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Contribution to the Systematic Inventory of Water Birds in Lake Kivu, Ishungu Basin, South Kivu, DR Congo

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Abstract:- This study is a work of memory that we conducted with a view to obtaining a bachelor's degree in science at the Official University of Bukavu. This study was carried out at Lake Kivu in the Ishungu basin on Ibindja Island and at Birava, during a period from March 19 to July 28, 2010. The inventory of birds was carried out at seven sites, including five in Ibindja and two other sites in Birava. Data collection was done by Japanese net capture, observation with a pair of binoculars and with the naked eye and by counting. Birds captured and / or observed were identified using the bird identification guides of Zimmerman, D.A., and al (1999) and Sinclair, I., (2003).

This work made possible to inventory several individuals of birds grouped into 6 orders, 12 families, 23 genuses and 32 species of birds. The abundant species are: *Ceryle rudis, Phalacrocorax carbo* and *Phalacrocorax africanus* with respectively 30.72%; 25.41% and 15.47%. The Passeriformes order represents only half of the inventoried families, or 50%. The Ardeidae and Ploceidae families represent a large number of genuses, 26.08% and 21.73% respectively. The genus Ploceus alone contains 12% of the identified species. The highest number of species was observed in June and the lowest in July, which was also the last month spent in the field. The similarity quotient in bird species between these two environments (Ibindja and Birava) is 72%. Among the seven sampling sites chosen, the Bwalimu site is more diversified (H = 2.257), but the Chabatalima site is more rich in species with 21.

Recommendations and suggestions are given for the sustainable protection not only of aquatic birds but also of the environments in which they live.

I. INTRODUCTION

Aquatic resources are classified among so-called renewable and conservable natural resources. Wet and stagnant regions provide the basis for bird watching and study (Nhombo M., 2010).

Bird research has led to the classification of more than 8,600 bird species around the world today (Pedersen, 2000). In DR Congo, there are an estimated 1086 known bird species but it is believed that there are still others not yet discovered. A total of 996 bird species are known specifically in eastern DR Congo (Pedersen, 2000).

The birds of the Albertine Rift are poorly known in the eastern part of DR Congo (Murhabale B., 2008). Lake Kivu, which is an aquatic environment and which forms the basis of our study of this work, is among the lakes of the Albertine Rift. This lake constitutes an important ecosystem in the province of South Kivu in DR Congo. However, its coastal biodiversity in general and in particular the avian fauna of the Ishungu basin still remains to be elucidated.

Among the works carried out on the birds of Lake Kivu, there are: Lippens (1938), Schouteden (1966) etc., they conducted a study on the aquatic birds of Lake Kivu in its northwestern part in Rwanda. Murhabale, B. (2008) and Ngumbu (2004) conducted an inventory of birds from Lake Kivu in the Bukavu basin. Magadju A. and al (2015) studied the biology and ecology of birds of the genus Acrocephalus at Lake Kivu, in the Bukavu basin.

As part of our memory work, with a view to obtaining a bachelor's degree in science at the Official University of Bukavu, we proposed to conduct a systematic inventory of water birds from Lake Kivu in the Ishungu basin more specifically in Birava and Ibindja, in order to contribute to the knowledge of the coastal biodiversity of Lake Kivu.

The specific objectives of this study are to:

- Systematically inventory the water birds of the Ishungu basin on Lake Kivu;
- Study the relative abundance, diversity, distribution and seasonal movement of species;
- Propose measures to protect bird life with a view to promoting ecotourism.

II. MATERIAL AND METHODS

- *Study environment and sampling site: Lake Kivu (Ishungu Basin)*

Lake Kivu is one of the great lakes of the African Rift, located in East Africa. It forms a natural border between DR Congo and Rwanda. It includes 5 major basins: North Basin, Kabuno-Kashanga Basin, Kalehe Basin, Ishungu Basin and Bukavu Basin (Damascus, 1937); Capart (1960) and Kaningini B., and al., (1999; 1995).

The Ishungu Basin, which is the focus of our study, is bordered to the north by the south of Idjwi Island, and is bounded to the south by Gombo Island. It communicates by

three channels with the Kalehe basin and by a deep valley (160m) with the large lake (Capart, 1960). It has a well-marked and stable chemocline throughout the year (Ishumbisho, and al., 2006).

