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Patterns of plant diversity in Uganda

JAMES KALEMA AND REMIGIUS BUKENYA-ZIRABA

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For its size, Uganda has a high number of species due to the country's varied habitats, altitude and the fact that it is located at the confluence of six of White's phytoclimates. However, its level of endemism is low as it shares many of its species with neighbouring countries. Unfortunately, a large portion of these habitats has been destroyed or modified, mainly through human activity. We review species richness, endemism and levels of threat of the country's vascular plants and provide information on recent work in Uganda's wetland and dryland areas as well as that from the forest ecosystems. A total of 30 taxa were registered as new records for the country and three for the entire East African flora area. These new records are of very rare species and many of them are of high conservation importance. The dryland ecosystems in particular support a rich flora in which is nested some globally threatened and range restricted species. It is expected that more surveys of such habitats will lead to more new records. It is important that some of the wetlands in the country be accorded some conservation status and protection in order to conserve the diversity of plants they harbour.

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Introduction

Uganda has a diversity of habitats supporting a rich and varied flora. The habitats may be divided into three broad categories: forests, wetlands and drylands. Figure 1 shows the detailed vegetation types in the country. Langdale-Brown *et al.* (1964) mapped the vegetation of Uganda and recognized a total of 22 vegetation types based on dominance and commonness. These broadly include heath and moorland, forest, forest-savanna mosaic, thicket, woodland, savanna, steppe, bushland, swamps, and post-cultivation communities. The forests are concentrated in the western part of the

country occurring either as lowland, mid-altitude, or high-altitude forests. The drylands occur in the areas of less rainfall in the north, while wetlands are mainly along the shores of the larger lakes. The factors that influence vegetation diversity and distribution include geology and soils, climate, altitude, fire, and human influences.

The country's natural flora has six of White's (1983) phytoclimates that converge here including the Lake Victoria regional mosaic, Sudanian regional center of endemism, Somalia-Masai regional center of endemism, Afromontane archipelago-like regional center of endemism, Guinea-Congolia /Sudanian

regional transition zone, and the Guineo-Congolian regional center of endemism. Uganda has considerable significance as far as species richness is concerned although there are only few national endemics as it shares many with other countries in the region. Its location in East-Central Africa accords it floral characteristics of East Africa and those of West Africa (Howard 1991). The number of native vascular plants so far described is 5406 (Davis *et al.* 1994) of which 70 (1.29%) are endemic. Out of the 70 endemics, three are globally threatened: *Afrothymia winkleri* (Engl.) Schltr. (Burmanniaceae) and *Diospyros katendei* Verdc. (Ebenaceae) are "Critically Endangered" while *Euphorbia bwambensis* S. Carter (Euphorbiaceae) is "Vulnerable". According to the IUCN Red List of threatened plants of 2000, Uganda has got 43 species of plants that are globally threatened (Hilton-Taylor 2000).

The vegetation of Uganda has undergone changes in a number of aspects including extent of coverage, species composition, continuity and connectivity, all of which have been reduced through the times under the influence of human actions (see Struhsaker 1997). In Uganda, the original extent of forest coverage is estimated to have been 103,400 km² (44% of the country). By 1984 it was only 7400 km² corresponding to 7% of the original coverage (Davis *et al.* 1994) and today it is estimated to be only 4063 km² (4% of the original cover). Fig. 1 shows areas of degraded forest and those that have been converted to farmland. Most of these were either forested or covered in dryland vegetation. Hamilton (1984) and Langdale-Brown (1960) estimate that ca 20% of Uganda's land surface was covered by other tree-rich vegetation such as woodland, including much of the Karamoja area which today is impoverished. Wetlands today occupy only 13% of Uganda's surface area (NEMA 2000). Drylands – here used to include grasslands, woodlands, scrub, shrubland – have been less

documented and little is known about their original extent of cover but these vegetation types have probably been less destroyed as they tend to occur on less fertile soils and now cover more area (about 42%) of the country (Fig. 1).

