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Vascular flora inventory and plant diversity of the Ruvubu National Park, Burundi

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ABSTRACT

The Ruvubu National Park, the biggest protected area and biodiversity refuge of the country, is comparatively less studied than western Burundi near Bujumbura, the capital. This article reports the results of a botanical inventory of the vascular plants from the protected area, evidences species newly encountered and establishes a comparison of the floristic diversity with the Akagera National Park in Rwanda located in the same phytochorion, in the Lake Victoria regional mosaic. Records from the Ruvubu include 522 species (including infraspecific groups) from 96 families and 306 genera, representing nearly 17% of the known vascular plants of Burundi. The most common families were the Fabaceae, the Asteraceae and the Poaceae. 96 species or 18% of the flora were encountered for the first time in the park. Study of environmental determinants of Leguminosae abundance and floristic variability would provide more precisions.

KEY WORDS

Akagera,
Burundi,
floristic inventory,
plant richness,
Ruvubu.

RÉSUMÉ

Inventaire de la flore vasculaire et diversité floristique du Parc national de la Ruvubu, Burundi

Comparé au Burundi occidental proche de Bujumbura, la capitale, le Parc national de la Ruvubu, la plus grande aire protégée, refuge de la biodiversité du pays, a été relativement peu étudiée. Cette étude rapporte les résultats d'un inventaire botanique des plantes vasculaires de l'aire protégée, met en relief les espèces nouvellement signalées dans le parc et établit une comparaison de la diversité floristique avec le Parc national de l'Akagera au Rwanda, localisé dans la même phytochorie, dans la mosaïque régionale du lac Victoria. La richesse spécifique de la Ruvubu fait état de 522 espèces (incluant les groupes infra-spécifiques) réparties en 96 familles et 306 genres représentant près de 17% des plantes vasculaires connues du Burundi. Les familles les plus nombreuses sont les Fabaceae, les Asteraceae et les Poaceae. 96 espèces (18%) de la flore sont signalées pour la première fois dans le parc. L'étude des déterminants environnementaux de l'abondance des légumineuses et de la variabilité floristique pourrait fournir de plus amples précisions.

MOTS CLÉS

Akagera,
Burundi,
inventaire floristique,
richesse floristique,
Ruvubu.

INTRODUCTION

Many studies (Lewalle 1972; Ndabaneze 1983; Bigendako 1989; Bizuru 2005) have reported that Burundi shelters several plant species on a reduced size. It is quite remarkable that western Burundi, not far from the capital Bujumbura, was more studied in relation to other remaining parts of the country. According to Bizuru (2005), areas corresponding currently to national parks and different other protected areas of Burundi have been until now very little studied. On the whole protected sites of East Africa, the Ruvubu National Park (RNP), the biggest protected area of Burundi with 50 800 ha, occupies a particular position. Although it does not shelter probably any species that does not exist elsewhere,

it has an interest that goes over burundian borders since it is about a rare evidence of the transition between dense forest and humid savannas. It represents the unique protected sample of the humid savanna ecosystem with *Parinari-Pericopsis* (Vande Weghe & Kabayanda 1992). This study carries on a botanical inventory conducted in the RNP, sanctuary and shelter of large mammals disappeared elsewhere in the country. Nzigidaheha (2000) underlined indeed that the vegetation of the RNP remains little known in its whole. Masharabu *et al.* (2008) observe that little study have been conducted and data related to its floristic composition are lacking either insufficient. In a context of good management, planning and biodiversity conservation, it is important to keep a better knowledge of its flora

and that requires proceeding to a plant resource assessment. Therefore, in order to reinforce a decision making of animal communities conservation and sustainable management of the protected area system, it is important to get a better knowledge of the botanical diversity (Lubini 1982; Laurance *et al.* 2006). The entire species list for the RNP has been published by Masharabu *et al.* (2010). The present paper provides an inventory of the RNP vascular flora (Pteridophytes and Phanerophytes) and highlights species newly encountered in the park. This paper is the first to provide an inventory of plant species as complete as possible in a given protected site of Burundi. The study hypothesis was that plant diversity in RNP and Akagera National Park (ANP) in Rwanda would be similar due to their biogeographical location at the crossroads of several biogeographical influences in the Lake Victoria regional mosaic. This region is the meeting place of five regional floras: Guineo-Congolian, Sudanian, Zambezi, Somalia-Masai and Afrotropical. Its vegetation is a mosaic of floristically impoverished variants of the first four plus some communities which are transitional between Afrotropical and lowland vegetation (White 1993).

