E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(2): 381-386

www.fisheriesjournal.com
Received: 20-01-2018
Accepted: 23-02-2018

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Benthic invertebrates of natural ponds of Ruzizi plain, Democratic republic of the congo

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Abstract
This study provides information about benthic invertebrates collected in natural ponds of Ruzizi Congolese plain. Benthic invertebrates were collected using a hand scoop net of 1 mm of mesh, sieve or plastic container. 6360 invertebrates were captured in the four ponds belonging to 38 genera, 36 families and 15 orders. Insecta dominated in the collection of invertebrates with 7 orders. Genera of *Gyrinus* was abundantly caught (18.75%) followed by *Canthydrus* (16.51%) and *Melanoides* (11.98%). Benthic invertebrates were most found at a depth varying between 0.50 and 0.75 m and in the sites dominated by aquatic vegetation, detritus and mud.

Keywords: Benthic invertebrates, diversity, natural ponds, Ruzizi plain

1. Introduction
Stagnant water ecosystems offer a large diversity of aquatic invertebrates. Some live there permanently (worms, leeches, molluscs, etc.), others temporarily (larval stages of insects) [1].
Micha and Nolset (1982) [2] showed the interest of these benthic macroinvertebrates in determining the nutritional quality of the habitat. These macroinvertebrates are also biological indicators of water quality [3, 4]. In addition, they play an important role in the functioning of aquatic ecosystems. They intervene in the mineralization and recycling of organic matter on the one hand, and on the other hand, they are involved in food chains as first or second-rate consumers [5, 6, 7]. Many aquatic insect larvae are, in fact, an important source of food for most fish species [8]. In fact, trophic relations studies in lake Tchad conducted by Lauzanne (1976) [9] report that 45% of fish species depend primarily on benthic insects for their diet.
In the Democratic Republic of the Congo, despite its mega biodiversity in fauna and flora, quantitative studies of aquatic organisms, particularly invertebrates, are few [10]. In the Ruzizi plain, most studies on aquatic invertebrates have focused on intermediate host molluscs of schistosomiasis [11, 12, 13, 14, 15]. On the other hand, there is no any study which has been conducted on benthic invertebrates in general in the ponds of Ruzizi plain. While ponds offer a large diversity of animal and plant species [1, 16].
Note that the scientific knowledge on benthic invertebrates of natural ponds of Ruzizi valley remains unknown. However, they are subjected to different stresses such as pollution, destruction of their habitats, global warming, etc. [17].
This investigation aims to determine the diversity and abundance of benthic invertebrates which are collected in natural ponds of Ruzizi valley and their degree of similarity.

2. Materials and methods
2.1. Study area
The Ruzizi Congolese plain is located in territory of Uvira between 2.5°-3°24' S latitude and 28.5°-29° E longitude. It is limited to the North-west by high mountains of Kivu, in the East by the Ruzizi River and on the South side by lake Tanganyika. The altitude varies between 773 m and 1000 m [18].
Sampling was carried out at four natural ponds, including Nyangara, Mwaba, Kindava and Kindobwe. The aquatic vegetation that dominated is *Typha domingensis*, *Typha laticifolia*, *Eichhornia crassipes*, *Phragmites mauritianus*, *Myriophylum spp*, *Potamogeton spp*, *Cyperus papyrus*, *Ceratophyllum demersum*, *Nymphae lotus* and *Pistia stratiotes*.

Some anthropogenic activities were recorded in sampling sites, such as fishing, agriculture, livestock and exploitation of *Phragmites* and *Typha* by shaved cut.

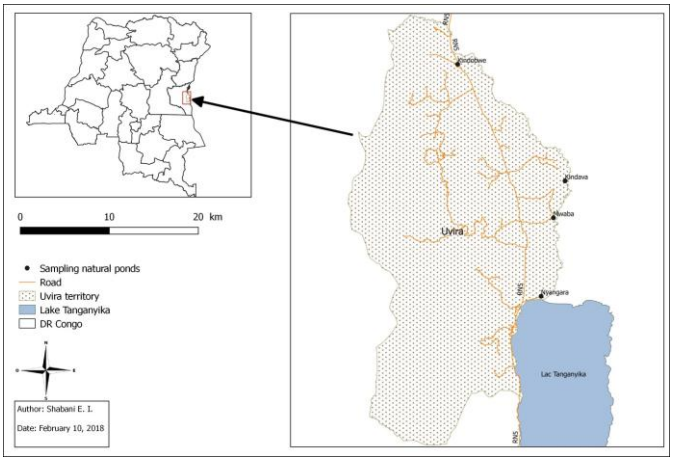

Fig 1: Map showing the sampling sites of investigation in the Ruzizi Congolese plain

2.2. Sampling procedure

Benthic invertebrate samples were collected on aquatic vegetation and the substrate type of the former was detritus, sand, mud and clay at different depths varying between 0 and 1 m using a hand scoop net of 1 mm of mesh, sieve or plastic container. Each pond was weekly visited from April to August 2017. The collected specimens were grouped according to the sites and dates of sampling and placed in labelled plastic containers filled with 70% ethanol, and then transported to Biology laboratory of Hydrobiological Research Centre (CRH) in Uvira for further processing.