The whole range of habitats have had their species composition altered through anthropogenic influences. They have been modified, degraded and impoverished by way of selective removal of some species that are preferred for socio-economic purposes. This overexploitation of some species has led to significant reductions in their population making them more rare, and changed the community structure. Another remarkable change has been fragmentation of the habitats thus turning the originally vast expanses of natural vegetation estate into mere patches. Fig. 1 shows how the remaining forest habitats, for example, have been fragmented. They occur as islands in a sea of degraded and converted area. This destroys habitat connectivity and continuity, which in turn affects such ecological processes as dispersal, increases the edge effects and renders management more difficult. Some of the dryland and forest ecosystems are represented in the protected area network in the country as shown in Fig. 2 but the wetlands are not.

Relatively more botanical research has been carried out in the forest than in wetland and dryland habitats of Uganda in the recent past. This study emphasized the later two ecosystem types with a view of getting current information on their contribution to the conservation of Uganda's flora today. It is through such surveys that patterns of distribution of taxa can be better understood and this is vital for planning and designing of conservation strategies.

Methods

For assessing the species richness, the sources of information we used included Davis *et al.* (1994), various floras of the Tropical East

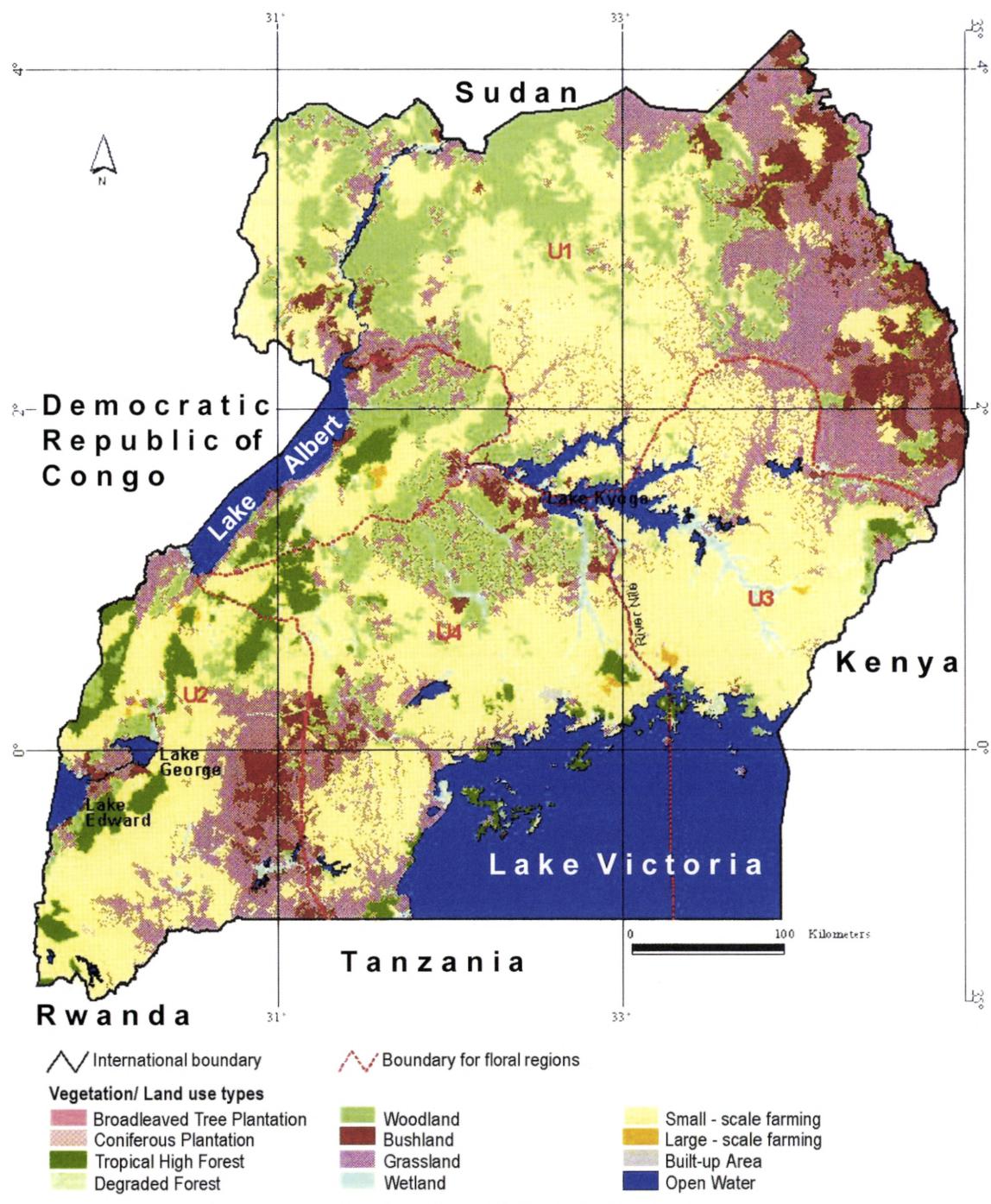


Fig. 1. The vegetation and land-use types in Uganda. The four floral regions in which the country is divided are indicated as U1, U2, U3 and U4.

