East African Scholars Journal of Agriculture and Life Sciences
Abbreviated Key Title: East African Scholars J Agri Life Sci
ISSN 2617-4472 (Print) | ISSN 2617-7277 (Online) |
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-2 | Issue-6 | Jun-2019 |

Research Article

Check-list of the *Poaceae* of the high altitude part of the Kahuzi-Biega National Park preserved in the Lwiro Collection since 1953

Sylvie Cirhuza Cimwemwesa[1], Orléanne Nangalire Nankafu [2], Joseph Masirika Matunguru[3], Corneille Ewango Ekokinya[4]

[1]Systematic and Taxonomy of Plant laboratory, Botanical Section, Research Centre in Natural Sciences, CRSN/Lwiro, DS/Bukavu, South-Kivu, Democratic Republic of Congo
[2] Ecology Plant laboratory, Botanical Section, Research Center in Natural Sciences, CRSN/Lwiro, DS/Bukavu, South-Kivu, Democratic Republic of Congo
[3]Department of Environment and Sustainable Development, Higher Institute of Development Techniques (ISTD / Kalehe)
[4]Faculty of Forestry & Renewable Natural Resource Management, Kisangani University (UNIKIS) Democratic Republic of the Congo

*Corresponding Author
Sylvie Cirhuza Cimwemwesa

Abstract: This article focuses on the botanical collection of the Poaceae family in the Research Centre in Natural Sciences (CRSN / Lwiro) Herbarium harvested at Kahuzi-Biega National Park (PNKB) in the high altitude portion (Tshivanga, Mount Kahuzi, Mount Bièga and Tshibati), east of the Democratic Republic of Congo (DRCongo) since 1953. The classical methods of Herbarium taxonomy were used in this study for the identification and hierarchical classification of *Poaceae* species. Inventoried in the Lwiro Herbarium (LWI). 57 species of *Poaceae* (84 individuals) were inventoried in the altitudinal range of 1200 and 3324 m. A total of 25 specimens were identified, corrected and updated during this study. For the biological type, the Hemicryptophytes dominate with 65.48% while the perennials dominate for the morphological type, with 73, 81%. The swamp forest species are more abundant (34, 52%) compared to all the habitats observed. The subfamily Panicoideae dominates with 67, 85%. All these species of *Poaceae* are of socio-economic importance (Corn, Wheat, Barley, Rice, Millet, Sorghum, etc.) and fodder.

Keywords: *Herbarium, Poaceae, Altitudinal Slice, Hemicryptophytes, Perennial and Forage herbs*.

BACKGROUND

Poaceae form an important botanical family. They derive their current name from the *Poa* genre (Dewet, 2004). They present a large number of species essential in the world economy and whose use is vital for the food of humans and their livestock (Piperno *et al*., 2005). They are used in the manufacture of several tools including baskets, handbags, calabashes, cabinets, huts etc. Several species of this family are cultivated in fields and gardens and are also ornamental and honey.

The species of this family are generally herbaceous, annual or perennial plants with hollow cylindrical stem bearing nodes, the stubble generally unbranched except at the level of the ground where the phenomenon of tillering often occurs, which leads to the formation of characteristic tufts . Some species produce rhizomes and stolons that allow surface occupation and lawn formation (Chase and Reveal, 2009). The roots form an important hair, thanks to the formation of many adventitious roots arising at the base of the stems. The leaves are narrow, with parallel veins with inflorescences formed of spikelets. The fruit is a caryopsis.

It is a family rich in species, with an estimated number of 12,000 distributed in about 700 genera (Dewet, 2004). It occupies fifth place in the Angiosperms, in relation to its specific richness. Its subdivision into subfamilies is still difficult because each time one observes taxa changes during taxonomic revisions (APG I 1998, APG II 2003, APG III 2009 and APG IV 2016).

In 1998, the APG I classification (Angiosperms Phylogeny Group) subdivided it into four subfamilies: *Bambusoideae*, *Pooideae*, *Chloridoideae* and *Panicoideae*. Then in 2003, the authors group of APG II subdivided into eight subfamilies namely: *Bambusoideae, Centothecoideae, Chloridoideae, Danthonioideae, Ehrhartoideae, Panicoideae, Pharoideae and Pooideae*. Under the APG III

Quick Response Code

Journal homepage:
http://www.easpublisher.com/easjals/

Article History
Received: 25.05.2019
Accepted: 08.06.2019
Published: 27.06.2019

DOI: 10.36349/easjals.2019.v02i06.008

classification, Mark and James (2009) classified *Poaceae* into two groups with thirteen sub-families including:

- The group of ancestral families: the three ancestral subfamilies (*Anamochlooideae, Pharoideae and Puelioideae*)
- Two monophyletic groups BEP clade (*Bambusoideae, Ehrhartoideae* and *Pooideae*).
- PACCMAD clade (*Panicoideae, Arundinoideae, Chloridoideae, Centothecoideae, Micrairoideae, Aristidoideae* and *Danthonioideae*).

The family *Poaceae* or *Graminae* is classified among the monocotyledonous plants, in the order of *Poales*. Grasses are angiosperms (Magnoliopsida). In difference of gymnosperms, the angiospermsegg is enclosed in the ovary.It comprises about 10,000 species and 600 to 700 genera, depending on the classification used. The *Poaceae* are subdivided into 13 sub-families of very unequal sizes, themselves subdivided into 46 tribes. Subfamilies can be grouped phylogenetically into two main groups, the BEP clade and the PACMAD clade (Kellegs, 2016).

