *G. superba* L. *G.*

superba is het meest wijdverbreide taxon, voorkomende in Zuid Afrika, tropisch Afrika en tropisch Azië. *G. simplex*, *G. carsonii* en *G. baudii* zijn begrensd tot het Afrikaanse continent, met *G. baudii* het kleinste verspreidingsgebied in de aride gebieden van Noord Kenya, Ethiopië en Somalië.

Het laatste deel van het proefschrift (Hoofdstukken 5, 6 en 7) beschrijven hoe fylogenetische studies de taxonomie van het genus *Gloriosa* hebben veranderd. De vele taxonomische veranderingen door dit onderzoek ontstaan zijn het resultaat van de moleculaire analyses die aangaven het genus *Littonia* Hook. in *Gloriosa* op te nemen. De uitbreiding van het genus maakte ook een bredere genusbeschrijving noodzakelijk, en een gedetailleerde weergave van de soortsrelaties. Dit deel wordt afgerond met een monografie van het genus. Twaalf soorten worden nu onderscheiden in het genus *Gloriosa*: *G. baudii* (Terracc.) Chiov.; *G. carsonii* Baker; *G. flavovirens* (Dammer) J.C.Manning & Vinnersten; *G. katangensis* Maroyi nom. nov.; *G. lindenii* (Baker) J.C.Manning & Vinnersten; *G. littonioides* (Welw. ex Baker) J.C.Manning & Vinnersten; *G. modesta* (Hook.) J.C.Manning & Vinnersten; *G. revoilii* (Franch.) J.C.Manning & Vinnersten; *G. rigidifolia* (Bredell) J.C.Manning & Vinnersten; *G. sessiliflora* Nordal & Bingham; *G. simplex* L. en *G. superba* L. Het is de bedoeling dat deze revisie van het genus *Gloriosa* de gebruikers in staat stelt de verschillende taxa te identificeren op basis van morfologie verwantschappen. Een sleutel naar de 12 erkende soorten is verschaft, zowel als beschrijvingen en verspreidingskaarten van iedere soort.

Acknowledgements

The research described in this thesis was financially supported by NUFFIC (Netherlands Organisation for International Cooperation in Hihger Education), grant number NFP-PHD.08/40.

I would like to thank the following people, who from the start have been involved in my project at many different levels:

I am particularly grateful to my principal supervisor, Professor Jos van der Maesen, for giving me the opportunity to undertake my PhD at the National Herbarium Nederland in Wageningen (WAG). Jos, thank you for inviting me to WAG in 2005, for your great patience between 2005 and 2007 when we finally got funding from NUFFIC. His meticulous guidance, constant encouragement and considerable support during the experimental period, and during the preparation of this thesis is highly appreciated. Jos has been supportive not just for this PhD research but my career as a whole. Thank you for a great time we had during the field work in Zimbabwe. Most photographs were taken by him. Special thanks to my co-promoter Dr Lars Chatrou for his advice, guidance and encouragement throughout the study; and particularly for the phylogenetical part. My sincere thanks also to Dr. Ir. Gaby Schmelzer for introducing me to my principal supervisor and for encouraging me in proceeding forward.

I wish to thank Professor Marc Sosef, Drs Freek Bakker and Ronald van der Berg, who from the start, have been involved in my project at many different levels. Ronald provided guidance and unlimited support with phenetic aspects of this research. Many thanks to Rutger Wilschut and Ms Ria Vrielink for assisting me in the molecular laboratory; and Hans de Vries for drawing Figure 6.6.

I owe a lot to Dr Jan Wieringa and Mr Folkert Aleva of the National Herbarium Nederland in Wageningen. Jan spent days with me loading specimen information and geographical coordinates into the BRAHMS database. He also assisted with addressing nomenclatural changes and generation of distribution maps of the species discussed in this thesis.

My sincere thanks go to the staff of the School of Molecular and Life Sciences, University of Limpopo: Professor P.A.S. Olivier and Dr W. Luus-Powell for supporting my studies. My gratitude to the staff and management of Bindura University of Science Education and the

Acknowledgements

National Herbarium of Zimbabwe for kindly allowing me access to their facilities during the course of the experimental work in Zimbabwe.

My deepest gratitude and love go to family members; my sons Ngoni and Mako, and to my wife, Vongai, who always encouraged and supported me throughout the study. Lastly, I would like to thank God almighty, in who everything is possible.

Curriculum vitae

Alfred Maroyi was born in Shurugwi, Midlands Province, Zimbabwe on 8 January 1971. He obtained a BSc Honours in Biological Sciences from the University of Zimbabwe in November 1994. He joined the National Herbarium and Botanic Gardens of Zimbabwe as a Research Officer in January 1995, where he was responsible for undertaking research work, collaborating with other national and international organizations in ensuring that the knowledge and understanding of the flora of Zimbabwe was adequate to meet all conservation, utilisation and management requirements. Three years later, he embarked on Plant Systematics research degree under the guidance of Dr Shakkie Kativu (University of Zimbabwe), Dr Clemence Zimudzi (now with National University of Lesotho) and Prof. Inger Nordal of Oslo University, Norway. He graduated with an M.Phil. degree in Plant Systematics in August 2000. He joined Bindura University of Science Education as a Botany Lecturer on 1 November 2000. Since then, he has been actively involved in botanical research and sharing his experiences with botany students. He has been married since 1997 to Vongai and they have two sons, Ngoni and Mako, aged 13 and 7 respectively.