Protected Areas

- National Parks
- Forest Reserves
- Wildlife Reserves
- Animal Sanctuaries
- Communal Wildlife Areas

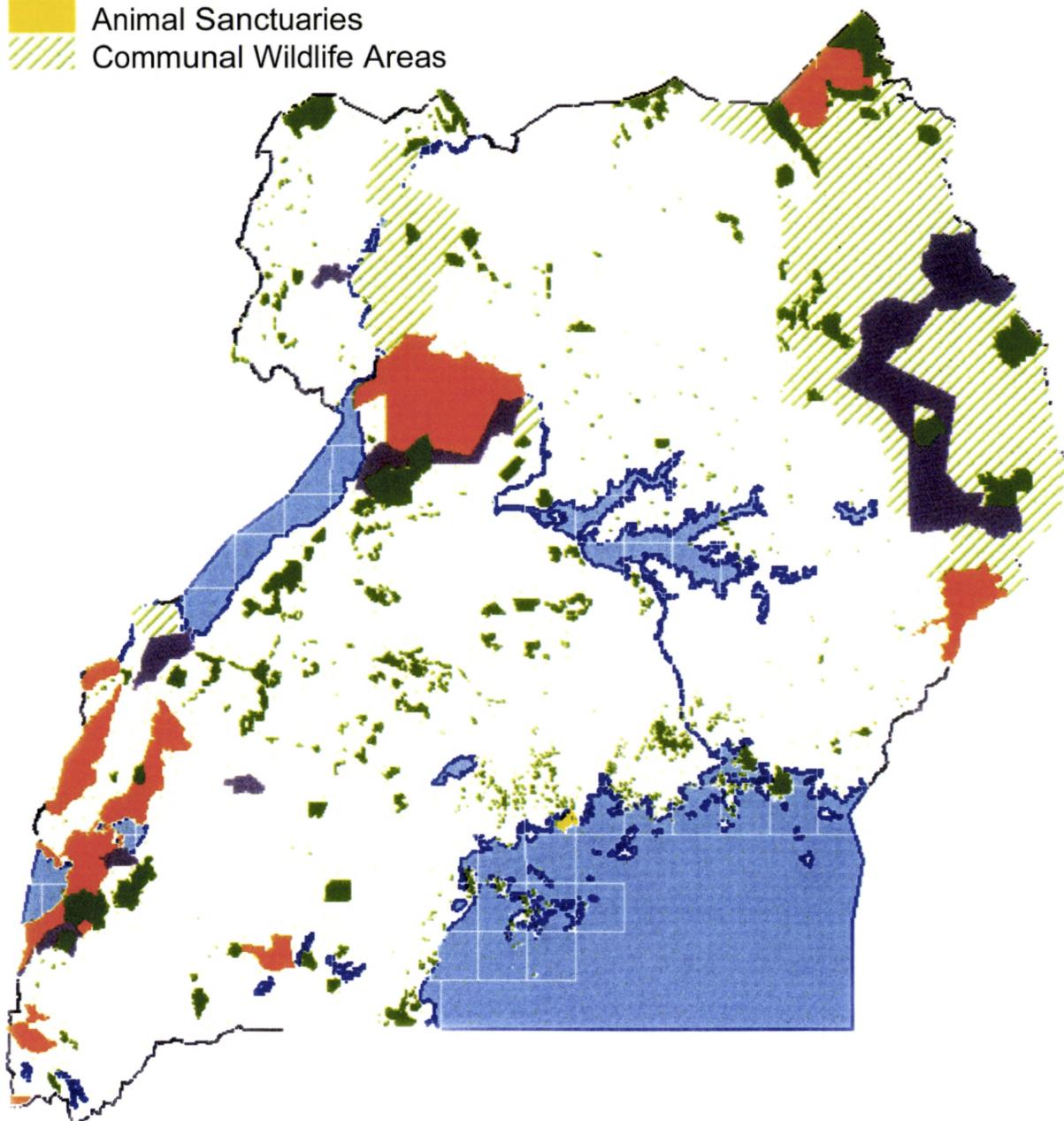


Fig. 2. The protected areas of Uganda. Note that some of the National Parks consist of forest.