This study aims to present the synoptic list of species of *Poaceae* populating the high altitude zone of the Kahuzi-Biega National Park (PNKB) including Tshivanga, Tshibati, Mont-Kahuzi and Mont-Bièga. They cover the specimens kept in the herbarium ofLwiro since 1953. The key idea is to identify the species of this family harvested for 65 years, to provide data for researchers and students, to guide future studies of this group in the collectionand in their natural environment, finally to encourage the conservation of these species given their socio-economic interests.

With regard to the plants from which samples were collected in 1953, this study will be supplemented by field data to confirm the state of conservation of these species in the current state, in case ofknowing their socio-economic roles and the demographic dynamics in the region after 65 years they may have been ravaged.

MATERIALS AND METHODS

Study Area

- **Presentation of the Lwiro Research Center**

The Institute for Scientific Research in Central Africa (IRSAC) currently Research Center in Natural Sciences (CRSN/Lwiro) was created on July 1, 1947 by Prince Charles of Belgium.Since its creation, the IRSAC had set itself the goal of creating, promoting, carrying out and coordinating especially in the Belgian Congo and Rwanda-Urundi the study of the sciences of man and nature.

In 1975, this Research Institution was renamed Lwiro Center in the Institute for Scientific Research (IRS), established by Law N°. 075-029 of October 22, 1975.By Order-Law No. 082-042 of November 5, 1982 on the organization of Scientific and Technological Research in our country, the Lwiro Center was renamed the " Research Center in Natural Sciences" (CRSN/Lwiro) with legal personality and financial autonomy by then disposing of Uvira and Mabali stations, Goma and Irangi branches and a liaison office in Kinshasa.

- **Lwiro Herbarium**

The four laboratories of Lwiro Herbarium are: Systematics and Taxonomy of Plant, Ethnobotany, Plant Ecology and Phytochemistry. The botanical section has a Herbarium. The latter is a museum or botanical sanctuary where specimens or plant collections are kept (samples of well-dried and well-treated plants ready for storage for further studies. This museum has been created since 1953 with two researchers: the first was a Belgian agronomist called Mrs CHRISTIANSEN. After, Georges TROUPIN considered as the pioneer of the Herbarium for putting order in the description, collection, classification and identification of plants. He was assisted by his assistant Jean Petit (Mwangamwanga, 2013).

This Herbarium is the second in our country DRC after YANGAMBI in Kisangani. It was created to promote and preserve all the specimens of the DRC. It has a historical and geological importance for the endemic plants that emerged a natural disaster (Mwangamwanga, 2013).

- **Location Area**

This study was carried out in Lwiro, Bugorhe grouping. It is located between 28 ° 48 ' E and 2 ° 15' SE on the side of the Kahuzi-Biega massif between 1470 and 2200 masl of altitude. This environment is characterized by a humid tropical climate including a long rainy season of 9 months (September to May) and a short dry season of 3 months (from June to August). The average annual temperature varies between 18 and 20 °Cand the air humidity between 68 and 75% (CRSN-Lwiro Climatology Station). This region with volcanic soil is formed by the alternation of hills and wide valleys that contain marshes irrigated by streams and tributaries of Lake Kivu that take in sources in the Kahuzi-Biega National Park (PNKB) and even in the valleys (Mushayuma *et al.*, 2012). The vegetation consists of a grassy mountain savanna dominated by highly diversified grasses and some shrubs. This vegetation replaced a very primitive one that consisted of native *Albizia grandibracteata* primary forest (Bagalwa and Baluku, 1997).

Photo 1: Lwiro Herbarium, the cabinets guarding the plant species

The Lwiro Herbarium is packed with botanical material harvested in the PNKB since the 1950s and is a major botanical conservation device in the Albertine Rift area. This Herbarium contains more than 15,000 specimens of botanical species divided into five branches such as Angiosperms, Gymnosperms, Pteridophytes, Lichens and Bryophytes. The proportions of conserved species are variable according to taxa (Mwangamwanga, 2013).

METHODS

This work was carried out from 19 September 2013 to 19 June 2014, it's 9 months; with the assistance of the technical agents of the laboratory of systematics and vegetable taxonomy. Conventional herbarium taxonomy methods have been used in this work (Devogel, 1987):

- The files containing the collections of *Poaceae* were pulled from the shelves to group all the species harvested in the PNKB and kept in the Lwiro herbarium. They were inventoried according to the origin indicated on their labels only in the high altitude part then the identification.
- These data have been encoded in Excel; while assigning to each specimen the name of the harvester, its location, morphological type, biological type, habitat type, geographic coordinates, collection number and use. The latitude and longitude of certain species were derived from the inventory of harvesting sites (Bamps, 1982).

Statistical Analysis

The data was analyzed by Descriptive Statistics by Microsoft Excel 2013 (version 15.0) included in Office 2013 and Office 365 (Dodge and Stinson 2013, Curties 2013)

RESULTS AND DISCUSSION

Results

1. Floristic list

The *Poaceae* inventory of the high altitude part of the KBNP conserved in the Lwiro Herbarium at the Natural Science Research Center has enabled us to establish a floristic list of 57 species with 84 specimens grouped into 25 genera and 3 subfamilies.