MATERIAL AND METHODS

This study was carried out in the RNP using a botanical inventory in 114 vegetation plots varying between 100 and 900 m². The inventory was conducted from December 2005 until June 2009, intermittently. The park is located in the north-eastern Burundi (Fig. 1) between latitudes 2°54'–3°22'S and longitudes 30°6'–30°33'E, and covers an area of 50 800 ha. The altitude ranges from 1350 to 1836 m (Vande Weghe & Kabayanda 1992). According to Köppen classification, it has a tropical climate classified as (AW₃)s. The main vegetation features are made of savannas, riparian forests and swamps. Duplicates of plant material were deposited at the Herbarium of the Université Libre de Bruxelles (BRLU), as well as at the Herbarium of the University of Burundi (BJA). The systematic determination and verification were conducted at BJA and BRLU Herbaria as well as at the Herbarium of the National Botanic Garden of Belgium (BR) at Meise by comparison of herbarium

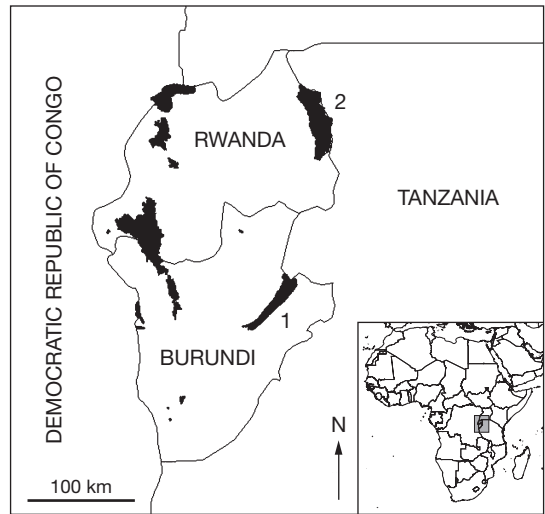


FIG. 1. — Location of the Ruvubu National Park (1) in Burundi and Akagera National Park (2) in Rwanda.

specimens and by the help of literature and specialists. The main bibliographic references consulted during taxa identification are: Blundell (1987) and Troupin (1971, 1978, 1982, 1983, 1985, 1988). Nomenclature follows Roux (2009) for ferns and Lebrun & Stork (1991–1997) for flowering plants. The names of flowering plants were checked in African Flowering Plants Database (AFPD) available online at <http://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php>. In order to provide a floristic inventory more complete as possible, our inventory was also partially completed by specific literature citations referring to the protected area (Ndabaneze 1989; Vande Weghe & Kabayanda 1992; Nzigidahera 2000). These documents produced at University of Burundi and at the National (Burundi) Institute for Environment and Nature Conservation (INECN) in different research activities were consulted in order to evidence species newly encountered in the protected area. The main richest families from ANP were sorted through Troupin (1966) inventory. Chi-Square test (Scherer 2007) was performed to test whether within the main richest families with at least 15 species each one, the numbers of species and genera from the two parks differ significantly.

TABLE 1. — Taxonomic composition of the Ruvubu National Park, Burundi.