Africa region, and Phillips *et al.* (1999). The global threat levels were obtained from the 2000 IUCN Red List of threatened plants which is available on the IUCN website (www.iucn.org). Endemism was assessed from the geographical distribution information provided in the Flora of Tropical East Africa (FTEA). The new records were obtained from both published and unpublished work of other collectors of Ugandan plants as well as that from our own collections that were made during the period of August 2000 to December 2001. In our surveys, we inventoried vascular plants in wetland and dryland Important Bird Areas (IBAs). Our study areas varied in size and the sampling effort was allocated in relation to the size of the study area and the level of habitat heterogeneity which itself was measured from the number of Langdale-Brown *et al.* (1964) vegetation types.

Results and discussion

The areas of wetland and dryland surveyed together cover an area of 10,628 km² representing only 4.5% of the country's total area. Nonetheless, we encountered 1038 species in the wetlands and 1448 in the drylands. The combined total for both habitat types was 2011 representing 37% of the national total number of vascular plants. This is an indication of the floral richness of these areas.

A number of species have been recently found to occur in the country for the first time ever. A total of 27 species are of importance in the entire Flora of Tropical East Africa region. They have not been recorded in the flora area before. The three most recent ones are: *Chasmopodium caudatum* (Hack.) Stapf (Poaceae) (Namaganda & Kalema 2003), *Dyschoriste multi-caulis* (A. Rich.) O. Kuntze (Acanthaceae) and *Ochna leucophloeos* Hochst. ex A. Rich. (Ochnaceae). Appendix 1 shows the taxa that were recorded for the first time in Uganda.

These were a total of 55. Overall, the floral region U2 registered the highest proportion of new species (66%) followed by U1 (21%), U3 (7%) and U4 had the lowest (6%).

The new records came mostly from the floral region U2 (Appendix 1). The particular areas in this floral region from which they were recorded are Bwindi (Impenetrable) National Park and Budongo Forest for the forested areas while in U1 the main contributors were Kidepo Valley National Park, Ajai Wildlife Reserve and Murchison Falls National Park for the savanna areas (also see Kalema 2003). Kidepo is located in White's (1983) Somali-Masai Regional Centre of Endemism characterized by very dry conditions, a unique feature in the country. This coupled with the remote nature of the area makes it a good candidate for encountering new records. The Ajai and Murchison areas tend to have Central and West African floral affinities thus having species occurring at their eastern limit of their range. Many of these new records are undoubtedly very rare species at least at national level (also see Namaganda 2003, Namaganda & Kalema 2003). However, the last five species in Appendix 1, namely *Flaveria trinervia*, *Nicandra physalodes*, *Acmella uliginosa*, *Xanthium strumarium* and *Aeschynomene americana* var *glandulosa* are not indigenous species in Uganda. *A. americana* var. *glandulosa* is a cultivated species while the rest are weedy species of cultivation and introduced in the country. This makes such species potential threats to the indigenous flora as they may become invasive. They can also exert a remarkable impact on the country's economy as notorious weeds of cultivation considering that Uganda's economy is hinged on agriculture.

Most of the endemic species in Uganda occur in floral region U2 (Appendix 2). This is essentially the western part of the country and also where the biotically significant Albertine Rift area is located. Most of them (89%) also

tend to occur in only one out of the four floral regions (see Appendix 2). And even more important, many have a very restricted range of geographical distribution within the floral region. This makes them vulnerable to extinction. *Diospyros katendei* Verdc., for example, has only been recorded from Kashyoha-Kitomi, while *Euphorbia bwambensis* S. Carter is only known from the Bwamba area.

The globally threatened species also exhibit a distribution pattern similar to that of the endemic species; thus most of them (54%) only occur in one floral region and again floral region U2 registered the highest proportion of the threatened species (Appendix 3). Among the threatened are eight species of the family Meliaceae – the mahoganies – and *Milicia excelsa* (Welw.) C.C. Berg all of which are under tremendous overexploitation pressure because of their commercially desirable good timber. *Prunus africana* (Hook.f.) Kalkm. is threatened because of its medicinal and good timber value.