Seven sampling sites were chosen in the Ishungu basin. We have 5 sites in Ibindja (Karhale, Civumu, Musimbo, Bwalimu and Kahumba) and 2 others in Birava (Kashombe and Chabatalima). These sites are characterized on the one hand, by stones surpassing the water level at the edge of the lake in the coastal area, and on the other hand, by the aquatic macrophytes (Cyperus). We also report the presence of fields in the vicinity (Soybeans, Sorghum, Cassava, etc.).

➢ *Data collection and processing method*

Samples were taken in the Ishungu basin at Birava and Ibindja on Lake Kivu for a period from March 19 to July 28, 2010, that is to say 5 months in the field at the rate of 3 days per month.

In the field, we observed and captured the birds. Observations of birds were made with the naked eye and using a pair of binoculars. For the capture of birds, we used two Japanese nets. These nets were stretched between three sticks 12m apart in length in aquatic macrophytes. After capture, the bird was identified, registered, marked with a red varnish on its left paw, and then released into its natural environment where it was captured, avoiding any injury to it.

All birds caught and observed are identified, counted and recorded. Identification was carried out using field guides (Zimmerman, 1999 and Sinclair, 2003).

For data processing, the relative abundance of species as well as the similarity and diversity indices was calculated.

Sorensen's similarity quotient (3) given by the relation:

$Qs = \frac{2C}{a+b} \times 100$ Was used to judge the similarity between the records of the two environments (Ibindja and Birava).

With:

a = number of species present in the environment a (Ibindja);

b = number of species present in environment b (Birava);

c = number of species present in the two environments (a and b);

Qs = Sorensen similarity quotient which can vary from 0 (no similarity) to 100 (total similarity).

The following other indices were used in the software "Past 1.97" to judge the similarity and equitability between the seven sampling sites:

Simpson's index: is given by the following relation:

$$D = \sum_{i}^{s} N\,(Ni - 1)/N(N - 1)$$

Hence: S (number of species), Ni (number of individuals in species i), N (total number of individuals) and D (Simpson's index).

Shannon Wienner's index: it is given by the following relation:

$H - \sum_{i=1}^{s} \frac{Ni}{N} \ln \frac{Ni}{N}$; With: Ni (number of individuals in species i) and N (total number of individuals.

Equitability index: given by the relationship:

$H' = \frac{H}{\ln S}$; With H (Shannon index) and S (number of species).

III. RESULTS

The inventory of birds carried out on Lake Kivu (Ishungu Basin) made it possible to inventory 32 species grouped into 23 genuses belonging to 12 families and 6 orders. Among these 32 species, 17 are aquatic and 15 others are non-aquatic. 29 species have been identified in Ibindja and 21 in Birava. 11 species were identified in Ibindja but absent in Birava and 3 species were absent in Ibindja but present in Birava. 18 species were present in these two environments (Table 1).

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Species		inventoried at :		Statutes
Scientific name	Vernacular names Shi(personal communication)	Ibindja	Birava	
*Phalacrocorax carbo**	Nshovu	+	+	Locally common
*Phalacrocorax africanus**	Nyamuloba	+	+	Common
*Amaurornis flavirostris**	Kafulibiri	+	+	Common
*Alcedo cristata**	Marta	+	+	Common resident
*Ceryle rudis**	Marta	+	+	Common
*Egretta garzetta**	Nyangi	+	+	Common
*Egretta gularis**	Nyangi	+	+	Common
*Egretta alba**	Nyangi	+	-	Common
*Bubulcus ibis**	Nyangi	+	+	Common,highly gregarious
*Ardea cinerea**	-	+	+	Common
*Nycticorax nycticorax**	Rhundwe	-	+	Common, Palearctic migrant
*Butorides striatus**	Lubondo	+	+	Common
*Ixobrychus minutus**	Nyamundubiki	+	+	Uncommon
*Scopus umbretta**	-	+	-	Common
*Acrocephalus rufescens**	Mununi	+	+	Locally common
*Acrocephalus gracilirostris**	Mununi	+	-	Common
Ploceus luteolus	Chisogosogo	+	-	Locally common
Ploceus xanthops	Chisogosogo	+	+	Locally common
Ploceus ocularis	Chisogosogo	+	+	Common
Ploceus melanocephalus	Chisogosogo	+	-	Locally common
Passer griseus	Chiterambwa	+	+	Common
Ambliospiza albifrons	Chilyabuzindu	+	+	Common
Quelea cardinalis	-	+	-	Locally Common, nomadic
*Eupletex orix**	Marangi	+	+	Common,highly gregarious
Nectarinia hunteri	Mununi	+	-	Common
Nectarinia mariquensis	Mununi	-	+	-
Nectarinia bifasciata	Mununi	-	+	-
Cisticola erytrops	-	+	+	Common
Sylvieta virens	-	+	-	Common
Pycnonotus barbatus	Nsholya	+	-	Abundant
Centropus monachus	Chibiribiri	+	-	Common
Lonchura bicolor	Mpungera	+	-	Common
Total : 32		29	21	