Family	Subspecies/ Varieties			Family	Subspecies/ Varieties		
	Genera	Species	Varieties		Genera	Species	Varieties
DICOTS							
Acanthaceae	11	16	–	Myrsinaceae	1	2	2
Amaranthaceae	4	4	–	Myrtaceae	2	4	1
Anacardiaceae	4	7	–	Nymphaeaceae	1	2	–
Annonaceae	3	3	–	Ochnaceae	1	2	–
Apiaceae	5	5	–	Olcaceae	2	2	1
Apocynaceae	10	11	–	Oleaceae	2	2	–
Araliaceae	1	1	–	Onagraceae	1	2	–
Asteraceae	32	57	–	Opiliaceae	1	1	–
Balsaminaceae	1	1	–	Oxalidaceae	2	3	–
Bignoniaceae	3	3	–	Passifloraceae	1	1	–
Bombacaceae	1	1	–	Pedaliaceae	1	2	–
Boraginaceae	2	2	–	Phytolaccaceae	1	1	–
Caesalpinaceae	3	6	–	Pittosporaceae	1	1	–
Celastraceae	1	4	–	Polygalaceae	2	2	–
Chrysobalanaceae	2	2	–	Polygonaceae	2	4	–
Clusiaceae	3	3	–	Primulaceae	1	1	–
Combretaceae	2	4	–	Proteaceae	2	4	–
Convolvulaceae	3	7	–	Ranunculaceae	1	3	–
Cucurbitaceae	2	3	–	Rhamnaceae	2	2	–
Euphorbiaceae	14	26	–	Rhizophoraceae	1	1	–
Fabaceae	22	59	5	Rosaceae	1	1	–
Flacourtiaceae	1	1	–	Rubiaceae	19	28	3
Gentianaceae	1	2	–	Rutaceae	1	1	–
Lamiaceae	12	16	–	Sapindaceae	4	4	–
Leeaceae	1	1	–	Sapotaceae	1	1	–
Loranthaceae	2	2	–	Scrophulariaceae	2	2	–
Malvaceae	5	11	–	Strychnaceae	1	4	–
Melastomataceae	3	7	–	Solanaceae	1	7	1
Meliaceae	2	2	–	Sterculiaceae	2	2	–
Melastomataceae	1	1	–	Thymeleaceae	1	3	–
Menispermaceae	3	3	–	Tiliaceae	1	4	–
Mimosaceae	5	8	–	Ulmaceae	2	2	–
Monimiaceae	1	1	–	Urticaceae	2	2	–
Moraceae	1	10	–	Verbenaceae	3	7	1
Myristicaceae	1	1	–	Vitaceae	4	9	–
MONOCOTS							
Agavaceae	1	1	–	Dioscoreaceae	1	6	–
Amaryllidaceae	2	2	–	Dracaenaceae	1	1	–
Anthericaceae	1	2	–	Hyacinthaceae	1	1	–
Arecaceae	1	1	–	Hypoxidaceae	1	1	–
Asparagaceae	1	2	–	Iridaceae	2	3	–
Asphodelaceae	3	3	–	Orchidaceae	2	2	–
Balanophoraceae	1	1	2	Poaceae	26	52	–
Colchicaceae	1	1	–	Smilacaceae	1	1	–
Commelinaceae	3	5	–	Xyridaceae	1	1	–
Cyperaceae	6	15	–	Zingiberaceae	2	3	–
PTERIDOPHYTES							
Cyatheaceae	1	3	–	Nephrolepidaceae	1	1	–
Dennstaedtiaceae	2	2	–	Osmundaceae	1	1	–
Dryopteridaceae	1	1	–	Pteridaceae	1	1	–

RESULTS

The floristic richness of the RNP comprises 522 species (including infraspecific groups) distributed into 96 families and 306 genera (Table 1). In total, Dicots are better represented with 78% of the whole species. Monocots represent 20% while Pteridophytes represent only 2% of the flora. The eight following families record over a half (51%) of the whole species from RNP: Fabaceae (59 species), Asteraceae (57 species), Poaceae (52 species), Rubiaceae (28 species), Euphorbiaceae (26 species), Acanthaceae (16 species), Lamiaceae (16 species) and Cyperaceae (15 species). Table 2 establishes a comparison of floristic richness of families recording at least 15 species each one in RNP and ANP, relatively closer and belonging to the same phytochorion in the Lake Victoria regional mosaic according to White (1993).

96 species (18%) were encountered for the first time in the RNP with predominance of Fabaceae (23% of the newly encountered species). The inventory of species newly encountered in the RNP is as follows:

Acanthaceae. *Hypoestes verticillaris* (L.f.) Sol. ex Roem. & Schult., *Thunbergia alata* Bojer ex Sims.

Amaranthaceae. *Alternanthera pungens* Kunth.

Asteraceae. *Bidens steppia* (Steetz) Sherff, *Cirsium buchwaldii* O.Hoffm., *Crassocephalum multicorymbosum* (Klatt) S.Moore, *Crassocephalum rubens* (Juss. ex Jacq.) S.Moore, *Crassocephalum sarcobasis* (DC.) S.Moore, *Erlangea cordifolia* (Benth. ex Oliv.) S.Moore, *Helichrysum keilii* Moeser, *Pleiotaxis pulcherrima* Steetz, *Vernonia fontinalis* S.Moore, *Vernonia lasiopus* O.Hoffm., *Vernonia ugandensis* S.Moore.

Boraginaceae. *Cordia africana* Lam., *Trichodesma zeylanicum* (Burm.f.) R.Br.

Caesalpiniaceae. *Cassia kirkii* Oliv., *Cassia mimoides* L., *Cassia siamea* Lam.