Conclusions

Uganda's diversity of flora is of significant conservation value globally, regionally and especially at national scale. Many new national records are likely to be made through more inventories and surveys, not only in forests but also wetlands and drylands. As would be expected, the diversity of plants in Uganda exhibits a pattern that indicates that some regions of the country are more significant than others. These deserve more attention in order to conserve the species they harbour.

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Appendix 1. New plant records in Uganda. The names of countries abbreviated in the last column are as follows: Sud=Sudan, Belg Congo=Belgium Congo, Eth=Ethiopia, Zam=Zambia, Moz=Mozambique, Som=Somalia, Mala=Malawi, Zim=Zimbabwe, S. Afr=South Africa, Trop. Afr=Tropical Africa, Rwa=Rwanda, DRC=Democratic Republic of Congo, Ang=Angola, Bot=Botswana, Nam=Namibia, Pak=Pakistan, Indi=India, Eri=Eritria, Mada=Madagascar, Sen=Senegal, S. Am.=South America, Trop. Am.=Tropical America, S. Lan=Sri Lanka, Thai=Thailand, Came=Cameroon.

Family	Species	Location where species was discovered (Floral region)	FTEA countries/regions where species is known	Countries outside FTEA where species is known
Poaceae	<i>Chasmopodium caudatum</i> (Hack.) Stapf	Murchison Falls National Park (U2); Namukongo-Nakasongola District (U4)	None Belg Congo	Nigeria, Sud, Belg Congo
Acanthaceae	<i>Dyschoriste multicaulis</i> (A. Rich.) O. Kuntze	Kidepo Valley National Park (U1)	None	Eth, Sud
Ochnaceae	<i>Ochna leucophloeos</i> Hochst. ex A. Rich.	Ajai Wildlife Reserve (U1)	None	Horn of Africa
Asteraceae	<i>Nicolasia nitens</i> (O.Hoffm.) Eyles var. <i>nitens</i>	Kidepo Valley National Park (U1)	K1,3,4,6,7; T1,2,5,7	Zam, Zim, Bot, Nam
Araceae	<i>Stylochiton borumensis</i> N.E Br.	Kidepo Valley National Park (U1)	K1,2,4,7; T1,3-8	Zam, Moz
Cucurbitaceae	<i>Kedrostis leloja</i> (Forsk.) C.Jeffrey	Kidepo Valley National Park (U1), Queen Elizabeth National Park (U2)	K7; T3,6,8	Som, Arabia
Amaranthaceae	<i>Pupalia lappacea</i> (L.) A.Juss. var. <i>glabrescens</i> C.C. Townsend	Ajai Wildlife Reserve (U1)	K7; T6,8; Z; P	Moz
Euphorbiaceae	<i>Caperonia stuhlmannii</i> Pax	Ajai Wildlife Reserve (U1)	T1-6,8; Z	Moz, Mala, Zam, Zim, S. Afr
Caryophyllaceae	<i>Polycarpa linearifolia</i> (DC.) DC	Ajai Wildlife Reserve (U1)	T4, 8	Trop. Afr.
Oleaceae	<i>Jasminum stenolobum</i> Rolfe	Ajai Wildlife Reserve (U1)	T5,6,8	Zim, Mala, Bechuanaland, S. Afr
Lamiaceae	<i>Plectranthus longipes</i> Baker	Lake Mburo National Park (U2)	K; T	Eth, Rwa
Papilionaceae	<i>Indigofera tenuis</i> Milne-Redh.	Kidepo Valley National Park (U1)	T1,2,4,7,8	Zam
Papilionaceae	<i>Indigofera vicioides</i> Jaub. & Spach var. <i>rogersii</i> (R.E Fries) Gillett	Kidepo Valley National Park (U1)	K4; T1,2,4,7	DRC, Moz, Mala, Zam, Zim, Ang, S.Afr