List of publications by the author

Peer-reviewed publication

Maroyi, A. 2000. Options for the recovery of *Warburgia salutaris* (Pepperbark tree) populations in Zimbabwe. *Zimbabwe Science News* **34**: 54-60.

Maroyi, A. 2002. Colchicaceae in Zimbabwe. *Kirkia* **18**: 1-10.

Maroyi, A. 2006. A preliminary checklist of naturalized and introduced plants in Zimbabwe. *Kirkia* **18**: 177-247.

Maroyi, A. 2008. Ethnobotanical study of two threatened medicinal plants in Zimbabwe. *International Journal of Biodiversity Science and Management* **4**: 148-153

Maroyi, A. 2009. Traditional homegardens and rural livelihoods in Nhema, Zimbabwe: a sustainable agroforestry system. *International Journal of Sustainable Development and World Ecology* **16**: 1-8.

Maroyi, A. 2011. Ethnobotanical study of medicinal plants used by people in Nhema communal area, Zimbabwe. *Journal of Ethnopharmacology* **136**: 347-354.

Maroyi, A. 2011. The gathering and consumption of wild edible plants in Nhema communal area, Midlands province, Zimbabwe. *Ecology of Food and Nutrition* **50**: 506-525.

Maroyi, A. & van der Maesen, L.J.G. 2011. *Gloriosa superba* L. (Colchicaceae): remedy or poison? *Journal of Medicinal Plant Research* **5**: 6112-6121.

Maroyi, A. 2011. Community attitudes towards the reintroduction programme for the Endangered pepperbark tree *Warburgia salutaris*: implications for plant conservation in south-east Zimbabwe. *Oryx - The International Journal of Conservation Fauna & Flora International*. doi:10.1017/S0030605311000767.

Maroyi, A. 2012. Use of traditional veterinary medicine in Nhema communal area of the Midlands Province, Zimbabwe. *African Journal Traditional, Complementary and Alternative Medicine* **9(3). in press.**

Maroyi, A. 2012. Garden plants in Zimbabwe: an analysis of their ethnomedicinal uses and toxicity. *Ethnobotany Research and Applications*. **in press**.

Maroyi, A. 2012. Use and management of homegarden plants in Zvishavane District, Zimbabwe. *Tropical Ecology*. i**n press**

Maroyi, A. & van der Maesen, L.J.G. 2012. Gloriosa superba (Colchicaceae): Ethnobotany and economic importance. *XIXth AETFAT Proceedings / Plant Ecology and Evolution*. **in press.**

Book chapters

Maroyi, A. 2007. *Ricinus communis* L. Pp. 144-150 in: van der Vossen, H.A.M. & Mkamilo, G. S. (eds.), *Plant resources of tropical Africa 14: vegetable oils*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2007. *Trichilia dregeana* Sond. Pp. 169-172 in: van der Vossen, H.A.M. & Mkamilo, G. S. (eds.), *Plant resources of tropical Africa 14: vegetable oils*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, the Netherlands.

Maroyi, A. 2008. *Albizia gummifera* (J.F.Gmel.) C.A.Sm. Pp. 55-57 in: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (eds.), *Plant resources of tropical Africa 7: timbers 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2008. *Holarrhena pubescens* Wall. ex G.Don. Pp. 332-335 in: Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2008. *Khaya anthotheca* (Welw.) C.DC. Pp. 324-329 in: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (eds.), *Plant resources of tropical Africa 7: timbers 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2008. *Maprounea africana* Müll.Arg. Pp. 375-377 in: Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2008. *Phyllanthus maderaspatensis* L. Pp. 425-427 in: Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2008. *Phyllanthus reticulatus* Poir. Pp. 432-434 in: Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2008. *Syzygium guineense* (Willd.) DC. Pp. 536-539 in: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (eds.), *Plant resources of tropical Africa 7: timbers 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2008. *Voacanga africana* Stapf. Pp. 623-627 in: Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 1*. PROTA Foundation, Wageningen \ Backhuys Publishers, Leiden \ CTA, Wageningen, the Netherlands.

Maroyi, A. 2010. *Burkea africana* Hook. In Lemmens, R.H.M.J., Louppe, D. & Oteng-Amoako, A.A. (eds.), Plant resources of tropical Africa: timbers 2. PROTA Foundation, [Internet] Record from PROTA4U (www.prota4u.org).