2.3. Identification of macroinvertebrates

In the laboratory, the samples were washed with running water and counted. A binocular Magnifier (Nikon SMZ745 KL 1500 HAL Schott model) was used for observation and the taxonomic identification was initially determined based on individual morphology using the identification keys of of Tachet *et al*. (1980) [19], Levêque (1981) [20], OMS (1982) [21]; Brown (1994) [22]; Tachet *et al*. (2000) [5], Day and De Moor (2002) [23], De Moor and Day (2002) [24], De Moor *et al*. (2003a, b) [25, 26]; Day *et al*. (2003) [27]; Stals and De Moor (2007) [28]; Moisan (2010) [17]; Yapo *et al*. (2012) [29].

2.4. Data analysis

Statistical analyses were performed using ANOVA test in R software (version 3.4.3) to compare variables, as well as Jaccard similarity index was performed using PAST software [30] in order to compare the ponds on the basis presence / absence of benthic invertebrate families caught.

3. Results and Discussion

A total of 6360 invertebrates were captured in the four sampling ponds of Ruzizi plain belonging to 38 genera, 36 families and 15 orders. As shown in the Tables (1), genera of *Gyrinus* was abundantly caught (18.75%) followed by *Canthydrus* (16.51%) and *Melanoides* (11.98%). Note that 1.04% of all collected invertebrates were not identified to genus level due to lack of appropriate key during identification.

Table 1: Systematic broad outline and relative abundance of benthic invertebrates collected in Ruzizi plain

Order	Family	Genus	%
Prostigmata	Hydrachnidae	*Hydrachna*	1.89
Coleoptera	Belostomatidae	*Appasus*	1.90
	Noteridae	*Canthydrus*	16.51
	Dytyscidae	*Cybister*	1.19
	Elmidae	*Potamophilus*	0.47
	Gyrinidae	*Gyrinus*	18.75
	Hydrophilidae	*Amphiops*	2.96
	Hygrobiidae	Unknown	0.16
Decapoda	Atyidae	*Atya*	1.79
Diptera	Anthomyidae	Unknown	0.02
	Ceratopogonidae	*Ceratopogon*	0.02
	Chironomidae	*Chironomus*	6.26
	Culcidae	*Culex*	0.52
	Limoniidae	Unknown	0.02
	Stratiomyidae	*Stratiomyia*	0.17
	Tabanidae	Unknown	0.05
Ephemeroptera	Baetidae	*Baetis*	4.39
	Polymitarcyidae	Unknown	0.77
Architaenioglossa	Ampullariidae	*Pila*	0.94
Hygrophila	Lymnaeidae	*Lymnaea*	4.26
	Planorbidae	*Biomphalaria*	3.90
		Bulinus	9.80
Sorbeoconcha	Thiaridae	*Melanoides*	11.98
Hemiptera	Corixidae	*Corixa*	0.39
	Gerridae	*Gerris*	0.44
	Naucoridae	*Naucoris*	0.38
	Nepidae	*Ranatra*	0.19
		Nepa	0.17
	Notonectidae	*Notonecta*	3.57
Rhynchobdellida	Glossiphoniidae	*Glossiphonia*	0.25
Lepidoptera	Pyralidae	Unknown	0.02
Odonata	Aeshnidae	*Aeshna*	0.03
	Coenagrionidae	*Coenagrion*	3.07
	Libellulidae	*Libellula*	2.28
Tubificida	Tubificidae	*Tubifex*	0.25
Trichoptera	Limnephilidae	*Limnephilus*	0.02
	Philopotamidae	*Philopotamus*	0.20
Tricladida	Planairiidae	Unknown	0.02

Table 2: Presence (1) and absence (0) of invertebrate families in four sampling ponds

S. No	Family	Nyangara	Mwaba	Kindava	Kindobwe
1	Aeshnidae	0	1	0	1
2	Pilidae	1	0	1	0
3	Antromyidae	0	1	0	0
4	Atyidae	0	1	1	0
5	Baetidae	1	1	1	1
6	Belostomatidae	1	1	1	1
7	Ceratopogonidae	0	0	0	1
8	Chironomidae	1	0	1	1
9	Coenagrionidae	1	1	1	1
10	Corixidae	0	1	1	0