Table 1:- List of bird species inventoried in the Ishungu basin at Ibindja and Birava on Lake Kivu.

Legend: the cross (+) indicates the presence of a species in a given site, the line (-) indicates the absence of a species in a site and the Asterix (*) indicates the aquatic species.

➢ *Relative abundance of species*

By observing table N ° 2 below, we have clearly seen that several individuals of birds have been inventoried, among which the species *Ceryle rudis* is the most abundant in this ecosystem with 30.72%. It is followed by *Phalacrocorax carbo* with 25.41%.

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Order	Family	Species	Numbers	Abundance (%)
Ciconiiformes	Ardeidae	*Egretta garzetta*	30	2,27
		Egretta gularis	21	1,59
		Egretta alba	1	0,07
		Bubulcus ibis	16	1,22
		Ardea cinerea	7	0,53
		Nycticorax nycticorax	3	0,22
		Butorides striatus	7	0,53
		Ixobrychus minutus	2	0,15
	Scopidae	*Scopus umbretta*	2	0,15
Pélécaniformes	Phalacrocoracidae	*Phalacrocorax carbo*	335	25,41
		Phalacrocorax africanus	204	15,47
Gruiformes	Rallidae	*Amaurornis flavirostris*	65	4,93
Coraciadiformes	Alcidinidae	*Alcedo cristata*	38	2,88
		Ceryle rudis	405	30,72
Passeriformes	Acrocephalidae	*Acrocephalus rufescens*	31	2,88
		Acrocephalus gracilirostris	1	0,07
	Ploceidae	*Ploceus luteolus*	4	0,3
		Ploceus xanthops	17	1,28
		Ploceus ocularis	3	0,22
		Ploceus melanocephalus	3	0,22
		Passer griseus	25	1,89
		Ambliospiza albifrons	8	0,6
		Quelea cardinalis	1	0,07
		Euplectex orix	45	3,41
	Sylvidae	*Cisticola erythrops*	8	0,6
		Sylvieta virens	18	1,36
	Pycnonotidae	*Pycnonotus barbatus*	3	0,22
	Nectarinidae	*Nectarinia hunteri*	1	0,07
		Nectarinia mariquensis	2	0,15
		Nectarinia bifasciate	2	0,15
	Estrildidae	*Lonchura bicolor*	1	0,07
Cuculiformes	Cuculidae	*Centropus monalus*	2	0,15
TOTAL : 6	12	32	1318	100

Table 2:- Relative abundance of species

➢ *Family's wealth in species*

With regard to species, Figure 1 below shows that it is the families Ardeidae and Ploceidae which contain a high number of species with each 8 species, ie 25% out of 32 identified species. These two families themselves contain half of the identified species (50%). They are followed by the family of Nectarinidae with 3 species (9.37%). The family of Phalacrocoracidae, Alcedinidae, Acrocephalidae and Sylvidae each have 2 species (6.25%). The other families each contain a single species (3.12%).