Table1. Floristic list of species

GENRES AND SPECIES	Sub-families	Harvest name	T. M	T. B	LOC	T. H	Latitude	Longitude	Altitude	N° de récolte	Date de récolte	Tribus
Agrostisproducta PILG	Pooideae	H.HUMBERT	HV	Hces	MtB	FOB	17'S02°	E 28°42'	2300 m	7637	19/08/1929	Poeae
Agrostis sp.	Pooideae	H.HUMBERT	HV	Hces	MtK	FOB	17'S02°	E 28°42'	2300 m	7639	22/07/1971	Poeae
Beckeropsisuniseta (NEES) STAPF α ROBYNS	Pooideae	J. PETIT	HV	Hces	MtK	FSV	18'S02°	E 28°41'	2200 m	26	26/02/2014	Poeae
Brachiariabrizantha STAPF	Panicoideae	P.PIERLOT	HV	Hces	TSH	SAH	14'S02°	E 28°47'	2100 m	3110	09/02/1971	Paniceae
Chlorisgayanna KUNTH	Chloridoideae	J.NTAKIYIMANA	HV	Tces	TSH	SAH	14'S02°	E 28°47'	2100 m	15	10/01/1971	Cynodonteae
Cynodondactylon (L) PERS	Chloridoideae	J.NTAKIYIMANA	HV	Chpr	TSH	SAH	14'S02°	E 28°47'	2050 m	12	10/01/1971	Cynodonteae
Dactylocteniumsp.	Chloridoideae	J.NTAKIYIMANA	HV	Tces	TSH	FSV	14'S02°	E 28°47'	2080 m	13	10/01/2013	Cynodonteae
Deschampsiaflexuosa (L) TRIN var*afromontana* HUBB	Pooideae	P.AUQUIER	HV	Hces	MtB	FSV	19'S02°	E 28°41'	2700 m	2160	06/01/1972	Poeae
	Pooideae	ERN	HV	Hces	MtK	FSJ	19'S02°	E 28°41'	3308 m	151	21/01/1970	Poeae
	Pooideae	LEONARD	HV	Hces	MtK	FSJ	19'S02°	E 28°41'	3000 m	1719	01/07/1959	Poeae
	Pooideae	P.BAMPS	HV	Hces	MtK	FSV	15'S02°	E 28°41'	3300 m	2890	28/12/1971	Poeae
	Pooideae	J.NTAKIYIMANA	HV	Hces	MtK	FOM	15'S02°	E 28°41'	3300 m	209	08/07/1972	Poeae
	Pooideae	J.PETIT	HV	Hces	MtK	FOM	15'S02°	E 28°38'	2920 m	339	24/05/1906	Poeae
Digitariahorizontalis WILLD var*Porrantha* HENR&HUBB	Panicoideae	P.VANDEVEKEN	Ha	Tces	MtK	FSV	15'S02°	E 28°41'	2300 m	8825	24/12/1971	Paniceae
Digitariavelutina (FORRSK) P/ BEAUV	Panicoideae	ERN	Ha	Tces	TSH	SAH	14'S02°	E 28°47'	2400 m	9	30/12/1969	Paniceae
	Panicoideae	ER N	Ha	Tces	TSH	FOM	14'S02°	E 28°47'	2050 m	3	26/02/1969	Paniceae
	Panicoideae	ERN	Ha	Tces	TSH	FOM	14'S02°	E 28°47'	2050 m	118	02/01/1970	Paniceae
Eragrostisboecknii HACK	Chloridoideae	P.VANDERVEKEN	Ha	Tces	MtK	FOM	17'S02°	E 28°41'	2300 m	8758	22/12/1971	Eragrostideae
Eragrostiscaespitosa CHIOV	Chloridoideae	P.AUQUIER	Ha	Tces	MtK	FOM	17'S02°	E 28°47'	2200 m	2030	22/12/1971	Eragrostideae
Eragrostisexasperata PETER	Chloridoideae	P.AUQUIER	Ha	Tces	MtK	FOM	17'S02°	E 28°47'	2200 m	2027	22/12/1971	Eragrostideae
Eragrostiskivuensis L.	Chloridoideae	P.AUQUIER	Ha	Tces	MtK	FOM	17'S02°	E 28°41'	2200 m	2029	22/12/1971	Eragrostideae
Eragrostistenuifolia A. RICH ex STEUD	Chloridoideae	P.AUQUIER	Ha	Tces	MtK	FOM	17'S02°	E 28°47'	2200 m	2026	22/12/1971	Eragrostideae
Eragrostisblepharoglomis K.SCHUM	Chloridoideae	P.AUQUIER	Ha	Tces	MtK	FOM	18'S02°	E 28°42'	2200 m	2025	22/12/1971	Eragrostideae
	Chloridoideae	P.VANDERVEKEN	Ha	Tces	MtK	FOM	18'S02°	E 28°42'	2300 m	8753	22/12/1971	Eragrostideae
	Chloridoideae	P.VANDERVEKEN	Ha	Tces	MtB	SAH	18'S02°	E 28°41'	2150 m	8999	06/01/1972	Eragrostideae
Festucaafricana (HACK) CLAY	Pooideae	P.AUQUIER	HV	Hces	MtB	FOB	17'S02°	E 28°42'	2550 m	2183	06/01/1972	Poeae
	Pooideae	P.VANDERVEKEN	HV	Hces	MtK	FSJ	17'S02°	E 28°42'	2260 m	47	24/12/1971	Poeae
Festucagigantea L.	Pooideae	P.AUQUIER	HV	Hces	MtK	FSV	17'S02°	E 28°42'	2550 m	2168	15/04/1959	Poeae