Family	Species	Location where species was discovered (Floral region)	FTEA countries/regions where species is known	Countries outside FTEA where species is known
Papilionaceae	<i>Tephrosia subtriflora</i> Bak.	Murchison Falls National Park (U2); Queen Elizabeth National Park (U2)	K1,4,6,7; T2,3,5,7	Cape Verde Is., Niger, Sud, Arabia, Pak, Indi, Burma, Eth, Eri, Som, Ang, Mada
Papilionaceae	<i>Aeschynomene pfundi</i> Taub.	Lake Opeta wetland (U3)	K1,3; T2,4,5	Sud, Mala, Zam
Celastraceae	<i>Maytenus putterlickioides</i> (Loes.) Exell. & Mendonca	Murchison Falls National Park (U2)	K1,3,4,6,7; T3-5,7,8	DRC, Eth, Moz, Mala, Zam, Zim, Ang
Poaceae	<i>Panicum phragmitoides</i> Stapf	Murchison Falls National Park (U2)	T1, 4-8	Guinee, Zam, Ang
Poaceae	<i>Panicum pole-evansii</i> C.E. Hubbard ^a	Luweero (U4)	Tanz.	DRC, Zam
Anthericaceae	<i>Chlorophytum occultum</i> A.D. Poulsen & I. Nordal ^b	Budongo Forest (U2)	None	Ituri Province of DRC
Anthericaceae	<i>Chlorophytum hirsutum</i> A.D. Poulsen & I. Nordal ^b	Albertine rift (U2)	None	DRC, BUR
Zingiberaceae	<i>Aframomum uniflorum</i> Lock & A.D. Poulsen ^b	Budongo (U2)	None	Ituri Province of DRC
Zingiberaceae	<i>Aframomum spiroligulatum</i> A.D. Poulsen & Lock ^b	Kasyoha-Kitomi (U2)	None	Rwa
Costaceae	<i>Costus foliaceus</i> J.M.Lock & A.D.Poulsen ^b	Kasyoha-Kitomi (U2)	None	None
Poaceae	<i>Sporobolus tenuissimus</i> (Schrank) O. Ktze	Ajai Wildlife Reserve (U1)	K7; T3,4,6,8; Z; P	From East Africa westwards to Sen & Trop. Am., eastwards to Burma
Poaceae	<i>Urochloa setigera</i> (Retz.) Stapf	Queen Elizabeth National Park (U2)	K1,7; T?1,3,6,8; Z; P	DRC, Eth, India, S. Lan, Burma, Thai
Asteraceae	<i>Flaveria trinervia</i> (Spreng.) Mohr*	Queen Elizabeth National Park (U2)	K; T; Z	None
Solanaceae	<i>Nicandra physalodes</i> (L.) Gaertn.*	Doho (U3)	K; T	Not covered in Flora
Asteraceae	<i>Acmella uliginosa</i> (Sw.) Cass.*	Doho (U3)	K; T	Last part of FTEA Asterac. not yet available

Family	Species	Location where species was discovered (Floral region)	FTEA countries/regions where species is known	Countries outside FTEA where species is known
Asteraceae	<i>Xanthium strumarium</i> L.*	Doho (U3)	K; T	Last part of FTEA Asterac. not yet available
Papilionaceae	<i>Aeschynomene americana</i> L. var. <i>glandulosa</i> (Poir.) Rudd*	Lutembe (U4)	K (Cultivated)	S. Am.
Caryophyllaceae	<i>Silene lyneborgii</i> Norman ^c	Mt. Elgon National Park (U2)	None	Central Sahara, Sud
Moraceae	<i>Ficus katendei</i> Verdc. ^c	South Kyambura River (U2)	None	None
Menispermaceae	<i>Syrrheonema fasciculatum</i> Miers ^d	Kibale National Park (U2)	None	Belgian Congo, Came, Gab
Thymelaeaceae	<i>Craterosiphon scandens</i> Engl. & Gilg ^d	Budongo Forest Reserve (U2)	None	Came
Sterculiaceae	<i>Cola pierottii</i> Germain ^e	Bwindi Impenetrable National Park (U2)	None	DRC
Orchidaceae	<i>Stolzia cupuligera</i> (Kraenzl.) Summerh. ^e	Bwindi Impenetrable National Park (U2)	None	DRC
Orchidaceae	<i>Angraecopsis</i> sp. nov? ^e	Kasyoha-Kitomi Forest reserve (U2)	None	Probably none
Orchidaceae	<i>Angraecopsis elliptica</i> Summerh. ^e	Bwindi Impenetrable National Park (U2)	None	West Tropical Africa
Begoniaceae	<i>Begonia subscutata</i> De Wild ^e	Kasyoha-Kitomi Forest Reserve (U2)	None	DRC, Came
Aspleniaceae	<i>Asplenium</i> sp. nov? ^e	Bwindi Impenetrable National Park (U2)	None	Probably none
Verbenaceae	<i>Clerodendrum welwitschii</i> Guerke	Bwindi Impenetrable National Park (U2)	None	?
Annonaceae	<i>Friesodielsia enghiana</i> (Diels) Verdc. ^d	Budongo Forest Reserve (U2)	None	?
Apocynaceae	<i>Landolphia foretiana</i> (Pierre ex Jumelle) Pichon ^d	Bwindi Impenetrable National Park (U2)	None	?
Celastraceae	<i>Loeseneriella apiculata</i> (Welw. ex Oliv.) R. Wilczek ^d	Bwindi Impenetrable National Park (U2)	None	?
Convolvulaceae	<i>Neuropeltis velutina</i> Hall.f. ^d	Budongo Forest Reserve (U2)	None	?
Cucurbitaceae	<i>Momordica jeffreyana</i> Keraudren ^d	Bwindi Impenetrable National Park (U2)	None	?
Rubiaceae	<i>Tricalysia anomala</i> E. A. Bruce var <i>montana</i> Robbrecht ^e	Bwindi Impenetrable National Park (U2)	None	?