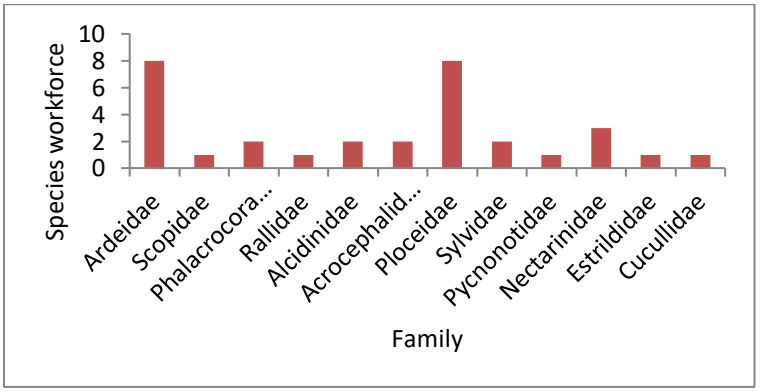

Fig 1:- Wealth of families according to species

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➢ *Family's wealth in genus*

Figure 2 reveals that the Ardeidae family is the richest in genus with 6 genuses (26.08%) out of 23 genuses obtained. It is followed by the Ploceidae family with 5 genuses (21.73%). The family of Sylvidae and Alcedinidae each represent 2 genuses or 8.69%. The other families occupy the last position, each with one genus only, 4.34%.

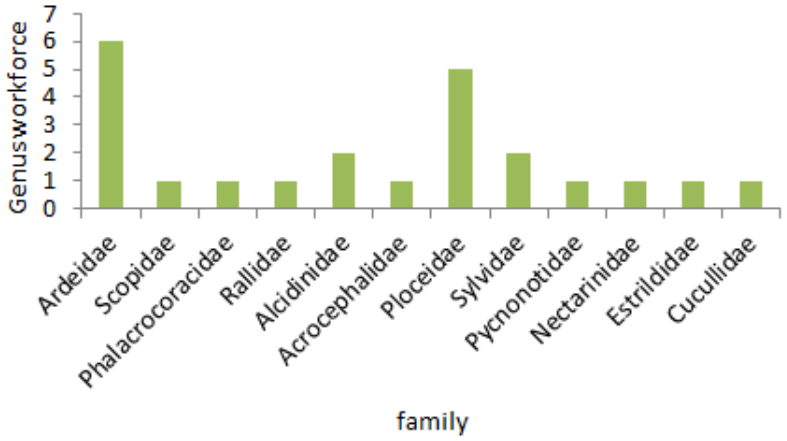

Fig 2:- Wealth of families in genus

➢ *Wealth of orders in family*

Figure 3 shows that the Passeriformes order is the richest in families with 6 families out of 12 families obtained (50%). This order contains half of the families. He is followed by the order of Ciconiformes with 2 families (16.66%). The other four orders each represent only one family (8.33%).

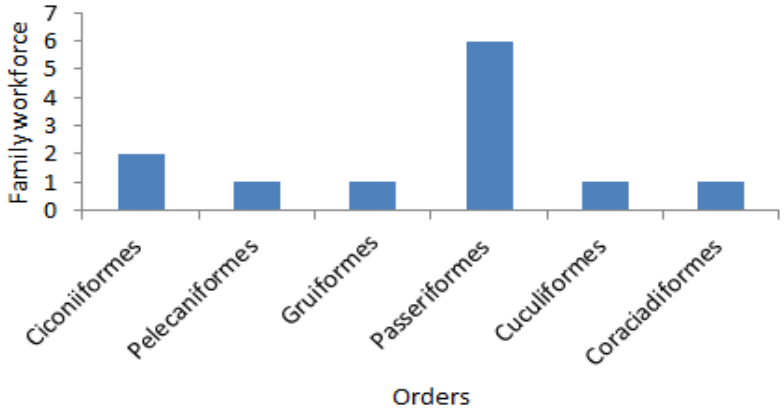

Fig 3:- Order's wealth in family

➢ *Richness's specific of the sites*

Figure 4 shows that the Chabatalima sampling site located in Birava is the richest in species compared to the other sites. It contains 21 species. The Kahumba site takes second place with 18 species followed by Bwalimu (15), Kashombe (14), Musimbo (13), Karhale (12) and Civumu with 7 species.