Festucasp 1.	Pooideae	ERN	HV	Hces	TSH	FSJ	17'S02°	E 28°42'	2300 m	40	10/05/1971	Poeae
Festucasp 2.	Pooideae	G.TROUPIN	HV	Hces	MtK	FSV	18'S02°	E 28°41'	2320 m	14262	06/01/1971	Poeae
Festucasp 3.	Pooideae	G.TROUPIN	HV	Hces	MtK	FSJ	18'S02°	E 28°41'	3300 m	14283	22/12/1971	Poeae
Festucasp 4.	Pooideae	P.VANDER VEKEN	HV	Hces	MtK	FSJ	18'S02°	E 28°41'	3350 m	8881	24/12/1971	Poeae
Helictotrichonelongatum HUBB	Pooideae	ERN	HV	Hces	MtK	FSV	17'S02°	E 28°42'	3200 m	146	06/01/1971	Poeae
	Pooideae	J.NTAKIYIMANA	HV	Hces	MtB	FOB	17'S02°	E 28°42'	2150 m	365	06/01/1971	Poeae
	Pooideae	HORTI BOT BRUX	HV	Hces	MtB	FOB	17'S02°	E 28°42'	2400 m	2363	21/01/1971	Poeae
Heteropogoncontortus (L) et SCHULT	Panicoideae	J.NTAKIYIMANA	HV	Hces	TSH	FOM	14'S02°	E 28°47'	2600 m	18	26/12/1971	Andropogoneae
Hyparrheniacofinis (HOCHST) ANDERS	Panicoideae	J.NTAKIYIMANA	HV	Hces	TSH	SAH	14'S02°	E 28°47'	2550 m	20	26/12/1971	Andropogoneae
Hyparrheniarufa (NEES) STAPF	Panicoideae	J.NTAKIYIMANA	HV	Hces	TSH	SAH	14'S02°	E 28°47'	2300 m	33	26/12/1971	Andropogoneae
Hyparrheniavariabilis STAPF	Panicoideae	ERN	HV	Hces	TSH	SAH	14'S02°	E 28°47'	2400 m	45	15/02/1973	Andropogoneae
	Panicoideae	J.PETIT	HV	Hces	TSH	SAH	14'SO2°	E 28°47'	2290 m	225	14/04/1960	Andropogneae
	Panicoideae	J. NTAKIYIMANA	HV	Hces	TSH	SAH	14'S02°	E 28°47'	2400 m	26	16/05/1971	Andropogoneae
	Panicoideae	CHRISTIAENSEN	HV	Hces	TSH	SAH	14'S02°	E 28°47'	2220 m	198	02/06/1959	Andropogoneae
I*mperatacylindrica* P.BEAUV	Panicoideae	J. PETIT	HV	Grh	TSH	FOM	14'S02°	E 28°47'	2310 m	29	26/02/1971	Andropogoneae
	Panicoideae	J. NTAKIYIMANA	HV	Grh	TSH	FOM	14'S02°	E 28°47'	2290 m	450	20/07/1972	Andropogoneae
M*elinisminutiflora* P.BEAUV	Panicoideae	P.AUQUIER	HV	Tpr	MtK	FOB	14'S02°	E 28°42'	2800 m	2028	22/12/1971	Paniceae
Panicumadenophorum K.SCHUM	Panicoideae	ERN	HV	Hces	MtK	FOB	18'S02°	E 28°42'	2400 m	28	25/12/1971	Paniceae
Panicumcalvum STAPF	Panicoideae	J.NTAKIYIMANA	Ha	TSC	MtK	FOB	17'S02°	E 28°42'	2400 m	56	10/05/1971	Paniceae
	Panicoideae	G.TROUPIN	Ha	TSC	MtK	FSJ	17'S02°	E 28°42'	2400 m	14053	06/01/1972	Paniceae
Panicummassaiense MEZ	Panicoideae	MEZ	HV	Hces	TSH	FSV	18'S02°	E 28°42'	2400 m	339	02/06/1959	Paniceae
Panicum maximum JACQ	Panicoideae	J. NTAKIYIMANA	HV	Hces	TSH	FSV	18'S02°	E 28°42'	2400 m	17	31/03/1971	Paniceae
	Panicoideae	J.PETIT	HV	Hces	TSH	FSV	18'S02°	E 28°42'	2220 m	356	24/03/1960	Paniceae
	Panicoideae	J.MOUREAU	HV	Hces	MtK	FSJ	18'S02°	E 28°42'	2400 m	789	16/05/1956	Paniceae
Panicum trichlocladum HACK ex K.SCHUM	Panicoideae	J.NTAKIYIMANA	Ha	TSC	MtK	FOB	18'S02°	E 28°42'	2450 m	266	26/10/1971	Paniceae
*Panicum sp*1.	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtK	FOB	17'S02°	E 28°42'	2360 m	316	29/01/1971	Paniceae
*Panicum sp*2.	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtB	FOM	17'S02°	E 28°42'	2800 m	407	06/01/1971	Paniceae
*Panicum sp*3.	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtK	FOM	18'S02°	E 28°31'	2310 m	380	16/01/1971	Paniceae
*Panicum sp*4.	Panicoideae	J.PETIT	HV	Hces	MtK	FOM	15'S02°	E 28°41'	2300 m	288	21/02/1971	Paniceae
Paspalumcommerso	Panicoid	P.	H	Gr	TS	FO	14'S0	E	2000	10	06/01/	Paniceae