Maroyi, A. 2010. *Croton megalocarpus* Hutch. In Lemmens, R.H.M.J., Louppe, D. & Oteng-Amoako, A.A. (eds.), *Plant resources of tropical Africa 7: timbers 2*. PROTA Foundation, [Internet] Record from PROTA4U (www.prota4u.org).

Maroyi, A. 2011. *Ilex mitis* (L.) Radlk. In Lemmens, R.H.M.J., Louppe, D. & Oteng-Amoako, A.A. (eds.), *Plant resources of tropical Africa 7: timbers 2*. PROTA Foundation, [Internet] Record from PROTA4U (www.prota4u.org).

Maroyi, A. 2012. *Crotalaria juncea* L. Pp. 104-108 in: Brink, M. & Achigan-Dako, E.G. (eds.), *Plant resources of tropical Africa 16: fibres*. PROTA Foundation, Wageningen \ CTA, Wageningen, the Netherlands.

Maroyi, A. & Oyen, L.P.A. 2012. *Phragmites australis* (Cav.) Trin. ex Steud. Pp. 362-367 in: Brink, M. & Achigan-Dako, E.G. (eds.), *Plant resources of tropical Africa 16: fibres*. PROTA Foundation, Wageningen \ CTA, Wageningen, the Netherlands.

Maroyi, A. accepted. *Calotropis procera* (Aiton) W.T. Aiton. In Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 2*. PROTA Foundation, Wageningen \ CTA, the Netherlands.

Maroyi, A. accepted. *Combretum caffrum* (Eckl. & Zeyh.) Kuntze. In Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 2*. PROTA Foundation, Wageningen \ CTA, the Netherlands.

Maroyi, A. accepted. *Combretum collinum* Fresen. In Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 2*. PROTA Foundation, Wageningen \ CTA, Wageningen, the Netherlands.

Maroyi, A. accepted. *Combretum molle* R.Br. ex G.Don In Schmelzer, G.H. & Gurib-Fakim, A. (eds.), *Plant resources of tropical Africa 11: medicinal plants 2*. PROTA Foundation, Wageningen \ CTA, Wageningen, the Netherlands.

Maroyi, A. accepted. *Markhamia lutea* (Benth.) K.Schum. In Lemmens, R.H.M.J., Louppe, D. & Oteng-Amoako, A.A. (eds.), *Plant resources of tropical Africa 7: timbers 2*. PROTA Foundation, Wageningen \ CTA, Wageningen, the Netherlands.

Articles published as abstracts

Maroyi, A. & van der Maesen, L.J.G.. 2009. Gloriosa superba: remedy or poison? *African Journal of Traditional, Complementary and Alternative Medicine*. Volume 6 (Supplement). pp 488.

Maroyi, A. 2009. Cultivation of medicinal plants in Zimbabwe: a strategy for meeting local traditional medicinal needs. *African Journal of Traditional, Complementary and Alternative Medicine*. Volume 6 (Supplement). pp 343-344.

Maroyi, A. & van der Maesen, L.J.G. 2010. Gloriosa superba (Colchicaceae): Ethnobotany and economic importance. In: Proceedings of the XIXth AETFAT Congress, Antananarivo, Madagascar, 25-30 April 2010. - Meise: National Botanic Garden of Belgium, XIXth AETFAT Congress, Antananarivo, Madagascar.

Education certificate

Appendix to PhD Proficiency certificate of Alfred Maroyi

1. Start-up phase	*date*	*CE*
First presentation of your proposal	March 2008	1.0
Literature review	Jan. 2008-Dec. 2010	6.0
Writing or rewriting a project proposal	Feb. 2008	6

2. Scientific Exposure	*date*	*CE*
Poster presentation during PhD-Day, Research School Biodiversity (WU)	November 2009	0.6
Local seminars, research review meetings and other scientific meetings, Bindura University	Jan. 2008 - June 2011	1.2
Poster presentations at WOCMAP congress (South Africa) & AETFAT congress (Madagascar)	Nov.2008, May 2010	1.2

3. In-Depth Training	*date*	*CE*
PhD and MSc courses		
Biosystematics and biodiversity (WU)	Jan.-Febr. 2008	3.0
Advanced Biosystematics (WU)	Oct.-Dec. 2009	3.0
Sustainable forest management in the tropics. Are we on the right track? (WU)	March 2008	1.5
Multivariate analysis (Bindura University)	September 2008	1.5
SPSS course (introduction, intermediate & advanced), Bindura University	Jan & Aug 2009, Aug. 2010	4.5
Environmental Impact Assessment (Bindura University)	May 2011	1.5

4. Personal development	*date*	*CE*
Project and time management (Bindura University)	November 2008	1.5
Web-based taxonomy, biodiversity information processing, mappit (National Herbarium, Zimbabwe)	April 2010	1.5

TOTAL NUMBER OF CREDIT POINTS		**34.0**

*Bio*DIVERSITEIT

Index to species names

This index lists species names of the genus *Gloriosa* (including *Littonia*) mentioned in the text, as well as other genera that have been associated with the genus *Gloriosa*. Genus names are in CAPITALS and species names in italics.