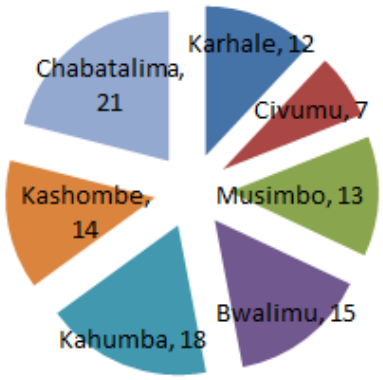

Fig 4:- Relative abundance of species according to the sampling sites

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➢ *Seasonal variation of species at the seven sites*

The seasonal species variation curve in Figure 5 shows that the number of species increased from May and peaked in June and decreased in July which is the last month spent in the field.

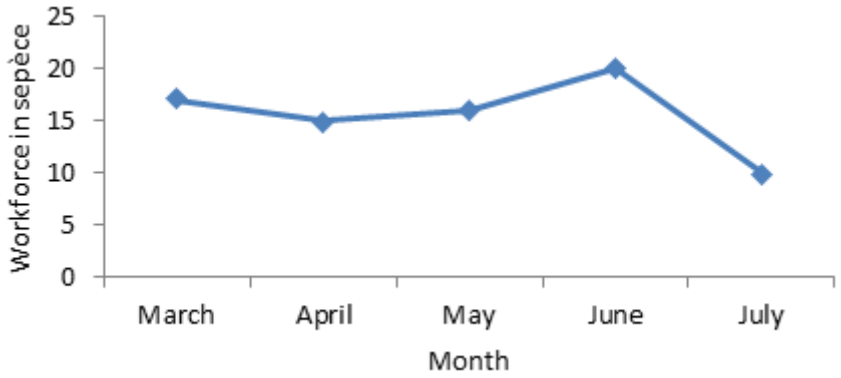

Fig 5:- Curve of variation of the species according to the months

➢ *Diversity's index of Shannon, Simpson and of Equitability*

This table 3 shows that the Bwalimu site is more diversified (H = 2.257 and D = 0.86). The Shannon and Simpson index have just confirmed this diversity with equitability (H ′ = 0.833).

The Quotient of similarity in bird species between the two environments (Ibindja and Birava) is 72% (a = 29; b = 21 and c = 18).

Index	Civumu	Musimbo	Bwalimu	Kahumba	Kashombe	Chabatalima	Karhale
Shannon_H	1,578	2,1	2,257	2,071	1,865	1,995	1,909
Simpson_1-D	0,758	0,8341	0,8661	0,8123	0,7805	0,7979	0,8060
Equitabilité-J	0,8107	0,8188	0,8335	0,7165	0,7067	0,6554	0,7681

Table 3:- Diversity's index of Shannon, Simpson and of Equitability

IV. DISCUSSION

The results of our investigations carried out at Lake Kivu in the Ishungu basin over a period from March 19 to July 28 show that, 32 species of birds have been inventoried grouped into 23 genuses, 12 families and 6 orders. In terms of the abundance of species; Ceryle rudis, Phalacrocorax carbo and Phalacrocorax africanus predominate with the proportions of 30.72%, 25.41% and 15.47% respectively. This abundance could be explained by the presence of fish in this environment which constitute their diet because these species are all piscivores. We therefore believe that these species have permanent food because the ichthyofauna of Lake Kivu is completely coastal (Snoeks, and al., 1987; 1994). This abundance was also reported in the Bukavu basin by Murhabale (2008) where the species Phalacrocorax carbo was the most abundant with 38.7% followed by the species Ceryle rudis with 11%.

In this study, the Passeriformes order is the richest in family, it includes half of the families obtained with 6 out of 12 distributed in the other orders. This could be true because Jacques Berlioz (1946; 1950), Upoki (2001), Murhabale (2008), show a consideration of the order Passeriformes of all avian orders because it contains more than half of all known species today in the world. In addition, the families of Ardeidae and Ploceidae are rich in genus and species, respectively 26.08% and 21.73% for the genuses; and for the species each of these two families contains 25%. This could also be due to the presence of their food (fish, aquatic insects, etc.).