Family	Species	Location where species was discovered (Floral region)	FTEA countries/regions where species is known	Countries outside FTEA where species is known
Rubiaceae	<i>Tarrena eketensis</i> Wernh. var. <i>auricluna</i> N. Halle	Bwindi Impenetrable National Park (U2)	None	?
Sapotaceae	<i>Chrysophyllum welwitschii</i> (Engl.) Pirre ex Aubr. & Pellegr.	Budongo Forest Reserve (U2)	None	?
Lamiaceae	<i>Aeollanthus buchnerianus</i> Briq. ^e	Bwindi Impenetrable National Park (U2)	?	?
Lycopodiaceae	<i>Huperzia gnidioides</i> (L.f.) Trevisan ^e	Kasyoha-Kitomi Forest Reserve (U2)	?	?
Hymenophyllaceae	<i>Trichomanes (Vandenboschia) radicans</i> Sw. ^e	Bwindi Impenetrable National Park (U2)	?	?
Hypericaceae	<i>Garcinia</i> L. sp. nov? ^e	Bwindi Impenetrable National Park (U2)	?	?
Menispermaceae	<i>Cissampelos truncata</i> Engl. ^d	Kibale National Park (U2)	?	?
Plantaginaceae	<i>Plantago lanceolata</i> L. ^c	Rwenzori Mountains National Park (U2)	?	?

^a Source: Namaganda, M. 2003. Lidia 6: 1-12.

^b Source: Poulsen, A.D. & Lock, J.M. 1997 Kew Bulletin 52: 601-616.

^c Source: Katende, A.B & Lye, K.A. 1997. Lidia 4(1): 3-12.

^d Source: Eilu, G. 1999. Lidia 4(4): 93-120.

^e Source: Eilu, G. *et al.* (in prep.).

* Introduced species, many of which are weedy.

Appendix 2. The distribution of endemic species in the floral regions of Uganda. The figures in brackets show the corresponding percentages.

(a)	
Floral region	Number (percentage) of endemic species occurring in floral region.
U1	10 (13%)
U2	40 (53%)
U3	8 (10%)
U4	18 (24%)

(b)	
Number of floral regions	Number (percentage) of endemic species occurring in floral regions.
One region	62 (89%)
Two regions	7 (10%)
Three regions	1 (1%)
Four regions	0 (0%)

Appendix 3. The distribution of globally threatened species in the floral regions of Uganda. The figures in brackets show the corresponding percentages.

(a)	
Floral region	Number (percentage) of globally threatened species occurring in floral region
U1	16 (24%)
U2	30 (45%)
U3	6 (9%)
U4	14 (21%)

(b)	
Number of floral regions	Number (percentage) of globally threatened species occurring in floral regions
One region	20 (54%)
Two regions	7 (19%)
Three regions	8 (22%)
Four regions	2 (5%)