11	Culcidae	1	0	1	1
12	Dytiscidae	1	0	1	1
13	Elmidae	1	0	1	1
14	Gerridae	1	1	1	1
15	Glossipholidae	1	0	1	1
16	Gyrinidae	1	1	1	1
17	Hydrachnidae	1	0	1	1
18	Hydrophilidae	1	0	1	1
19	Hygrobiidae	1	0	0	1
20	Libellulinidae	1	1	1	1
21	Limnephilidae	1	0	0	0
22	Limoniidae	1	0	0	0
23	Lymnaeidae	1	1	1	1
24	Naucoridae	1	0	1	1
25	Nepidae	1	1	1	1
26	Noteridae	1	0	1	1
27	Notonectidae	1	0	0	1
28	Philopotamidae	0	0	1	0
29	Planairiidae	1	0	0	0
30	Planorbidae	1	1	1	1
31	Polymitarcyidae	0	0	1	1
32	Pyralidae	1	0	0	0
33	Stratiomyidae	1	1	0	0
34	Tabanidae	1	0	0	0
35	Thiaridae	1	1	1	1
36	Tubificidae	1	1	1	1

The table (2) shows that 29 families were collected in the Nyangara pond. While in the ponds of Kindava and Kindobwe, 25 families were captured in each one, and 16 families were identified in Mwaba. Note that 17.80% of invertebrates were only collected at the larval stage, included families of Aeshnidae, Antromyidae, Baetidae, Ceratopogonidae, Chironomidae, Coenagrionidae, Culcidae, Libellulinidae, Limnephilidae, Philopotamidae, Polymitarcyidae, Pyralidae, Stratiomyidae and Tabanidae.

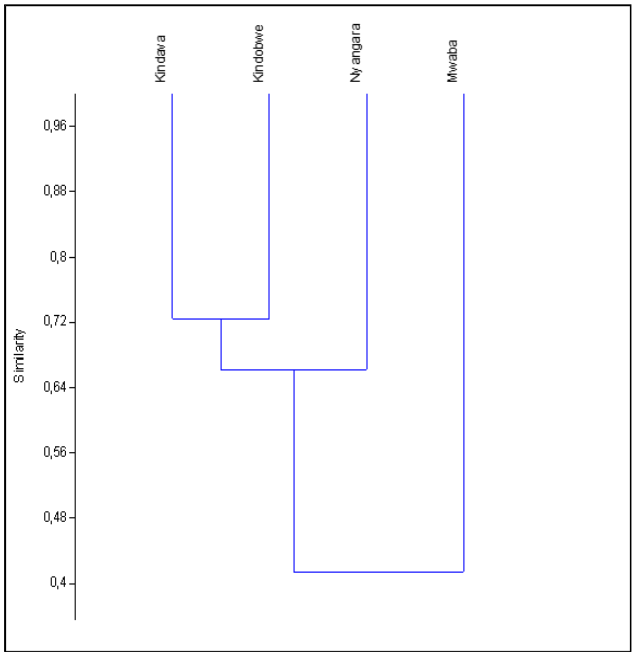

Fig 2: Jaccard similarity dendrogram

The Figure (2) indicates the information on the degree of similarity of families caught between ponds. It proves that the ponds of Kindava and Kindobwe are similar. However these 2 ponds indicate more affinity with Nyangara pond than Mwaba pond.

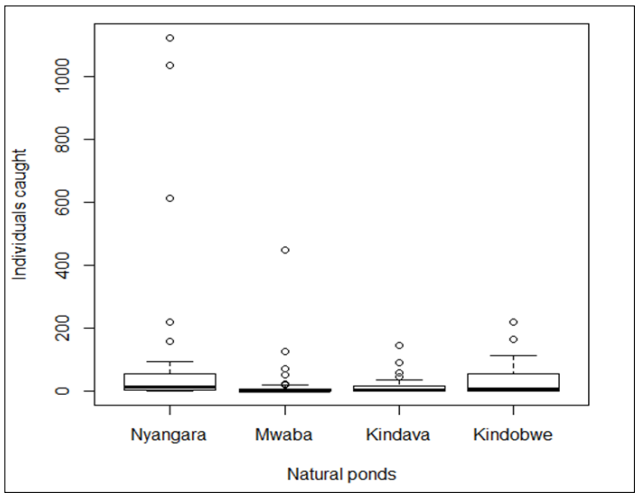

Fig 3: Comparison of mean values of total numbers of individuals of genera collected in the four natural ponds

This figure shows that three genera abundantly caught in Nyangara pond, inclunding *Gyrinus* (n= 1124), *Canthydrus* (n= 1038) and *Melanoides* (n= 614). Note that most invertebrates were collected in Nyangara pond with 59.14% followed by Kindobwe with 19.28%, Mwaba with 12.58% and Kindava with 9.01%. The mean values of these four natural ponds show a significant difference (p= 0.0311) in the total number of individuals collected. This could be attributed to the fact that Nyangara pond is dominated abundantly by aquatic vegetation namely *Typha domingensis*, *Typha laticifolia*, *Eichhornia crassipes*, *Phragmites mauritianus*, *Myriophylum spp* and *Potamogeton spp*.