nii L.	eae	AUQUIER	V	h	H	M	2°	28°41'	m		1972	
Pennisetumpolystachyon L.	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtB	FOB	17'S02°	E 28°47'	2000 m	376	16/02/1973	Paniceae
Pennisetumpurpureum SCUMACH	Panicoideae	P.VANDERVEKEN	HV	Hces	TSH	FOM	14'S02°	E 28°47'	2000 m	6	29/12/1972	Paniceae
	Panicoideae	J.PETIT	HV	Hces	TSH	FOM	14'S02°	E 28°47'	2000 m	376	11/01/1962	Paniceae
Pennisetumtrachyphyllum PILGER	Panicoideae	CHRISTIAENSEN	HV	Hces	TSH	FOM	14'S02°	E 28°42'	2560 m	5	30/07/1959	Paniceae
Pennisetumsp.	Panicoideae	P.AUQUIER	HV	Hces	MtB	FOM	17'S02°	E 28°42'	2900 m	2173	06/01/1972	Paniceae
Poasp.	Pooideae	P.VANDERVEKEN	HV	Hces	MtK	FOM	18'S02°	E 28°46'	2100 m	8887	29/12/1971	Poeae
Rhynchelytrumrepens (WILLD) C.E.HUBB	Panicoideae	J.NTAKIYIMANA	Ha	Tces	TSH	FOM	14'S02°	E 28°47'	2500 m	8	01/10/1972	Paniceae
Setariaangustifolia STAPF	Panicoideae	J.NTAKIYIMANA	Ha	Tces	TSH	FOM	15'S02°	E 28°47'	2250 m	17	01/10/1971	Paniceae
Setariacaudula STAPF	Panicoideae	J.NTAKIYIMANA	Ha	Tces	TSH	FOM	14'S02°	E 28°47'	2150 m	20	01/10/1971	Paniceae
Setariachevalieri	Panicoideae	CHRISTIAENSEN	HV	Hces	MtK	FOB	15'S02°	E 28°46'	2983 m	3400	02/06/1959	Paniceae
Setarialongiseta P.BEAUV	Panicoideae	J. PETIT	Ha	Tces	TSH	FOM	14'S02°	E 28°41'	2050 m	21	01/10/1960	Paniceae
Setariasphacelata STAPF	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtB	FSJ	14'S02°	E 28°38'	2300 m	364	15/02/1973	Paniceae
	Panicoideae	J.PETIT	HV	Hces	MtB	SAJ	14'S02°	E 28°42'	2220 m	865	24/03/1960	Paniceae
Setariasphacelatavarsplendida (STAPF) CLAY	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtK	FOB	15'S02°	E 28°36'	2400 m	103	08/07/1971	Paniceae
	Panicoideae	CHRISTIAENSEN	HV	Hces	MtK	FOB	15'S02°	E 28°42'	2300 m	890	28/05/1959	Paniceae
Setariamegaphylla STUDENT	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtB	FOB	15'S02°	E 28°23'	2000 m	170	16/02/1973	Paniceae
	Panicoideae	P.AUQUIER	HV	Hces	MtK	FOB	15'S02°	E 28°23'	2090 m	210	02/01/1972	Paniceae
	Panicoideae	P.AUQUIER	HV	Hces	TSH	FOM	15'S02°	E 28°46'	2200 m	43	22/12/1971	Paniceae
Setariasp.	Panicoideae	P.AUQUIER	HV	Hces	TSH	SAH	14'S02°	E 28°41'	2300 m	19	22/12/1971	Paniceae
Sorghumbicolor (L) MOENCH	Panicoideae	P.AUQUIER	Ha	Tces	TSH	SAH	14'S02°	E 28°41'	2400 m	37	26/02/1971	Paniceae
SorghumvulgarePERS	Panicoideae	P.AUQUIER	Ha	Tces	TSH	SAH	14'S02°	E 28°35'	2100 m	13	26/02/1971	Paniceae
Sporoboluspyramidalis P.BEAUV	Chloridoideae	P.AUQUIER	HV	Hces	TSH	SAH	15'S02°	E 28°33'	2050 m	7	06/01/1972	Eragrostideae
*Trichopterixmarungensis*L.	Panicoideae	J.NTAKIYIMANA	HV	Hces	MtB	FSV	15'S02°	E 28°28'	2100 m	56	16/02/1973	Paniceae
Zeamays L.	Panicoideae	J.PETIT	Ha	TSC	TSH	SAH	14'S02°	E 28°47'	2350 m	30	24/03/1972	Paniceae

a. Morphological Types (TM)
Ha: Annual grass; HV: Perennial herb.

b. Subfamilies
Poo: Pooideae; Chl: Chloridoideae and Pan: Panicoideae

c. Biological Types (TB)
- Hoppy hemicryptopytes (Hces): herbs that support fire and grow in tufts during the good season.
- Rhizomantous geophytes (Grh): plants where wintering buds are on a rhizome or a subterranean stem with mono or sympodal growth.
- Bunching Therophytes (Tces): herbs forming very compact tufts.
- ScaposeTherophytes (TSC): annual herbs scapers.
- Prostrate Therophytes: annual prostrate herbs.
- Chamephytes prostrate: herbs having an aerial axis.

d. Location (Loc)
Mount Kahuzi (Mt Kah); Mount Biega (Mt Bie) and Tshibati (Tsh).

e. Types of Habitats

Old Secondary Forest (FOSV); Junior Secondary Forest (FOSJ); Bamboo Forest (FOB); Marsh Forest (FOM) and Savannah Grassland (SH)

2. Analysis of Morphological Types

Table2. Morphological types of listed species

Morphological types	Number of individuals	Percentages
Perennial herb	60	73,17
Annual herb	22	26,83
Total	**82**	**100,00**

Table 2 shows that the PNKB *Poaceae* flora inventoried in the Lwiro collection is dominated by perennial herbs with 60 individuals (73.17%) and annual herbs with only 22 individuals (26.83%).