Commelinaceae. *Commelina benghalensis* L., *Commelina diffusa* Burm.f. subsp. *diffusa*, *Floscopa africana* (P.Beauv.) C.B.Clarke.

Convolvulaceae. *Dichondra repens* J.R.Forst. & G. Forst., *Hewittia sublobata* (L.f.) Kuntze.

Cucurbitaceae. *Zehneria thwaitesii* (Schweinf.) C.Jeffrey.

Cyperaceae. *Kyllinga sphaerocephala* Boeckeler, *Mariscus macrocarpus* Kunth.

Dennstaedtiaceae. *Histiopteris incise* (Thunb.) J. Sm.

Dioscoreaceae. *Dioscorea alata* L., *Dioscorea bulbifera* L., *Dioscorea odoratissima* Pax.

Euphorbiaceae. *Acalypha ornata* Hochst. ex A.Rich., *Clutia abyssinica* Jaub. & Spach, *Croton macrostachyus* Hochst. ex Delile, *Phyllanthus niruri* L., *Synadenium grantii* Hook.f., *Tragia brevipes* Pax.

Fabaceae. *Crotalaria aculeata* De Wild., *Crotalaria lachnophora* A.Rich., *Crotalaria ononoides* Benth., *Crotalaria* sp., *Desmodium salicifolium* (Poir.) DC., *Desmodium setigerum* (E.Mey.) Benth. ex Harv., *Desmodium triflorum* (L.) DC., *Desmodium velutinum* (Willd.) DC., *Eriosema chrysadenium* Taub., *Eriosema rhodesicum* R.E.Fr., *Eriosema stanerianum* Hauman, *Indigofera emarginella* Steud. ex A.Rich., *Indigofera homblei* Baker f. & Martin, *Indigofera paracapitata* J.B.Gillett, *Indigofera rhynchocarpa* Welw. ex Baker, *Indigofera spicata* Forssk., *Indigofera zenkeri* Harms ex Baker f., *Rhynchosia sublobata* (Schumach. & Thonn.) Meikle, *Tephrosia linearis* (Willd.) Pers., *Teramnus labialis* (L.f.) Spreng., *Vigna luteola* (Jacq.) Benth., *Vigna parkeri* Baker.

Lamiaceae. *Leucas calostachya* Oliv., *Solenostemon platostomoides* (Robyns & Lebrun) Troupin.

Malvaceae. *Hibiscus aponeurus* Sprague & Hutch., *Sida cordifolia* L.

Melastomataceae. *Antherotoma naudinii* Hook.f., *Dissotis brazzae* Cogn., *Dissotis ruandensis* Engl., *Dissotis senegambiensis* (Guill. & Perr.) Triana, *Dissotis trothae* Gilg, *Tristemma incompletum* R.Br.

Mimosaceae. *Acacia sieberiana* DC.

Moraceae. *Ficus ovata* Vahl.

Osmundaceae. *Osmunda regalis* L.

Poaceae. *Hyparrhenia cymbaria* (L.) Stapf, *Hyparrhenia newtonii* (Hack.) Stapf, *Hyparrhenia rufa* (Nees) Stapf, *Loudetia kagerensis* (K.Schum.) C.E.Hubb. ex Hutch., *Oplismenus compositus* (L.) P.Beauv., *Pennisetum polystachion* (L.) Schult., *Setaria kagerensis* Mez, *Setaria pumila* (Poir.) Roem. & Schult., *Urelytrum digitatum* K.Schum.

Polygonaceae. *Rumex usambarensis* (Dammer) Dammer.

Rubiaceae. *Agathisanthemum globosum* (Hochst. ex A.Rich.) Bremek., *Fadogia obovata* Schweinf., *Hymenodictyon floribundum* (Hochst. & Steud.) Robbr., *Pavetta ternifolia* (Oliv.) Hiern, *Spermacoce dibrachiata* Oliv., *Spermacoce sphaerostigma* (A.Rich.) Vatke.

Scrophulariaceae. *Buchnera keilii* Mildbr., *Lindernia* sp.

Solanaceae. *Solanum anguivi* Lam.

Thymeleaceae. *Gnidia ericoides* C.H. Wright.

Tiliaceae. *Triumfetta cordifolia* A.Rich.

Urticaceae. *Urtica massaica* Mildbr.

Vitaceae. *Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm.

Xyridaceae. *Xyris capensis* Thunb.