Lévêque (1967) [31]; Lévêque and Durand (1980) [32]; Gryseels (1985) [33]; Dillon (2000) [34]; Thiam and Diallo (2010) [35]; Hyangya (2012) [36]; Alhou *et al*. (2014) [37]; Shabani (2015) [15]; Shabani *et al*. (2016) [38] noted to this effect that the sampling of invertebrates is related to the abundance of aquatic vegetation in stagnant waters and the density of its root system which can be a suitable habitat for these aquatic animals.

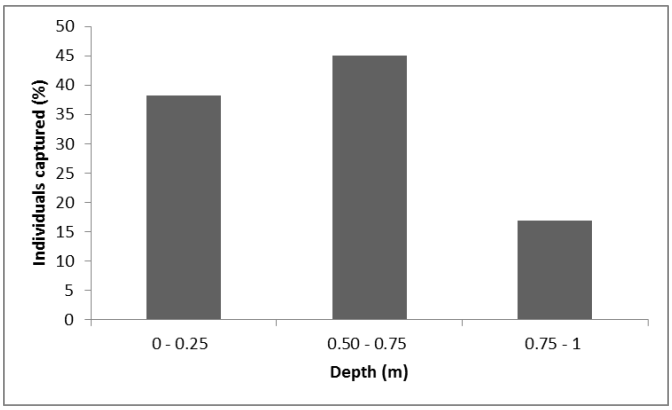

Fig 4: Sampling of invertebrates according to depths

The Figure (4) reports that invertebrates were sampled at different depths. About 45% of them were collected at a depth varies between 0.50 and 0.75 m. The families of Hygrobiidae, Limnephilidae and Planariidae were not found at a depth of 0 to 0.25 m. While the families of Aeshnidae, Antromyidae, Limoniidae, Philopotamidae, Pyralidae, Pyralidae, Stratiomyidae, Tabanidae were only reported at a depth of 0.50 to 0.75 m, and Ceratopogonidae was only identified at a depth of 0.75-1 m. It was observed that at a depth of 0.50-0.75 m, the substrates are characterized at 80% by aquatic vegetation, detritus and mud.

The class of Insecta dominated in the population of invertebrates of Ruzizi plain with 7 orders, included Coleoptera, Diptera, Ephemeroptera, Hemiptera, Lepidoptera, Odonata and Trichoptera. These results are similar to these found by Kankonda (2001) [39]; Juakaly (2002) [40]; Amisi and Juakaly (2011) [41]; Tambwe *et al*. (2011) [3] in tropical rainforest; Shabani *et al*. (2016) [38] in Mambasa region.

Checklist of freshwater snails recorded in Ruzizi plain by Gryseels (1985) [33], Muhigwa *et al*. (2011) [14], Shabani (2015) [15] reported also the presence of *Pila*, *Lymnaea*, *Biomphalaria*, *Bulinus* and *Melanoides*.

Gryseels (1985) [33], Baluku (1990) [12], Shabani (2015) [15] concluded that *Biomphalaria* is present in all types of freshwater biotope except in the Rivers and sole intermediate host of *Schistosoma mansoni* in Ruzizi valley. Ntonifor and Ajayi (2007) [42], Sarr *et al*. (2011) [43], Stauffer and Madsen (2012) [44] noted that *Biomphalaria pfeifferi*, main intermediate host of *Schistosoma mansoni* in tropical Africa.

The presence of invasive genus in our collecting ponds was indeed affect local molluscan fauna. This is the case of *Melanoides tuberculate* who is a very effective competitor of some medical interest [45, 46].

The presence of Odonata in aquatic environments is justified by the fact that they are predatory insects that are indissolubly related to wetlands and can therefore be considered good biological controls. Barbarin and Teynié (2009) [47] indicated that it is a group generally associated to slow-current Rivers and canals, ponds and marshes.

4. Conclusion

This study clearly shows that benthic invertebrates recorded from four natural ponds in Ruzizi Congolese plain (Nyangara, Mwaba, Kindava and Kindobwe) revealed Insecta dominated in the population of invertebrates with 7 orders, and genera of *Gyrinus* and *Canthydrus* are found as the highest abundant with 18.75% and 16.51% respectively. Nyangara is a natural pond with most diversity of benthic macroinvertebrates, there is a significant difference (p= 0.0311) in the total number of individuals collected in these four ponds. These findings might suggest a need for conservation and management to be targeted in the stagnant freshwater ecosystems of Ruzizi Congolese valley.

5. Acknowledgement

The authors thank the staff members of Hydrobiological Research Centre (CRH) in Uvira for their advices. Our thankful feelings are also addressed to the Department of Biology for the realization of this work.

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