3. Analysis of Biological Types

The data analysis in Table 1 shows, in the aggregate, four biological types (Hemicryptophytes, Therophytes, Geophytes and Chamephytes) recorded in this study with a very high prevalence of Hemicryptophytes (with 53 individuals, or 64.63%) on Therophytes (25 individuals, 30,49%), Geophytes (3 individuals, 3,66%) and Chamephytes (1 person, 1,22%) as shown in Figure 1 below.

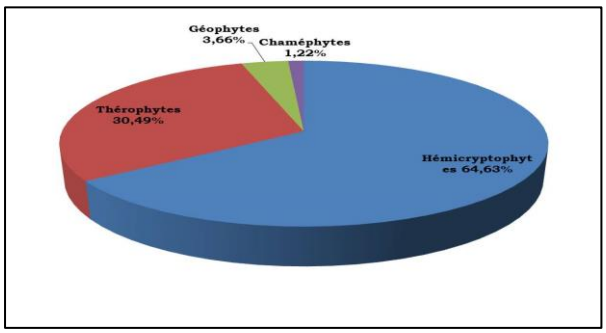

Figure1. Proportion of biological types

4. Habitat Type Analysis

Table3. Habitat types of inventoried species

Types of habitats	Young secondary forest	%
Marsh forest	27	32,93
Bamboo forest	17	20,73
Grassy Savannah	16	19,51
Old secondary forest	12	14,64
Young secondary forest	10	12,19
Total	**82**	**100,00**

This table shows that the swamp forest dominates the grassland area of the KBNP species found in the Lwiro Herbarium with 27 individuals (34,52%); it is followed by bamboo forest with 17 individuals (20,73%); followed by grassy savannah with 16 individuals (19,51%); second old secondary forest has 12 individuals (14,64%) and young secondary forest has only 10 individuals (12,19%).

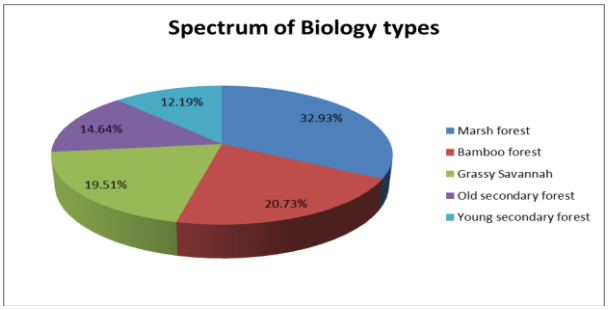

Figure.2 Spectrum of biology types

5. Location of Harvest Locations

The map showing the different harvesting sites indicates that the Tshibati sector and Mount Kahuzi are the richest in the PNKB in *Poaceae* (Figures 4 and 5). Note that these results are based only on samples collected only at PNKB in the high altitude area since the colonial years until 2014. This can be verified and confirmed during our study on this family in this environment, because it can be due either to repeated exploration in the same environment or to the interest that the collectors gave to the family in question.

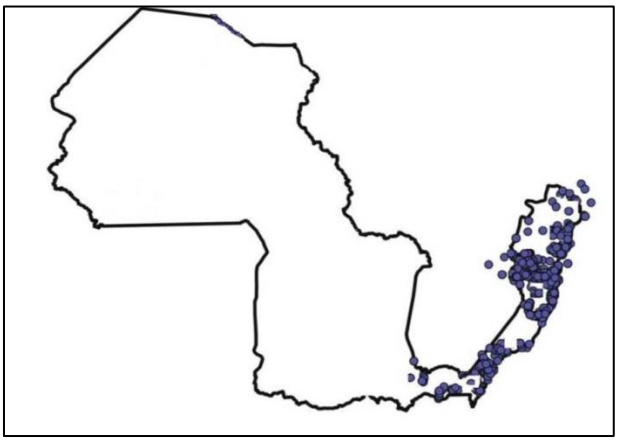

Figure.3 Location of harvest sites (JDM, 2011)

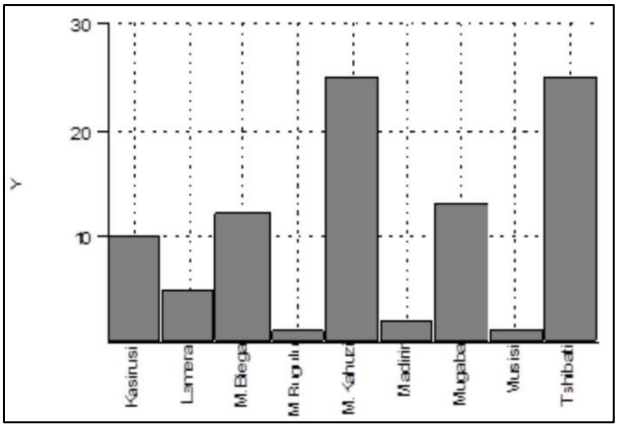

Figure.4 Importance of crops according to the sites

Systematic classification of inventoried species

East African Scholars Journal of Agriculture and Life Sciences
Abbreviated Key Title: East African Scholars J Agri Life Sci
ISSN 2617-4472 (Print) | ISSN 2617-7277 (Online) |
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-2 | Issue-6 | Jun-2019 |

a) Identification of species

Out of a total of 84 individuals of *Poaceae* inventoried in this study, more than 20 individuals were updated (have the old identification names on the labels fell into synonymy) and 5 individuals recorded with incorrect identification were corrected.