DISCUSSION

The 522 taxa recorded from the RNP represent 17% of the vascular plant species so far estimated for Burundi and 17% of the flora recorded in the Lake Victoria regional mosaic. The vascular plants are estimated at about more than 3000 species for Burundi (Ndabaneze 1989) and 3000 species in

the Lake Victoria regional mosaic (White 1993). Ferns are weakly represented in the PNR (nine species distributed into six families) and it is not strange as the RNP is mainly made of savannas. Moreover, it is well-known that the Pteridophytes diversity in Africa is exceptionally poor (Tryon 1986; Roux 2009). Burundi comprises 32 families of Pteridophytes distributed into 69 genera and 178 species (Roux 2009). Therefore, the Pteridophytes of the RNP represent 5% of those of the whole country.

The flora of the RNP represents besides 5% of the flora of Central Africa (Burundi, Democratic Republic of Congo and Rwanda). According to Brenan (1978), floristic richness of the Central Africa region is estimated at more or less 10 000 species. According to Léonard (1994), spermatophytes' statistics of the flora of Central Africa include 9377 species. Burundi (27 834 km²) being confined between Eastern and Central Africa (Bidou *et al.* 1991), the RNP floristic richness represents about 4.8% of the flora of Eastern Africa which is estimated according to Linder (2001), at 11 000 species.

The plant communities of the RNP present relatively a poor taxonomic diversity when compared with tropical forests. In the humid tropical forests, flowering plants are estimated at 7146 species in the Guianas (Guyana, Suriname, French Guiana) according to Haripersaud *et al.* (2010), 4300 species in French Guiana (90 000 km²) and 8000 species in Peninsular Malaysia (130 000 km²) according to Blanc (1997). The tropical forests record the largest known specific diversity and also shelter numerous even unknown species, because inventories are far to be finished there (Puig 2001).

Families with the greatest number of species in RNP and ANP are not statistically different in terms of species richness as well as for genera richness ($p > 0.05$). It was hypothesized that plant diversity in RNP and ANP in Rwanda would be similar due to their biogeographical location at the crossroads of several biogeographical influences in the Lake Victoria regional mosaic. The hypothesis is accepted for species and generic richness within families in the two protected areas. However, even if they are not statistically

TABLE 2. — Comparison of the floristic richness of families with at least 15 species each one in Ruvubu National Park with their correspondences from Troupin (1966) in Akagera National Park (species: $ddl = 7$, $c^2 = 9.98$, $p > 0.05$; genera: $ddl = 7$, $c^2 = 2.63$, $p > 0.05$).

Families	Ruvubu National Park, Burundi				Akagera National Park, Rwanda			
	species		genera		species		genera	
	observed	expected	observed	expected	observed	expected	observed	expected
Fabaceae	59	51	22	21	65	73	24	25
Asteraceae	57	59	32	33	85	83	39	38
Poaceae	52	61	26	30	95	86	40	36
Rubiaceae	28	23	19	17	28	33	19	21
Euphorbiaceae	26	21	14	12	25	30	13	15
Acanthaceae	16	19	11	12	29	26	16	15
Lamiaceae	16	16	12	11	23	23	12	13
Cyperaceae	15	19	6	5	31	27	5	6

different, the numeric gap in observed species and generic richness would be due to the fact that the ANP includes xerophytic groves and xerophytic forests not found in Ruvubu, while wetlands spread on 50% of the total area. The current size of the ANP has been fixed at 108 500 ha in 1997 after an encroachment of practically $\frac{2}{3}$ of the total area with negative effects on biodiversity (Buda *et al.* 2005).

The Fabaceae family has the greatest number of species in RNP. It is also the third biggest family of flowering plants worldwide after Orchids and Asteraceae (Mabberley 1997; Lewis *et al.* 2005). Fabaceae and Asteraceae are basically the first predominant families in Central Africa (Burundi, Democratic Republic of Congo and Rwanda) in terms of species richness listed by Léonard (1994). Particularly, according to Rundel (1989), Arianoutsou & Thanos (1996), the Leguminosae taxa (Fabaceae, Caesalpiniaceae & Mimosaceae) are ecologically very successful in terms of dominance and productivity. Leguminosae, through their symbiotic abilities to fix atmospheric nitrogen, have adaptations to establish on soils with limited nitrogen availability and play an important role in colonizing disturbed ecosystem, including those that are fire prone (Arianoutsou & Thanos 1996), of which the RNP. That would justify partially their abundance in the RNP and within the newly encountered species. Nevertheless, the study of environmental determinants of Leguminosae abundance and floristic variability would provide more precisions.

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