This inventory shows that out of 32 species of birds identified, 17 species are aquatic and 15 others are not fully aquatic. The presence of these non-aquatic species in this environment could be justified by the presence of fields around where we grow sorghum (Sorghum vulgare) and corn (Zea mays), because some are granivores and others are insectivores. This is confirmed by Kizungu (1996).

Among the seven sampling sites visited, the Chabatalima site which is the richest in species, while Bwalimu is the most diverse (H = 2.257). This richness in Chabatalima could be justified by the fact that this site seems to be the least disturbed because there is still a cover of macrophytes serving as shelters and nesting places for birds. Consequently, the low numbers of birds found in certain sites would be due to the various disturbances which weigh on these sites such as the presence of fields, activities of the population, presence of Beach, etc. Let us also add that it is because of constructions on the 10 m of the banks which are also the cause of deforestation which disturbs the place of habitation of these birds in certain places.

By comparing the two study environments (Ibindja and Birava), we note that Ibindja has a higher number of species compared to Birava, that is 29 against 21 species. This could be explained by the fact that five sampling sites were targeted there because of the security that was there, compared to Birava with two sites where there was insecurity. The value of the 72% quotient shows that the similarity is more noticeable between the birds of Ibindja and Birava. This is explained by the fact that many species in these two environments stay in open environments only for nutritional purposes.

By observing the variation curve, we can clearly see that in June there was an increase in species as also found Murhabale (2008) in the Bukavu basin. But in the last month spent on the ground in July there was a decrease in species. This decrease in species in July could be explained by the closure of fishing during this period in the Ishungu basin, reason given by the fishermen who explained to us that many aquatic birds feed on fish caught in the gill net. by diving to unravel the fish caught in the net and the others feed on dying fish which float on the surface of the water after unravelling.

Our study made it possible to add 9 more aquatic birds species to the list of species inventoried in the Bukavu basin seen on Lake Kivu by Murhabale (2008), and 18 more species to the list of species also inventoried by Ngumbu (2004). But several other species (11) were inventoried by Murhabale (2008) and 25 species by Ngumbu (2004), were not identified during our research period. This may be due to the migratory movement of the birds, the season, the study environment, the methodology, the materials and the objectives.

According to Dirk C., and al. (1981), in Ngumbu (2004), shows that fish-eating birds, especially in Lake Kivu, are reduced in number due to the lack of suitable resting and feeding places. All of this could be true by the fact that out of 77 known bird families in eastern DR Congo (Pedersen, 2000), we found that 12 families in the Ishungu basin or 15.5%. Murhabale (2004) also found 13 families or 16% in the Bukavu basin, on Lake Kivu.

The absence of vernacular names for certain species highlights the little interest that the local population places in birds or simply their limited knowledge of avifauna.

V. CONCLUSION AND RECOMMENDATIONS

Our study on the systematic inventory of water birds was carried out in the Ishungu Basin on Lake Kivu at Ibindja and Birava at seven sampling sites over a period of five months. The main objective of this work is to contribute to the knowledge of the coastal biodiversity of Lake Kivu

This study made it possible to count, birds, distributed in 32 species, 23 genuses, 12 families and in 6 orders.

Our results generally show that Lake Kivu is poor in aquatic birds because it is a lake poor in fish. Léon Lippens (1938) pointed out that Lake Kivu is excessively poor in fish and aquatic birds, because aquatic birds are birds that depend on the aquatic environment for reproduction or for food (Guillet and Crowe, 1985; Coulter, 1991).

Taking into account these results, we make the following recommendations:

- State services (transport and communication, cadastre, environment, etc.) to comply with ordinance No. 64/560 which prohibits any construction of buildings for residential use within 10 m of the banks of rivers and lakes.
- To NGOs working on the conservation of ecosystems, to sensitize the local population in order to show them the importance of wetlands and to develop a project on the conservation of coastal macrophytes in all parts of Lake Kivu, because these macrophytes constitute a place of refuge, reproduction and food not only for aquatic birds but also for all aquatic animals.
- Scientists to make inquiries at the end of knowing the birds of Lake Kivu and preserving the littoral zone of Lake Kivu as well as the biodiversity it contains.
- It is up to the local population to respect the littoral zone of Lake Kivu.

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