b) Classification of species into subfamily

The classification of species into subfamily is presented in the table 4 bellow

Table.4 Subfamily Division of *Poaceae*

Subfamilies and tribes	Number of species	% Species	Number of individuals	% of individuals
1. POOIDEAE/*Poaceae*	12	20,69	20	24,39
2. PANICOIDEAE	36	62,08	50	60,97
- Paniceae	26	44,83	36	43,90
- Andropogoneae	09	15,53	13	15,85
- Tristachyideae	01	01,72	01	01,22
3. CHLORIDOIDEAE	10	17,23	12	14,64
- Eragrostideae	06	10,34	08	09,76
- Zoysieae	01	01,72	01	01,22
- Cynodonteae	03	05,17	03	03,66
Total : 3 Sub-families and 7 Tribes	**58**	**100,00**	**82**	**100,00**

For the 12 subfamilies of *Poaceae*; three are well represented in the high-altitude flora of PNKB. Of the 58 species (82 individuals) reported in this work, the subfamily Panicoideae ranks first with 36 species and 50 individuals (62,08 % and 60,97%), followed by family of Pooideae that have 12 species and 20 individuals (20,69 % and 24,39%) and finally it is the subfamily Chloridoideae which has only 10 species and 12 individuals (17,23% and 14,64%)).The figure of taxonomic classification of species into subfamilies and tribes is presented bellow

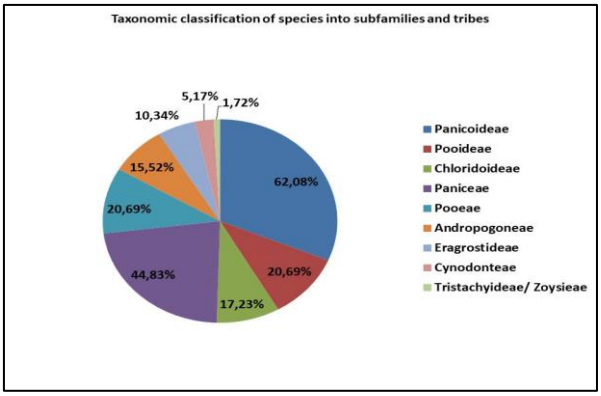

Figure 5.Taxonomic classification of species into subfamilies and tribes

DISCUSSION

The inventory of *Poaceae* species of the Kahuzi-Biega National Park (PNKB) in its high altitude part conserved at the Herbarium of the Natural Science Research Center (CRSN / Lwiro) has 58 species belonging to 25 genera. The *Poaceae* family occupies the first position with respect to all monocotyledonous species conserved in the CRSN / Lwiro Herbarium, followed by *Orchidaceae* and *Cyperaceae* (Cirhuza, 2012). This has been proven by Buhendwa et al. 2014 and Iragi Kaboyi 2006 who also found the dominance of *Poaceae* in the results of their studies at Lwiro and Mugeri towards Katana in the territory of Kabare.

The species-rich PNKB flora is estimated at 1043 species of which those of the family *Poaceae* occupy the fifth position with 58 followed by *Orchidaceae* (103 species) and *Asteraceae* with 74 species, *Fabaceae* with 70 species and *Rubiaceae* with 65 species (Fischer, 1993). *Poaceae* occupy a considerable place in the PNKB as evidenced by the study carried out on the grouping at *Sinarundinaria alpina* in the PNKB between 2005 and 2006, which showed the dominance of the *Poaceae* family with 10 species, (Amani, 2006). and also the study on the ecology of *Sericostachysscandens* at PNKB (Balezi, 2008) showing the dominance of *Poaceae* with 12 species. The particularity of PNKB on the taxonomic composition of *Poaceae* is located on endemic Kahuzi species such as *Melinisminutiflora* P.BEAUV,

Quick Response Code

Journal homepage:
http://www.easpublisher.com/easjals/

Article History
Received: 25.05.2019
Accepted: 08.06.2019
Published: 27.06.2019

DOI: 10.36349/easjals.2019.v02i06.008

*Helictrotrichonelongatum*HUBB and *Deschampsiaflexuosa* (L) TRIN var*afromontana* HUBB. It should be noted that these species were not included in the KBNP endemic list reported by Steinhauer-Burkart et al. (1995).

Some species of *Poaceae* endemic to the region that have been reported by Fischer and Dorothée (2008) were also found in the PNKB, including *Heteropogon contortus* (L) and SCHULT, *Panicum massaiense* MEZ, *Hypparhenia concesis* (HOCHST) ANDERS, *Trichopterix marungensis* L., *Rhynchelytrum repens* (WILLD) C.E. HUBB, *Pennisetum trachyphyllum* PILGER.

We agree with the ideas of Evrard (1968) and Kagazo (1995) to assert that the Hémicryptophytes form almost the entire floristic procession in equatorial and tropical forests.

In this study, perennial herbs are the much-harvested morphological types. A large number of species are harvested at open land locations.

Given its creation (1937), the part currently called high altitude was the first to be erected in reserve, which is why it benefited from the many explorations. Our study proves this and shows that the Tshibati sector and Mount Kahuzi, which are located in this part (high altitude), have a high concentration and diversity of *Poaceae* with a rate of 87.80%.

CONCLUSIONS

In view of the objectives assigned to this study, the investigations led to the following conclusions:

- The study of the PNKB *Poaceae* dead collection (high altitude) is rich and allowed us to inventory 58 species divided into 25 genera and 3 sub-families.
- As it is herbaceous, perennials occupy the best place with 73.81%, followed by annuals which have 26.19%.
- The interpretation of the biological types shows the predominance of the Hemicryptophytes (64,63%). Therophytes (30,49), Geophytes and Chamephytes intervene successively with 3,66% and 1,22%.
- Analysis of habitat types shows that the forest biotope of the swamp forest (32.93%) is the most diversified. Bamboo forests, grassy savannah and old secondary trees account for 20.73%, 19.71% and 14.64%. Secondary secondary forests account for a small proportion of 12.19%. Species associated with aquatic environments are generally harvested more than those that affect the soils of the mainland.
- The mapping, which represents the different location areas of the species harvested in the high altitude part of the KBNP, indicates that many species of *Poaceae* of the KBNP conserved in the Lwiro collection came from Tshibati and Mount Kahuzi. In spite of this observation, an intensified study on the *Poaceae* of this country of the park proves essential. Although our study did not reach the full extent of the park, it was observed that *Poaceae* are represented in 3 sub-families with proportional dominance of Panicoideae (62.08%).

This study of the NPKB *Poaceae* inventory in the high altitude part conserved in the Lwiro Herbarium beats record with 58 species of *Poaceae*, which shows a specific richness of the family in the Lwiro collection because all our predecessors in their work proves it but with a lower rate, although the family was on the list of well-represented families. This proves to the satisfaction that the Lwiro Herbarium remains the essential source in our country which can better inform about the specific and generic richness of *Poaceae* of the PNKB in its high altitude part. An extensive study on the entire PNKB is underway, especially since the PNKB is recognized as a world heritage of UNESCO which remains little documented with regard to its flora. It is also important to remember that its western position within the ecosystem of the Albertine Rift region which has a high rate of endemism can prevail at this park a deepening of floristic research, especially for the flagship families like *Poaceae.*

Acknowledgements

The authors thank the laboratories of the Systematic and Vegetal Taxonomy laboratory of the CRSN Lwiro for the accompaniment on the ground in spite of the difficulties met and traversed.

.

Availability of data

The datasets supporting the conclusions of this article are included within the article (and its additional files).

Authors' contributions

SCC, CEE and JMM participated in the design of the study, conducted the experiments, SCC prepared the manuscript, and performed the statistical study. SCC and ONN helped to improve this paper. SCC, contributed to this study design. All authors read and approved the final manuscript.

REFERENCES

1. DEWET, (2004). *The Genus Danthonia in Grass Phylogeny*.AmericanJournay of Botany, 41, (3), New York 201-211pp.
2. PIPERNO D., et SUEZ R., 2005. « *Dinosaurs Dined on Grass";* New York. 3-10 pp.
3. CHASE A., & REAVEAL W., (2009). *An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III.* Botanical Journal of the Linnaean Society 161, 105-121.
4. MUSHAYUMA, N., BISUSA, M., WANGA, B.N., & BUGOMA, (2012). Diversité des macros

invertébrés benthiques des rivières tributaires du Kivu, CERDAF, sciences naturelles, 31-32 p.

5. MWANGA MWANGA, I. (2013). *Check-list des Rubiaceae de la partie haute altitude du parc national de Kahuzi-Biega*. Cahiers du CERUKI, nouvelle Série n°43/2013, 188-205pp.
6. CURTIES, D. (2013). Frye, *Microsoft Excel 2013*, Sebastopol, Microsoft Press, coll. « Step by Step », 512 p.
7. DODGE, M. & STINSON, C. (*2013*). *Microsoft Excel 2013*, Sebastopol, Microsoft Press, coll. « Inside Out », 1170, 1154 p.
8. AMANI, I. (2006). *Etude floristique et structurale de la forêt des bambous (Sinarundinariaalpina) du Parc National de Kahuzi-Biega*, D.E.A, UNIKIN/R.D.Congo. Fac.SC.Dép.Biologie, 86-120p.
9. BUHENDWA, M., HANGY, W., & BIRINGANINE, M. (2014)**.** *Evaluation de l'état de la colonisation de la flore adventice dans les champs de maïs (Zeamays) a lwiro, sud-kivu, République Démocratique du Congo.* International Journal of Innovation and Applied Studies, 6 (3), July 2014, pp. 448-455.
10. BALEZI, Z., NYAKABWA, M., & LEJOLY, J. (2008). *Etude écologique de la liane envahissante Sericostachys scandes dans la partie de haute altitude du Parc National de Kahuzi-Biega* (Sud-Kivu, R.D.Congo). Annales Scie & Scie. Appli. U.O.B. 1, 28-36p.
11. IRAGI, K. (2006). *Etude floristique et structurale de la végétation côtière du lac Kivu à Mugeri-Katana, Sud-Kivu/R.D. Congo*. Annales Scie. &Scie. Appli U.O.B. 1, 91-98.
12. BAMPS, P. (1982). Flore d'Afrique Centrale. Répertoire des lieux de récolte. Jardin botanique national de Belgique, Dom. Bouchots, Meise, 224 p.
13. DEVOGEL, F. (1987). Manuel of herbarium taxonomy: theory and practice. Ed.UNESCO Regional Office for Sciences and Technology, Indonesia, 144 p.
14. EVRARD, L. (1968). Recherches écologiques sur le peuplement forestier des sols hydromorphes de la cuvette centrale congolaise. Publ. INEAC – Bruxelles, sér. Sc. (110), 295p.
15. FISCHER, E. (1993). *La végétation du Parc National de Kahuzi-Biega (Sud-Kivu,Zaïre)*.Projet PNKB/GTZ, Bonn, 93 p.
16. FISCHER, E., & DOROTHEE, K. (2008). Illustrated field Guide to the Plants of Nyungwe National Park Rwanda, University of Koblenz-Landay, 1st edition, 771p.
17. KAGAZO, W. (1995). Florule Angiospermique de la forêt de l'Ituri. Mémoireinédit. I.P.N/Kinshasa, 49p.